Establish an Urban Data Exchange for Smart Cities

Refreshed 28 September 2021, Published 26 March 2020 - ID G00377302 - 25 min read

FOUNDATIONAL This research is reviewed periodically for accuracy.

By Analyst(s): Bettina Tratz-Ryan, Bill Finnerty

Initiatives: Government Digital Transformation and Innovation

> Data's value depends on its quality and the context needed to support the service and business requirements of all stakeholders in a smart city ecosystem. CIOs in government and industry building data-driven decision and business models need to understand data exchanges to succeed in a data economy.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- Where Next? Technology Leadership in a World Disrupted: Key Insights From the 2021 Gartner IT Symposium/Xpo Keynote

Overview

Key Findings

- Government CIOs share responsibilities with their chief data officer counterparts in areas such as technical standards, data management policies, information governance and management of the open data environment. The availability of quality open government data in real time is fundamental to supporting a data exchange.
- A transparent exchange of quality, real-time, open data and the ability to apply user context to the access of data are key requirements of a sustainable data marketplace.
- Governments are applying standardized methodologies like International Organization for Standardization (ISO) 37120 and commercial data orchestrators like the Industrial Data Space to create a blueprint of data governance.
- CIOs turn to open-source architectures and delivery models to provide flexibility for new stakeholders in government and business to contribute in the data exchange.

Recommendations

CIOs who are involved in cross-industry innovation and disruption should:

- Jump-start their exchange development initiatives by providing full advantage of "lessons learned" from other cities or resources for a successful data exchange implementation, especially in how to establish good quality data.
- Encourage investment from the private sector by creating a collaboration platform around data value creation, such as traffic flow, parking usage or business development.
- Create a foundation for future service benefits by taking a user-centric view for the design of data architecture, remembering that users also include machines and intelligent systems.
- Provide a visualization mechanism that will consider the variation of data and value understanding of the data requestor by building identity management via logins, passwords and profile settings.

Strategic Planning Assumption

By 2023, 30% of smart city initiatives will lose political and public support and be discontinued for lack of integrated services and data analysis.

Analysis

Data is becoming the ubiquitous resource for digitalization in intelligent urban ecosystems. Therefore, smart city services rely on the quality of the data mapping between different stakeholders and assets to drive citizen value (see Note 1).1

The concept of a data marketplace or exchange injects a methodology to evaluate the usefulness, as well as the ethical and privacy concerns of data.

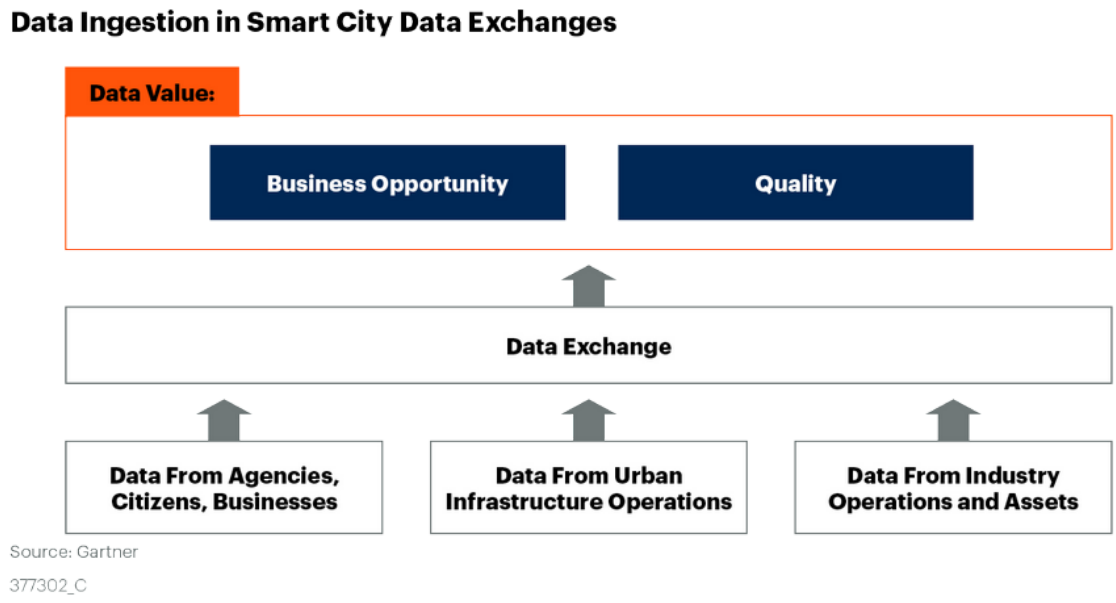
The terminology is diverted into "data marketplaces," a preferred term by industry, as well as "data exchange," which is preferred by government, because the notion of monetization is often controversial.

