AI and Machine Learning for Complex Business Decision Making

PART 3 – SYSTEMS THINKING AND A FRAMEWORK FOR APPLYING AI

In **Part 3** of this six-part series of 10-minute reads, we present highlights of the **2020 MMPA Conference**,[1] **AI and Machine Learning for Complex Business Decision Making**, to illustrate the versatility and ubiquity of new digital technologies and to spotlight CPAs' changing competencies and emerging opportunities.

Part 1 – From Excel to AI: The Analytics Evolution looks at the **analytics evolution** and the way CPAs in finance and audit need to adapt their analytics skillset to keep up with this rapidly changing field.

Part 2 – Technology for Problem Solving warns against the **digital transformation trap**: losing sight of problem solving and, instead, following the lure of technology. How should CPAs assess AI technology and **value creation**?

Here, Part 3 – Systems Thinking and a Framework for Applying AI looks at **systems thinking** – a critical-thinking competency for CPAs – and a **framework** for applying AI and machine learning to complex business decision making.

1 The 2020 MMPA Conference was hosted by the Master of Management & Professional Accounting (MMPA) Program and BIGDataAIHUB at the Institute for Management & Innovation (IMI), University of Toronto at Mississauga (UTM). The MMPA Program combines an MBA curriculum with the development of technical and leadership skills vital for the accounting profession.

CPA CHARTERED PROFESSIONAL ACCOUNTANTS CANADA

MMPA Master of Management & Professional Accounting

Institute for Management & Innovation UNIVERSITY OF TORONTO MISSISSAUGA

Part 4 – Data and Trust examines **data management value chains**, new roles for CPAs and initiatives to ensure that data and AI systems are used fairly, accountably and transparently.

Part 5 – Humans, Machines and Humachines focuses on **human skills**. It introduces AI-augmented intelligence in emerging organizations called **humachines** and the way CPAs' human and technical skills can play a role in commercializing Canada's AI start-ups.

Part 6 – Moving to an AI Advantage looks at the way companies move to an **AI advantage** and steps CPAs can take to be future ready.

PART 3 – Systems Thinking and a Framework for Applying AI

Systems Thinking – A Form of Critical Thinking

Organizations need to understand that problems or decision-making processes they want to improve should be considered as parts of a **system**, not in isolation. In this section, speaker Nada Sanders explains (1) systems thinking as it applies to supply-chain management and (2) the way to create an intelligent supply chain.

> **Systems thinking is the ability to view an enterprise, machine or subject holistically, making connections between different functions in an integrative way.**
>
> NADA SANDERS (SANDERS & WOOD, 2020, p. 254)

This means that optimizing departments or functions as silos just won't work, Sanders explains. If one area is optimized but isn't aligned with other parts of the organization, technology adoption isn't likely to succeed. AI needs to be **integrated**, not treated as an "add-on." Companies are better off with less technology or older technologies that are integrated than with technology in silos, she continues. Think of a supply chain as an example of where systems thinking should apply.

For CPAs, systems thinking is a critical thinking skill, according to the new "Way Forward" Competency Map (CM2.0). How are technological, organizational, regulatory and social systems connected? How should organizations adapt and manage interdependencies, unpredictable interactions and uncertainties?

