ADELANTE

THE DNA OF TMS:

Four Important Building Blocks

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Architected for the Cloud

Transportation management systems (TMS) were among the very first enterprise applications to be offered in the software-as-a-service (SaaS) model, going back to the dot com era of the late 1990s and early 2000s. The SaaS model made it easier and less expensive for companies to deploy a TMS, especially small and midsized companies that typically lacked the IT budget and resources to implement an in-house solution.

Today, virtually all TMS solutions and deployments are in the cloud. However, the way these solutions are architected for cloud deployment has changed significantly over the past 20 years.

To provide some perspective, when the first SaaS TMS were released, the iPhone and App Store did not exist yet (they were introduced in 2007 and 2008, respectively). Neither did the cloud services provided by Amazon AWS (2006), Google Cloud (2008) or Microsoft Azure (2010). The emergence of smartphones, mobile apps and cloud services — together with their underlying technologies — have influenced the way many enterprise applications are now designed and architected for cloud deployment.

For example, many enterprise applications, particularly those that have grown in size and complexity over the years (which includes TMS), have migrated from a "monolithic" architecture to a "microservices" one. As defined by technology consultants James Lewis and Martin Fowler:

[T]he microservice architectural style is an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms [such as application program interfaces, or APIs]. These services are built around business capabilities and independently deployable by fully automated deployment machinery. There is a bare minimum of centralized management of these services, which may be written in different programming languages and use different data storage technologies.[1]

Putting this in the context of a TMS, instead of being one big piece of software code, think of a TMS that is built using the software equivalent of LEGO bricks. Each brick (microservice) is designed to perform a different TMS function, such as rating or tendering. You can add new bricks, remove outdated ones and connect them together in different ways to enable specific workflows.

Why the move to a microservices architecture? The following statement by BigPicture.io founder and CEO Michael Frye highlights some of the main reasons:

Previously, we developers built applications in a way that is now known as the monolith: The project starts off small, then we just add something here, bolt on a new feature there. Then fast-forward a year or two and you suddenly have this monster of a project where you change one thing and the whole system can break. Everything is interconnected. […] It's also much harder to scale this type of system. It's just one monster project, so you end up having to scale by throwing more servers at it, which ends up being very expensive.[2]

Lewis and Fowler add:

Monolithic applications can be successful, but increasingly people are feeling frustrations with them — especially as more applications are being deployed to the cloud. Change cycles are tied together — a change made to a small part of the application requires the entire monolith to be rebuilt and deployed. Over time it's often hard to keep a good modular structure, making it harder to keep changes that ought to only affect one module within that module. Scaling requires scaling of the entire application rather than parts of it that require greater resources.[3]

1 "Microservices - a definition of this new architectural term," James Lewis and Martin Fowler, MartinFowler.com, March 25, 2014

