The Key to Modern Governmental Supply Chain Practice: Analytical Technology Innovation

By Dr. David Preston, Dr. Daniel Chen, and Dr. Morgan Swink

Supply chain management (SCM) is a fundamental practice of government organizations that facilitates the exchange of products for its stakeholders. Government purchases include expenditures on goods and services by federal, state, and local governments. Each year the United States spends trillions of dollars to purchase goods and services for public use. For example, it was estimated that the U.S. government purchases contributed about $3.18 trillion, or about 17 percent of the total GDP in 2018. The cost of operating supply chains is a cumbersome endeavor and accounts for up to two-thirds of the final costs reflected in traded goods. As such, effective supply SCM is essential for procurement operations.

Over the past few years, the COVID-19 pandemic has done much to expose and highlight critical gaps and flaws in the global supply chain. Any improvement in supply chain operations achieved through effective supply chain management will have a significant positive impact on timely delivery and appropriate pricing of goods and services. Many of these improvements can be realized through analytical or technology improvements, yet both commercial and government entities have not tapped into the full potential of technologies and analytical approaches available to them.

Improving Supply Chain (SC) Effectiveness and Efficiency

Investment in information technology (IT) is often considered an essential means to improve SC effectiveness and efficiency. However, government executives remain in a quandary on how to best invest in technology to truly make such performance improvements in SC practices. An even greater level of uncertainty has arisen about SCM due to recent issues associated with COVID-19 and tenuous international relationships that can alter the nature through which government organizations provide its services. Therefore, effective use of technology to

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improve SC practices has become essential for governmental organizations. This study examines the role that organizational use of technology innovation plays in improving SCM activities for public organizations.

Technology innovation is imperative to SCM success since organizations along the value chain require information flows and knowledge creation. Technology innovation has key organizational implications to the domain of SCM. SCM activities are boundary-spanning by their nature since they often most involve other organizational partners across the value chain.

However, public entities often lag in technological innovation and as such their supply chain (SC) practices are affected accordingly.

Three Frameworks for Analytics Usage

Government organizations should look to industry practice to model how technology innovation can improve SCM. In this study, technology innovation is examined via the potential use of analytics, blockchain, and artificial intelligence (AI) as they apply to SCM practice. In this report, we first examine analytics usage for SC impacts since analytics currently has wider rates of adoption in industry. Through an empirical analysis of industry survey data, the research design develops three frameworks for analytics usage.

Framework I: The first framework examines the key drivers of analytics usage for SC practice which consists of the following contexts: 1) Technical; 2) Organizational; 3) Environmental. Specifically, this framework examines how the mechanisms within each context either directly or indirectly influence analytics usage.

The technological context is comprised of both the organization's expected benefits and its technological capability. Such technological concerns are relevant to both public and private organizations. To adopt a technology to an appreciable and useful degree, an organization must expect to benefit from such technology. For an organization to adopt analytics for SCM, it should expect a series of operational and strategic benefits will arise: cost savings, inventory reduction, reduced cycle times, better product/service delivery rates, improved customer service, improved knowledge sharing, and increased confidence levels in decision-making, etc. Therefore, key decision-makers will need to assess if analytics use as a technology is truly compatible with the values and SCM work practices of the organization.

The organizational context is considered in terms of "organizational readiness," which is the degree to which an entity has the required organizational resources to effectively implement analytics. Such resources include financial capital available for allocation and technical infrastructure as needed. Top management is key in assessing the external landscape and how the industry is engaging with from technology standpoint. Findings indicate that the organizational and environmental factors alone are not sufficient to influence analytics adoption and usage directly and adequately, rather managerial leadership is needed as a mediating effect. Hence, top management is likely to sponsor analytics ubiquitously for organizational functions if it views that the entity has proper resources in place and there are salient competitive pressures.

Framework II: The second framework examines the influence of analytics usage on SC performance outcomes: 1) Asset Productivity; 2) Organizational Growth. Furthermore, this framework examines the moderating effect of a dynamic environment that influences the degree to which analytics usage can impact each component of SC performance.

Despite the optimism expressed about the benefits of analytics usage in the SC context, there has not been substantial empirical support for this direct link. For effective use of analytics in SCM, it is essential that such tools are fully assimilated within SCM processes. SCM processes are clearly noted to be of great complexity since they can involve varied roles and tasks (e.g., purchasing, inventory management network optimization, etc.).