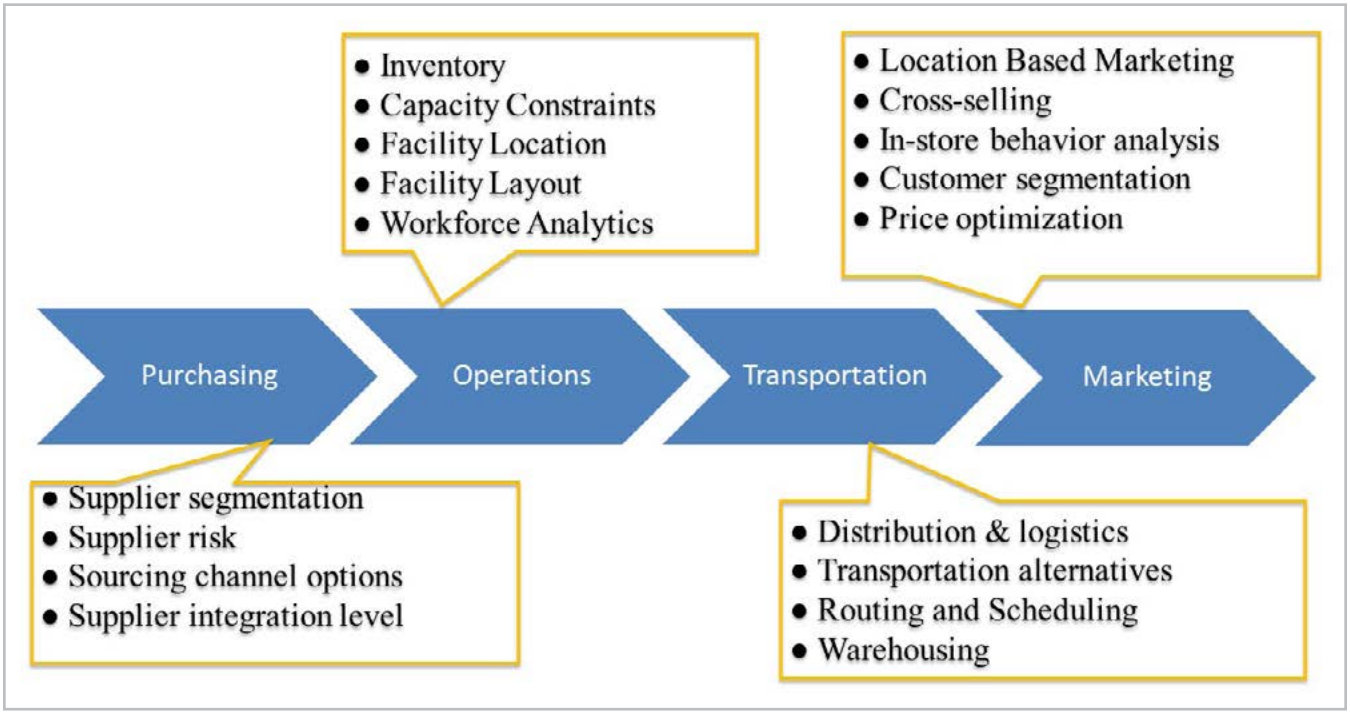
"Broader information on value creation covering critical assets such as people, innovation, data and key relationships; environmental, social and governance (ESG) factors; and wider impacts, are needed to serve all key stakeholders better and more sustainably."

(IFAC, 2020, p. 4)

Supply chains as systems

Modern supply chains are systems enabled by data, data analytics and technology (Figure 3.1). However, optimizing individual functions without an end-to-end view of the system can result in bottlenecks. For example, Sanders says, "Marketing may offer customized products, but if Operations cannot produce them, and Logistics cannot deliver them, the supply chain is unable to respond to changes, disruptions, or shocks to the system."

FIGURE 3.1: ANALYTICS APPLICATIONS ACROSS SUPPLY CHAIN FUNCTIONS



Source: Nada Sanders

PANDEMIC SURVIVAL: COMPANIES MUST UNDERSTAND THEIR SUPPLY CHAIN

Speaker Nada Sanders recommends that companies:

- Identify critical customers and high-margin items
- Narrow the product line
- Understand risks faced by their suppliers (upstream risks) and identify alternative suppliers
- Understand risks to sales, logistics (downstream risks)

The 2020 pandemic was a shock to many supply chains, on both the demand and supply sides: travel plummeted; demand for disinfectants skyrocketed. Work-at-home orders increased demand in electronics requiring computer chips, which later led to a shortage of chips for auto manufacturers (Handwerker, 2021) whose demand had initially decreased in the pandemic's early days. No AI technology could foresee those changes, based on past data. Inventory management – e.g., the deceivingly simple stocking of shelves – required human judgment. "Humans must be able to override algorithms when historical data is insufficient for decision making," Sanders says. In addition, "algorithms that integrate human

judgment are absolutely critical to successfully managing a supply chain system because AI makes predictions using historical data."

Further, decision makers must understand both their supply chain system and whether it can support a given decision. See Use Case: Can a Supply Chain Support a Decision?