2 How to explain microservices in plain English," Kevin Casey, The Enterprisers Project, August 16, 2017

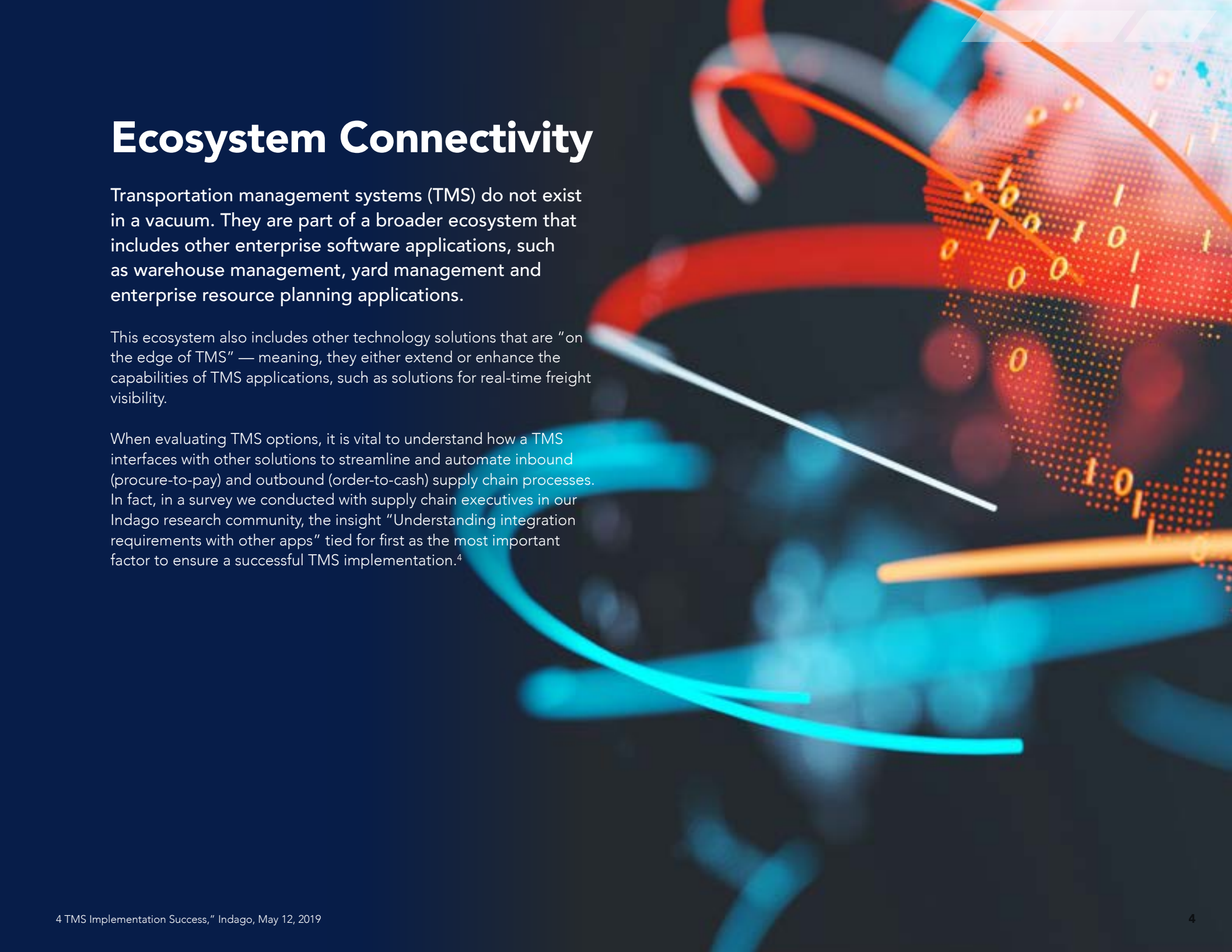
3 "Microservices - a definition of this new architectural term," James Lewis and Martin Fowler, MartinFowler.com, March 25, 2014

Ecosystem Connectivity

Transportation management systems (TMS) do not exist in a vacuum. They are part of a broader ecosystem that includes other enterprise software applications, such as warehouse management, yard management and enterprise resource planning applications.