Gartner asserts that, in a data economy, data exchange will happen as an ecosystem driven through value, so a data exchange or data marketplace combines both industry and government benefits.

Data exchanges create a valuable data stream for different public and private users, while measuring the impact and usefulness of data collaboration across different smart city partners and the local government (see "The Urban Data Marketplace Will Be an Engine of Community Innovation")

To function effectively, smart cities must continuously process data streams from multiple sources. This includes data streams from various sources and in different features, as shown in Figure 1.

Figure 1. Data Ingestion in Smart Cities



The value and market price of enriched data is determined by the business opportunity it represents and the certified quality of the data itself. To establish requisite levels of trust and confidence among data consumers, a transparent governance and valuation system must underpin any large-scale data marketplace. Urban data marketplaces are being developed in several ways:

- Directly or governed by the cities or authorities
- Via public/private partnerships with IT players
- Via independent service providers

Ownership of the data usually resides with the producer of the data, although ownership may also be established through a contract with the value-added service provider of datasets. However, the current data marketplace incarnations are not likely to succeed in the long term until developers implement fundamental governance mechanisms and viable business models.

The business benefit of urban data marketplaces resides in the contextualization of the user requirements to access data. Issues around data quality, the digital maturity of the society and users, as well as data trust are critical, and can lead to limited viability, due to the lack of data exchange and value generation.

Data Access to Drive Digital Citizen Equity

Digital data inclusion requires that every entity — that is, person, business, governmental organization, smart machine or smart system — that could potentially benefit from accessing marketplace data be enabled to do so. Different entities have different needs and abilities. Not every citizen or organization is a data scientist, but all should have equal access to the same content of data as somebody who can understand the nuances of it. Therefore, identifying the different levels of data literacy through user login is key to tailoring the insights to be gained from data. That will instill data literacy and trust across the citizens that understand the power of data and digital. In addition, it will also empower individuals, entrepreneurs or organizations to look for digital progress to support their own setup, and personal and professional environments. Gartner's digital citizen equity index (see Note 1) provides a view of the trust in the digital penetration of business and consumers in selective countries based on the perception of digital enablement that it will provide. Understanding and discovering which data or information is helpful in this enablement is key for digital trust.

The various types of data discovery will likely follow the broader trends in the data discovery market, which are powered by smart machines or artificial intelligence. Here, the buying priority will be on extending and automating the user experience for preparing data, finding patterns in data and sharing data findings. Every participant in urban data marketplaces can benefit from the data that is available from the city ecosystem.

A broad-based smart city marketplace environment will consist of multiple data marts, capable of supporting several cities sharing and trading reliable data within a larger ecosystem that includes businesses, government and citizens. Such a shared data environment is especially important for smaller cities or urban corridors. These communities can benefit from the data orchestration and governance environment that ensures the universal and secure exchange of high-quality data. Organizations such as the World Council on City Data (WCCD)2 (see Note 2) have built a framework on ISO 37120 for data clarity, so that cities that have adopted the guidelines can directly compare their city data libraries with each other.3

Gartner Recommendation:

