

# THE SMARTER SUPPLY CHAIN OF THE FUTURE

GLOBAL CHIEF SUPPLY CHAIN OFFICER STUDY



AUTOMOTIVE INDUSTRY EDITION



## INTRODUCTION

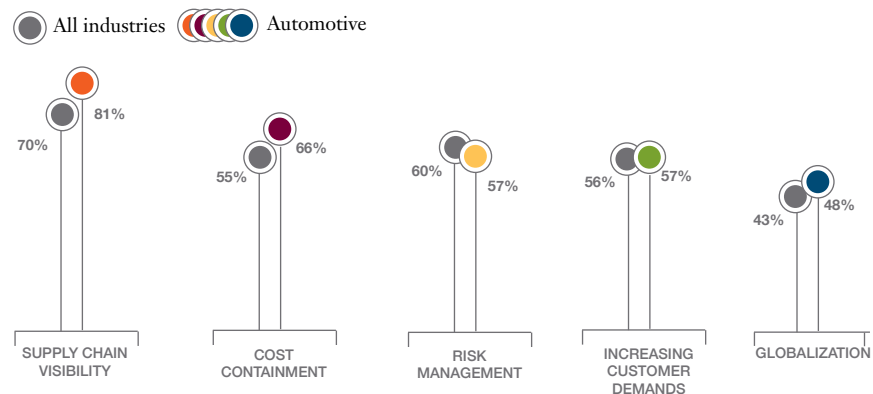
In the course of our research for IBM's Global Chief Supply Chain Officer Study, we conducted face-to-face interviews with nearly 400 senior supply chain executives from 25 countries and 29 different industries.<sup>1</sup> Here, we focus on the responses of the 33 supply chain executives from automotive companies, including light vehicle, truck and heavy equipment OEMs, suppliers and service providers.

As part of our analysis, we compared automotive responses to those of supply chain executives across sectors as well as leaders of some of the world's top supply chains.<sup>2</sup> In some areas, the responses were similar. But in others, key differences reveal potential opportunities for improving the automotive supply chain.

Across industries and also within automotive, supply chain executives told us they struggle with five primary challenges: visibility, risk, cost containment, customer demands and globalization (see Figure 1).

**FIGURE 1 THE TOP FIVE CHALLENGES FOR THE AUTOMOTIVE SUPPLY CHAIN**

Automotive respondents viewed these challenges as impacting their supply chains to a significant or very significant extent.



Not surprisingly, cost containment is a concern that figures prominently on the automotive agenda. However, visibility ranks even higher. Executives identified it as a critical means to effectively contain cost and address their other top challenges. The most interesting finding, though, is the lack of significance placed on risk management, especially given the turmoil the industry has seen.

To effectively address these challenges, we believe automotive companies will need not simply a more efficient supply chain, but rather a **smarter** supply chain that embodies three key characteristics:



**Instrumented** – Using sensors and “smart” devices to gain greater visibility across the network, mitigate risk, reduce cost and manage rising complexity.



**Interconnected** – Integrating the entire supply chain – even the fragmented aftermarket – to share information, make decisions collaboratively and manage in realtime.



**Intelligent** – Relying more on advanced analytics, simulation and modeling tools to evaluate increasingly complex and dynamic risks and constraints and act on better insight.

A smarter approach allows automotive supply chains to make progress against all five of these top challenges simultaneously by providing timely decision-making advantages that are difficult for traditional supply chains to match.



# THE CASE FOR A SMARTER AUTOMOTIVE SUPPLY CHAIN



## EIGHT OUT OF TEN LACK VISIBILITY

.....

“Visibility of pipeline at overseas distributors is a critical issue, as is management and timely adjustment of production, sales and inventory... Insufficient granularity and silo-to-silo operations are obstacles to streamlined supply chain operations.”

*Supply chain executive,  
Japanese OEM*

.....

Similar to their peers across industries, automotive supply chains’ top challenge is visibility. In fact, the concern is even stronger for automotive (81 percent compared to 70 percent study-wide).

Although 84 percent of automotive executives have implemented realtime supply chain information transparency inside and outside the enterprise, only 13 percent have done so extensively. In addition, less than 30 percent of automotive companies view their collaborative practices as extremely effective – in some areas, it’s below 10 percent. For example, none of the automotive respondents report being highly effective at customer inventory planning and deployment programs.