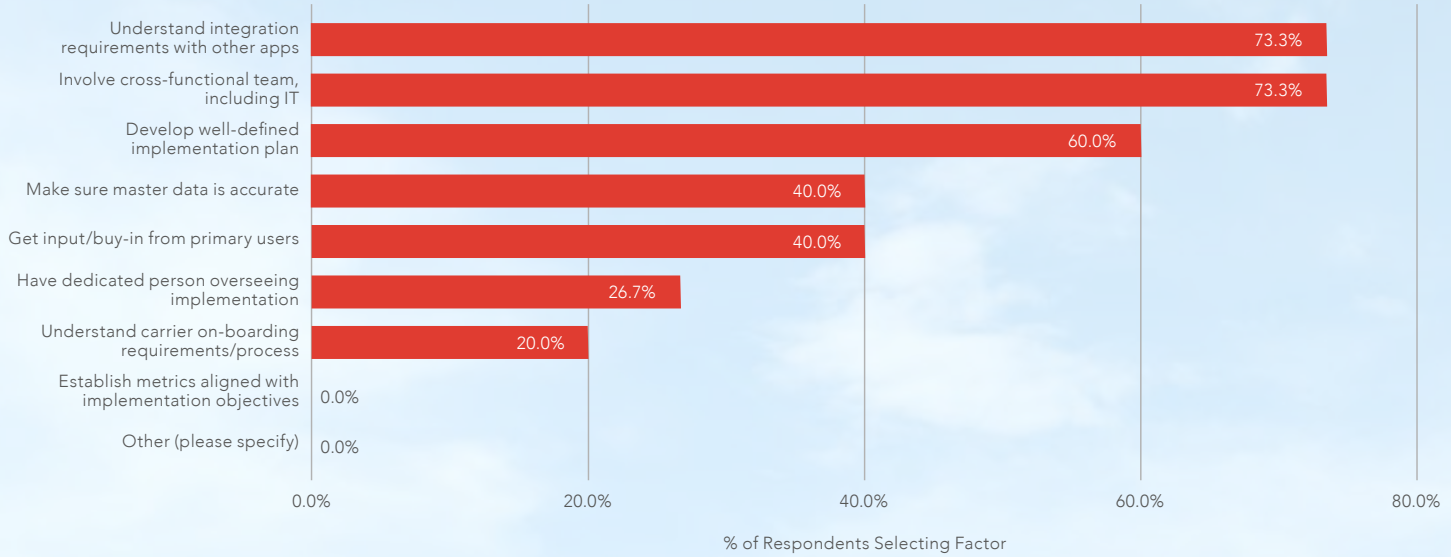
This ecosystem also includes other technology solutions that are "on the edge of TMS" — meaning, they either extend or enhance the capabilities of TMS applications, such as solutions for real-time freight visibility.

When evaluating TMS options, it is vital to understand how a TMS interfaces with other solutions to streamline and automate inbound (procure-to-pay) and outbound (order-to-cash) supply chain processes. In fact, in a survey we conducted with supply chain executives in our Indago research community, the insight "Understanding integration requirements with other apps" tied for first as the most important factor to ensure a successful TMS implementation.[4]



4 TMS Implementation Success," Indago, May 12, 2019

Which factors are the most important to ensure a successful TMS implementation? Select 1-3 success factors.



Source: "TMS Implementation Success," Indago survey, May 2019 (n = 23)

Here, again, architecture matters. If the TMS is part of a common supply chain execution platform that is also microservices-based and includes, for example, warehouse management system (WMS), capabilities, then there is no integration required with a WMS in the traditional sense. The focus is not on passing data between different applications, but on defining and building workflows that span warehousing and transportation, using a set of microservices (again, think of building with LEGO bricks).

When it comes to integrating with other third-party applications, without getting into the weeds of system integration, it is sufficient to say that application program interfaces (APIs) and web services are the dominant and preferred way for solutions in the TMS ecosystem to transact with each other, especially in the cloud.

Which "on the edge of TMS" solutions are in high demand today?

REAL-TIME FREIGHT VISIBILITY

This is one of the hottest segments of the TMS ecosystem. Most leading TMS vendors have partnerships with multiple freight-visibility solution providers. Demand for these solutions is being driven by the need for more realtime and accurate visibility to orders, shipments and trucks in response to more stringent customer service expectations, such as Walmart's on-time infull (OTIF) requirements.

DIGITAL FREIGHT BROKERS

TMS vendors are partnering with a variety of digital freight brokers to provide shippers with real-time access to rates and capacity. For example, if a tendered load is rejected by the primary and backup carriers in a routing guide, the TMS can automatically (and almost instantaneously) retrieve a real-time rate from a digital freight broker and, if accepted, automate the booking process. The integration also allows shippers to compare their existing contract rates with real-time market rates.