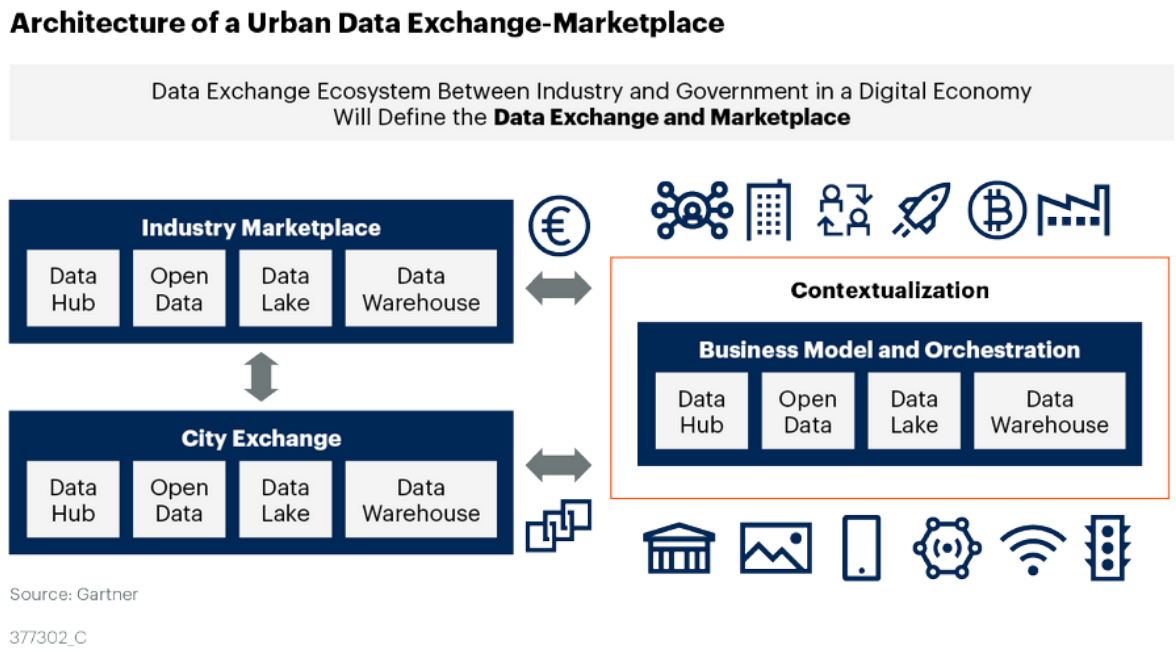
In preparing their city urban ecosystems for the development and scalable data exchange, CIOs in local governments, as well as in cross industries, could build their architecture foundations on open-source application, data delivery and monetization models. Those will be key when developing their application operation systems and platforms. The ability to interface with the middleware underlying a proposed ecosystem will be critical. Systems employ various delivery and innovation models, such as used by standards organizations like FIWARE, the platform for smart cities and local government API development in Europe. Therefore, CIOs may look to engage with third-party developers or other entities to enable solutions to be built on their platform.

CIOs will also want to pursue discussions with the business and knowledge community in their cities, and collaborate with them on digital rights management, data attributes required and privacy issues. This will lead to examining the data maturity of the ecosystem to find interaction hooks with potential business stakeholders. In the long term, they will want to develop a roadmap for connecting a “system of data marts” that embeds open data portals and warehouses in an algorithmic or even autonomous business environment. They may also want to consider chatbots and smart machines to create automatic machine learning insights.

The Data Exchange-Marketplace Architecture

An urban data exchange or marketplace depends on the ability to obtain good data. Driving demand for data by other government entities, businesses or citizens will require assurance that all data is authenticated and orchestrated through a standardized methodology. Easy availability to good quality data is fundamental to any viable marketplace business model. Frameworks such as ISO 37120 or Publicly Available Specifications (PAS) 182 of the British Standards Institute (BSI)4 ensure data integrity and quality (see Note 3). Such standards form the foundation of the data exchange or marketplace by driving the economics of scale of availability of useful data. When applied well, maintaining the quality of data also supports citizen engagement efforts from a bottom-up view. Integrity requires a data governance environment (see "How to Achieve Better Business Model Strategies With Industry Data Governance"), as well as a data ethics environment that understands the potential physical and virtual data validation routines and defines data privacy and accuracy on market principles (see Figure 2).

Figure 2. Architecture of an Urban Data Exchange-Marketplace



The urban data exchange-marketplace consists of three different elements: the data orchestration architecture, the business model orchestration and the context visualization environment.

Data Orchestration Architecture

The data repository stores and categorizes data based on architectural data warehouse and data management principles. It applies the governance principles of processing languages and has the potential to handle more flexible queries that will lead to logical data warehousing, hubs and data lake architectures.5 Data architecture can be defined by the data ontologies that describe the semantic characteristics of the data. Deciding to replace, upgrade or overlay a data warehouse depends on the complexity of data queries, the interactivity and fluidity of analytics needed and also the proprietary construct of it.

Adding or integrating data marts in a data warehouse architecture allows the architecture to be a system of systems. This enables priorities or levels of data — from a security or privacy aspect — to be defined, accessed and traded differently or at a premium. It also allows the definition of data models that may be interesting for semantic alignment, proliferation of analytics and the different use cases that require different processing styles. In the definition phase of the data orchestration, it is important to define the rules for data ingestion and data sorting to ensure that the data is usable when pulled and contextualized.

