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**Technological ambivalence in Urban Dashboards and their
digital governance**

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"People say 'It's as plain as the nose on your face.' But how much of the nose on your face can you see, unless someone holds a mirror up to you?"

"You can prove anything you want by coldly logical reason--if you pick the proper postulates."

Isaac Asimov

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Abstract

Dashboards, ubiquitous in today's digital landscape, serve as versatile tools facilitating diverse interactions with data across various sectors and individuals, from scientists to managers to everyday consumers. These visual displays enable the aggregation, analysis, and visualization of multifarious data streams, making them indispensable in the arsenal of any ambitious smart city or organization. However, amidst their proliferation and utility, it is crucial to recognize the nuanced social construction and historical context of these technologies. While they represent aspirations and desires for efficient data management, they also embody potential pitfalls and unintended consequences, such as privacy breaches, surveillance concerns, and the potential for biased or discriminatory outcomes. The technological ambivalence surrounding these tools invites scrutiny; their intended purposes may diverge from actual usage, raising ethical questions. In essence, while dashboards offer promising avenues for data-driven decision-making, their multifaceted nature warrants critical examination to navigate the intricacies of their implementation and impact. Focusing on urban dashboards specifically, this dissertation shows that these tools are imbued with technological ambivalence, serving as more than neutral mediums of information. Their design and implementation inherently reflect and shape power dynamics, social values, and political agendas. Drawing upon affordance theory, the dissertation argues that the specific features of dashboards create unique "affordances" or action possibilities, capable of both empowering and constraining users. Furthermore, urban dashboards transcend mere data presentation; they become "matters of concern" by raising ethical dilemmas and prompting consideration of broader social implications. Therefore, robust digital governance is essential to ensure responsible data use, transparency, and accountability. However, most existing urban dashboards are lacking when it comes to digital governance principles. To make this case, this dissertation is based on desk research of 10 existing urban dashboards and the ways in which digital governance principles are applied in each case.

Key Words: Urban dashboards, Technological ambivalence, Digital governance, Affordance Theory, Matters of Concern, Big Data

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Introduction

0.1 Urban dashboards

In the realm of urban planning, the integration of digital technologies has ushered in an era of unprecedented possibilities and complexities. From the advent of urban dashboards to the principles of digital governance, the landscape of city management is undergoing a profound transformation. At the heart of this transformation lies a fundamental ambivalence—an interplay between empowerment and control, efficiency and surveillance, innovation and unequal social impact. This ambivalence, resonant with themes explored in science fiction movies like Terminator or I, Robot, underscores a critical question: who controls whom in the age of digital technology?

The creation and implementation of dashboards reveal significant ambivalence inherent in urban governance. This ambivalence is both intentional and unintentional, stemming from multiple sources. On the one hand, dashboards are intended to provide clear, actionable insights by presenting urban data in a visually engaging and accessible manner. Yet, the process of building these dashboards is fraught with challenges, such as the lack of available, updated, and clean

data, and the internal barriers within government agencies that restrict data sharing and integration. These issues are compounded by the fact that prototypes, even when populated with fake data, can still significantly influence stakeholders' perceptions, leading to confusion and misinterpretation. Additionally, the political dynamics within organizations, including changes in leadership and varying priorities, further stall progress, leaving dashboards in a state of limbo. On the other hand, dashboards have a longer history in relation to the policing and control of urban space, a history often marked by racism and other forms of spatial inequality. This highlights a critical tension: while dashboards symbolize the promise of data-driven governance and inclusive smart city initiatives, their practical realization often falls short, revealing the complexities and contingencies of technological integration in bureaucratic settings (Sadowski, 2024).

The capacity to exploit causal knowledge extracted from big data can lead to the manipulation of individuals and groups for political or commercial gain. Furthermore, constant data collection erodes privacy and

autonomy, potentially hindering the ability to act freely without being nudged and influenced. This concentration of power in the hands of those who control data flows presents a significant societal risk. The traditional privacy debate focused on personalized data misses a crucial point. The real danger lies in the ability to categorize individuals and predict their behavior based on group affiliation, facilitating manipulation and control without necessarily violating traditional privacy notions (Pietsch, 2013).

0.2 Why are urban dashboards important?

The increasing adoption and experimentation with urban dashboards by cities worldwide suggest a growing trend towards their utilization in addressing urban challenges (Yap & Biljecki, 2023). While urban dashboards are not a new concept and have been extensively discussed in existing literature, their continued integration into urban planning practices underscores their perceived value as a tool for managing and monitoring complex urban systems (DeLoyde & Donald, 2024). Beyond their functional aspects, dashboards harbor political implications through their

operationalization, influencing perceptions, controlling information flows, and potentially reinforcing existing power dynamics. Tracing the historical evolution of dashboards from rudimentary data displays to complex interactive formats underscores how these formats accumulate meanings over time, embedding cultural, social, and political implications within their design and usage. By mediating human interaction with data, dashboards shape not just what is perceived but also how it is perceived within the realms of cognition and media theory (Mattern, 2015). Thus, dashboards emerge as pivotal interfaces shaping knowledge, decision-making practices, and societal dynamics in contemporary digital environments (Tkacz, 2022).

0.3 Research question

The primary research question that led this study was the following: given the inherent technological ambivalence of urban dashboards, and the risks associated with them, what kinds of digital governance mechanisms have been deployed to ensure ethical practices in urban management – if at all?

To find an answer to the research question, this dissertation employs a qualitative research

methodology to explore the ambivalence of urban dashboards and the ways in which existing different cities have adopted digital governance principles to reduce the risks associated with ambivalent uses of urban data.

0.4 Conceptual framework and methodology

The epistemic framework of this dissertation draws upon two key theoretical lenses: Affordance Theory and Matters of Concern Theory, each contributing to a critical analysis of the ambivalence in urban dashboards' function as socio-technical tools.

Affordance Theory

Affordance Theory, originally developed by James J. Gibson and further expanded in the context of technology studies, provides a framework for analyzing the interaction between users and technological objects. In this research, it is used to examine how the specific design features of urban dashboards offer users particular "affordances," or action possibilities, which may both empower and limit governance practices. By focusing on the affordances of dashboards, this analysis reveals the practical ways in which these tools shape decision-

making, data transparency, and public engagement in urban governance. Rather than charting the multiple affordances of each dashboard, this work traces how affordances – especially in the form of unintended uses and consequences of urban data dashboards – are dealt with through the existing principles of digital governance, the framework that guides ethical adoption and regulation of digital technology.

Matters of Concern Theory

Latour's **Matters of Concern** theory offers a complementary perspective by highlighting the complex, contested nature of urban dashboards as socio-technical artifacts. Rather than viewing dashboards as neutral tools, this theory treats them as arenas where diverse actors, interests, and values intersect and compete. According to Latour (2014), "matters of fact" become "matters of concern" when we recognize that technologies are embedded in social, political, and ethical contexts. He asserts that traditional scientific approaches often prioritize matters of fact—immutable and objective truths—while neglecting the dynamic and relational aspects of reality that constitute matters of concern (Latour, 2014). This perspective is particularly

valuable for understanding the ambivalence of urban dashboards, as it shifts attention from what the dashboards are supposed to do (i.e., visualize urban phenomena through data) to how they are actually designed and interpreted in practice. By exploring the diverse concerns that urban dashboards raise—including issues of privacy, surveillance, and the concentration of power—this thesis will uncover the ethical dilemmas and potential risks associated with their use in digital governance.

Methodology

This research follows a **comparative approach** (Galès & Robinson, 2023), using multiple cases of urban dashboards deployed in smart city initiatives across different global urban centers. Empirically, the research combines **document analysis**, and **dashboard interface analysis** to understand the affordances and ethical considerations linked to urban dashboard use. Comparative approaches are a vital methodological framework in urban studies that enhances understanding of the complexities of urbanization by analyzing and contrasting different urban contexts and processes. It fosters theoretical innovation and provides insights into the diverse experiences of

cities around the world (Galès & Robinson, 2023).

Comparative approaches can be very diverse: they can entail systematic analyses of comparable contexts, or simply hold side by side different urban experiences, tracing patterns, variations and unique responses to urban phenomena (Robinson, 2022). Ultimately, the comparative approach not only enhances empirical analysis but also contributes to the evolution of urban theories by applying existing concepts to new contexts, facilitating a deeper engagement with the complexities of global urbanization (Galès & Robinson, 2023).

Case Studies Selection

The selection of case studies aimed to achieve a balance between widely recognized, extensively researched dashboards and those offering unique functionalities or addressing specific urban challenges. This approach ensured the inclusion of diverse tools representing a range of geographical contexts and functional areas, including public health, transportation, and law enforcement. By considering the availability of documentation and public accessibility, the selection process facilitated a comprehensive analysis of the features, functionalities, and

underlying governance mechanisms of each dashboard.

Special attention was given to dashboards that, while not exclusively designed for urban management, have significant implications for urban decision-making. In particular, those used in fields such as law enforcement were included to explore their potential for both enhancing public safety and raising ethical concerns, such as surveillance and profiling, which can influence broader urban governance practices. This balanced selection enabled a robust comparative analysis across different governance contexts, technological affordances, and societal impacts, providing valuable insights into the ambivalence of urban dashboards as tools for digital governance.

Comparison

The comparison was structured around a two-part framework. First, the dashboards' **stated aims and functionalities** (Matters of Concern) were examined to reflect their intended purposes and contributions. Second, their **potential affordances** were analyzed, focusing on unintended consequences and systemic risks through the lens of five key governance dimensions: Privacy, Transparency

and Data Collection, Stakeholder Collaboration, Citizen Engagement, and Accountability. This approach ensured that the comparative analysis highlighted both the aspirational and problematic aspects of urban dashboards, facilitating a nuanced understanding of their role across diverse urban contexts.

Analytical Strategy

The analysis integrates these two theoretical perspectives to examine the **ambivalent role** of urban dashboards. First, the **affordances** of dashboards are analyzed to understand the specific ways they enable or constrain urban governance, focusing on how they shape decision-making and transparency. Second, the research critically engages with the **matters of concern** raised by various stakeholders, investigating how these dashboards become sites of ethical contention, where the ideal of enhanced governance may clash with concerns over power abuse, surveillance, and inequality. This dual analytical strategy enables an exploration of the central research question, this thesis aims to provide an understanding of the socio-technical and ethical dimensions of urban dashboard deployment in smart city programs.

In practice, I developed a table based on two complementary dimensions of analysis:

Matters of Concern: This dimension reflects the stated ideas and functionalities of the dashboards, showcasing their intended goals and aspirations, such as promoting transparency, enhancing citizen engagement, and enabling data-driven decision-making.

Affordances: This dimension examines the potential unintended consequences, misuse, and power abuse associated with each dashboard. The analysis was conducted using the five key dimensions of digital governance—Privacy, Transparency and Data Collection, Stakeholder Collaboration, Citizen Engagement, and Accountability. Each dashboard was assessed against these criteria to uncover patterns, risks, and systemic vulnerabilities.

0.5 Contributions

The main argument of this dissertation is

Urban dashboards are not neutral tools of governance. Their design and implementation reflect and shape power dynamics, social values, and political agendas. They are more than just mediums of information; they actively shape

knowledge, decision-making practices, and societal dynamics.

The main findings of this dissertation can be summarized as follows:

- ✓ Transparency and Accessibility: Dashboards can increase transparency and accessibility of information, but may also be used for surveillance or to manipulate data.
- ✓ Citizen Engagement: Dashboards can promote citizen engagement, but may also lead to superficial engagement or tokenism.
- ✓ Data-Driven Governance: Dashboards can facilitate data-driven decision-making, but may also reinforce existing power structures and biases.
- ✓ Ethical Considerations: Dashboards raise ethical concerns about privacy, surveillance, and the potential for misuse.
- ✓ Systemic Risks: Dashboards can perpetuate systemic inequities and undermine trust in governance.

In doing so, my contribution addresses the ambivalence of urban dashboards by highlighting the need for robust digital governance mechanisms that mitigate risks while leveraging their transformative potential.

The research advances theoretical understanding by integrating affordance theory with matters of concern and offers practical strategies to align dashboard design with principles of inclusivity, transparency, and accountability.

Ultimately, even though most of the dashboards analyzed in this work show weak mechanisms of digital governance at play, policy alignment remains fundamental to ensure dashboards comply with legal and ethical frameworks. Technological safeguards are necessary to protect privacy and ensure accountability, and they can only be achieved through collaborative governance and citizen participation.

Chapter 1: What are Digital Dashboards and Why they Matter

1.1. A short history of Urban Dashboards

Urban dashboards are one of the latest incarnations of data dashboards in general. These visualization systems have evolved significantly over time, reflecting changes in technology, urban management, and governance. Initially, dashboards in automobiles and airplanes provided critical operational information to drivers and pilots, respectively. By the mid-1950s, these dashboards began simplifying complex data into binary signals, making them more user-friendly. This trend toward simplification continued with the introduction of the "Maintenance Required" light, which condensed numerous measurements into a single alert (Mattern, 2015).