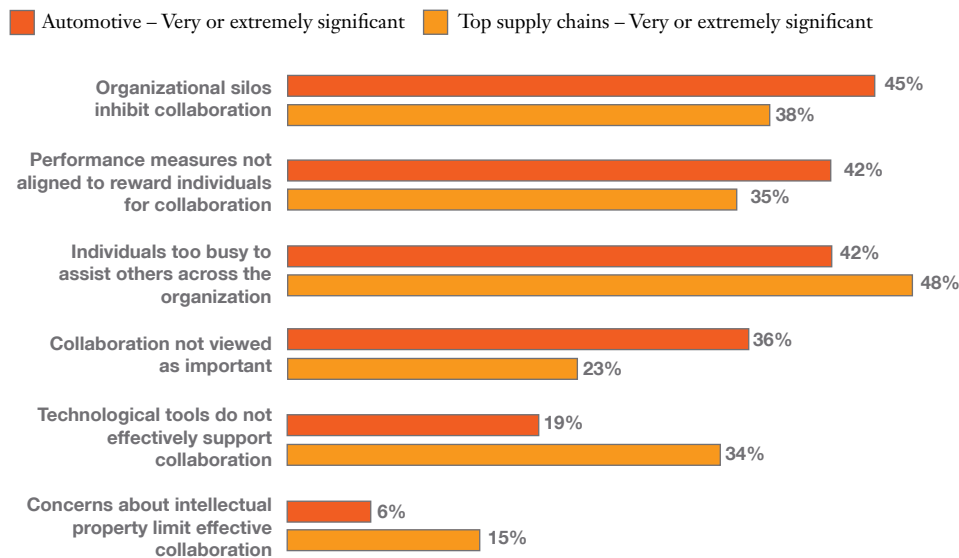
Looking across the various visibility practices, automotive companies trail top supply chains by some fairly significant margins. The percentage of top supply chains that are extremely effective at sharing realtime demand and inventory data, for instance, is five times higher than automotive supply chains (25 percent versus just 5 percent).

Surprisingly, however, the responses across industries suggest that the most significant barriers to visibility and collaboration are organizational, rather than technological. Automotive executives agree, with organizational silos cited as the primary obstacle (see Figure 2). It's also interesting to note that top supply chains perceive technology as a larger problem than automotive companies do. This appears to be driven by the maturity of their collaboration processes – which often include technology as an enabler.

**FIGURE 2 FOUR OUT OF TEN STRUGGLE WITH ORGANIZATIONAL OBSTACLES TO VISIBILITY AND COLLABORATION**

The top barriers are organizational in nature; technology and intellectual property concerns have far less impact.

*How significant are the following barriers to visibility and collaboration?*





## VISIBILITY IN THE SMARTER SUPPLY CHAIN

The smarter automotive supply chain recognizes the critical business need for supply chain visibility. It sees visibility as the key building block for responding to the other top challenges, including cost containment, risk, customer and globalization issues.

To gain more visibility, the smarter supply chain uses RFID tags, sensors and “smart” devices to track and optimize the movement of materials from suppliers to receiving docks and throughout assembly. However, it takes instrumentation even further, using it to improve visibility downstream. For example, dealers might use smart tags not only to locate specific automobiles across expansive lots but also to ensure they install the right customizations on the right vehicles.

Embedded systems and software are also aiding the smarter supply chain through instrumentation of the vehicle itself. These sensors provide data on leading indicators of potential failure. This information, in turn, provides demand visibility for parts and service and helps the manufacturer improve quality and reduce warranty costs.

Smarter automotive supply chains are also highly interconnected – even across extended dealer networks. For example, dealers can view their own parts inventory as well as the inventory of other dealers and distribution centers. They can also order the parts they need from any location. Dealers are not forced to choose between locally stocking slow-moving inventory and losing business because of service delays.

These smarter supply chains also have the intelligence needed to optimize their operations based on increased visibility. Sourcing quantities, safety stock levels and replenishment thresholds are calculated using accurate information and sophisticated analytics. And event triggers automate actions based on these predetermined rules.



## CUTTING COST IS CRITICAL – BUT WHERE?

Within the automotive industry, more supply chain executives rank cost containment as a top challenge (66 percent versus 55 percent across industries). While three-quarters of automotive companies are concentrating on cost containment to meet business challenges, only 48 percent of top supply chains are doing so, choosing instead to position their supply chains to drive revenue growth.

Cost-cutting intentions are obviously strong; but are automotive supply chains looking in the right areas? Are they selecting targets strategically? Our findings suggest some uncertainty here. For example, more than 80 percent of automotive supply chain executives say they have implemented variable cost structures that align costs with fluctuating revenues – 20 percent have done so extensively. Top supply chains have roughly the same rate of adoption. And yet, automotive executives’ continuing focus on cost indicates there is still much more to do.

.....  
“If we had better transparency of total cost, we might find that Indiana is the low-cost source for our system. However, our company doesn’t share data, so suppliers won’t.”