Business Model Orchestration

In data exchanges or marketplaces, business model platforms depend on context brokers6 to create context — that is, to add individualized value indicators and value-added features that connect the usefulness of the data to the potential demand for it. Context is also a key driver for decision management. Context-aware services are based on the semantics of data — that is, the information that allows machines to understand the meaning of data based on the different timing and data trading models. Refinement rules that are developed by context brokers, orchestration agents or other empowered data architects allow for added refinement to the attributes and links to datasets. They are modeled according to applications and the transactions on the user side. The definition of analytics frameworks offers analytics-based understanding of raw data and its value, or the semantical enrichment and linkage whose outcome can be simulated to rate usefulness.

Visualization, User Dashboards and Applications

Visualization, user dashboards and applications give users access to data and the information that raises business intelligence and market value for the requests for insights.

Visualization of data insights can be created in a number of ways — through dashboards, reporting tools, web portals, graphs, application layers/systems or geographical information system maps. Especially in times of critical information requirements, like during the current COVID-19 pandemic, data visualization allows citizens to get easy-to-understand and meaningful data from a variety of different sources, such as Singapore's COVID-19 dashboard. Frequently, APIs provide access to raw data that innovators and application developers need to build their own solutions. Organizations and governments may want to create their own data marts or data discovery, and interact on different user requirements on the application layer of the data exchange or marketplaces to interactively engage with and query data analysis.

As the autonomous business evolution progresses in city ecosystems and exchanges, the underlying business analytics and data orchestration in dashboards will be based on machine learning and intelligent systems. Such systems will be able to anticipate or emulate the user's data and business requirements, and pull algorithms and assessment frameworks for it. Creating a user-friendly visualization and access methodology is a critical element for user adoption of the information requests within a data exchange or marketplace. On the other hand, understanding the user's context of data requests enables users with specialized data requests to create digital twins of asset, location and business process data in a very visual and communications-driven approach.

The list of users will extend well beyond people and governmental or business entities. Machines and applications will draw on data and information with various techniques and approaches. While data democratization among nondata scientists is a performance goal for visualization, equally important will be the ability for applications to access data in a contextualized manner. That will significantly increase transaction volumes and utilization rates.

Examples of the above are already in operation:

- New York City's Open Data is the first step for connecting users to open data, using a mix of data lenses for specific views, as well as city records online through the data tracker.
- Dubai's data exchange is commissioned by the Dubai Data Establishment and started with a Dubai data law, describing the framework of data governance for citizens and businesses.

- Data for London ("City Data Analytics Programme," London Datastore) is the city data strategy that will — through the London Office of Technology and Innovation's (LOTI) City Data Analytics Programme — architect the data economy based on a City DataStore.
- Global Big Data Exchange,7 based in southwest China's Guizhou Province, serves big data trading for over 20 industries with around 2,000 members and an approximate trading value of 120 million yuan ($19 million).
- oneTRANSPORT Data Marketplace in the U.K. by InterDigital is exchanging transport and mobility data, managed on real-time data for cities, such as Buckinghamshire County Council and Hertfordshire County Council.8 It's sold as a commercial managed service. It works as a contextualization of data exchanges for different entities and customers without creating individual data-sharing agreements.

All of those projects have one thing in common, they require CIOs to determine a data governance model — the guidelines for the data and information methodology to be used and communicated. Without this governance, the trust and accuracy in a city data marketplace are fragile and can be disrupted through malfunction or cyberattacks. In addition, data governance models build trust into the systems of privacy and agreements for data exposure and data collection.

Smart Data Will Fuel Contextualized Business Value for an Intelligent Urban Ecosystem

The business value generated through an urban data exchange or marketplace benefits local government, businesses, service providers and citizens, as well as application developers in research and innovation hubs. It is important that interested users be able to access the insights and the value within their own means of understanding it. This context — that is, the terms and conditions under which the access and the transfer of insights is granted — can be delivered through login or authentication of the access to the exchange.

Data architects need to thoroughly understand the user profiles (or personas) or use cases to determine how context is achieved. Read-only access can be offered as an information or report tool without individualized access, with a low level of customization on the side of the users. In addition, data solution providers, such as the National Technical Information Service (NTIS) in the U.S., provide a business process around aggregation, management and enrichment, cleansing, and analysis of data sources for the sake of licensing data to external customers.