Figure 1 Concept of Urban Dashboard

The control room, as an immersive dashboard, further illustrates the evolution of dashboards. The Control Room of No. 11 Group of the RAF Fighter Command during the Battle of Britain in 1940 is a notable example. It featured a vast array of displays and communication systems, allowing controllers to manage operations in real-time. This environment of mosaic displays, switchboards, and dashboards became a template for other military and governmental control rooms, such as Churchill's War Rooms and later mission control rooms in the Space Age (Mattern, 2015).



Figure 2 Churchill's War Rooms (Visiting the Churchill War Rooms in London, 2020)

Project Cybersyn in early 1970s Chile represents a significant advancement in the use of dashboards for governance. Designed as a cybernetics-informed decision-support system for managing the nation's economy, Cybersyn's

hexagonal Opsroom featured multiple datafeed screens, algedonic alerts, and interactive displays. Despite its futuristic appearance, maintaining this high-tech illusion required substantial human labor. The project

highlighted the importance of ergonomics, human-computer interaction, and data visualization in control room design (Medina, 2006).



Figure 3 Project Cybersyn in early 1970s Chile (Merchant, 2023)

Urban dashboards today embody a complex intersection of technology, governance, and ideology. They represent an epistemological and methodological pastiche, defining what variables are important and how they are measured and displayed (Mattern, 2015). This selective representation can normalize certain civic epistemologies, influencing public

administration and performance metrics. However, these dashboards often decontextualize and sanitize data, limiting users' understanding of the underlying processes and politics (Mattern, 2015).

Urban indicators are, however, vital tools in city governance, playing a crucial role in various

applications that enhance the management and development of urban areas. These indicators provide essential data that inform policy decisions, allowing city authorities to make evidence-based choices that address specific needs and challenges. They are also instrumental in performance tracking, as cities use them to monitor the effectiveness of services and programs, ensuring that objectives are met and resources are efficiently utilized. By making this data available to the public, governments can foster transparency and accountability, which are key to building trust and engagement with citizens. Strategic planning processes are heavily guided by these indicators, enabling cities to set measurable goals and track progress over time. Public engagement is further enhanced through the use of interactive dashboards and data visualizations that make complex information more accessible, encouraging citizen participation in governance. Additionally, urban indicators assist in resource allocation by highlighting areas that require improvement, ensuring that investments are directed where they are most needed. They are also essential for policy evaluation, providing tools to assess the impact

of various initiatives and allowing for adjustments based on empirical evidence. Collaboration among city departments and stakeholders is facilitated by the use of a common framework provided by these indicators, which promotes a unified approach to addressing urban issues. Many cities also align their indicators with sustainability objectives, integrating environmental and social metrics to promote long-term health and resilience. In times of crisis, real-time indicators become particularly valuable, offering immediate insights that aid in assessing situations and coordinating effective responses. Overall, urban indicators are indispensable in supporting informed decision-making, strategic planning, and sustainable development in city governance (Kitchin et al., 2015a).

Despite their promises, however, Kitchin (2014) argues that urban dashboards are not neutral tools but are imbued with power dynamics, politics, and ideologies. Urban dashboards are part of a broader movement towards "smart cities," where data-driven decision-making is prioritized (Kitchin, 2014). This shift is often framed as a way to enhance efficiency and innovation in urban

governance. However, while dashboards can make data more accessible, they can also obscure the complexities and biases inherent in data collection and interpretation processes (Kitchin, 2015). This opacity can lead to a lack of accountability and a potential misuse of data to reinforce existing power structures. Moreover, data dashboards are also aligned with the increasing influence of technocratic governance, where decision-making is driven by technical expertise and data analysis rather than

public participation and deliberation. While this approach can bring efficiency and objectivity to urban planning, it also risks disenfranchising citizens and neglecting the social and political dimensions of urban issues. Urban dashboards, with their emphasis on data visualization and performance indicators, can reinforce this technocratic trend by prioritizing quantitative metrics over qualitative insights and community input (Barns, 2016)



Figure 4 Urban Dashboards data visualization

The design and use of urban dashboards also shape the agency and subjectivity of their users.

These tools not only define user roles but also influence how users conceive of and interact

with their urban environments. For government officials, dashboards facilitate data-driven decision-making, allowing for macro, longitudinal views of city operations. However, this can lead to the fetishization of data and the potential for analytical errors and logical fallacies (Mattern, 2015). Additionally, Kitchin (2016) also points out the potential for urban dashboards to contribute to surveillance and control. By constantly monitoring and analyzing urban activities, these tools can enable more granular control over populations. This surveillance aspect raises significant privacy concerns and the risk of data being used to exert power and control over citizens (Kitchin, 2016a).

In the end, the history of urban dashboards reflects a complex interplay of technology, governance, and ideology. While these tools offer significant potential for enhancing urban management and governance, they also pose substantial risks and ethical challenges.

1.2. Digital Dashboards and Urban Management

Digital dashboards have emerged as pivotal tools in urban management, offering real-time

insights into a city's operational and infrastructural metrics. Initially developed to address the need for integrated data systems, these dashboards now serve as interactive platforms that streamline urban management by consolidating diverse data sources into a single, user-friendly interface. This integration supports various functions, including real-time monitoring of traffic, environmental conditions, and public services, thereby enhancing decision-making and operational efficiency. The benefits of digital dashboards are manifold: they facilitate improved decision-making by providing comprehensive data views, increase operational efficiency by identifying and addressing inefficiencies, and foster citizen engagement by making data accessible to the public (Crawford, 2021).

However, their implementation is not without challenges. One key obstacle is the integration and quality of data from various city systems, as inconsistencies can hinder effective decision-making. Furthermore, robust technical infrastructure, including reliable internet connectivity and computing resources, is crucial for successful deployment. Ensuring user training and adoption through

comprehensive education on data interpretation and tool utilization is equally important. It is also essential to address concerns surrounding data privacy and security that arise from the collection and visualization of urban information. Moreover, fostering interdepartmental collaboration is often necessary to maximize the effectiveness of these dashboards. Another challenge lies in the cost and resource allocation required for development, maintenance, and ongoing support. Finally, it's crucial to avoid overreliance on technology and remember the value of qualitative insights and community input in the decision-making process (Barns et al., 2017). Ensuring data quality and security is crucial, as inaccurate or compromised information can lead to flawed decision-making and erode public trust. The complexity of designing user-friendly dashboards also poses challenges. Effective governance and policy frameworks are vital to address these risks, guiding the ethical use of data and ensuring accountability. Thus, while digital dashboards hold significant promise for enhancing urban management, their success depends on

navigating these challenges within a robust governance structure (Crawford, 2021).

1.3. Urban Dashboards and Digital Governance

Digital governance provides a framework for organizations to manage their digital presence effectively and ethically. It entails establishing clear accountability for digital strategy, policy, and standards, defining roles and responsibilities for oversight, and establishing rules of engagement for digital activities. This framework facilitates analysis, collaboration, and distribution of the complex tasks associated with governing digital resources, while prioritizing stakeholder needs and user experience. Ultimately, digital governance aims to bring order and structure to the digital landscape of an organization, ensuring consistent, effective, and user-centered online engagement (Andrews, 2017). Automating various governance functions, enables efficient and scalable management of digital platforms and communities, addressing challenges such as trust, accountability, and resource allocation that are amplified in the digital realm (Hanisch et al., 2023). The convergence of digital governance and urban dashboards highlights

their intersection at the nexus of data, technology, and governance. Digital governance provides the essential foundation for the effective and ethical use of urban dashboards in cities. It establishes the framework of rules, processes, and structures that guide how a city collects, uses, shares, and protects data, ensuring transparency, accountability, and citizen participation in the process. By visualizing and analyzing complex urban data, dashboards inform governance strategies, enhance decision-making, and foster public participation. However, the true power of urban dashboards is only realized when they are embedded within a robust digital governance system that prioritizes data quality, privacy, security, and accessibility.

The emergence of data-driven algorithmic governance in urban settings is reshaping the relationship between municipalities and their citizens. By adopting business-like practices, governments are leveraging new data streams to monitor performance, regulate infrastructure, and enhance operational efficiency. However, as Barns (2020) points out, the rise of platform urbanism has introduced new complexities in the use of big data for urban governance. Digital

platforms, acting as intermediaries in various urban exchanges, have established conditions for data access and use that pose challenges to traditional urban governance models. These platforms, while offering potential benefits like improved urban planning and sustainability initiatives, also raise concerns about data ownership, privacy, and the potential for unevenly shared urban intelligence. This shift towards platform-based data governance necessitates a critical examination of how these platforms shape urban data ecosystems and influence the future of data-driven urban development (Barns, 2020). For example, the use of algorithms, particularly in applications like predictive policing, raises concerns about surveillance, privacy, and civil liberties. As data-driven governance becomes increasingly prevalent, understanding the relationship between digital governance and urban governance is essential (Kitchin, 2023).

1.4. Policy frameworks in digital governance

Policy frameworks in digital governance are essential for governments to effectively leverage technology for the benefit of their citizens. These frameworks provide a structured

approach by aligning digital strategies with national priorities, ensuring regulatory coherence across sectors, and promoting stakeholder engagement. By emphasizing capacity building, governments can equip their institutions with the necessary skills and resources to implement digital initiatives effectively. Robust legal and regulatory frameworks address critical issues such as data privacy and cybersecurity, while a continuous improvement cycle allows for adaptation to evolving needs and technological advancements. A holistic approach, considering all dimensions of digital transformation, is crucial for creating mature, digitally enabled states (*The E-Leaders Handbook on the Governance of Digital Government*, 2021).

Policy frameworks in governing digital innovation activities have evolved significantly, focusing on constructive policies to maximize positive impacts. Digital transformation has reshaped how innovation activities are governed, prompting the development of frameworks that address policy needs, orientations, and dimensions crucial for sustainable digital innovation. These frameworks play a vital role by providing

guidelines and structure to manage the complexities brought by digital transformation, improving governance structures, fostering knowledge creation, and ensuring data security (Xu et al., 2023).

International organizations like the UN and OECD provide overarching frameworks promoting digital inclusion, ethical AI, and data privacy (Hustinx, 2021). Regional bodies such as the EU and AU tailor these principles to their specific contexts, focusing on issues like data protection and digital infrastructure development (Inverardi, 2019). National governments, in turn, adapt these international and regional frameworks to their unique contexts (Paragi, 2021).

1.5. Global Challenges Addressed in the Role of Governance in Digital Technology

The role of governance in digital technology addresses global challenges through several key implications and recommendations. Digital transformation is portrayed as inherently political, involving various interests and power dynamics critical to realizing its developmental potential. This necessitates a politically

informed approach to navigate the non-neutrality of digital technologies effectively. The introduction of new actors in governance challenges traditional state authority in providing public goods, highlighting the need for adaptive governance structures (Schoemaker, 2024).

The governance gap in digital technologies underscores the importance of effective governance to mitigate risks and maximize developmental benefits. While digital technologies offer opportunities to enhance governance and service delivery, their inherent non-neutrality introduces new risks that must be managed. Recommendations include adopting politically informed approaches to digital transformation, bridging the governance gap, and investing in digital public infrastructure to strengthen the public sphere (Schoemaker, 2024).

Amidst global polycrises encompassing environmental, economic, and social challenges, technological governance faces significant hurdles. Multilateral approaches are evolving to address these complexities, emphasizing governance practices that deliver

public value and foster trust in technology and data usage. Initiatives such as the DPI Safeguards Initiative, the High-Level Advisory Board on AI, and the Global Digital Compact are emerging to enhance global governance frameworks (Schoemaker, 2024).

Chapter 2: Understanding Technological Ambivalence

2.1. Ambivalence

Public perception of technology is often polarized, oscillating between utopian optimism and dystopian fear. On the one hand, technology is hailed as a panacea, promising to enhance human life, eradicate global challenges, foster equality, and expand human potential. Visions of artificial intelligence curing diseases or creating a world without suffering epitomize this optimistic outlook. Conversely, technology is frequently cast as a villain, capable of dehumanization, exacerbating inequality, infringing upon privacy, and harming the environment. The specter of unchecked artificial intelligence dominating humanity exemplifies this pessimistic perspective. In reality, the impact of technology is far more nuanced, encompassing a complex interplay of both beneficial and detrimental outcomes (J. Davis, 2012).

From its initial conceptualization by psychiatrist Eugen Bleuler (1911) as the simultaneous holding of conflicting thoughts and feelings, ambivalence has evolved into a complex interplay of emotions and attitudes, particularly evident in our contemporary relationship with technology. The amassing of

massive datasets, coupled with sophisticated algorithms, has given rise to a new form of "social physics." This emerging field leverages the intricate mechanics of human behavior, gleaned from our digital footprints, to predict and potentially control individual and collective actions. While this knowledge could offer significant benefits, it also presents a profound ethical challenge. The potential for manipulation and exploitation by those who control these datasets is a growing concern, highlighting the urgent need for democratic oversight and regulation (Pietsch, 2013). This rapid advancement of digitization and artificial intelligence, as underscored by the Federation of German Scientists (VDW) in 2019, necessitates a public discourse on the implications of such technology. The organization argued that the far-reaching implications of these technologies necessitate a comprehensive and inclusive examination. Key concerns include the potential misuse of vast datasets, the transformative impact on society, and the ethical challenges posed by these advancements. Moreover, the VDW emphasized the importance of public awareness regarding the potential risks associated with

new technologies, drawing parallels to historical misuses (Graßl et al., 2022). In other words, we are surrounded by conversations about the ambivalence of technology, even when this is not explicit.