The results found that analytics usage directly influences the following two fundamental components of SC performance.

Asset productivity is a primary measure used to assess SC performance with established measurements including turnover rate and return on assets. Organizations can potentially use analytics to collect and integrate information from various sources along the supply chain and consequently disseminate such aggregated knowledge to key decision-makers.

The knowledge derived from analytics usage can mitigate certain levels of uncertainty about managing inventories and demand capacity. With smoother management of the supply chain, an organization can operate with leaner asset inventories while also ensuring that financial and inventory assets are not fully depleted. Analytics usage can enable more accurate predictions that allow asset managers greater

forecasting accuracy help them properly manage resources for optimal asset allocation.

In addition, the study examines the influence of analytics use in SC activities to generate growth opportunities for the organization. This outcome also pertains to public organizations that wish to expand operations and service opportunities. Using analytics, organizations can identify innovative opportunities to capitalize on temporary advantages driven through SC activities. For instance, the analysis of inventory and resources capacity across the supply chain can result in better availability of products, reduced shipping time, customized services, and customer analysis. As such, analytics use can enable organizational executives to anticipate and hence exploit emerging opportunities for driving growth.

Framework III: The final framework examines analytics usage through more granular dimensions: 1) Analytics use for Optimization; 2) Analytics use for Learning. In addition, this framework examines the mechanisms through which each of these dimensions of analytics usage influences organizational decision-making capability These two distinct patterns of analytics usage involve different analytics approaches and applications:

- **SC optimization** activities generally use advanced mathematical programming algorithms to evaluate alternative solutions to highly structured problems, using highly structured data.

- **SC learning** activities make use of analytics which apply a broader array of tools and address solutions for a wider range of questions posed. They may analyze both programmable and nonprogrammable questions using structured or unstructured data.

Many organizations wish to capitalize on analytics. However, many entities take a haphazard approach with no a-priori design strategy. The public entity should first understand the objectives of analytics initiatives before committing organizational resources.

SC decision-making capability is fundamental to the organization's SC strategy. Analytics usage can enhance both speed and quality of the collection, analysis, and dissemination of information for organizational decision-making. Supply chain executives have traditionally made "gut decisions" rather than using analytical intelligence. There may also be incongruent goals among the different decision-makers across the various partners of the supply network.

There is great demand for SC organizations to implement analytics to capture more detailed data for decision-making at multiple points within the supply chain (e.g., sourcing analysis, network design, inventory optimization, demand management, etc.). The thorough implementation and utilization of analytics allows for the development of a knowledge base that can be collectively shared among the various leaders during different stages of the supply chain.

The findings provide evidence that analytics use for SC optimization has a direct influence on organizational decision-making capability without the need for human/managerial intervention. However, analytics use for SC learning does not have a direct, but an indirect effect to decision-making capability, which requires internal integration. Most public entities will be focused on optimization to some degree. However, such organizations need to have the right mindset and integration across channels to benefit from analytical learning opportunities.

Impact of Blockchain and AI on Supply Chain Practice

In addition, this study examines organizational potential for blockchain and AI. Blockchain and AI are assessed with consideration to the analytics frameworks as applicable and based on their idiosyncratic technology characteristics. We examine adoption of these three technologies via the approach of a technology portfolio.

Blockchain is an emerging open-source recordkeeping technology that enables intra- or interorganizational transactions via a series of peer-to-peer transaction represented by blocks that are "chained" together. Specifically, blockchain technology utilizes time stamps and

cryptographic hashes to ensure information within a block is tamperproof. Technological advances are transforming traditional linear supply chains into dynamically connected digital supply networks; however, most organizations are not properly prepared for such disruptions. Blockchain is considered a potential technological innovation that can make the supply chain more efficient and resilient, despite volatile environments. As such, blockchain is an emerging technology that can efficiently connect stakeholders of government supply chains and monitor and document the transitions of goods across the supply chain. Government organizations can seek to benefit from the potential promise of blockchain for an array of necessary activities: financial/real estate transactions, health care data, and SC activities related to an assortment of products and services.