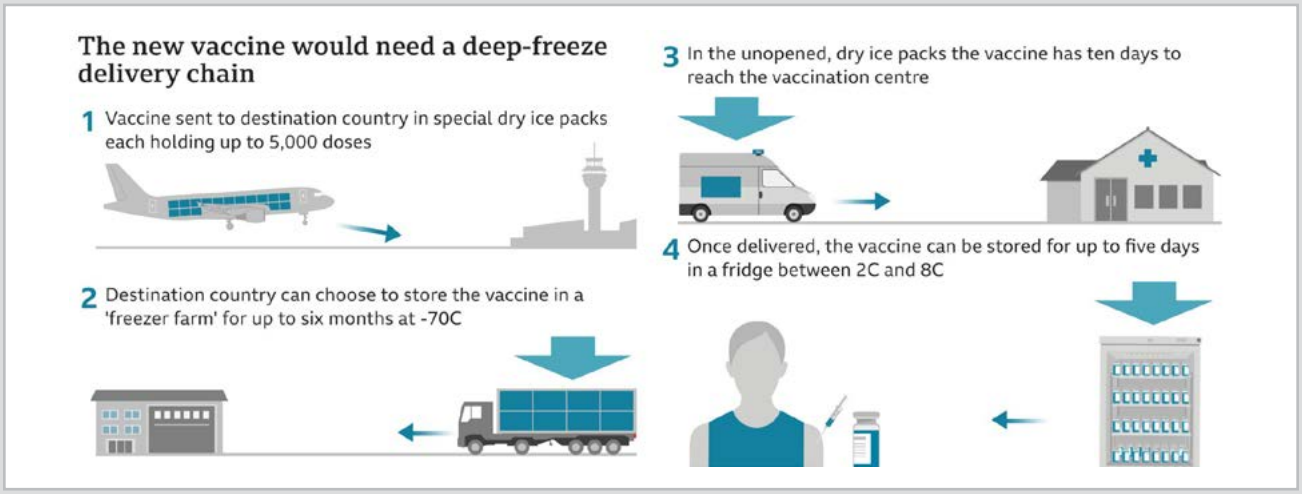
Ultimately, the goal is to have responsive, intelligent supply chains. A **responsive** supply chain coordinates action, because information from each "lever" – e.g., supply shortages in Purchasing, delayed shipments in Transportation, or production delays in Operations – is conveyed to the system's other levers.

USE CASE: Can a Supply Chain Support a Decision?

(Michael Lionais and Nada Sanders)

Pfizer-BioNTech was the first COVID-19 vaccine available in Canada. To maintain quality and potency, it requires ultra-cold storage during transportation (-70° C), compared to a normal home-freezer temperature (-18° C), and has a limited five-day refrigerator shelf life once thawed (Ontario Ministry of Health, 2021). Despite the urgency to vaccinate vulnerable populations, this vaccine would be a poor choice compared to the refrigerator-stored Moderna vaccine for remote northern Canadian rural communities that lack all-season road access or ultra-cold freezers.

Nada Sanders adds, "A layperson has no concept of what [the Pfizer vaccine] means for logistics and supply-chain operations. The requirement for two doses, in addition to the complications of a cold chain – a temperature-controlled supply chain – are immense."