Philosopher of technology Andrew Feenberg (1990) argues that technology is not inherently good or bad but rather shaped by political and social forces. He emphasizes that technological design is relative to political forces influenced by social interests. Technology's impact is determined by the societal context in which it is used. He critiques the prevailing treatment of technology in communist and socialist societies as a sociopolitical invariant, advocating instead

for a democratic technical politics that considers the societal implications of technological advancements.

Further, Feenberg (1990) suggests that technology is intertwined with social struggles, shaping and being shaped by them. By understanding technology through this critical lens, it becomes possible to address issues of control, power distribution, and societal impact in a more nuanced manner. His call for a critical theory of technology signifies a need to go beyond viewing technology as a neutral tool and to consider its implications and power dynamics.

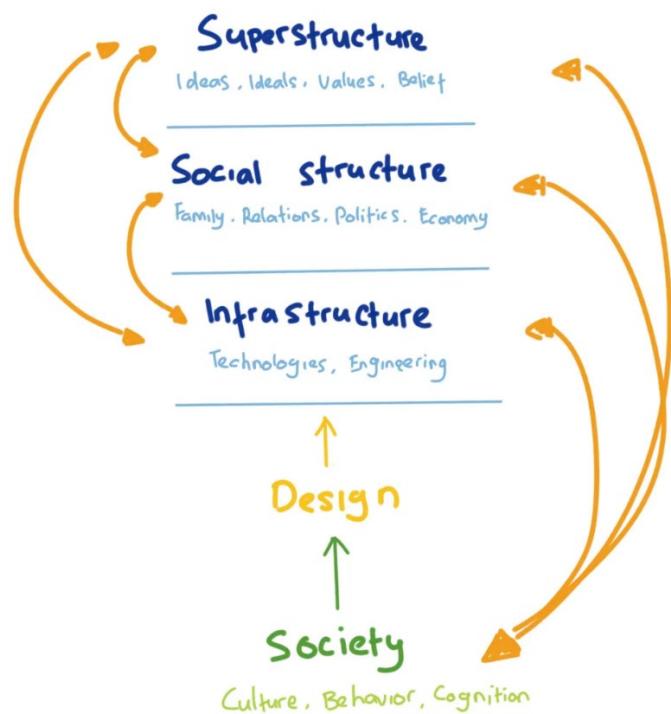


Figure 5 The impact of technology on society and vice versa (Wesch, 2018)

Ambivalence in technology is a recurring theme in contemporary discourse, reflecting the dual nature of technological advancements. Technologies often embody conflicting potentials: they can empower individuals and communities while simultaneously introducing new forms of control and surveillance. This ambivalence is evident in debates surrounding urban governance, where technologies such as data dashboards can enhance urban planning efficiency and raise concerns about privacy and data security. The tension between these dual roles highlights the complex interplay between technological innovation and societal values, underscoring the need for critical examination and ethical considerations in the deployment of technology in governance frameworks. Understanding and navigating this ambivalence is crucial for policymakers and scholars alike as they grapple with the implications of technological advancements on contemporary society (Voss, 2024).

2.2. Ambivalence in Urban Dashboards

Urban dashboards, although intended to enhance transparency and promote citizen engagement, are far from neutral tools. As Kitchin et al. (2015a) argue, these visualizations

not only reflect specific political agendas and biases but also actively shape public perceptions of urban governance. While dashboards make data more visually accessible and engaging, they can obscure the complexities inherent in data collection and analysis. This can lead to significant misrepresentation, as dashboards often create a false sense of comprehensiveness in urban management while neglecting other valuable forms of knowledge. The data they present is frequently limited, offering only a partial snapshot of urban conditions, and the reduction of complex urban realities into simplified visual metrics can obscure important contextual nuances. Furthermore, the design of these dashboards can manipulate user understanding, emphasizing certain narratives and downplaying others, thus influencing decision-making processes and policy directions. Finally, the accuracy and reliability of the insights derived from dashboards are contingent on the quality of the underlying data, which may be compromised by errors, biases, and methodological flaws (Kitchin et al., 2015a).

Similarly, Kitchin et al. (2016) highlight the complexities and contradictions involved in the

development and deployment of urban dashboards, questioning their purported objectivity. While often viewed as neutral tools for visualizing city data, the data presented by these tools are typically selective, offering only a limited perspective on urban realities. This simplification can obscure crucial contextual factors and present an overly sanitized version of urban life. Furthermore, while dashboards claim to foster user interaction, the level of interactivity often remains constrained, limiting the ability of users to interpret or manipulate the data fully. The influence of dashboard design on user engagement and understanding can lead to normative decision-making and policy biases. As with any data-driven tool, the reliability of dashboard insights depends heavily on the accuracy and completeness of the underlying data, which can be susceptible to biases and errors. Additionally, the implementation of dashboards involves numerous stakeholders, creating potential challenges and uncertainties in their practical use (Kitchin et al., 2016).

The ambivalence of data manifests in its dual capacity to empower and to surveil, to liberate and to control. On one hand, data facilitates

innovation, efficiency, and personalized services, promising societal benefits and economic growth. Yet, concurrently, it enables unprecedented levels of surveillance, manipulation, and inequality, perpetuating existing power differentials and vulnerabilities. This ambivalence necessitates critical scrutiny for how data is collected, used, and governed to mitigate harms and uphold principles of justice and equity in digital societies (Kitchin, 2023). Datta and Söderström (2023) further argue that the ambivalence of war rooms, a particular type of dashboard in action, lies in their dual role as both instruments of state control and potential platforms for civic empowerment. On one hand, these war rooms, with their sophisticated data-driven surveillance capabilities, epitomize a new modality of governance that can reinforce existing power dynamics and deepen inequalities. They enable the state to monitor and manage populations, particularly marginalized groups, through a centralized and often opaque system of data collection and analysis. This centralized control raises concerns about privacy, data security, and the potential for misuse of information. On the other hand, the war rooms also present opportunities for

enhanced civic participation and localized responses to crises. This duality highlights the interaction between empowerment and control, suggesting that the true impact of the war rooms depends on how their capabilities are harnessed and regulated (Datta & Söderström, 2023).

As the debate around war rooms highlights the duality of data-driven technologies, the potential for exploitation is also pronounced in the context of data capitalism. Data capitalism extracts value from data to generate profit, and cities are prime targets for this practice. Companies use smart city technologies to capture public assets and services, drive real estate investment, and promote a neoliberal approach to urban governance. This process, known as data colonialism, can lead to exploitation and marginalization (Kitchin, 2023).

The questions raised in this section—regarding the complexity of cities, the potential for bias in indicator data, the impact of data presentation, the broader purposes of indicator projects, the potential for gaming indicators, the unintended consequences of policy based on them, the influence of political ideology, and the ultimate

usefulness of dashboards—underscore the multifaceted nature of these tools. Despite acknowledging these complexities and limitations, many involved in developing and using urban dashboards often adopt a realist epistemology, asserting that they provide an objective representation of the city. This stance allows them to claim authority, justify specific policies, and deflect criticism. However, as we have seen, this approach is inherently flawed, as dashboards inevitably present only one perspective of a complex city, influenced by various factors, including political ideology and technical limitations. Therefore, while urban dashboards can be valuable tools for understanding and improving cities, it is essential to approach them with a critical eye, recognizing their limitations and the ways in which they can be misused (Kitchin et al., 2015b).

In the realm of urban dashboards, a persistent ambivalence also emerges regarding the balance between local autonomy and regional cooperation. Key stakeholders, while acknowledging the potential advantages of federated data sets and collaborative services, often prioritize preserving local autonomy and

catering to the unique needs of their respective municipalities. This stance reflects a deeply rooted preference for maintaining operational independence and identity within their communities. Officials express apprehensions about the prospect of adopting standardized regional approaches, fearing that such initiatives might erode the distinct cultural identities and governance models that define their municipalities. This tension underscores the complexity of achieving effective digital governance in urban settings, where the pursuit of efficiency and integration must navigate the enduring values of localism and the preservation of community identity (Kitchin & Moore-Cherry, 2021).

3.1. Affordance Theory

Affordance theory has been a cornerstone in education research, particularly within the domain of educational technology. Researchers have extensively employed this theoretical framework to examine a diverse range of educational contexts, including 3D virtual environments, online social networks, scaffolded social learning, blogs and learning, science learning, and literacy (Blewett & Hugo, 2016).

Despite the widespread use of Affordance theory in educational technology research, remains a subject of ongoing debate. Gibson's and Norman's perspectives offer contrasting views, with the former emphasizing objective action possibilities and the latter focusing on subjective perception. Gaver's (1991) categorization of affordances, while helpful, presents limitations in explaining certain categories. Parchoma's (2014) relational perspective highlights the dynamic interplay between perceiver and perceived, emphasizing the influence of context and agency. To provide a comprehensive framework for understanding affordances, four dimensions—perspective, causality, ontology, and philosophical

paradigm—are proposed. These dimensions are used to situate affordance theory within three movements: Object Affordances, Subject Affordances, and Actant Affordances. The latter, a proposed third movement, aims to provide a more nuanced understanding of affordances by considering the active role of both objects and subjects in their emergence (Blewett & Hugo, 2016).

Latour's Theory of Actant

Latour introduces the concept of actants into the object-actor discussion. He does this in order to remove the dichotomy and illustrate the equal import of the role played by both the 'object' and the 'actor' where both operate together to construct activity. **Latour's theory of actants** is a central component of Actor-Network Theory (ANT), a framework used to analyze social and technical configurations. In this theory, an **actant** is any entity that can have an effect or be affected. This includes not only humans but also non-human entities like objects, technologies, and even abstract concepts (Latour, 2005b).

Latour's theory of actants offers a radical departure from traditional sociological

perspectives. By positing that all entities, human and non-human, are equally capable of shaping the social world, ANT challenges the primacy of human agency. In these heterogeneous networks, actants interact in complex and contingent ways, their actions influenced by their position within the network. These networks are made up of diverse entities (humans, technologies, natural objects), and their interactions define social phenomena. This distributed agency rejects hierarchical models that privilege human actors over non-human elements. Instead, ANT proposes a flat ontology where all entities, from scientists to viruses, can exert significant influence. This shift in perspective allows for a more nuanced understanding of social phenomena, recognizing the interconnectedness and interdependence of diverse actants within our world (Latour, 2005b).

When Latour applies the concept of **affordances** to actants in ANT, he extends the idea to emphasize how any actant (human or non-human) not only acts but also **affords specific actions** to other entities within the network. The affordances of an actant are its potential uses or actions as shaped by its

position and connections within a given network. The concept of actant affordances, highlights the relational and contextual nature of interactions between entities. Unlike intrinsic properties, affordances are defined by the network of relationships in which an actant is embedded. For instance, a hammer's affordances vary depending on its context—whether wielded by a carpenter, vandal, or archaeologist. Actants mutually influence each other, with both human and non-human entities shaping their respective affordances. A smartphone, for example, affords communication, internet access, and social media use, but its capabilities are also influenced by user configurations and external infrastructure. Moreover, affordances are not static but evolve with the network itself. Legal regulations, technological advancements, and cultural shifts can alter what an actant affords.

For instance, a dashboard affords the ability to visualize and monitor various actions depending on the network of relationships and users interacting with it. However, if the dashboard integrates machine learning, it could further afford predictive insights and forecasting based on historical data and trends.

Importantly, affordances extend beyond human agency, as non-human actants like machines or natural objects can influence human actions and societal processes. A river dam, for example, affords electricity generation,

water control, and ecosystem impact. Ultimately, affordances are context-dependent, with the same actant potentially enabling different actions in varying environments and interactions (Latour, 2005).

Aspect	Description
Relational	Affordances are defined by relationships with other entities.
Mutual Influence	Actants influence and are influenced by other affordances.
Shaped by Networks	Affordances evolve as the network changes.
Agency and causality	Non-human actants have agency and can influence human actions.
Context-Dependent	Affordances vary based on context and situation.

Table 1 The key features of Actant Affordances (Latour, 2005)

The Role of Power in Actant Affordances

In ANT, **power** is not something inherent to certain actants but is **distributed** across the network through their affordances. The power an actant holds comes from the extent to which it can influence other actants or shape what they can do. For example, a government law (an actant) can afford compliance or protest, depending on how it interacts with citizens, businesses, and other stakeholders in the network (Latour, 2005b).

Ultimately, Actant Affordances is defined as the opportunities that exist for action within a network of actants, both human and

environmental. These opportunities arise from the interactions between actants and are represented by verbal nouns. Actant Affordances are co-dependent on the environment and the actor, and they indicate the widening range of possibilities through which technological affordances can be explored. This extends beyond the traditional view of objects affording opportunities to actors or actors perceiving opportunities in objects, as it also includes the possibility of objects affording action opportunities to other objects and actors to other actors (Blewett & Hugo, 2016).