Applying AI technology—machines and algorithms—to make predictions, recommendations, and decisions has enormous potential to improve social welfare and organizational productivity. AI-led transformation can certainly improve government services, fundamentally changing how government delivers value to its citizens. For example, AI has been reportedly generating powerful new abilities in areas like national security, food safety, regulation, and health care.

However, very few government organizations have initiated plans on taking advantage of AI capabilities to improve their SC processes. AI-based applications have the potential to reduce backlogs, cut costs, stretch resources, release workers from routine tasks to perform higher value work, improve the accuracy of projections, and bring intelligence to scores of processes, systems, and uses. For example, changes in weather patterns, trade policies, and the inventory status of suppliers of cryptic ingredients or secondary parts can make it hard to know how much of anything to order at one time in any location.

AI can help with predicting and making sense of SC dynamics by identifying and differentiating varying supply sources or using sensor data in a variety of ways that improve efficiencies. However, AI-based SCM may not be effective merely by layering AI over existing organizations or processes without appropriate investment in the transformation and reimagination of the delivery model.
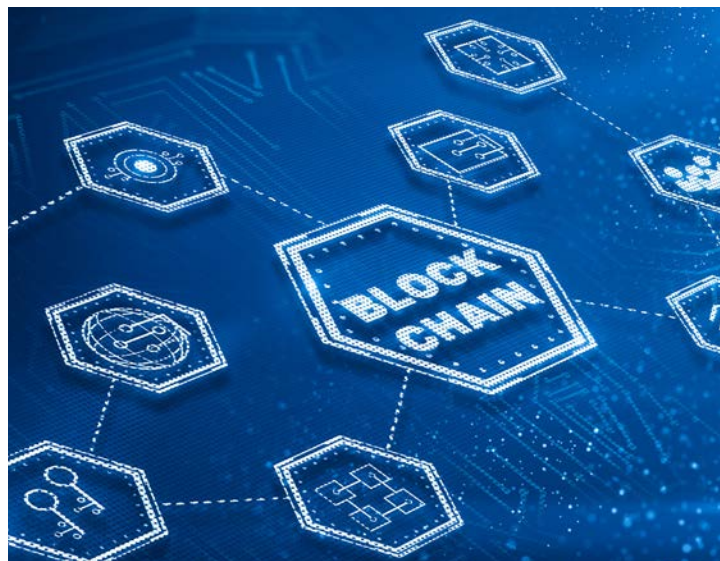
Recommendations for Government Technology Innovation

Implications and recommendations for practice are provided to government executives for actionable results. Such recommendations include a series of managerial and organizational factors relevant for adoption of these technologies.

Leverage the Lessons Learned from Analytics Analysis. Government organizations should leverage the empirical findings outlined about analytics frameworks. Public organizations should seek to examine how these analytics findings can be applied to blockchain and AI for SC practice. The decision to adopt blockchain or AI may have similar technical, organizational, and environmental factors that parallel that of analytics but differ based on the idiosyncratic nature of these different technologies. Public entities should consider a series of strategic questions, covering the three identified aspects when crafting their blockchain and AI adoption strategies. These questions are provided in the Table below.

Strategic Questions for Implementing Blockchain and AI-Based SC Models

Technological Benefits	Organizational Readiness	Environmental Pressure
What are the expected values of blockchain and AI to our supply chain organizations?	What blockchain uses and AI applications should we target and do we have the right IT infrastructure to support them?	What blockchain and AI features are suppliers/customers using?
How will these values be defined and measured?	What are the resource requirements to support our blockchain and AI initiatives and where do we locate these resources?	What blockchain and AI related initiatives are other functions of the government organizations pursuing?

Follow the Leader. When considering the adoption of technology, an organization can seek several pathways about innovation: first mover, fast follower, slow follower, or laggard. As emphasized, there is little value that a government organization can derive as a laggard. On the

other hand, being a first mover may not be worth the risk as government organizations generally do not benefit from seeking extreme risk-taking opportunities. As such, this study recommends that government organizations seek to fall somewhere between a fast follower and slow follower based on organizational goals. As addressed within the following portfolio recommendation, public entities should seek to first gain capabilities in analytics and rapidly follow industry use cases from industry and other public entities as applicable. Government organizations would likely benefit from a more conservative approach to blockchain and AI initiatives and can follow suit after these technologies have greater proof of concept and the fit with organizational objectives are clear.

