Data Mining, Engineering Solutions in Transport & Infrastructure

Why data is the new currency of business
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Executive summary

In this article, WSP approaches data as a strategic business asset, with the objective to optimize data intelligence through the creation of value-added assets and solutions for our clients.

Across business sectors worldwide, organizations face the challenge of how to manage the ever-expanding volume of information generated by legacy data and newly acquired assets.

With increasingly complex data sets stretching the limits of network capacity and the capabilities of data analysis tools, development of new processes and technologies has accelerated to help organizations capture, store, analyze, search, share and visualize raw data.

In turn, these new, more sophisticated tools for data capture and analysis—machine learning, drones, sensors, 3D modelling, analytical simulation, spatial databases, real-time visualization, virtual reality and more—add to the enormous quantity of data businesses need to manage while also opening up opportunities to discover valuable insights.

How can businesses capture value amidst all the noise? Data mining.

Data mining is the process of finding anomalies, patterns and correlations within large data sets to predict outcomes. Using a broad range of techniques, businesses can use this information to increase revenues, cut costs, improve customers relationships, reduce risks and more. Data mining depends on effective data collection, warehousing and computer processing.

Source: SAS
Collecting and processing increasingly substantial amounts of data will yield results, but data in itself is insufficient for evidence-based decision-making. Data only becomes “smart” and actionable with a strategy in place to identify what data should be filtered and analyzed to deliver insights that produce competitive advantages.

“At WSP, we recognize that to deliver value for clients, data generated from business and IT processes is only the start,” notes Ryan Avery, Supervising Transportation Planner/Engineer.

“The journey of transforming data into information and knowledge is key to learning and understanding the environments we live and work in,” adds Tim Cross, WSP Business Intelligence Lead, “and measuring the performance and value of assets that communities rely on.”

With the digital universe doubling in size every two years, the International Data Corporation (IDS) projects that by 2020, the data created and copied annually will reach 44 zettabytes, or 44 trillion gigabytes—with nearly as many digital bits as there are stars in the universe.

The exponential growth of data is relative to every level of business.

Getting a handle on data is critical to business processes, and inaction may prove costly in the future.

Across the multiple types of data assets available, two distinct repositories have emerged: data warehouses and data lakes.

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Diverse data sources and asset storage repositories

- Location data
- Mobile data
- Operational data
- Log file data
- Transitional data
- Business data
- Social network data
- Public data
- Commercial databases
- Streaming data
- Internet of Things (IoT)

Data warehouse and data lake characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data warehouse</th>
<th>Data lake</th>
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<tbody>
<tr>
<td>Data</td>
<td>Relational from transactional systems, operational databases, and line of business applications</td>
<td>Non-relational and relational from IoT devices, websites, mobile apps, social media and corporate applications</td>
</tr>
<tr>
<td>Schema</td>
<td>Designed prior to the data warehouse implementation (schema-on-write)</td>
<td>Written at the time of analysis (schema-on-read)</td>
</tr>
<tr>
<td>Price/performance</td>
<td>Fastest query results using higher cost storage</td>
<td>Query results getting faster using low-cost storage</td>
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<tr>
<td>Data quality</td>
<td>Highly curated data that serves as the central version of the truth</td>
<td>Any data that may or may not be curated (i.e. raw data)</td>
</tr>
<tr>
<td>Users</td>
<td>Business analysts</td>
<td>Data scientists, data developers, and business analysts (using curated data)</td>
</tr>
<tr>
<td>Analytics</td>
<td>Batch reporting, business intelligence and visualizations</td>
<td>Machine learning, predictive analytics, data discovery and profiling</td>
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In the ever-changing data landscape, businesses will need to have the necessary infrastructure in place for data retrieval, consolidation and storage as the first critical component in their data mining strategy. As part of asset management, the categorization/classification/organization of data into data sets enables machine-based intelligence to make connections and build relationships that translate into actionable insights and business value. These insights can materialize into intelligent builds or new apps that then further enhance future data mining cycles.