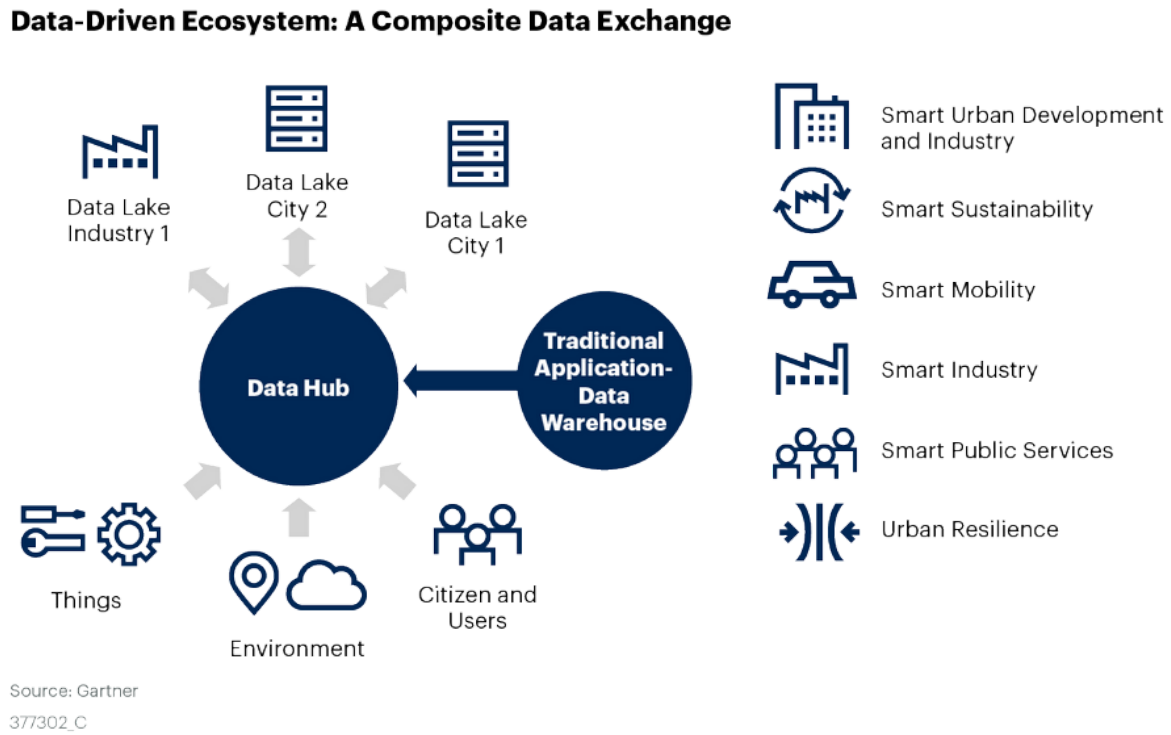
Data architectures will require contextualization to encourage the trustful engagement between data ecosystem partners over time, with the right:

1. Digital culture and mentality of society and industry
2. Prioritization of business models based on data as an asset
3. Level of data communications by stakeholders
4. Depth of data governance and data value qualifier
5. Data trust and General Data Protection Regulation visibility

Gartner expects to see data exchanges and marketplaces that build on multiple marketplaces and exchange platforms being orchestrated together.

Figure 3 shows the data exchanges and marketplace “system of systems.”

Figure 3. A Composite Data Exchange Based on a Data-Driven Ecosystem



Gartner expects that many CIOs working on creating the vision and executing the plan for smart cities will eventually be looking to monetize their sites. This could be done by migrating their existing open data portals into the transaction environment of data exchanges and marketplaces, together with industry players. This also will apply for visualization portals such as Data USA, which lets users query data based on specific requests. This can be used purely for information gathering or — when inserted or connected to the data marketplace — as a base for further transactions.

To create a foundation for further service benefits, CIOs need to take a user-centric view of the design of the data architecture and keep access and user interfaces in mind. The more that users recognize the site's benefits, the more they will use it for information, applications and insights. Therefore, CIOs need to look for standardized best practices to take full advantage of lessons learned from other cities or resources for a successful data exchange implementation (see Note 4):

- There is standards development for data generation, such as the World Council on City Data, using a portal approach for city open data to support the scale of city insights globally. Together with an ISO 37120 methodology, the methodology of open data development can be published in a transparent way for cities in different city and business segments.
- Data marketplaces apply to counties, cross-jurisdictional government entities and urban corridors. It will no longer work to build a data portal in isolation. Strive to get comparable datasets in place so they can be visible, accessible and evaluated based on the meaning for the individual requestor.
- Increasingly, business or industry data marketplace architectures, such as mobility-related data marketplaces, are being built — for instance, the U.K. oneTRANSPORT Data Marketplace, for the entire urban and rural mobility ecosystem. HERE Mobility is developing a logistics and transportation service and data hub for urban mobility and logistics stakeholders.
- An increasing number of data governance examples exist that contain guidance on data updates of metadata, queries, transactional guarantees or safety labels. With this guidance, government can act as a trusted source of data governance and trading. One example is Finland's Sitra's IHAN initiative.