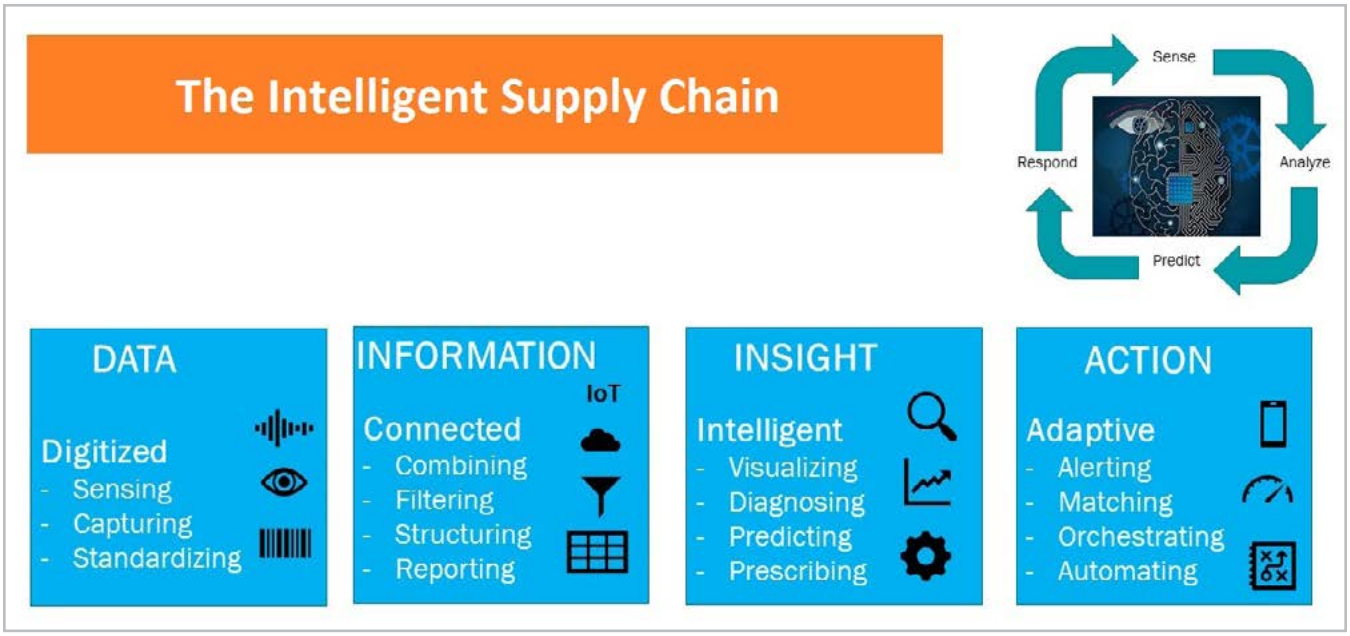
Source (modified): Kleinman [BBC News], 2020

In other words, timely **information visibility** is important to stakeholders and decision makers throughout the supply chain. Sanders says that many executives and supply chain managers are "awash in data but lack information" about their supply chain's performance.

An intelligent supply chain (Figure 3.2) "...senses, analyzes, predicts, and responds to changes in its operating environment. This means that the supply chain uses technologies, organizational structures, and skills to capture data, convert it into information, analyze it, and quickly adapt to it much more quickly, accurately, and specifically than conventional supply chains," says Sanders (Sanders & Swink, 2019, p. 32).

Beyond summarizing and organizing data, supply chain **intelligence** comes from insights from analytics used "...to diagnose situations and events [by] using algorithms to predict possible outcomes and risk assessments and prescribing courses of action with possible alternatives" (Sanders & Swink, 2019, p. 33).

FIGURE 3.2: THE CONCEPT OF AN INTELLIGENT SUPPLY CHAIN



Source: Speaker Nada Sanders

Ultimately, those actions make the supply chain responsive to changes and disruptions.

However, intelligent supply chains are a limited reality, because, Sanders says, "most companies aren't even at a place where they have real time data available that has been scrubbed."

Our supply chains are disruptable and vulnerable. Many of us had previously taken them for granted and they were otherwise invisible. The are now highly visible and are being scrutinized along many dimensions. This is a good thing. How can we strenghten them?

IRENE WIECEK, CHAIR, 2020 MMPA CONFERENCE

Applying AI to Complex Business Decision Making

Big or small, every firm in every industry will use some form of AI-driven analytics.

"If your company makes things, moves things, consumes things, or works with customers you have increasing amounts of data on those activities. Every device, shipment, and consumer leaves a trail." Your company can analyze those data sets for consumers or markets or embed analytics to optimize business decisions.

(DAVENPORT, 2013)

From work to transform systems in a huge hospital complex to manage its scarcest resource – inpatient beds – **Retsef Levi** has developed a general framework for improving a business metric, a workflow or decision process (see **Figure 3.3**) by applying analytics and AI.

The traditional way of thinking about analytics and AI is to start with data and talk about predictions by the technology, says Retsef Levi. Instead, he asserts, the **starting** focus should be on improving a business metric, a workflow or decision process. (See Part 2's section, Start with a Problem, Not the Technology.)