3.2. Matters of Concern Theory

While affordance theory provides a framework for understanding how objects and environments afford certain actions, **matters of concern** offer a broader perspective on the social and political dimensions of technological artifacts.

The concept of "**Matters of Concern**" was also developed by Bruno Latour. It challenges the traditional focus of science and design on "**matters of fact**" (objective, tangible data or phenomena) by introducing a more nuanced perspective that includes complex, socially charged issues. In this view, "matters of concern" are dynamic, subjective, and entangled with various social, cultural, ethical, and political dimensions (Stephan, 2015). Latour asserts that traditional scientific approaches often prioritize matters of fact—immutable and objective truths—while neglecting the dynamic and relational aspects of reality that constitute matters of concern (Latour, 2014). Latour's goal is to shift the focus from static facts to concerns that encapsulate broader social, political, and environmental issues, urging designers to visualize and address these (Stephan, 2015).

Ultimately, matters of concern suggests that reality is not a fixed entity but a dynamic process shaped by a network of actors, including humans, non-humans, and objects. Matters of concern are these dynamic, contested elements that emerge from the intricate interplay of these actors. Unlike matters of fact, which are often assumed to be neutral and universally agreed upon, matters of concern are inherently involved in social, political, and material processes, their meanings and impacts shaped by diverse interpretations and interests. This shift in perspective underscores the relational nature of reality and the importance of considering the complex networks that give rise to our understanding of the world (Latour, 2005a).

Dynamic and Controversial

Unlike matters of fact, which are seen as final and uncontested, matters of concern are constantly in flux. They are part of ongoing debates and controversies that bring together various stakeholders (e.g., scientists, politicians, citizens, and technologies) to shape what is at stake (Latour, 2005a).

Involvement of Diverse Actants

Matters of concern integrate both human and non-human actants. For example, in climate change, non-human entities like CO₂ levels, ocean temperatures, and weather patterns are deeply entangled with human actors like policymakers, corporations, and activists. These entities are not passive background elements but are active participants in shaping the issue (Latour, 2005a).

Embedded in a Network

Matters of concern are part of complex **actor-networks**, where no single actor or entity can claim full responsibility or ownership of the issue. For instance, a new technological device may raise concerns about privacy, safety, or societal implications, involving engineers, lawmakers, users, and the technology itself in the network of concern (Latour, 2005a).

Hybrid of Fact and Value

Matters of concern blur the line between facts and values. While matters of fact are considered value-neutral, matters of concern recognize that facts are never truly separate from values, interests, and power structures (Latour, 2005a).

For example, traffic control systems collect data

on vehicle speeds and congestion patterns (facts), but the concerns surrounding privacy, surveillance, the equitable use of data, and potential over-policing in specific neighborhoods involve subjective values and political interests.

Engaging Multiple Perspectives

Latour's concept encourages looking at issues from multiple perspectives rather than relying on a singular, authoritative account. For instance, in environmental controversies, different actors (scientists, indigenous communities, corporations, environmentalists) will have different concerns, all of which need to be accounted for to fully understand the issue (Latour, 2014).

Productive Tensions

Matters of concern generate productive tensions that keep controversies open. Instead of closing down debates with a final "matter of fact," matters of concern leave space for negotiation and further inquiry. This openness allows for a more democratic and inclusive approach to addressing complex issues, where multiple voices and interpretations can

contribute to the resolution or redefinition of the matter at hand (Latour, 2005a).

Examples of Matters of Concern

Climate change is not just a matter of fact (i.e., rising temperatures, CO₂ emissions); it is a matter of concern because it involves a wide array of actors (scientists, governments, corporations, environmentalists, and citizens) each of whom brings different perspectives, interests, and potential solutions. Non-human actors, like the atmosphere, polar ice caps, and ocean currents, also play significant roles in shaping the concern (Latour, 2005a).

A disease outbreak (e.g., COVID-19) is not just a biological fact but a matter of concern because it impacts economies, societies, and governance structures. Vaccines, treatments, and public health policies bring together pharmaceutical companies, government agencies, medical professionals, and citizens in a network where the resolution of the issue is constantly negotiated (Latour, 2005a).

Consider a debate over the implementation of surveillance technology (e.g., facial recognition systems). It is not just about the technological facts of how the system works; it is a matter of

concern because it raises issues of privacy, human rights, security, and ethical governance. Different actors (governments, tech companies, civil rights groups, and citizens) each contribute to the network of concern, with non-human elements (the surveillance technology itself) also influencing the debate (Latour, 2005a).

3.3. Integrating the perspectives

By combining **Affordance theory** and **Matters of Concern**, we can gain a more nuanced understanding of how urban dashboards shape and are shaped by their sociotechnical context.

This sociomaterial perspective significantly reshapes urban dashboards research by emphasizing the interplay between materiality and social factors. This approach challenges traditional dichotomies, such as data/information and technology/society, fostering a nuanced understanding of the complexities surrounding urban data visualization. By focusing on interconnections, affordance theory, and the rejection of binaries, researchers can delve deeper into the dynamic and often unpredictable nature of urban dashboard interactions.

The sociomaterial perspective encourages researchers to explore the relationships between human and non-human actants, recognizing that both play crucial roles in the development and use of urban dashboards. This approach aligns with affordance theory, which examines how both materials (such as dashboards themselves) and social interactions shape urban data practices. By considering how different elements afford various opportunities for understanding and intervention in urban environments, researchers can gain valuable insights into the complexities of data visualization.

Moreover, the sociomaterial perspective calls for a departure from simplistic categorizations, allowing for a more complex analysis of urban dashboard phenomena. By emphasizing the context in which urban dashboards are used, researchers can gain insights into how space, technology, and social interactions fold to influence urban data visualization practices. Also, the sociomaterial perspective allows urban dashboards research to benefit from acknowledging the material conditions that facilitate or constrain data visualization efforts. It presents a networked view of urban

dashboard environments, highlighting the importance of understanding how various actants (both human and technological) interact within these networks.

Bruno Latour's concept of "matters of concern" offers a valuable lens by shifting the focus from objective facts to the subjective, socio-political dimensions of issues, this approach can enrich the understanding of how these dashboards are constructed, interpreted, and utilized in urban contexts.

Urban dashboards are inherently interdisciplinary tools, drawing on data from various fields (e.g., economics, sociology, environmental science). A "matters of concern" approach encourages a transdisciplinary perspective, recognizing that the challenges facing cities are complex and interconnected.

The use of urban dashboards also raises ethical questions about data privacy, surveillance, and the potential for bias which a "matters of concern" approach encourages to consider the ethical implications and to engage in critical reflection on the potential consequences.

In this dissertation, I combine **Affordance Theory** and **Matters of Concern** to showcase

the ambivalence of urban dashboards as socio-technical tools. **Affordances** allow me to examine the potential actions and unintended consequences embedded within the technological and operational capabilities of dashboards. By focusing on the ways dashboards enable, constrain, or unintentionally shape governance practices (such as facilitating surveillance, profiling, or selective transparency) affordances reveal the inherent risks and power dynamics that can emerge from their use. This perspective highlights how unintended consequences are not merely accidental but are often byproducts of the socio-technical design of these tools.

Matters of Concern, on the other hand, provide a lens to investigate the broader intentions, rationalities, and political ideologies that public bodies and institutional actors inject into the design and deployment of urban dashboards. By tracing how these stakeholders conceptualize the role of dashboards (whether as tools for transparency, data-driven decision-making, or public engagement) this perspective uncovers the agendas, values, and priorities that shape their functionalities.

Together, these perspectives enable an analysis of the **ambivalence of urban dashboards**.

4.1. The Ambivalent Affordances of Urban Dashboards

Urban dashboards are powerful tools for managing and evaluating urban services, formulating policy, and creating public knowledge. However, drawing on Latour's affordance theory, we can see that these seemingly straightforward benefits are intertwined with potential drawbacks, creating a situation of ambivalent affordances. While dashboards afford increased access to information, they simultaneously afford the possibility of surveillance and control. This duality necessitates a framework of ethical guidelines to ensure responsible data use and navigate the complexities of digital governance in the urban context.

Digital governance can help raise public awareness of ethical issues and provide a structured approach to addressing them. It can also promote the competency of organizations in handling big data ethically. The ethical implications of city dashboard usage require careful examination. This includes exploring the potential harmful applications of the data and developing strategies to mitigate any adverse effects that may arise from using these

tools (Kitchin, 2016b). Victor Chang's (2021) ethical framework for Big Data and smart cities focuses on addressing contemporary ethical issues in big data analytics, particularly in urban environments. This framework aligns with the principles of digital governance, which aim to establish ethical, transparent, and accountable practices in managing urban data and technology. By addressing key issues such as privacy, surveillance, and data integrity, the framework supports digital governance objectives, ensuring that data-driven innovations in smart cities are deployed responsibly and equitably. The four key areas addressed in the framework include:

Data Collection and Usage

To ensure ethical data collection, data subjects must be explicitly informed about the purpose of data collection. This transparency allows individuals to make informed decisions about their personal information. Moreover, data collectors should maintain transparency by reporting the actual usage of the collected data, enabling data subjects to understand both the potential benefits and risks associated with their participation. Lastly, data collection should be strictly limited to data that is directly relevant to

the stated purpose, avoiding the unnecessary acquisition of personal information (Chang, 2021).

Privacy and Consent

When dealing with significant amounts of personal data, especially sensitive information such as health records, obtaining explicit consent from users is imperative. To ensure adherence to stringent data protection standards, organizations must prioritize compliance with the General Data Protection Regulation (GDPR). This regulation underscores the importance of safeguarding user privacy and data security. Furthermore, the ethical handling of sensitive data necessitates approval from relevant governmental bodies and ethical committees, guaranteeing responsible data management practices (Chang, 2021).

Data Ownership and Regulation

It is crucial to establish clear regulations regarding data ownership. These regulations should affirm that individuals retain the rights to their own data. Additionally, the framework proposes the creation of specialized data protection institutes to effectively address the

challenges posed by big data technologies. Furthermore, regulations should delineate the permissible access of public entities to private information, striking a balance between fostering innovation and safeguarding individual privacy (Chang, 2021).

Public Awareness and Ethical Practices

To foster a culture of privacy protection, it is essential to raise public awareness about data privacy issues. This strategy is a cornerstone of the ethical framework, which also emphasizes the need for policymakers to regularly review and update ethical guidelines to ensure fairness and compliance. By prioritizing ethical practices, smart cities can build trust with their citizens and demonstrate accountability in their data management strategies.

The ethical framework serves as a guide for raising public awareness about the complexities of big data and its ethical implications. By focusing on transparency, education, and regulatory compliance, it aims to empower citizens and enhance their understanding of privacy rights in an increasingly data-driven world.

4.2. Stakeholder Collaboration in Dashboard Development

Urban dashboards depend on collaborative efforts among various stakeholders, including government bodies, technology providers, and local communities. Stakeholders are indispensable to the successful integration of big data analytics (BDA), especially in the realm of sustainability. By providing access to critical data, fostering collaboration among diverse parties, and addressing concerns and expectations, stakeholders contribute to a more comprehensive and holistic approach to decision-making. Moreover, BDA-driven insights can mitigate uncertainties and facilitate smoother transitions (Gupta et al., 2019).

Stakeholder engagement is paramount in big data projects due to its multifaceted benefits. Firstly, it facilitates the effective allocation of essential resources, such as financial, technological, and human capital, by securing support from key stakeholders like university administration, funding agencies, and technical teams. Secondly, it fosters collaboration among diverse project participants, including researchers, IT staff, and administrative bodies, leading to improved communication, shared

objectives, and a more cohesive approach to project implementation. Thirdly, it contributes to capacity building by providing big data science teams with the necessary tools, training, and infrastructure, thereby enabling the adoption and implementation of crucial cyberinfrastructure and big data techniques. Fourthly, it enables continuous feedback, which can be leveraged to assess and enhance the effectiveness of big data initiatives, allowing teams to adapt their strategies to better align with institutional goals and improve project outcomes. Finally, it ensures the long-term sustainability of big data projects by aligning them with institutional priorities and policies, thereby securing ongoing support and funding and enabling teams to achieve their long-term goals (Kee et al., 2022).

Moreover, to understand the nature of stakeholder collaboration in Urban Dashboard Development, it is valuable to draw upon the **Digital Innovation Ecosystem** (DIE) framework. The DIE framework outlines a network of stakeholders co-evolving to generate, integrate, and utilize digital innovations, guided by mutual dependencies,

risk management, and information-sharing processes.

A Digital Innovation Ecosystem (DIE) consists of interconnected stakeholders who collaboratively create value, manage risks, and innovate using digital technologies. In DIE, stakeholders such as companies, government bodies, service providers, and end-users contribute to a digital initiative by sharing resources, aligning values, and facilitating technological integration. The DIE framework operates on the premise that innovation in such ecosystems is not a linear process but a dynamic, interconnected system shaped by ongoing interaction and adaptation among stakeholders (Li et al., 2022). Nevertheless, they are highly complex due to the integration of digital expertise with diverse specialized knowledge and the involvement of various stakeholders. Meanwhile, they show convergence and thus organizational boundaries become ambiguous within them. Their malleable, editable, open and transferable characteristics make them uncontrollable, that is, the scale and scope can be easily expanded by various stakeholders. On the whole, the nature of complexity, ambiguity, uncertainty and dynamism embedded in these

ecosystems leads to the occurrence of various risks, which are regarded as the root cause of many failures (Li et al., 2022).