CARRIER CONNECTIVITY NETWORKS

Although electronic data interchange (EDI) remains well entrenched in transportation, the future of carrier connectivity is APIs and web services. They provide more realtime data and visibility than EDI, along with other integration and maintenance benefits. Many cloudbased TMS vendors have their own pre-built carrier networks that shippers can access, which greatly simplifies the carrier onboarding process. Others have partnerships with multiple API-based carrier integration partners. Rating APIs exist for less-thantruckload, truckload, parcel and rail carriers, as well as APIs for status updates, transit times and other data sets.

REAL-TIME WEATHER AND TRAFFIC DATA

Leading TMS solutions are also starting to leverage a broader set of data sources — including weather and traffic — to create more executable plans and enable predictive capabilities, especially around determining more accurate estimated times of arrival.

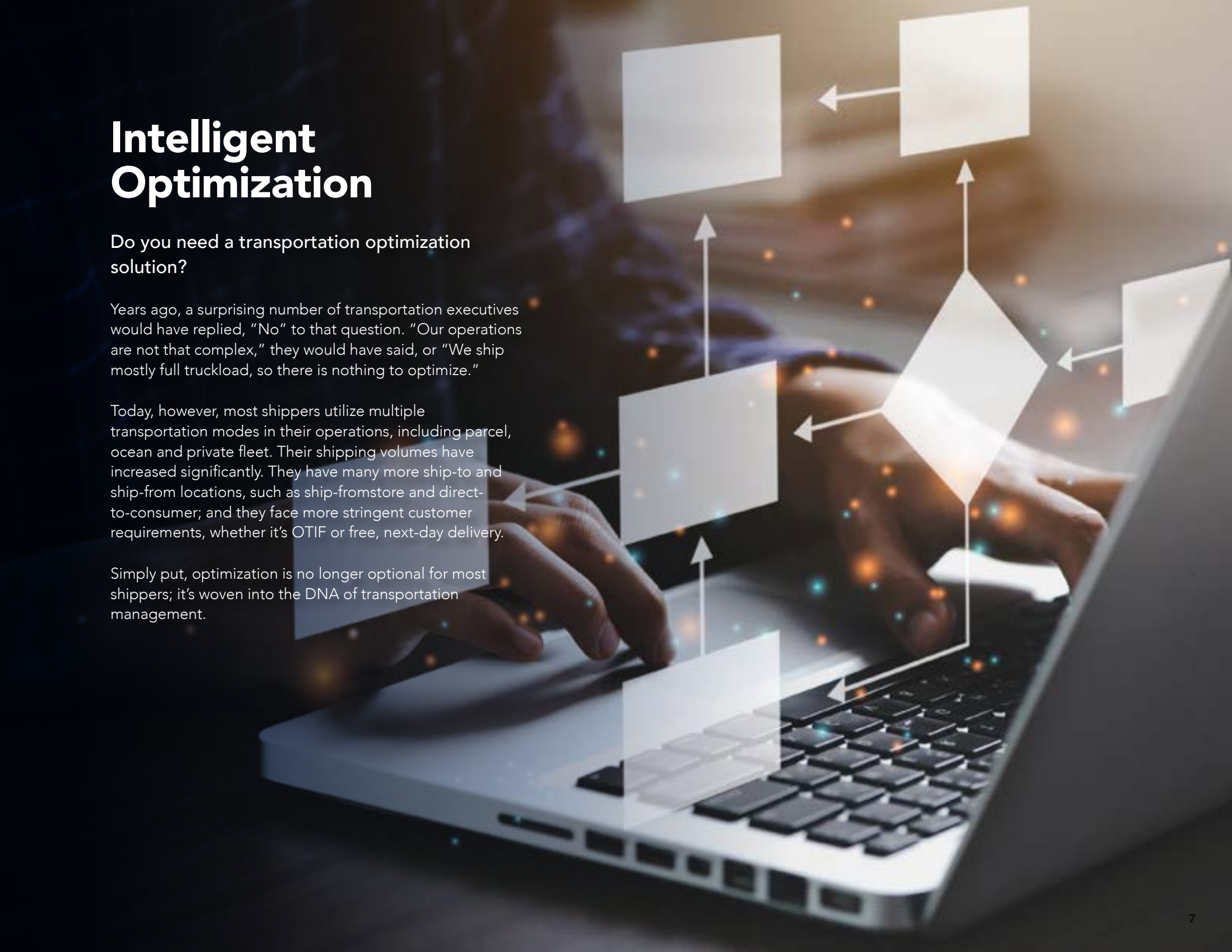
Intelligent Optimization

Do you need a transportation optimization solution?