As a trusted data advisor, WSP has extensive experience working with data sets ranging from hundreds of millions to billions of data points. Our experts provide data-driven solutions and critical analysis to help clients become future ready.

WSP can also provide clients with tailored platforms that significantly reduce costs associated with the implementation of data-driven enterprise solutions. With multiple platforms available, WSP remains technology- and supplier-agnostic to assist clients in identifying what data they need and when they need it, regardless of the source.

By advocating for the proper use of available tools, we help ensure that costs align with the client’s needs.

“We take our clients through a journey to develop value for them—from data to information to knowledge to decisions.”

Wayne Hatcher, WSP Technical Director - Asset Management
Future-ready data solutions

Diverse trends are impacting the world we live in, creating complex and uncertain outcomes. These disruptive influencers include automation and digitization of industry, emerging business models, urbanization, changing generational behaviours, climate change and shifting global dynamics—all driven by data and challenging our ability to make decisions today that will enable us to succeed into the future.

“We take our clients through a journey to develop value for them, from data to information to knowledge to decisions,” explains Wayne Hatcher, WSP Technical Director Asset Management.

WSP equips clients with fit-for-purpose data solutions that address their business—across infrastructure assets and customers—present and future.

At WSP, we not only envision the future, we build it. Our worldwide experts are harnessing the power of data to create the world of tomorrow.

WSP’s Scenario Planning Toolbox creates a situational framework to apply expert human thought, utilizing quantitative and qualitative analysis of potential event impact. The Toolbox enables us to predetermine which actions will endure through a wide range of possible futures.

Scenario Development, the first of a three-part process, features a flexible set of tools that can interact with a wide range of qualitative and quantitative data, depending on project needs, whether relating to new mobility, any other area in transport, business planning, urban planning or sustainability across diverse sectors.

Data mining—identifying and procuring of relevant, quality data—plays an essential role in the development of plausible scenarios, as does understanding what should be modelled and what ranges of variables should be considered, given the scale of uncertainty and potential change. Scenario Development is one way to develop a clear set of parameters, enabling effective modelling and quantitative analysis.

In what ways might the population change? How might prices fluctuate? How might various populations or consumer groups respond? WSP’s Scenario Planning process relies on Scenario Development to help answer these questions and to provide the context, relationships and limits required as input into System Dynamics and Modelling analyses, which form parts 2 and 3 of the Scenario Planning Toolbox.

Exploring the future inspires us to think of progressive ways to deliver more thoughtful, impactful and durable projects today.
Once we have considered all the possibilities, we challenge ourselves to create new ones. We apply this future-responsible spirit to how we mine data, allowing us to more effectively align with our clients needs and we run our own business.

Enhanced data analysis
In addition to our strengths in the fields of capturing and verifying data, WSP helps clients to better understand their data by putting it into context. To help clients understand how their data compares with benchmarks or comparison cases, our experts can combine client data with our own in-house data, or with data obtained from external sources. In Canada, WSP has assisted clients including Bell Canada, Bike Share Toronto, Ontario Growth Secretariat and more in such endeavours, combining their data with valuable data obtained from sources such as Statistics Canada.

WSP experts in automated post-processing of data can set up business processes that foster healthier data. We develop system solutions for clients that apply carefully selected technologies to ensure we are mining their most important and relevant data.

Accessing and assessing data
WSP understands today’s data landscape will not be the landscape of tomorrow. We can assist clients in more effectively drawing out meaningful information from all available in-house data sources. Additionally, our experts can obtain access to external databases on behalf of our clients, positioning data sources in a segment that is becoming more affordable. WSP is also developing its own data ecosystem, with national and international data sets that will prove useful to clients on a global scale.

Data integrity
In 2016, IBM estimated that poor data used in the decision-making processes of businesses and government agencies costs the US economy alone $3.1 trillion a year.