Urban Dashboards can be viewed as digital tools within a localized innovation ecosystem. By visualizing urban data (e.g., traffic, pollution levels, public safety), these dashboards enhance city management through real-time, data-driven decision-making. However, their development and maintenance depend on the same collaborative dynamics seen in DIE, such as robust data-sharing practices, risk mitigation, and stakeholder alignment.

4.3. Ensuring Transparency and Citizen Engagement

Urban indicators, benchmarking, and dashboards can improve decision-making and transparency in cities, but they are often naive, susceptible to manipulation, and often lack transparency and methodological issues (Kitchin et al., 2015a).

Empowering citizens with comprehensive knowledge about their city's strengths and weaknesses is a cornerstone of effective local governance. By providing residents with access to information about their community's assets,

challenges, and opportunities, we can foster a more engaged, informed, and resilient population. When citizens understand the dynamics of their city, they are better equipped to participate in decision-making processes, advocate for targeted improvements, and hold local governments accountable. This knowledge empowers residents to actively shape their community, leading to enhanced civic engagement, improved quality of life, and a more equitable and sustainable future (Pluto-Kossakowska et al., 2022).

Dashboards, by presenting city data in an accessible and visually engaging manner, play a pivotal role in fostering community engagement in urban development. They empower residents by providing them with the tools to understand their environment, participate in decision-making processes, and hold local authorities accountable. By making complex data easily interpretable, dashboards encourage active participation, facilitate public consultations, and promote transparency. Through real-time data sharing, feedback mechanisms, and visual analytics, dashboards create a platform for collaboration between local governments and residents, leading to

innovative solutions to urban challenges. To make dashboard data accessible to citizens, a combination of user-friendly design, interactive features, accessibility considerations, and tailored user experiences is essential. Intuitive indicators, effective graphic forms, and concise summarizing comments should be employed to present data clearly and efficiently. Dashboards should be designed as cognitive tools, allowing users to navigate through interconnected data and explore information intuitively. Accessibility features, such as high-contrast visuals and audio formats, should be implemented to cater to users with disabilities. By creating dashboards with two functionality levels—basic for residents and advanced for experts—cities can ensure that data is presented in a manner suitable for all users. Additionally, dashboards can be used to foster civic engagement by providing real-time information and encouraging residents to participate in urban policies and initiatives. Through these techniques, dashboards can serve as effective communication channels between cities and their residents, promoting transparency and facilitating civic participation (Pluto-Kossakowska et al., 2022).

The effectiveness of citizen data access dashboards is contingent upon several factors, including data quality, accessibility, visualization, and user engagement. Incomplete or outdated data can erode trust and lead to misinformation, while complex datasets and technical barriers can hinder usability. Effective visualization is crucial for clear interpretation, but poor design can result in misinterpretation. Furthermore, dashboards must be accessible across various devices and platforms to ensure widespread reach. A positive user experience, including feedback mechanisms, is essential to encourage engagement and participation. However, many dashboards fail to effectively engage citizens, resulting in low usage rates. Overwhelming users with excessive information can also hinder their ability to focus on key indicators and understand the data's implications (Pluto-Kossakowska et al., 2022).

Ultimately, dashboards can foster a more democratic and participatory city governance, where residents are not merely passive observers but active contributors to shaping their communities. This shift from passive observers to active participants is essential for building

trust and ensuring ethical governance. Privacy, a cornerstone of digital governance, plays a crucial role in maintaining this trust. Principles like confidentiality, integrity, availability, unlinkability, transparency, and intervenability are essential for protecting personal data and ensuring its ethical handling in digital environments. And, confidentiality ensures that sensitive information is protected from unauthorized access, reinforcing trust between individuals and governing bodies. By adhering to these principles, governing bodies can foster a digital environment where residents feel confident in their interactions and contributions (Vazquez, 2022).

4.4. Ethics and Accountability in Urban Dashboard Implementation

Data power is increasingly used to shape our lives, often benefiting corporations and governments more than individuals. This can lead to unfair treatment and exacerbated urban problems. While people are resisting this trend through ethical and just approaches, data ethics alone is insufficient to address the root problems of data power. Data ethics focuses too narrowly on individuals and technical systems, seeking procedural solutions rather than

systemic change. It can be easily co-opted by powerful actors, serving primarily to legitimize existing practices. To effectively curb the discriminatory and exploitative practices of data capitalism and state dataveillance, we need a comprehensive approach that includes data policy, regulations, laws, and governance models. These measures can address the structural conditions that enable such practices, offering a genuine alternative to the current systems. For example, data regulations can limit the collection and use of personal data, laws can protect individuals' privacy rights, and governance models can ensure that data is used for the public good. By combining ethical principles with robust regulatory frameworks, we can create a more equitable and just data ecosystem. This requires ongoing collaboration between individuals, organizations, and governments to develop and implement policies that promote transparency, fairness, and accountability in the use of data (Kitchin, 2023).

In digital governance, maintaining a balanced approach to digitalization is critical to prevent potential misuse of power and uphold the rule of law. Continuous scrutiny is necessary to

assess human rights implications across all stages of initiative development, while robust data protection measures are essential to safeguard personal information and ensure privacy. Legislative frameworks must be reformed to align with modern digital standards, focusing on privacy protections and integrating AI-related norms. Inclusivity and accessibility efforts are crucial, requiring proactive measures to overcome infrastructure gaps and digital literacy disparities, ensuring equitable access to justice. Gender analysis and accountability frameworks play key roles in addressing discrimination and monitoring rights abuses within digital projects. Upholding righteousness and combating corruption necessitate transparent processes, while ethical technology use requires constant oversight of data collection and biases (E-Justice: Digital Transformation to Close the Justice Gap, 2022).

5.1. Case analysis

This section provides an overview of 10 dashboards, examining their stated aims and functionalities to highlight their potential as tools for transparency, citizen engagement, and data-driven governance (**Matters of Concern**) while critically analyzing how and if they address the systemic risks, unintended consequences, and power dynamics they might entail (**Affordances**).

To provide a structured overview of the potential ambivalent nature of urban dashboards, this section will examine them in

two primary areas: affordances and matters of concern. By examining urban dashboards through this lens, we can identify both the opportunities they present for smart cities and the potential risks and limitations. While matters of concern encompass the broader ideas and potential issues associated with urban dashboards, the following sections will delve deeper into the key affordances, drawing on insights from the previous chapters. This categorization is informed by earlier discussions on affordance theory and its application to technological artifacts.

Affordances				
Privacy	Transparency and Data Collection	Stakeholder Collaboration	Citizen Engagement	Accountability

Table 2 Affordances Criteria

5.2. An overview of the Urban Dashboards under analysis

The Toronto Police Service's "Major Crime Indicators (MCI)" dashboard, provides a comprehensive overview of crime trends in the city. This publicly available resource visualizes reported occurrences of major criminal offenses, including assaults, homicides,

robberies, and sexual violations, dating back to 2014. The dashboard facilitates the exploration of crime data by various categories, such as offense type, date, and location, offering valuable insights into the temporal and spatial distribution of criminal activity within Toronto (*Major Crime Indicators Open Data*, n.d.).

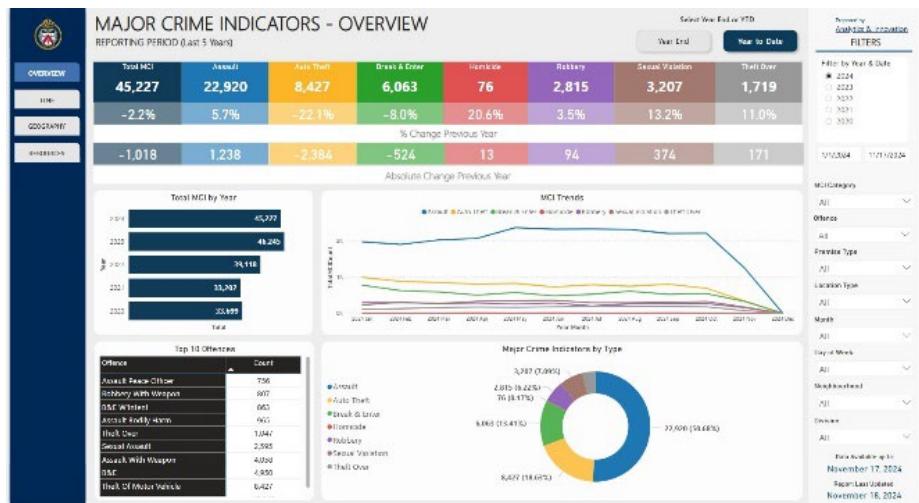


Figure 6 Major Crime Indication Dashboard

The Metropolitan Police Service utilizes a suite of public dashboards to visualize key performance indicators and operational data. This dashboard, which include the "Crime Data Dashboard," "Stop and Search Dashboard," and "Use of Force Dashboard," present information

on crime rates, stop and search practices, and the use of force by officers. This data offers insights into police activity and its impact on London's communities (*MET Stats and Data*, n.d.).

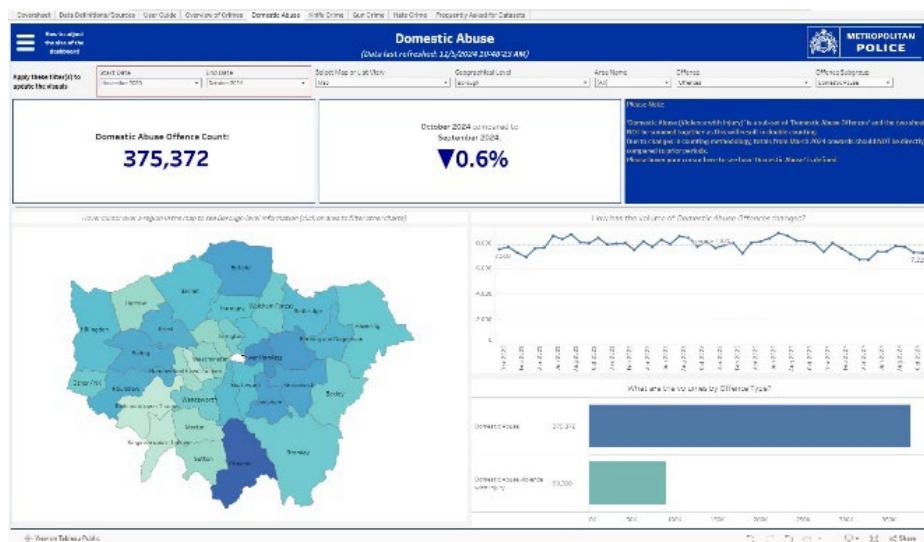


Figure 7 Metropolitan Police Services's Dashboards

The New York Police Department employs "CompStat 2.0," a data-driven approach to

crime analysis and resource allocation. Accessible through the NYPD's online crime

statistics portal and the dedicated CompStat website, this system provides up-to-date visualizations of crime data across New York City. CompStat 2.0 dashboards allow for the

exploration of crime trends by various factors, including precinct, time period, and offense type (*NYPD Statistics*, n.d.).



Figure 8 CompStat 2.0 Dashboard

The Dublin Dashboard was an interactive web application designed to visualize and analyze urban data related to the city of Dublin, Ireland. Launched in September 2016, it served as a publicly accessible platform that aggregates a wide range of data sources to provide insights into the city's performance and dynamics. The Dublin Dashboard compiled a range of data about the city, including environmental conditions, transportation information, socio-economic factors, and public health metrics. This data was presented to the public and may be used by individuals or organizations for various purposes (McArdle & Kitchin, 2016).

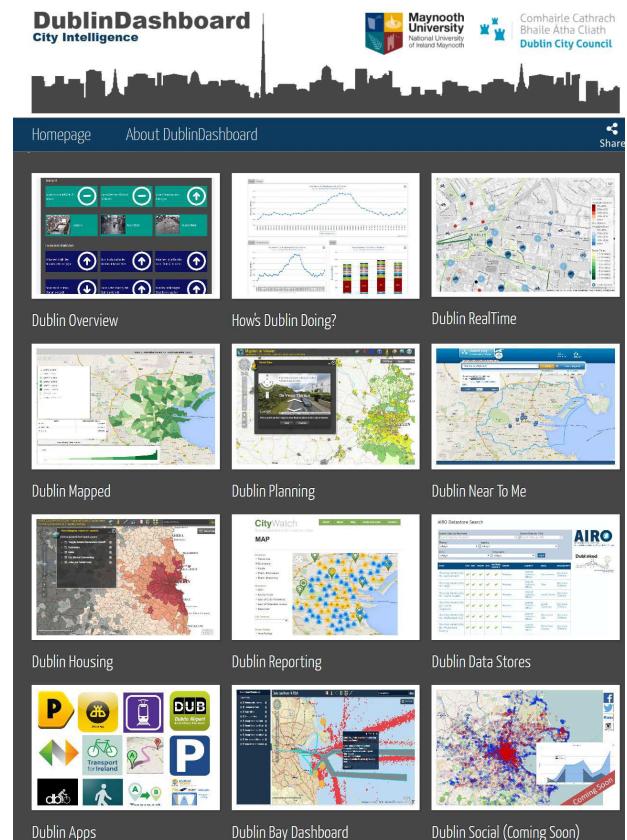


Figure 9 Dublin Dashboard Home Page

The Sustainable Development Report Dashboard, developed by the Sustainable Development Solutions Network (SDSN), provides a comprehensive overview of global progress towards achieving the Sustainable Development Goals (SDGs). This dashboard presents data visualizations and analysis on various SDG indicators, allowing users to

explore trends, compare country performance, and identify areas requiring urgent action. The dashboard also highlights the interconnectedness of the SDGs and the need for integrated solutions to address global challenges (*Sustainable Development Report, 2024*).