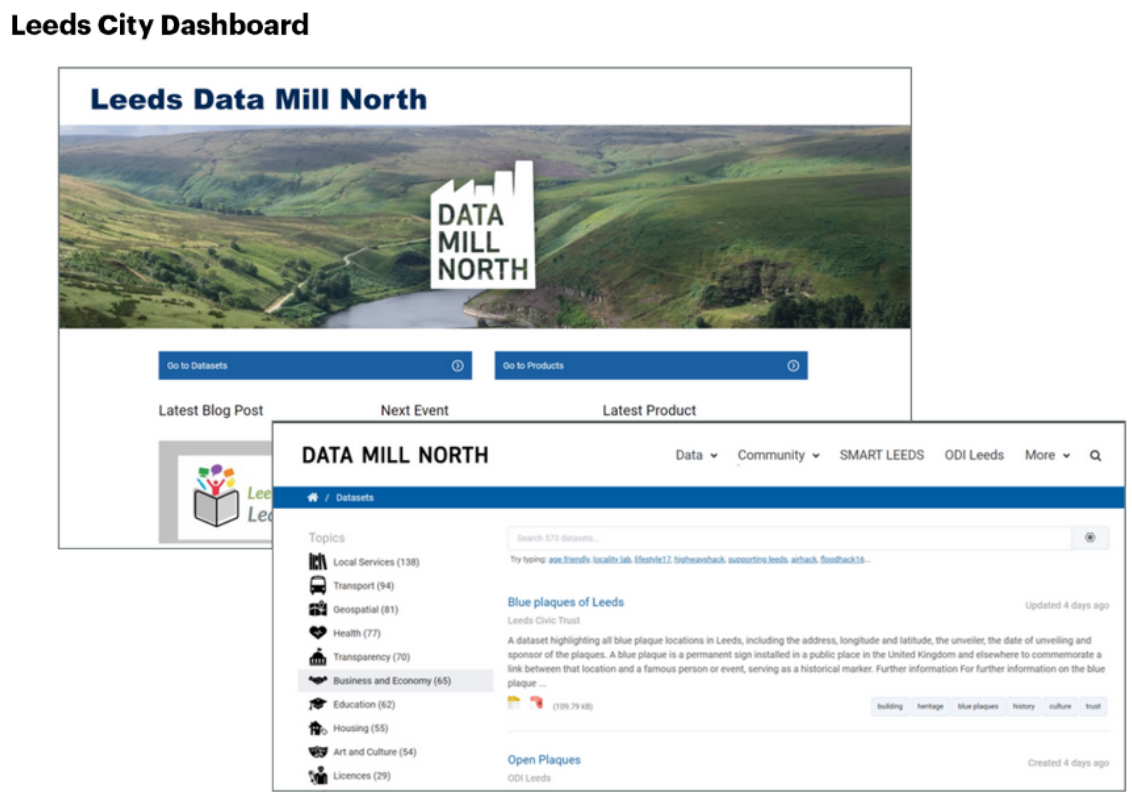
Copenhagen, Testbed for Data Exchanges to Learn From

However, there are also examples of failures of the development of urban data marketplaces, such as Copenhagen City Data Exchange (CDE). Being established as a public-private partnership between the city of Copenhagen and Hitachi, the CDE was based on the bleeding edge of technology. However, the with a strong drive being commercially viable, the business goals were not met, and Hitachi terminated the contract. As a lesson learned and published by the city of Copenhagen ("Learnings From the City Data Exchange," Copenhagen Solutions Lab), CIOs in local government and cross-industry ecosystems should design the commercial focus base (see also "The Urban Data Marketplace Will Be an Engine of Community Innovation").

Case Study: Leeds Council

Data Mill North (formerly Leeds Data Mill) is an open data portal with a data exchange and marketplace strategy and, as of February 2020, contains around 568 datasets from local governments and agencies, as well as community and industry. It has a wide mix of structured, machine-readable and non-machine-readable datasets, and a product section where users of datasets can publish their findings and solutions for other users. The datasets are available for developers who are building new applications and insights, and for those who may want access to information that would otherwise have meant submitting a Freedom of Information Act request (see Figure 4).