Develop a Technology Portfolio. Government organizations and regulatory agencies need to consider developing a technology portfolio. This portfolio should have a sequence of adoption. The technologies of analytics, blockchain, and AI are independent yet highly complementary. Government organizations should prioritize developing its capabilities in analytics. Based on the outlined findings from the empirical analysis in this study, it is observed that analytical savviness can be developed via series of managerial efforts and organizational commitments. Blockchain adoption can be considered an independent organizational decision. But it should be noted that blockchain will facilitate the organization's ability to enhance its capabilities in both analytics and AI. As outlined, AI has promise for great potential for public entities; however, AI is still very much in its infancy. Government organizations should first develop analytical maturity prior to seeking to fully engage in AI.

Empower Technology Champions. To fully engage and capitalize on technology innovation, organizational leadership is paramount. It is rare that technology will be fully infused in an organization without the sponsorship of its leaders. Visionary technology leaders play a primary role in the assimilation and effectiveness of technology initiatives. Organizations that merely appoint a top technology executive but fail to provide this individual with both formal and informal means to provide influence will likely fail in fully capitalizing on innovative technology initiatives. Information derived from analytics has become the key organizational "currency" and as such many "data owners" across the supply chain may intentionally or inadvertently hoard such information rather than share it across channels.

Facilitate a Climate for Innovation. The organizational climate is fundamental to the adoption and utilization of technology. Government organizations are often considered bureaucratic and hierarchical when compared to private

industry. Such hierarchical structures can provide benefits in providing organizational efficiencies and standardized processes. However, such structures do not necessarily foster a climate for innovation. Having a "data-driven" culture is imperative for organization to derive expansive value from information-related technologies. Such a climate that enables knowledge dissemination and organizational learning is particularly relevant for SCM. Fostering a climate for innovation within the structures is essential for a government organization to fully capitalize on the potential of analytics, blockchain, and AI.

Ensure Strategic Alignment. For optimal performance value, a public organization needs to ensure that the supporting technology strategy is aligned with organization's SC strategy. It is not enough for an organization to realize technology as potential strategic resource. The organization must strive for strategic alignment of the technology strategy with the supply chain to derive a competitive advantage. There are two elements of technology strategic alignment that must be considered: 1) social dimension, which constitutes a shared level of understanding of the role of technology within the organization; and 2) intellectual dimension of alignment, which addresses the congruence of the entity's technical strategy with the organization's mission. Each public entity should not merely follow the herd when it some to technology investments, it is imperative that alignment of each technology is assessed with organizational goals.

View Functional Managers as Key Stakeholders. To fully implement, adopt, and capitalize on analytics, blockchain, and AI for SCM, functional managers must be viewed as key stakeholders in the process. Functional managers serve as a bridge between top management and the end users of technology. It has been observed that within public entities, most of the innovation arises at staff levels and tends to diffuse upward yet strategy is implemented from the higher ranks top-down. As such, functional managers who understand the purpose of technology to achieve SC objectives are needed to ensure a pervasive utilization of analytics, blockchain, and AI.

Manage Technology Talent. The competition for technical and analytical talent remains fierce. Government organizations and agencies have had notorious difficulty in the attraction technical talent for strategic purposes and have even had a lack of success with external consultants. To develop talent resources for SC analytics, blockchain, and AI, it requires both technology experts and SC experts. It is mandatory that there is collaboration between these two groups and that there is some overlap in knowledge. To optimally perform

and deliver value, there must be analytical/technical training for the SC professionals and SC/operational training to develop the knowledge of the technologists.

In conclusion, this report aims to provide insight on how technology innovation can facilitate SCM practice within government organizations. Technology innovation is examined through the lens of emerging technologies via analytics, blockchain and AI.

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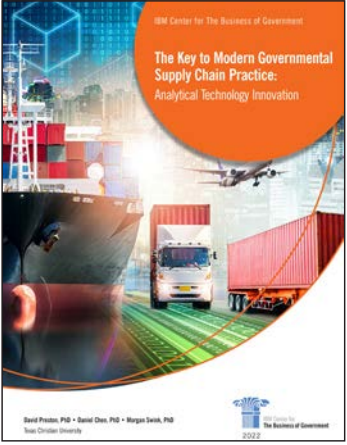*by Dr. David Preston, Dr. Daniel Chen, and Dr. Morgan Swink*

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