Involve people from the start

Next, involve the people/decision makers/expert operators associated with the process or workflow at the beginning, because the technical challenges are not nearly as hard as the organizational challenges, Levi warns. Applying technology to improve a process, workflow or business metric will also require:

- data engineers that will build the infrastructure
- data scientists that will interpret it and build the algorithms
- people with the ability to translate the data products and disseminate those into workflows

In addition, **business translators** – people that speak the organization's business language and the data language – will have one of the most important roles. Without that functionality, it will be very hard for organizations to move forward and become data-driven organizations.

For more on how CPAs may fulfill these roles, see Part 4's section, Data Management Value Chains and Roles for CPAs.

Understand the data

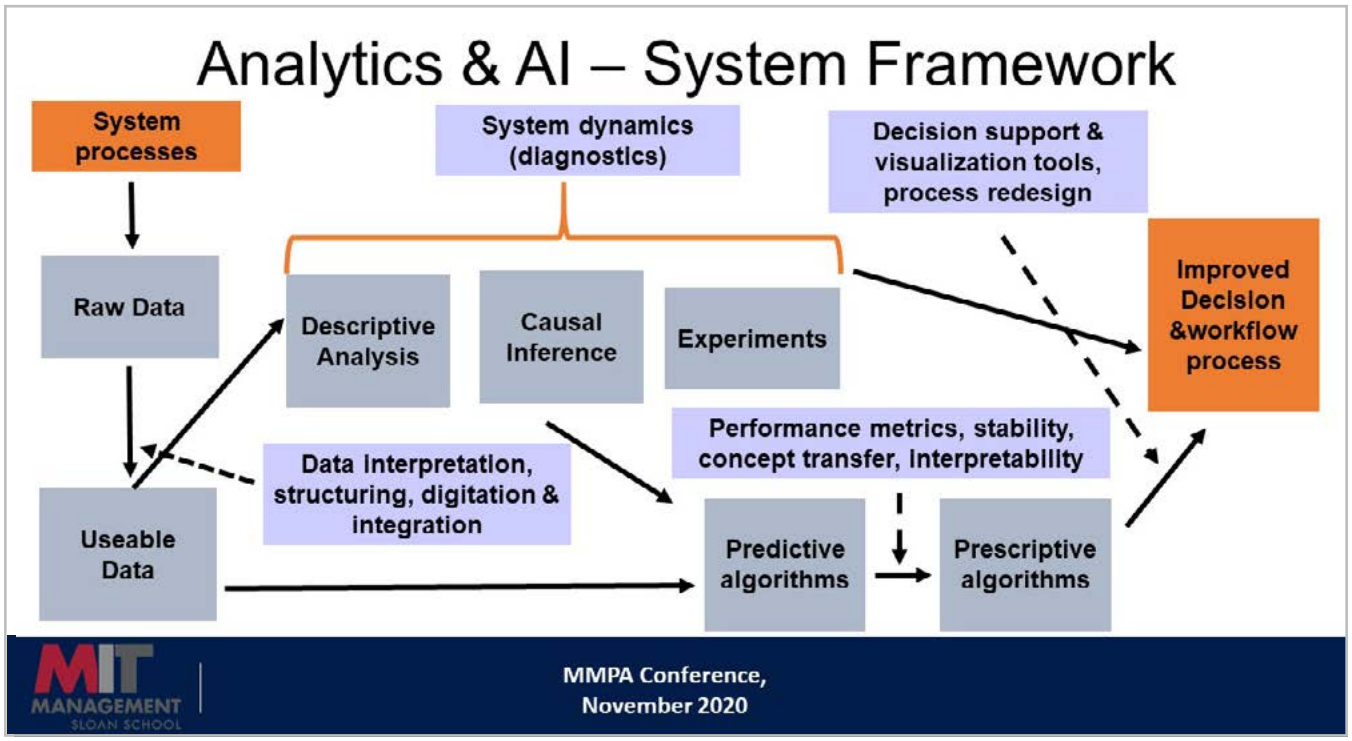
Once the organization focuses on a problem to solve, it needs to understand the data it collects.