*Supply chain executive, US OEM*  
.....

.....  
 “We need more visibility into supplier costs to collaborate and jointly drive waste out. Suppliers, however, have been reluctant to share this information because we have not shared the savings.”  
 .....  
 .....  
 .....  
 .....  
 .....

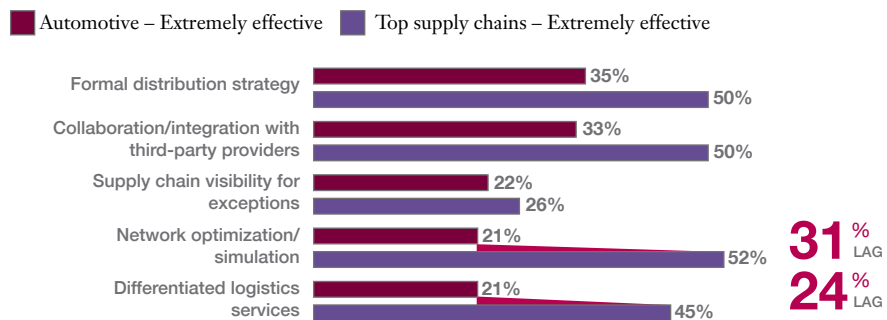
*Supply chain executive, US OEM*

Our findings suggest outsourcing is one potential area of opportunity to “variabilize” costs. The only supply chain function that is extensively outsourced by the majority of automotive executives is transportation (76 percent). Only one in five reports widespread outsourcing of customs/export management and warehousing/distribution centers. Less than 5 percent use contract manufacturing. And not a single automotive executive reports extensive outsourcing of procurement.

Automotive supply chains also have room to improve outsourcing effectiveness. Even in areas like transportation, which 95 percent of automotive companies outsource to some extent, the industry’s effectiveness lags that of top supply chains. The gaps are larger in areas that require more flexibility and advanced analytics capabilities, such as differentiated logistics services and network optimization (see Figure 3).

**FIGURE 3 FEWER AUTOMOTIVE COMPANIES ARE EXTREMELY EFFECTIVE AT CONTROLLING LOGISTICS COSTS**  
 Only one in five is proficient at complex cost reduction techniques.

*How effectively have these logistics practices and initiatives been implemented?*







## COST CONTAINMENT IN THE SMARTER SUPPLY CHAIN

The smarter automotive supply chain takes full advantage of increased instrumentation, interconnectivity and intelligence to reduce cost. Using these capabilities, it maintains the optimum inventory of incoming materials, finished products, spare parts and accessories spread across distribution centers and thousands of dealer repair shops.

Intelligent forecasting, inventory management and dynamic pricing of parts are particularly important – not just for efficiency, but because they position the smarter supply chain to capture the expected growth in the service segment as consumers hold onto their vehicles longer.<sup>3</sup>

In a smarter supply chain, spare parts forecasting and planning is done at a lower level of detail. Even with hundreds of thousands of parts and millions of part-location combinations, it can simulate different scenarios and tailor replenishment strategies for each individual part. Sophisticated algorithms help to better predict sporadic demand fluctuations. The entire value chain saves money by carrying less inventory and reducing obsolescence through better parts utilization.

The smarter automotive supply chain also uses analytics to optimize distribution networks. For example, by analyzing production and customer locations, order quantities, transportation costs and delivery times, a manufacturer can determine the right number of distribution centers and their ideal locations. The optimized network reduces warehousing and transportation costs, while still maintaining high service levels.



## RISK MANAGEMENT STUCK IN THE CFO'S OFFICE

.....  
 “Our supplier performance scorecard process is good. But this information is not used strategically to manage risk.”

*Supply chain executive, US OEM*  
 .....

Across industries, one-third of all supply chains fail to manage risk on a formal basis. The story is slightly worse for automotive companies, with 37 percent acknowledging no formal practices for monitoring risk.

Automotive companies trail top supply chains in implementing risk management practices. Currently, 61 percent of automotive companies have incorporated risk mitigation into their supply chain planning processes. Within three years, this adoption rate is expected to rise to 75 percent – which is the current level among top supply chains.