Validating data is a crucial first step toward leveraging its power and worth. WSP can provide a variety of tools and solutions designed to ensure accurate data collection, management, analysis and reporting. WSP is experienced in data extraction, processing and data analytics. By creating data sets from structured and unstructured data, we help clients ensure data set validation and verification to establish consistency and reliability.
With the advent and dominance of cloud computing, customers rightfully want reassurance that their data and information is being managed securely, that privacy issues are being dealt with appropriately (including any legal requirements) and that their interests are entrusted to a competent, responsible organization. High-profile data breaches and security vulnerabilities have only reinforced and amplified these concerns. 

Increasingly we are seeing our customers ask for ISO:27001, and anticipate that this certification will soon become the norm, much like ISO:9001. The ISO:27001 certification process represents serious investment and substantial achievement. As trusted digital advisors, WSP teams in Australia, India and the UK have achieved ISO 27001 data security certification, with future certification on the horizon for much of our global network.

**ISO:27001** is a specification for an information security management system (ISMS). An ISMS is a framework of policies and procedures that includes all legal, physical and technical controls involved in an organization’s information risk management processes.

*Source: TechTarget*

**Actionable intelligence**

With the right tools, data can be transformed into actionable business intelligence critical to maximizing revenue, streamlining operations and mitigating risks. While most companies recognize a need to increase spending on data collection and analytics, many do not have adequate or sustainable access to the leading-edge tools and skill sets needed for effective data mining. This kind of a gap can make the difference in identifying key information that can result in paradigm-shifting business decisions.

WSP provides clients with windows on their data, not only by leveraging existing and emerging solutions, but also through our research and development of in-house tools.

WSP experts are already engaging with clients to prepare them to harness the power of data, including digital twins that combine data with technologies such as artificial intelligence, machine learning and software analytics to provide evolving real-time digital replicas of physical assets.
Some of the solutions WSP has designed for clients include:

PRIME for Cities

PRIME for Cities, WSP’s proprietary web platform, captures the mapped location, character, magnitude, approval and construction status of real estate developments and urban planning initiatives in our launch market of Ontario, Canada.

A GIS database of development, infrastructure and policy information, PRIME for Cities provides WSP a robust and flexible way to consolidate data, facilitate analysis, and share findings/recommendations with colleagues, business partners and clients.

To date, Prime for Cities has tracked tens of thousands of real estate development projects and growth-related infrastructure and policy initiatives. Each month, WSP adds or updates approximately 1,500 developments and infrastructure and policy initiatives.

Because we know where future-ready communities and infrastructure are being planned, proposed and built, WSP can provide timely, accurate, and relevant intelligence to clients to assist them in making well-informed planning and decisions.

We also create custom PRIME for Cities modules that enable us to integrate even more seamlessly with the day-to-day operations of our clients.
WSP leverages PRIME for Cities for virtually all our clients in southern Ontario, including the City of Toronto, Toronto Parking Authority, York Region Transit and Bell Canada.

We continue to invest in PRIME for Cities to enhance both our traditional consulting services and our growing SAAS / subscription offerings. PRIME for Cities can be deployed anywhere Cloud hosting resources are available, and we are actively exploring opportunities to expand to other markets.

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**WSP-designed solutions**

**CITY OF TORONTO**
83 Major Residential Projects
49,547 Residential Units

Dwellings:
* 259 Singles / Semis
* 1,900 Townhomes
* 46,315 Multis

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**WSDOT Toll Division**

In the US, WSP helped the Washington State Department of Transportation (WSDOT) Toll Division automate its database reporting for over 290 million toll trips in the Puget Sound region since December 2011 through an easy-to-use dashboard.

As the Toll Division’s database expanded across all workflows and extended to new facilities, traditional Microsoft Excel and Comma Separated Values (csv) analysis and reports became unsustainable.