Figure 10 Sustainable Development Report Dashboard

The Transit Center Equity Dashboard analyzes public transit systems across seven major US regions, evaluating their effectiveness in serving riders equitably. This dashboard tracks access to essential destinations, service coverage,

frequency, and affordability for diverse demographic groups, comparing accessibility by public transit to private car usage (Klumpenhouwer et al., 2021).

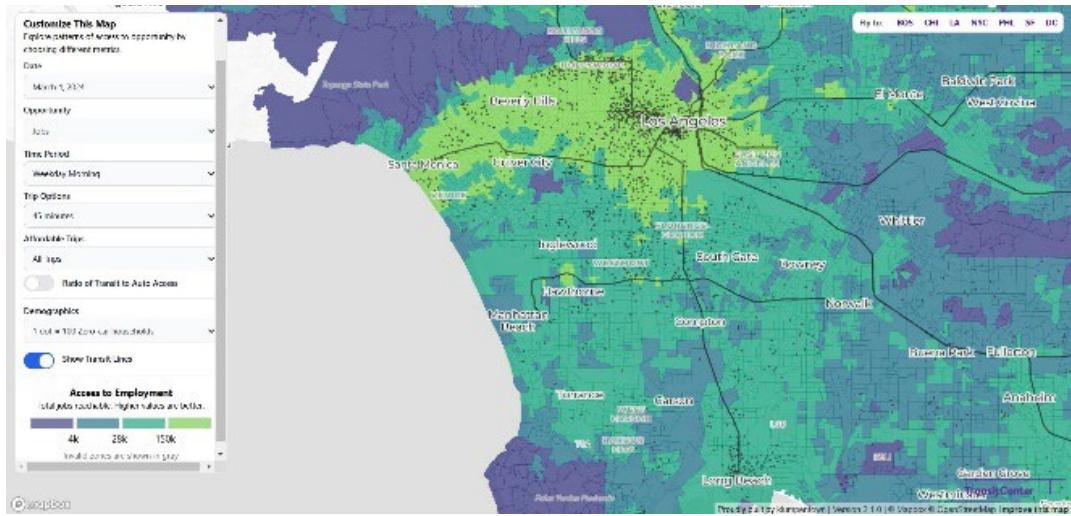


Figure 11 Transit Center Equity Dashboard

The SMART Congestion Management Dashboard (CMD) provides real-time mobility data for Miami-Dade County, supporting decision-making for the Strategic Miami Area Rapid Transit (SMART) Plan. This web-based platform offers user-friendly congestion

management information and reporting tools, utilizing data collected as the SMART Plan progresses from planning to implementation (*SMART Congestion Management Dashboard*, n.d.).

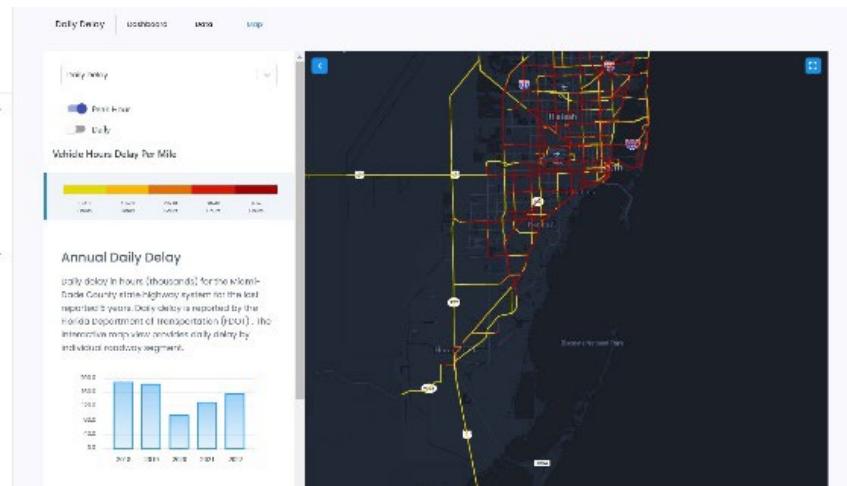


Figure 12 Miami-Dade SMART Congestion Management Dashboard

The Geospatial Indicators Dashboard, a collaborative effort by Urban Shift and Cities4Forests, provides data visualizations on

climate change and urban environmental indicators across seven themes, including air quality, extreme heat, biodiversity, and

flooding. This tool, available for 35 cities participating in the Urban Shift and Cities4Forests initiatives, allows users to explore city-level and neighborhood-scale data on

current baselines, recent trends, and projected changes related to environmental assets and climate risks.

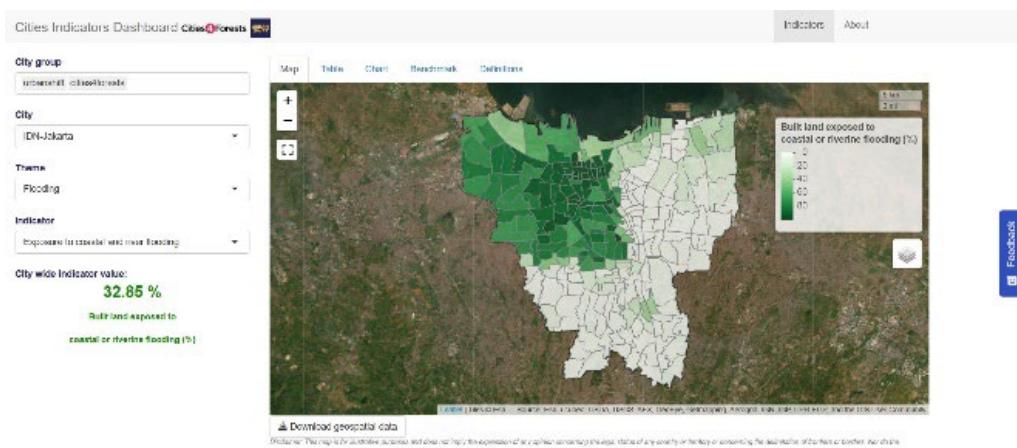


Figure 13 Geospatial Indicators Dashboard

The City Health Dashboard, developed by NYU Grossman School of Medicine, offers a comprehensive overview of health and well-being indicators for over 970 cities across the United States. This interactive platform provides data on over 40 measures, including life expectancy, access to healthcare, and

socioeconomic factors, at both city and neighborhood levels. The City Health Dashboard aims to equip community leaders and policymakers with data-driven insights to address health disparities and improve community well-being.

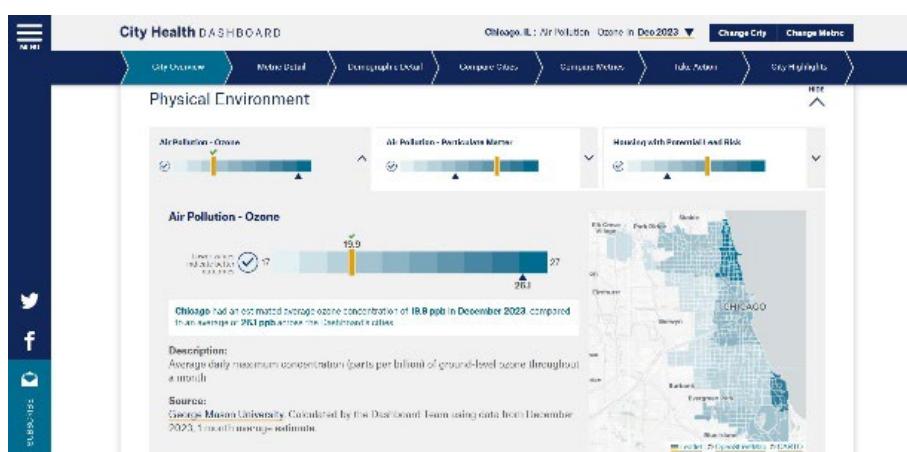


Figure 14 City Health Dashboard

Brampton's CityDashboard provides a centralized platform for accessing and visualizing a diverse range of city data. This interactive dashboard offers insights into various aspects of urban life, including infrastructure, service delivery, economic development, and community well-being. Through maps, charts, and graphs, the CityDashboard allows users to explore trends, compare datasets, and monitor key performance indicators (*Brampton City Dashboard, 2019*).

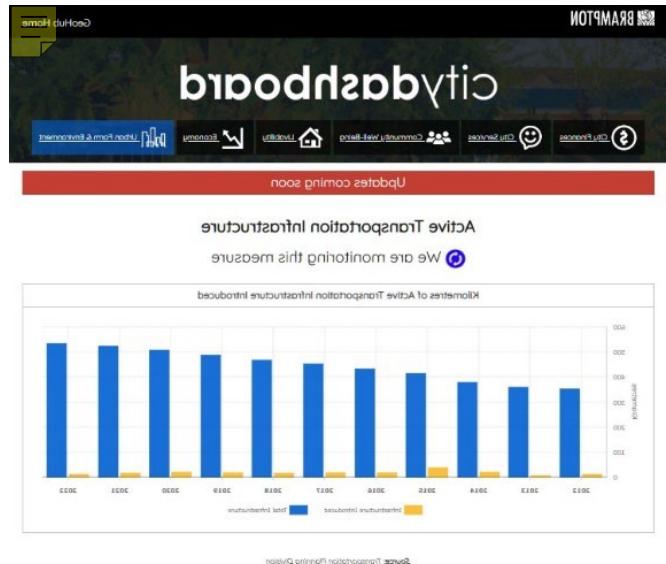


Figure 15 Brampton CityDashboard

Urban Dashboard Name	Ambivalence in Urban Dashboards					
	Matters of Concerns	Privacy	Transparency and Data Collection	Stakeholder Collaboration	Citizen Engagement	Accountability
	Affordances					
1 Major Crime Indicators (MCI)	✓ Providing information on major crime trends ✓ Protecting Privacy ✓ Acknowledging data limitations (<i>Major Crime Indicators Open Data</i> , n.d.)	Risk of re-identification of individuals, especially in less populated areas, leading to targeted harassment or privacy breaches.	Lack of clarity in data methods undermines trust in crime statistics.	Exclusion of community voices marginalizes certain groups.	Stigmatizes neighborhoods without empowering solutions.	No feedback mechanisms for contesting data errors or misuse.
	Crime Data Dashboard	Privacy breaches to attain self-benefited results.	Data manipulation, and Internal focus obscures systemic public safety flaws.	Limited collaboration with community safety groups reduces trust.	Lacks citizen oversight of stop-and-search activities.	Focus on internal metrics ignores public accountability.
2 Metropolitan Police Service's dashboards	✓ Easy access to data ✓ How we police London ✓ Transparency and accountability (<i>MET Stats and Data</i> , n.d.)	Data risks reinforcing racial or ethnic profiling, amplifying inequalities.	Focus on targets hides systemic policing biases.	Minimal collaboration reinforces systemic policing issues.	Lacks citizen oversight of stop-and-search activities.	Performance targets hide discrimination issues.
	Stop and Search Dashboard	Data on force use could violate privacy norms by exposing sensitive incidents.	Internal accountability lacks public-facing transparency.	Community engagement in law enforcement accountability is ignored.	Fails to encourage public dialogue on force accountability.	Internal focus avoids law enforcement reforms.
3 CompStat 2.0	Use of Force Dashboard	Data on force use could violate privacy norms by exposing sensitive incidents.	Internal accountability lacks public-facing transparency.	Community engagement in law enforcement accountability is ignored.	Fails to encourage public dialogue on force accountability.	Internal focus avoids law enforcement reforms.
	✓ Proactive Crime Prevention ✓ Data-Driven Decision Making ✓ Accountability and Transparency ✓ Continuous Improvement (<i>NYPD Statistics</i> , n.d.)	Over-policing of specific communities, profiling, and discrimination.	Data manipulation encouraged by performance targets.	Focus on enforcement neglects systemic crime causes.	Superficial engagement and risk of SWATting abuse.	Data manipulation encouraged by results-driven metrics.
4 Dublin Dashboard	✓ Data-Driven Decision Making ✓ Improved Urban Planning ✓ Smart City Development (<i>Dublin Dashboard</i> , 2016)	Tokenism-related risks.	Selective transparency misrepresents urban dynamics.	Risk of tokenism by special interest groups in urban planning.	Limited engagement due to digital divide barriers.	-
5 Sustainable Development Report Dashboard	✓ Comprehensive Measurement ✓ Global Comparisons ✓ Emphasis on Interconnectivity (<i>Sustainable Development Report</i> , 2024)	SDG reporting risks misusing sensitive data for selective progress narratives.	Selective reporting downplays SDG failures.	Co-optation by elite interests excludes grassroots participation.	Fails to activate communities for SDG action.	Selective SDG reporting avoids institutional accountability.