Figure 4. Leeds City Dashboard



Source: Adapted From Data Mill North

377302_C

The CIO of Leeds City Council, Dylan Roberts, is responsible for the development and continuous advancement of the data exchange that is able to scale data engagements in a trusted and ethical framework that's applicable for the city's future digital economy.

The Data Mill supports the six pillars of the council's smart cities program, SMART LEEDS, of which one is concerned with delivering the data and insights needed to accomplish digital-data-driven decision making. Other data exchanges with whom Data Mill collaborates include Calderdale Data Works, Northern Data Hub, Sheffield City Council Open Data and York Open Data.

The city of Leeds is also home to ODI Leeds, a pioneer node of the Open Data Institute set up by Sir Tim Berners-Lee, inventor of the world wide web. Together, ODI Leeds and Data Mill North have developed innovative approaches to the exchanging and reuse of data across different stakeholders and partners (see the Leeds Dashboard).

Developing a “system of systems” approach is a logical next step, given that Data Mill North is already consuming data from a variety of sources and working closely with other open data portals. The Data Mill and London Datastore will be working together to understand the data platform architecture requirements and the data governance that are needed to develop the wider data ecosystem. In the data ecosystem, there is a need for a data orchestration platform that facilitates “innovation labs” with the digital sector, industry and citizens to work together to create new solutions that support sustainable growth for citizens and industry. This not only includes the creation or transformation of urban, suburban and rural services, but also citizen empowerment to enable participation in the digitalization efforts and inclusive growth of the city, leading to digital equity and inclusion. London’s chief digital officer Theo Blackwell is driving a purpose-driven data exchange where the development of data culture and lessons across the stakeholders and citizens are key initiatives.

An important factor in the advancement of the data exchange and marketplace model will be the use of an office park as a “living lab” area that will become a regional center of innovation and excellence. Data can be used to create more trusted exchange patterns, using data privacy and protection. In addition, it will also support the underuse of the data and encourage more-frequent applications of data in innovation programs.

Currently, Gartner observes that data generated by local government and orchestrated and exposed through the data marketplace is being exchanged without payment. In the long run, CIOs that are building those data exchanges, facilitating partnerships of data trades or providing the architecture for data governance may consider planning to commercialize data interactions. That value will be related to the cost of storage or data value for autonomous business requests, or the intrinsic value of the data. Therefore, transformational CIOs will be looking to establish a data culture or digital mentality supported by IT within the government organizations or business organizations.

At first glance, to drive a data culture, CIOs need to transform conventional governmental or business operations. They can do this by assessing how businesses or users are interacting with each other in their daily lives through social media, chats, web applications or others. Very often, national open data policies can be leveraged for that. In addition to the European Data Portal or the U.S. Project Open Data site, many local governments are driving open data as a way of exposing their data records and creating transparency of the data they own. The growth in open government data has reenergized performance management programs, which, in turn, can produce greater accountability.

Business Benefits — Private Sector/Businesses

CIOs can deliver business benefits by:

- Providing transparency and access to government tenders and requests for proposals for all organizations
- Minimizing financial and operational risk when engaging in joint government and private-sector partnerships, as well as service hubs, due to transparent disclosure of financial and transactional records and valuation information
- Creating new digital business models by understanding the city as a contextualized marketplace with many different customer markets (for example, turning traffic statistics into granular information about bike share, parking frequency and retail values)
- Increasing market agility by identifying market behavior and demographics in real time or near real time, cross-referencing the environment and the context in which the data and the insights were gathered (for example, Zillow, Trulia or Waze using open government data today)
- Using data insights for digital knowledge management or education on crowdsourced insights, possibly extending into innovation management or incubation
- Increasing productivity or efficiency by identifying supply chain, logistic and geolocation data, improving asset management and incident reporting

Business Benefits — Citizens

CIOs can deliver benefits to citizens by providing:

- Access to easy-to-use contextualized data based on the profile used for login
- Convenience of data and information access based on remote browsing and portal environment
- Ability to trade and upload citizen data, based on an aspect of citizen-perceived value and merit
- Feedback and pricing structure that gives a sense of community, ownership of data and insight development.

In addition to human and business/entity users, applications and machines can use a preconfigured process for data ingress in applications, which result in updates on traffic maps, digital signs, driverless cars or wearables for touristic or wellness services.