WSP accessed the vendor enterprise systems on behalf of the agency, programming the relational database to automatically extract customized data summaries for various key metrics. WSP then developed a data dashboard to give decision-makers a clear view of network components and usage, accelerating the problem-solving and decision-making processes.

The Tolling dashboard provides the WSDOT multiple data views into “Trips by Payment Method.”

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01 Heat map of residential development projects in southern Ontario from PRIME for Cities.

02 Zoom-in on active City of Toronto residential development projects in PRIME.

03 The Tolling dashboard provides the WSDOT multiple data views into “Trips by Payment Method.”
**Bridge-related client work**

WSP is also an experienced leader in the collection of behavioural data. As clients move toward driving behavioural changes within their transport systems, WSP helps them identify new key performance metrics and quantify decision-making.

The process involves integration of data derived from private sector databases with data set solutions developed by WSP, which enables clients to structure outputs; aggregate and transfer data; and gain greater insight into data sets with value.

WSP also provides expertise in automated post-processing of data. We assist clients in cleaning up business processes in order to foster healthier data, and develop system solutions that apply the right technologies to mining their most important data.

As an example, WSP's award-winning Remote Bridge Monitoring system, a digital tool to assist asset management of infrastructure, provides access to real-time data that can be customized to address specific structural queries that clients and their engineers require to make evidence-based decisions.

This technology has been used to collect data from structures throughout New Zealand, which is then used to validate the structural models used by engineers. This approach highlights differences between structural modelling and real-world performance, and helps WSP to more intimately understand the performance of individual structures.

**WSP's award-winning Remote Bridge Monitoring system collects real-time data from structures throughout New Zealand.**
**VicRoads and Telstra**

In Australia, WSP’s collaboration with VicRoads and Telstra led to the development of MyRo™, a fully-automated, IoT online tool designed to keep road users informed of real-time traffic conditions during the M80 Upgrade Project.

The system enhances interactions between VicRoads staff and key internal and external stakeholders via a central point of control, facilitating the booking, scheduling and reviewing of roadwork and other events.

Following successful implementation of MyRo™ on the Tullamarine Freeway, the system has been extended for use on the CityLink Tullamarine Widening Project and across 40 km of the M1. By building a documented history of road event successes and failures, MyRo™ is paving the road to safer and more streamlined projects in the future that draw upon valuable lessons learned.

**A complete approach to data assets**

For any business, the challenges of extracting value from data grow exponentially greater over time, as data collection accumulates across different systems. And quantity does not necessarily guarantee quality. Organizations may be data rich, yet information poor.

WSP offers clients a complete approach to data assets. We start with a thorough assessment to determine tactics and strategies required to streamline processes and put a framework in place to give clients control of their data lifecycle. Our experts understand data and are experienced in working with large, complex data sets and with multiple systems and technologies.

We work with clients across the world, helping them transform raw data into business intelligence that becomes an ongoing asset for their business.
Regional contacts

**Australia**
Henry Okraglik  
henry.okraglik@wsp.digital

**Canada**
Mausam Duggal  
mausam.duggal@wsp.com

**New Zealand**
Wayne Hatcher  
wayne.hatcher@wsp.com

**Nordics**
Sara Hederos  
sara.hederos@wsp.com

**United Kingdom**
Andy Porter  
andrew.porter@wsp.com

**United States**
Ryan Avery  
ryan.avery@wsp.com
As one of the world's leading professional services firms, WSP provides technical expertise and strategic advice to clients in the Transportation & Infrastructure, Property & Buildings, Environment, Industry, Resources (including Mining and Oil & Gas) and Energy sectors, as well as offering project and program delivery and advisory services. Our experts include engineers, advisors, technicians, scientists, architects, planners, surveyors and environmental specialists, as well as other design, program and construction management professionals. With approximately 48,000 talented people globally, we are uniquely positioned to deliver successful and sustainable projects, wherever our clients need us.