Years ago, a surprising number of transportation executives would have replied, "No" to that question. "Our operations are not that complex," they would have said, or "We ship mostly full truckload, so there is nothing to optimize."

Today, however, most shippers utilize multiple transportation modes in their operations, including parcel, ocean and private fleet. Their shipping volumes have increased significantly. They have many more ship-to and ship-from locations, such as ship-fromstore and direct-to-consumer; and they face more stringent customer requirements, whether it's OTIF or free, next-day delivery.

Simply put, optimization is no longer optional for most shippers; it's woven into the DNA of transportation management.



MULTI-MODE / MULTI-LEG OPTIMIZATION

In the early days of TMS, optimization was done in a fragmented way. For example, truckload and lessthan- load freight was optimized separately from private fleet. Optimizing a shipment across multiple legs and modes of a journey was fairly limited, too. It would have taken an optimization engine many hours to come up with a solution, due to limitations in the algorithms and computing power. Today, however, thanks to advancements in optimization technology and almost limitless computing power, TMS solutions can perform multi-mode/multi-leg optimizations very quickly (in minutes instead of hours). This includes evaluating common carrier versus private fleet options, simultaneously.

DYNAMIC OPTIMIZATION

Leading solutions use dynamic optimization engines for execution. Unlike static optimization engines that determine the best solution based on a snapshot in time (which can become outdated, very quickly), dynamic optimization engines continuously analyze and provide the best solution as new orders or exceptions come in.

SELF-TUNING

It takes time to set up and fine-tune a TMS, particularly its optimization capabilities, so that it accurately reflects your company's transportation operations. And since your company's operations change over time — routing guide, rates, lead times, delivery windows, optimization constraints and so on — you need to continuously fine tune the TMS; otherwise, the quality of the output will degrade, and you'll end up thinking the solution is "broken" and, so, stop using it. Simply put, a TMS is like a car: You have to perform regular tune-ups or else its performance will start to degrade. Historically, this has been a manual and time-consuming effort, which is why many companies fail to keep their TMS well-tuned. Leading TMS solutions, however, are employing selftuning capabilities that leverage real-time operational data to automatically and continuously adjust optimization parameters.

EXPANDED SCOPE

The scope of TMS optimization is expanding beyond execution into the tactical and strategic realms, too. Execution-focused optimization has always been a part of leading TMS solutions, while tactical and strategic optimizations were typically separate, standalone applications. However, since all three types of optimization depend on TMS data, and transportation networks are continuously changing, TMS vendors are adding tactical and strategic capabilities to their platforms. This includes procurement-related optimization solutions and transportation modeling capabilities for (among other things) network design, determining fleet versus common carrier policies, and fleet sizing.

Productive User Experience

Historically, one of the things supply chain software users have complained the most about is user interfaces (UIs). Simply put, many UIs are crammed with too many features and too much information that users don't need or want in order to accomplish their tasks; have non-intuitive workflows that don't align with the way users are accustomed to working (or the way they want to work); and force users to open multiple windows and tabs, and click countless times, to accomplish what should be a straightforward task.

Fortunately, the tide is starting to turn, driven by various factors. First, we're seeing the "consumerization of IT" as a generation of workers who have grown up in the Web/Mobile/Social era enter the workforce. These workers expect the software they use at work to be as easy and intuitive to use as the apps they use at home and on their mobile devices. Secondly, as a way to compete beyond features and functions, supply chain software vendors have invested heavily in improving the design and user experience of their applications.