Urban Dashboard Name	Ambivalence in Urban Dashboards						
	Matters of Concerns	Privacy	Transparency and Data Collection	Stakeholder Collaboration	Citizen Engagement	Affordances	Accountability
6 Transit Accessibility and Equity Dashboard	✓ Transport System Accessibility ✓ Transport System Equity ✓ Transport System Affordability (Klumpeehouwer et al., 2021)	Tracking risks exposing vulnerable groups without consent.	Data ambiguities mislead public transit priorities.	Focus on technical groups marginalizes vulnerable users.	Tokenistic engagement leaves citizens powerless in transit reform.	Blame-shifting hides transit access inequalities.	
7 Miami-Dade SMART Congestion Management Dashboard	✓ Real-time Traffic Monitoring ✓ Data-Driven Evaluation and Support for Decision-Making ✓ User-Friendly Interface (<i>SMART Congestion Management Dashboard</i> , n.d.)	Risks related to vehicle tracking without clear user consent.	Ambiguous congestion metrics justify unpopular policies.	Exclusion of local groups reduces urban collaboration.	Superficial input deters collaboration on traffic solutions.	Harmful policies justified by incomplete congestion data.	
8 Geospatial Indicators Dashboard	✓ Visualizing Climate Impacts ✓ Nature-Based Solutions ✓ Data-Driven Decision-Making (<i>Geospatial Indicators Dashboard</i> , n.d.)	Environmental data misuse stigmatization of areas.	Flawed indicators worsen trust in environmental policies.	Stakeholders limited to elite environmental groups.	Environmental data poorly adapted for public advocacy.	Flawed data decisions erode public trust.	
9 City Health Dashboard	✓ Hyperlocal Health Data ✓ Equity Focus ✓ Data for Action ✓ Educational Resource (<i>City Health Dashboard</i> , n.d.)	Health data misuse risks exposing inequities.	Flawed health indicators obscure community challenges.	Disadvantaged populations excluded from health discussions.	Health data inaccessible for grassroots policy discussions.	Flawed health data worsens inequities.	
10 Brampton City Dashboard	✓ Tracking Urban Sustainability ✓ Data-Driven Progress ✓ Public Access to Information (<i>Brampton City Dashboard</i> , 2019)	Selective use of citizen data raises profiling risks. Labeling and stigmatization of areas.	Overly positive reporting hides systemic issues.	Community voices sidelined in governance decisions.	Tokenistic reporting alienates local populations.	Unrealistic targets shift blame from systemic challenges.	

Table 3 Ambivalence Surrounding Urban Dashboards

5.3. Analysis of Urban Dashboard Aims and Functionalities (Matters of Concern)

This analysis examines the stated aims and functionalities of ten urban dashboards, focusing on their common ground, and a comparative narrative to identify trends and potential challenges in urban data visualization.

Common Ground

Despite their diverse focuses, the examined dashboards share common threads, revealing key objectives relevant across urban contexts. These are the stated matters of concern and have been gleaned from analyzing the documentary material available for each dashboard. A strong emphasis on **transparency** emerges, with dashboards serving as tools to build public trust and empower citizen participation in governance by making information readily accessible. Furthermore, the dashboards prioritize **data-driven decision making**, presenting information in clear and actionable formats to facilitate evidence-based policy and planning. **Citizen engagement** is another recurring theme, with many dashboards designed for public accessibility, encouraging residents to

understand and engage with the complexities of urban management. Finally, a commitment to **equity and inclusivity** is evident, particularly in dashboards like the Transit Center Equity Dashboard and City Health Dashboard, which highlight the distribution of resources and opportunities. This focus reflects a growing recognition of the importance of social justice and equitable development within contemporary urban planning.

Comparative Narrative and Insights

These dashboards exhibit diverse priorities, reflecting the unique challenges and contexts of their respective urban areas. However, they collectively illustrate several key trends in urban governance. A strong focus on **public safety** is evident in dashboards like MCI, the Metropolitan Police Service's dashboards, and CompStat 2.0, which leverage data visualization to enhance transparency and accountability in law enforcement. This highlights the growing role of data in improving public safety while simultaneously raising important questions about privacy and ethical data use. Another trend is the increasing emphasis on **sustainability and global goals**, as seen in dashboards like the Sustainable Development

Report Dashboard and Geospatial Indicators Dashboard. These platforms emphasize the interconnectedness of urban issues with global challenges and the importance of aligning local action with global objectives. Furthermore, dashboards like the Dublin Dashboard and Brampton CityDashboard showcase the growing role of technology in urban governance, particularly in areas like integrated planning, data-driven progress tracking, and community engagement, signifying a shift towards "**smart city**" development. Finally, the City Health Dashboard and Transit Center Equity Dashboard underscore a growing commitment to **social justice and equity** by highlighting disparities in health and transportation services. This reflects a broader shift towards inclusive urban development that prioritizes the needs of all citizens.

5.4. Comparative Analysis of Urban Dashboard Governance & Affordances

This analysis identifies themes, patterns, and trends across the expanded dataset, examining the five dimensions of digital governance: **Privacy, Transparency and Data Collection, Stakeholder Collaboration, Citizen Engagement, and Accountability**. In other

words, it focuses on how the different dashboards address (or not) the inherent affordances that may cause technological risks. Using a comparative approach based on Robinson's framework for digital governance, the analysis categorizes risks, highlights recurring issues, and contrasts dashboards to reveal systemic vulnerabilities.

Ambiguity in Data Use and Ownership

A lack of clear protocols surrounding data ownership and usage. This ambiguity creates several significant risks. Firstly, dashboards may become tools of surveillance or facilitate unintended data repurposing. Examples like the MCI and Miami-Dade SMART Dashboard highlight the potential for privacy breaches due to weak anonymization standards. Secondly, the absence of transparency in data collection and methodology, as seen in tools like the SDG Dashboard, can lead to a selective framing of information, potentially misleading the public. Finally, the lack of defined ownership frameworks can marginalize stakeholders, favoring institutional control over collaborative governance. Ultimately, the operation of dashboards in this "gray area" of data governance erodes public trust and opens

avenues for misuse, highlighting an urgent need for clearer guidelines and ethical frameworks.

Power Centralization

Dashboards, while often acknowledged as tools for transparency and accountability, can inadvertently perpetuate traditional power dynamics. Their focus on data aggregation and performance metrics can inadvertently marginalize less powerful stakeholders. For instance, dashboards like Sustainable Development Report Dashboard might reflect the views of the actors that implemented them, at the expense of other urban communities that don't share the same level of power. Additionally, performance-driven tools like CompStat might allow institutional actors to manipulate narratives, potentially deflecting scrutiny or obscuring underlying issues. This trend suggests that dashboards, if not carefully designed and implemented, can inadvertently reinforce existing power hierarchies, limiting their potential to foster equitable and participatory governance.

Manipulation of Metrics for Selective Narratives

A concerning pattern emerges when examining the use of data visualization tools in civic contexts: the selective framing of information to present a potentially misleading narrative. While dashboards offer the promise of transparency and accountability, platforms like Brampton CityDashboard and the SDG Dashboard can be used to selectively highlight positive metrics while obscuring data that might reveal systemic shortcomings. This not only undermines the potential for accountability but also erodes public trust. Furthermore, dashboards like the City Health Dashboard, by presenting data devoid of context or actionable insights, can risk misleading citizens about the true state of progress and equity. This practice hinders meaningful citizen engagement and impedes the ability of residents to participate in informed decision-making. Ultimately, the selective use of data visualization tools to construct narratives aligned with institutional goals, rather than reflecting a complete and nuanced picture, masks underlying systemic issues and perpetuates a cycle of opacity and inaction.

Superficial Citizen Engagement

While dashboards hold the promise of increased citizen engagement in governance, their implementation often falls short, remaining tokenistic or surface-level. This limitation stems from several key issues. Firstly, concerns surrounding privacy and trust, as exemplified by dashboards like the Stop and Search Dashboard, can hinder genuine engagement. By failing to actively involve affected communities in their design and implementation, these tools risk perpetuating distrust and reinforcing existing systemic biases. Secondly, barriers such as the digital divide can exclude vulnerable populations due to accessibility challenges. This exclusion further limits the ability of these groups to participate meaningfully in governance processes. Finally, there is a pervasive trend of treating citizens as passive consumers of information rather than active participants in decision-making. This approach undermines the potential of dashboards to truly democratize governance, reducing them to mere presentations of data rather than catalysts for collaborative action and informed decision-making by the citizenry.

Surveillance and Control

While designed to enhance public safety and urban management, can inadvertently become tools of surveillance and control. Platforms like CompStat and the Transit Center Equity Dashboard, despite their potential benefits, raise concerns about the monitoring of vulnerable groups and activists, potentially leading to privacy violations and data misuse. Furthermore, the emphasis on enforcement metrics in dashboards such as the Use of Force Dashboard may foster a culture of control rather than genuine collaboration with stakeholders. This trend highlights a critical tension. While dashboards offer transparency, their affordances can be easily extended to enable surveillance, blurring the lines between public benefit and potential misuse. It is essential to address these concerns by implementing robust privacy protections, promoting stakeholder engagement, and ensuring that dashboards are used ethically and responsibly.

Misalignment Between Stated Goals and Implementation

Many dashboards, despite their promise, fall short of effectively aligning their stated objectives with their practical implementation. This disconnect often manifests in several key ways. Firstly, accountability gaps emerge when dashboards set unrealistic targets, as seen in tools like the SDG Dashboard. Such an approach can inadvertently shift blame for systemic failures onto communities or external factors, rather than fostering genuine accountability. And, there is a general trend among dashboards to emphasize aspirational goals while neglecting the structural issues that undermine their stated purpose. This disconnection between aspiration and action can render dashboards ineffective tools for driving meaningful change.

Performance Metrics as Incentives for Data Manipulation

When rewards or punishments are linked to metrics displayed on these dashboards, there's a strong incentive to present data in a way that flatters the institution, even if it deviates from reality. For example, the MET system, originally

designed to improve crime reporting and policing strategies, can inadvertently encourage the falsification of crime data to meet performance targets. Similarly, dashboards like the Brampton CityDashboard, while aiming to promote transparency and accountability, may end up prioritizing results-driven metrics and obscuring deeper systemic issues within the governance structure. This trend of prioritizing institutional narratives over genuine accountability poses a significant risk, as it undermines the very purpose of these dashboards and erodes public trust in the institutions they represent.

Tokenism in Stakeholder Collaboration

Often, these platforms prioritize the perspectives of elite stakeholders, as exemplified by initiatives like the Dublin Dashboard, which may focus on urban priorities favored by those in power while marginalizing the concerns of grassroots organizations. Similarly, even when dashboards aim for citizen engagement, such as in the Stop and Search Dashboard, the involvement of communities can remain superficial, failing to address their deeper concerns and needs. This tendency towards tokenism undermines the potential of

dashboards as tools for truly inclusive governance, highlighting the need for a more genuine commitment to incorporating diverse perspectives in meaningful ways.

Accountability Avoidance and Blame-Shifting

The design of dashboards, such as SDG Dashboard and Brampton CityDashboard, could deflect responsibility by externalizing failures onto communities or other actors. This, in turn, could shield institutions from scrutiny and needed reforms. Furthermore, the lack of mechanisms for citizen feedback or redress on many dashboards could exacerbate this issue, enabling a culture of unaccountability.

5.5. Broader Implications

The detailed analysis of specific risks across different urban dashboards paints a concerning picture. These risks, ranging from privacy breaches and manipulation to the reinforcement of systemic biases, point towards broader implications that can undermine the very foundation of digital governance in smart cities.

Systemic Risks

The examples of selective data presentation, misleading visualizations, and lack of context in dashboards like the MCI or MET would demonstrate how these tools might perpetuate existing inequalities. This reinforces the broader implication of institutionalizing systemic biases within urban governance.

Ethical Dilemmas

Concerns about surveillance and the erosion of privacy, highlighted by the misuse of the Miami-Dade SMART Congestion Management Dashboard, would underscore the tension between data utility and ethical safeguards. This necessitates stricter governance frameworks to ensure responsible technological development.

Power Concentration

The potential for dashboards to be used for control and social sorting, as exemplified by CompStat 2.0 or the City Health Dashboard, highlights the risk of power concentration in the hands of elite stakeholders. This can undermine the participatory ethos that should be at the heart of smart city initiatives.

Trust Erosion

The lack of transparency and accountability, coupled with the potential for manipulation and stigmatization, as seen in various dashboards, could severely erode public trust in digital governance. This erosion of trust can hinder the adoption of beneficial technologies and create barriers to citizen engagement.

Lost Potential

The risks of superficial engagement and tokenism, along with the digital divide, as mentioned in the analysis of Citizen Engagement, demonstrate how dashboards could fail to engage citizens meaningfully. This results in missed opportunities to democratize governance and co-create urban solutions, limiting the transformative potential of smart city initiatives.