The transformational business aspects have been discussed in the European Open Data Portal. Based on the data economy and the lack of digital equity, the EU has put initiatives in place to create data trading and exchange mechanism so that people stay in the ownership or control of where data is being leveraged.9 In Dubai, data will be available and transformative for all business environments, not just government.

Cities like Dubai are planning to advance the value exchange of this marketplace through a clearinghouse, a financial banking or trading entity, blockchain, or social trading environments. Therefore, it is critical to determine in the rules and condition what the different "currency" for the transaction should be. While this sounds like an academic exercise, in reality, the aspects of enrichment of data, the service level and the identity of the requestor could all trigger different valuation modes. In comparison, citizens like universities, entrepreneurs and everybody interested in developing APIs will be able to obtain raw data for data scientific analysis and correlation.

Evidence

[1] Urban data marketplaces are interactive exchange platforms that government and cross-industry CIOs can develop in smart cities to benefit citizens, industry and government by linking data with commercial or societal value (see "The Urban Data Marketplace Will Be an Engine of Community Innovation").

[2] "Global Cities Registry for ISO 37120," World Council on City Data.

[3] "World Council on City Data Open Data Portal," World Council on City Data.

[4] "PAS 182 Smart City Concept Model," BSI.

[5] See "Data Hubs, Data Lakes and Data Warehouses: How They Are Different and Why They Are Better Together" for an explanation on the different data architecture pillars and their agility toward exchange of data in rest and in motion.

[6] Context brokering is a form of a personalization engine that manages, tests and delivers consistent, orchestrated and measurable individualized experiences.

[7] "Explore China's 'Big-Data Valley' in Guiyang," The Telegraph.

[8] "Transport for West Midlands to Use Chordant's oneTRANSPORT Data Marketplace," Traffic Technology Today.

[9] "What is DECODE?" DECODE.

Note 1
Digital Citizen Equity Index

Gartner's digital citizen equity research provides a firsthand analysis of the digital indicators, surveys and statistics from multiple sources, and aggregates it to develop insights around digital perceptions and maturity. It provides CIOs with high-level input for a variety of talk tracks and incremental scenarios that can support decision making on digital transformation strategies, development of digital personas, and the design of outreach and communication assets.

The critical element is access to digital resources that enable everybody to become digital citizens and avoid a digital divide, also referred to as "digital equity of the citizen." In digital equity, citizens have the connectivity, as well as the information and communication technology and content, to collaborate and participate self-sufficiently within society. It is often a mix of government and private-sector business models that will lead to providing digital inclusion, due to an infrastructure rollout to communities and society. Digital equity requires initiatives that empower citizens to self-sufficiently participate through digital means, based on their own understanding of digital capability in the digital society and economy.

Note 2
World Council on City Data

The WCCD offers different maps and visualization mechanisms to view open data and compare cities side by side by granting levels of compliance to the data model. As of February 2017, there are 46 cities globally aligned at the aspirational, gold and platinum levels with ISO 37120 management systems for data.

Note 3
PAS 182: British Standards Institute

The PAS 182 smart city concept model is a guide to establishing a model for data that tackles the barriers to implementing smart city concepts, including the interoperability of systems and data sharing between agencies.

The PAS has been developed around concepts from the public sector concept model, aimed at providing the basis of interoperability at the upper ontology level, and outlines details of the smart city concept model.

The standard establishes an interoperability framework for smart cities in which:

- Information can be shared and understood between organizations and people at each level.
- The derivation of data in each layer can be linked back to data in the previous layer (that is, the assumptions on which a decision was made).
- The impact of a decision can be observed back in operational data.

Note 4
Open Data Use Cases and Best Practices

"Open Data Institute Homepage," ODI.

"Wise Council: Insights From the Cutting Edge of Data-Driven Local Government," Nesta.

Document Revision History

Data Governance and User Context Are Pillars of Sustainable Data Marketplaces in Cities - 12 July 2017

Recommended by the Authors

Some documents may not be available as part of your current Gartner subscription.

The Urban Data Exchange Will Be an Engine of Community and Ecosystem Innovation

Governments Are Developing a Unique Kind of Digital Twin

4 Steps to Drive Sustainable Value for Government Shared Data Initiatives

Turning Smart Cities Into Intelligent Urban Ecosystems

Hype Cycle for Smart City Technologies and Solutions, 2019

How to Achieve Better Business Model Strategies With Industry Data Governance

---