These trends are particularly true in TMS, where user interfaces have become much easier to configure based on user roles and preferences. They are also much more graphical in nature, provide a consistent look and feel across different platforms (desktop and mobile), and include features often found in consumer applications, such as drag-and-drop capabilities and in-app messaging and notifications.

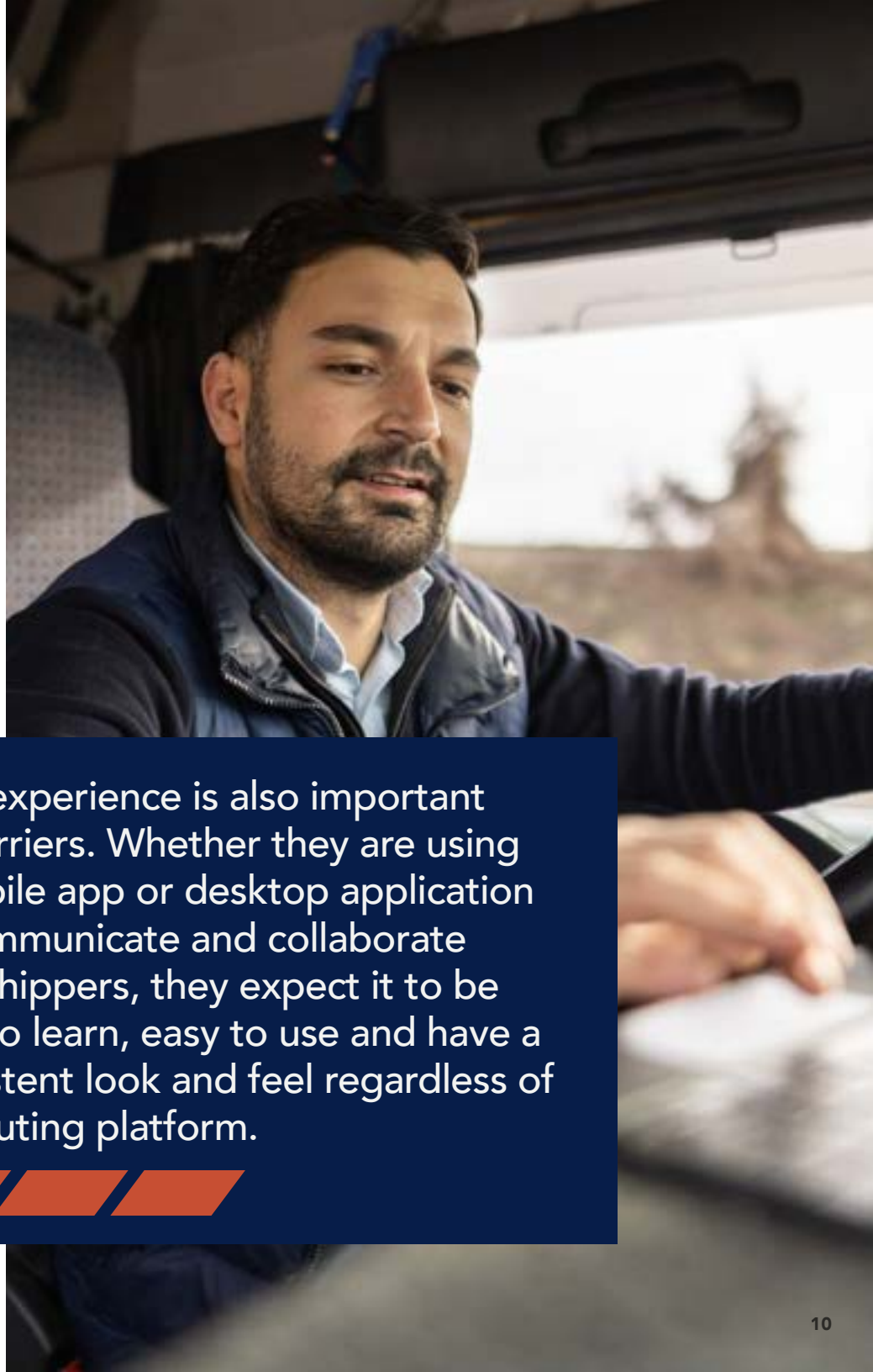
Why should companies care about user experience? Because there is a strong business case for it. **Here are two examples:**

FASTER, MORE COST-EFFECTIVE TRAINING

Today's consumer applications are designed to be easy to use and intuitive with the precise goal of breaking down adoption barriers. Imagine how much time and money companies could save if supply chain applications were, relatively speaking, as easy and intuitive to use as consumer applications. Instead of days (or weeks) of training, you might only need a few hours.