5.6. Key findings

Matters of Concern

Enhance Transparency and Accessibility: Tools like the Dublin Dashboard and SDG Dashboard aim to demystify governance by presenting actionable, data-driven insights that build public trust.

Promote Citizen Engagement: Dashboards like the Transit Center Equity Dashboard and City Health Dashboard prioritize social equity by highlighting disparities in transportation access and health outcomes.

Facilitate Data-Driven Governance: Tools like CompStat and Brampton CityDashboard emphasize data-driven decision-making to improve public safety and urban management.

Affordances

Privacy Breaches and Surveillance: Tools like CompStat and Miami-Dade SMART Dashboard might enable profiling or over-surveillance of vulnerable groups, undermining the very transparency they claim to enhance.

Selective Transparency and Data Manipulation: Dashboards like the SDG Dashboard, and MET might present skewed narratives that favor institutional interests, eroding public trust.

Power Concentration and Stakeholder Exclusion: Dashboards like the Dublin Dashboard often reflect the priorities of elite stakeholders, sidelining marginalized communities in decision-making processes.

Superficial Citizen Engagement: Despite their claims, tools like the Stop and Search Dashboard might treat citizens as passive observers rather than active participants, perpetuating tokenism and mistrust.

Ambivalence features

Dual Potential: Dashboards possess the capacity to empower communities and enhance governance while simultaneously reinforcing systemic inequities and exclusionary practices. For example, the City Health Dashboard could inform equitable healthcare reforms but might also stigmatize underserved neighborhoods through public exposure of disparities.

Ethical Tensions: The potential for misuse and unintended consequences, such as surveillance or selective transparency, highlights the ethical dilemmas embedded in digital governance.

Systemic Risks: Dashboards might institutionalize biases, prioritize elite narratives, and undermine trust in governance, as seen in tools like the Brampton CityDashboard and SDG Dashboard.

5.7. Ambivalence in Urban Dashboards

Urban dashboards, while promising tools for civic engagement and data-driven governance,

are fraught with inherent tensions. While marketed as instruments of transparency, they can be subtly manipulated to present selective narratives, as exemplified by the MET, potentially masking deeper urban issues. This tension between transparency and manipulation underscores the inherent power dynamics at play. Furthermore, despite aspirations towards inclusivity, many dashboards inadvertently exclude marginalized communities due to the digital divide or superficial engagement strategies. This gap between intended engagement and actual exclusion raises concerns about equitable representation. Finally, the potential for empowerment through data access is counterbalanced by the risk of surveillance and profiling, evident in the MCI Dashboard. This duality highlights the fine line between citizen empowerment and control. Ultimately, urban dashboards embody both aspirational innovations (Empowerment), aiming to democratize urban governance and address societal challenges, and risk-prone systems (Control and Exclusion), capable of enabling unintended consequences and ethical dilemmas. Their effectiveness and ethical

implications are inextricably linked to the socio-political contexts in which they are deployed.

This thesis explored the ambivalence of urban dashboards as socio-technical tools, situated at the nexus of technological innovation and urban governance. Through the lenses of Affordance Theory and Matters of Concern, the study illuminated how dashboards simultaneously empower governance with data-driven insights while posing risks of privacy erosion, data manipulation, and exclusionary practices. The research addressed the central question: How can urban dashboards enhance digital governance while simultaneously posing risks of power abuse, and how can these conflicting potentials inform ethical practices in urban management?

Key findings reveal that urban dashboards embody dual potentials:

Empowerment: By enhancing transparency, fostering citizen engagement, and supporting data-driven policymaking, dashboards hold the promise of democratizing governance and improving urban management.

Control and Exclusion: Conversely, dashboards risk exacerbating systemic inequities through surveillance, selective data representation, and

exclusionary practices that marginalize vulnerable populations.

The ambivalence of these tools is not an inherent flaw but a reflection of the socio-political contexts in which they operate. Their outcomes depend on governance structures, stakeholder collaboration, and the ethical frameworks guiding their implementation.

Despite their potential, dashboards are far from neutral. They are imbued with political and ideological agendas, as seen in the selective affordances that prioritize quantifiable metrics over qualitative insights and public engagement. This tension underscores the importance of robust digital governance frameworks that uphold principles of inclusivity, equity, and accountability.

Furthermore, the integration of AI and machine learning into urban dashboards presents both exciting opportunities and significant challenges. These technologies have the potential to further enhance the capabilities of dashboards, but they also raise new ethical concerns regarding bias, transparency, and accountability. As we move forward, it is crucial to carefully consider the implications of AI and

machine learning in the context of urban dashboards and to develop responsible frameworks for their deployment.

In conclusion, urban dashboards exemplify the complexities of urban governance in the 21st century. As tools of both empowerment and control, they challenge us to navigate their ambivalence responsibly. By critically examining their affordances and matters of concern, we can harness their transformative potential while mitigating risks, striving toward more equitable, transparent, and ethical urban governance.

To address the complexities revealed in the analysis (such as risks of privacy erosion, exclusionary practices, and selective transparency) the following strategies provide actionable pathways emphasizing robust governance mechanisms, ethical frameworks, and inclusive citizen engagement. Together, they aim to mitigate systemic vulnerabilities while maximizing the transformative potential of dashboards, striving toward their realization as equitable, transparent, and accountable tools for digital governance, in response to the dual nature identified throughout this study.

6.1. Leveraging Digital Governance to Harness Urban Dashboards

To effectively harness the power of urban dashboards, it is essential to approach their implementation through a multifaceted strategy. Robust digital infrastructure is essential to support the real-time data processing and analysis required for effective urban dashboards.

The analysis of various dashboards revealed a range of critical concerns. Several dashboards risk excluding vulnerable populations due to the digital divide and inadequate infrastructure. Furthermore, dashboards like the SDG Dashboard and City Health Dashboard may prioritize elite narratives or misrepresent systemic failures by lacking contextualized data visualization. Ethical concerns are also prevalent, with risks of data misuse, privacy breaches, and surveillance identified in dashboards such as CompStat and the Miami-Dade SMART Dashboard. The analysis consistently found that power concentration and the exclusion of marginalized groups are systemic issues, evident in many dashboards. Privacy concerns, particularly profiling and re-identification risks, were recurring themes,

notably in the policing-oriented dashboards. Finally, dashboards often fail to foster meaningful public engagement or address mistrust, treating citizens as passive observers rather than active participants, as seen in the Stop and Search Dashboard and the Brampton CityDashboard.

Knowing that, we can ensure that urban dashboards are designed and implemented to address the specific needs and challenges of different urban contexts. Aligning dashboards with existing policy frameworks ensures

adherence to standards of data privacy, security, and transparency, thereby promoting ethical use. Governance mechanisms must be established to mitigate risks of power abuse, while technological safeguards are necessary to protect sensitive data. Transparency and citizen engagement further enhance dashboard effectiveness by making data accessible and comprehensible to the public. These strategies create a comprehensive approach to leveraging urban dashboards for more effective and accountable governance (Crawford, 2021).

Strategy	Description
Align with Policy Frameworks	Implement dashboards within established policy frameworks to adhere to data privacy, security, and transparency standards, ensuring ethical governance.
Mitigate Risks of Power Abuse	Establish governance mechanisms such as oversight committees to prevent misuse and ensure the responsible use of dashboards.
Ensure Privacy and Security	Incorporate safeguards like encryption and access controls, and conduct regular security audits to protect data and maintain dashboard integrity.
Promote Transparency and Citizen Engagement	Design dashboards with transparency features and user-friendly interfaces, and engage citizens through feedback mechanisms to align functionalities with public needs.
Leverage Case Studies	Analyze successful dashboard implementations to identify best practices and strategies for optimizing dashboard use in urban governance.

Table 4 Strategies to address Urban Dashboards' Complexities

6.2. Mitigating Risks of Power Abuse in Urban Dashboards

This dissertation suggests that the success of open data dashboards is not solely dependent on the visibility of data but also on the

underlying decision-making processes within government organizations, which may not be fully transparent to the public, and the availability of data has not been enough to support open governance. Data must be

analyzed and presented in easily digestible formats if it is to serve the government and community. In another classification of urban dashboard (real-time urban dashboards), while it is useful for operational decision-making, often limit citizen participation to passive observation and data consumption. By design, these dashboards are typically used by operators to monitor and manage systems in real-time, reinforcing the assumption that the tool is a tool of power for those in control. This lack of direct engagement hinders the potential for citizens to influence decision-making processes and shape their urban environments. To address this issue, it is essential to transition towards a more interactive and participatory model of citizen-government relationships through real-time urban dashboards. This involves creating opportunities for citizens to actively contribute data, provide feedback, and participate in decision-making processes related to urban planning and governance. By leveraging the power of real-time data and technology, dashboards can become platforms for collaborative problem-solving and democratic engagement (Lock et al., 2020).

The success of open data dashboards depends not only on data visibility but also on transparent decision-making processes and meaningful citizen participation. To achieve this alignment, several key enhancements could be implemented:

1. First, the dashboard could be further democratized by incorporating more direct and interactive opportunities for citizen participation. This might involve real-time feedback mechanisms, citizen-led data collection initiatives, or even the creation of citizen-driven visualizations. By empowering citizens to actively contribute, the dashboard can foster a sense of ownership and encourage deeper engagement with community issues (DeLoyde & Donald, 2024).
2. Second, the underlying decision-making processes within government organizations should be made more transparent. This could involve publishing decision-making documents, providing opportunities for public input on policy decisions, and clearly articulating how data from the dashboard is used to inform policy and action. By increasing transparency, citizens can better understand the rationale behind policy choices and hold

decision-makers accountable (DeLoyde & Donald, 2024).

3. Third, the dashboard could be enhanced with more real-time data and interactive features. This might include real-time updates on key indicators, interactive mapping tools, or simulations that allow citizens to explore different policy scenarios. By providing a more dynamic and engaging experience, the dashboard can better capture the attention of citizens and facilitate collaborative problem-solving (DeLoyde & Donald, 2024).

4. Finally, it is essential to establish clear mechanisms for data-driven policy development. This might involve creating dedicated policy teams that analyze dashboard data, conducting regular reviews of policy effectiveness, and incorporating citizen feedback into the policy-making process. By ensuring that data is used effectively to inform policy, the dashboard can contribute to more evidence-based and responsive governance (DeLoyde & Donald, 2024).

Urban dashboards, as integral components of smart city infrastructure, provide unparalleled opportunities for enhanced data-driven

governance. However, they also harbor potential risks of power abuse, necessitating a proactive approach to mitigate these threats. Addressing these risks involves a combination of technological safeguards, policy frameworks, and ethical guidelines that collectively ensure the responsible use of dashboard capabilities.

6.3. Technological Safeguards?

Implementing robust technological safeguards is a foundational step in preventing power abuse associated with urban dashboards. Key measures include encryption, access controls, and audit trails, which collectively secure data integrity and restrict unauthorized access. Encryption techniques protect sensitive data from being intercepted or tampered with during transmission, while access controls ensure that only authorized personnel can interact with critical dashboard functions. Moreover, audit trails provide a detailed log of user activities, enabling the detection and investigation of any suspicious behavior (G. Davis et al., 2005). In this context, the Standard Data Protection Model (SDM) is a critical tool designed to ensure that personal data is processed in compliance with the General Data Protection Regulation (GDPR). Although

established by the European Union, the GDPR imposes global obligations, as it applies to any organization that handles or targets data related to individuals in the EU. The SDM guides the selection of both technical and organizational measures across all phases of data processing, ensuring that organizations meet legal data protection requirements through defined processing goals. This structured approach helps organizations maintain responsible data management, particularly in sectors like urban governance (Rost & Weichelt, 2022).

At the heart of the SDM are seven protection goals—data minimization, availability, integrity, confidentiality, unlinkability, transparency, and intervenability—each of which ensures that personal data is processed lawfully while minimizing risks to data subjects.

These protection goals are operationalized through adaptable measures, providing a scalable framework that integrates data protection with broader information security practices (Rost & Weichelt, 2022).

By operationalizing these goals through technical and organizational measures, the SDM ensures that personal data is processed in

compliance with legal requirements, and the rights and freedoms of data subjects are safeguarded (Rost & Weichelt, 2022). In the context of urban dashboards, where vast amounts of data are aggregated and visualized, these safeguards are crucial to maintaining transparency and trust.

6.4. In conclusion...

Acknowledging the technological ambivalence of urban dashboards, as well as the importance of digital governance to ensure that critical safeguards exist in the use and adoption of these digital tools, speak to the necessity of a shared vision at the intersection of urban and digital governance. Effective governance is crucial in managing these technologies to mitigate challenges and maximize urban benefits. A politically informed approach to digital and urban transformation, emphasizing inclusivity, sustainability, and accountability within digital ecosystems is required. Ultimately, digital transformation in the governing of cities is a political process that requires inclusive governance to harness positive outcomes effectively and address challenges comprehensively. (Schoemaker, 2024)

“The combination of hatred and technology is the greatest danger threatening mankind.”

Simon Wiesenthal

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