> **CPAs** may need to start auditing algorithms and data sets as more companies adopt AI.
>
> (CPA ONTARIO, [2019], p. 17)

System processes. Most of the data are the *output* of existing system processes. (See the **left side** of Figure 3.3) Without understanding the system processes that create the data, whether purchased or generated in-house, the company will not understand the data.

Raw data. For most companies, raw data are not usable. Interpreting, structuring, digitizing and integrating the data take tremendous effort and investment.

FIGURE 3.3: A SYSTEM FRAMEWORK FOR ANALYTICS & AI



Source: Speaker Restef Levi, MIT Sloan School of Management

Systems diagnostics. Before developing any predictive algorithms, the company needs to conduct systems diagnostics (see the **top-middle** of Figure 3.3) (i.e., describing the system, understanding causal mechanisms, and conducting experiments). "The insights that come from just better understanding the system can improve company decisions," Levi asserts.

Usable data. Only when the company has usable data, and an understanding of its system, can it then consider developing (1) **predictive algorithms** to predict outcomes and (2) **prescriptive algorithms** to achieve desired predicted outcomes. (See the **bottom-middle** of Figure 3.3)

Process improvement

Finally, disseminating and incorporating those algorithms into human workflow processes generate additional challenges. (See the **right side** of Figure 3.3.)

In a typical project – from raw data to improved decisions or workflow processes – Levi says a company will spend:

- between 6 to 12 months on getting data (from system processes owned or purchased), making the data usable (the **left side** of Figure 3.3) and conducting diagnostics
- about 3 to 6 months creating the algorithms (the **bottom-middle** of Figure 3.3)
- about one to two *years* disseminating and incorporating predictive algorithms into workflow processes (the **right side** of Figure 3.3)

TAKE HOME LESSONS

Most companies plan around developing or applying AI. What companies overlook or don't understand, Levi emphasizes, is that they need to spend more attention on the first and last phases, because the real challenges arise at the beginning (making data useable) and at the end (integrating technology, people and processes).

Part 4, the next part in this six-part series, examines **data management value chains**, new roles for CPAs and initiatives to ensure that data and AI systems are used fairly, accountably and transparently.

"Process improvement...has a significant big data skills gap (35%), ranking near the top when it comes to big data skills that **finance employers** seek yet don't have in their ranks."

"Big data is only as valuable as the outcomes to which it leads, and the ability to re-engineer processes in response to data analytics can produce one of the biggest organizational impacts."

ROBERT HALF CANADA INC., 2017

References, Part 3

CPA Ontario. [2019]. *Evolving Alongside Artificial Intelligence* [PDF] [Thought Leadership Series]. CPA Ontario.

Davenport, T. H. (2013, December). Analytics 3.0. *Harvard Business Review* [Online].

Handwerker, C. (2021, March 11). A Global Computer Chip Shortage Shows Danger of U.S. Production Trends: A Small and Shrinking Number of the World's Computer Chips Are Made in the U.S. *Scientific American* [Online].

International Federation of Accountants (IFAC). (2020). *The CFO and Finance Function Role in Value Creation* [PDF]. IFAC.

Kleinman, Z. (2020, December 8). How will we keep the Covid vaccine at a cold enough temperature? *BBC News* [Online].

Ontario Ministry of Health. (2021, February 1). *COVID-19: Vaccine Storage and Handling Guidance – Pfizer-BioNTech and Moderna COVID-19 Vaccines (Version 2.0)* [PDF]. The Ministry. [Note: The weblink updates to the latest version.]

Robert Half Canada Inc. (2017, January 10). Increase Your Worth With These 6 Big Data Skills [Blog]. Robert Half Talent Solutions [Website].

Sanders, N. & Swink, M. (2019, January). Digital Supply Chain Transformation: Visualizing the Possibilities. *Supply Chain Management Review* [Online], v. 23 (1), pp. 30-41.

Sanders, N. & Wood, J. (2020). *The Humachine: Humankind, Machines, and the Future of Enterprise*. New York: Routledge (Taylor & Francis).

CONTACTS

Michael Wong
Principal
Research, Guidance and Support
email: michaelwong@cpacanada.ca

Davinder Valeri
Director
Research, Guidance and Support
email: dvaleri@cpacanada.ca

Chartered Professional Accountants of Canada