IMPROVED PRODUCTIVITY

How much more can you get accomplished in a day, with how many fewer people, if instead of opening five windows and clicking 20 times to complete a task, you could do it all from one screen with just one or two clicks?



User experience is also important for carriers. Whether they are using a mobile app or desktop application to communicate and collaborate with shippers, they expect it to be easy to learn, easy to use and have a consistent look and feel regardless of computing platform.

Summary

Transportation management systems (TMS) have become a must-have application for companies to meet the service and cost expectations of its customers (as well as to navigate through a very dynamic and constrained transportation environment) in the most cost effective, efficient and scalable way possible.

The DNA of TMS has evolved over the past three decades in response to both advancements in technology and the changing needs of shippers.

A TMS built for the 1980s would not "survive" today; neither would one built for the late 1990s or early 2000s.

There are many building blocks in the DNA instruction book for a TMS, but the following four building blocks are among the most important for companies to consider because they are among the core attributes of a modern TMS:

ARCHITECTED FOR THE CLOUD

A microservices architecture offers a variety of benefits related to scalability and how new functionality is added and updated, including the ability for users to create their own unique functionality to extend the capabilities of the application.

ECOSYSTEM CONNECTIVITY

TMS do not exist in a vacuum. It is important to understand how a TMS interfaces with other solutions to streamline and automate inbound (procure-to pay) and outbound (order-to-cash) supply chain processes. These other solutions include enterprise apps such as WMS, yard management systems, and enterprise resource planning, as well as real-time freight visibility, digital freight brokers, carrier connectivity networks and real-time weather and traffic solutions.

INTELLIGENT OPTIMIZATION

Optimization is no longer optional for most shippers; it's woven into the DNA of transportation management. Thanks to advancements in optimization technology and almost limitless computing power, TMS solutions today can quickly perform multi-mode/multi-leg optimizations; are able to dynamically optimize as new orders or exceptions come in; and have self-tuning capabilities.

PRODUCTIVE USER EXPERIENCE

TMS user interfaces have become much easier to configure based on user roles and preferences. They are also much more graphical in nature, provide a consistent look and feel across different platforms and include features often found in consumer applications (e.g., drag-and-drop capabilities and in-app messaging and notifications). User-experience matters, for both shippers and carriers, because it leads to faster, more cost-effective training and improved productivity.

About the Author

Adrian Gonzalez, President, Adelante SCM

Adrian Gonzalez is a trusted advisor and leading industry analyst with more than 22 years of research experience in transportation management, logistics outsourcing and other supply chain and logistics topics. He is the founder and president of Adelante SCM, a peer-to-peer learning, networking and research community for supply chain and logistics professionals. Adelante's services include Talking Logistics, an online video talk show and blog featuring thought leaders and newsmakers in the supply chain and logistics industry, and Indago, a market research service that brings together a community of supply chain and logistics practitioners who share practical knowledge and advice with each other while giving back to charitable causes.

Prior to his current roles, Gonzalez held various leadership positions at ARC Advisory Group, Motorola, Polaroid and Clare. Gonzalez speaks frequently at industry events and conferences and is regularly quoted in industry publications. He is also a member of the Council of Supply Chain Management Professionals and a LinkedIn Influencer with more than 251,000 followers.

Gonzalez has a BS degree in Materials Science and Engineering from Cornell University. He also earned a Graduate Certificate in Supply Chain Management from Northeastern University, where he has served as an adjunct instructor in the university's Executive MBA program.

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