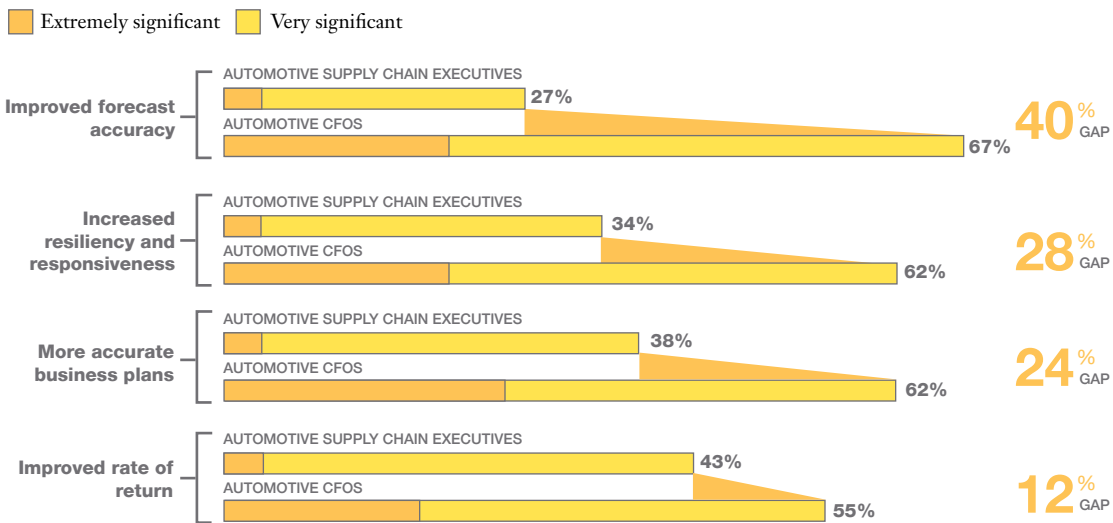
Also in three years, more than nine out of ten top supply chains expect to have process controls implemented across logistics and operations (96 percent) and compliance programs in place with their suppliers and service providers (92 percent), as compared to 85 percent and 75 percent, respectively, of automotive supply chains.

However, what we found most troubling was automotive supply chain executives' opinions on the benefits of risk mitigation (see Figure 4). This is particularly apparent when we compare their answers to the responses of top supply chains and automotive CFOs (from the IBM Global CFO Study). Fewer automotive supply chain executives believe risk mitigation would increase forecast accuracy despite the link between this metric and the importance of realtime visibility. Similarly, automotive supply chains do not see a strong link between risk mitigation and increased resiliency and responsiveness – even though they are depending on variable cost structures that scale up and down as situations change.

**FIGURE 4** AUTOMOTIVE CFOS PLACE A MUCH HIGHER VALUE ON RISK MITIGATION

Automotive supply chain executives seem to be underestimating the impact of risk management.

*How much impact would/does a risk mitigation strategy have on the following aspects of your business?*



In this study, we also found that responsibility for supply chain risk management is rarely included in the role of the automotive Chief Supply Chain Officer. This may explain the participants' view that risk mitigation strategies do not significantly impact their supply chains. Without formal accountability for a comprehensive, enterprise-wide view of risk, executives can easily misjudge business impact.



## RISK MANAGEMENT IN THE SMARTER SUPPLY CHAIN

For automotive companies, supply chain risks are many and varied. Increasing globalization and new economic realities have spawned even more.

However, with sophisticated demand planning, variable cost structures and better integration with suppliers, the smarter automotive supply chain is more capable of flexing supply up and down with demand. Greater visibility along with closer customer and supplier collaboration help maintain the right mix of vehicles and products in stock. Stronger build-to-order capabilities also reduce the risk of having dealer lots full of unwanted inventory.

With vehicles staying in use longer, the demand for spare parts is rising, along with it the incidence of counterfeit and gray market parts. It's a trend that threatens one of the industry's most profitable segments. The smarter supply chain mitigates these risks with smart tags that allow parts to be authenticated and traced throughout the supply chain.

In addition, at any given time, more than 15 million containers are traveling through international waters or waiting to clear customs.<sup>4</sup> These deliveries face many risks: delays, diversion, even physical damage. For traditional supply chains, cross-continental transit typically means loss of visibility. But the smarter supply chain can track its cargo containers anywhere in the world. Instrumented containers collect information and report on their

physical locations, environmental factors such as temperature and humidity, as well as signs of tampering. Besides reducing risk, these capabilities enable “green-lane” customs treatment, which offers further supply chain efficiencies.

To help identify and prepare for the unknown, the smarter automotive supply chain equips itself with advanced business analytics. Instead of simply responding to changes it senses, the smarter supply chain uses realtime information and sophisticated modeling to predict outcomes and take appropriate actions ahead of time. For example, a manufacturer could model the effects of a pandemic – such as supplier shut-downs and closures of ports and airports – and implement mitigation plans to minimize supply chain disruptions.



## MEETING CUSTOMER DEMANDS REQUIRES MORE REALTIME COLLABORATION

Across industries, demand planning with customers is the least frequently implemented process for synchronizing supply and demand. The same is true among automotive companies. When contrasted with the full sample, a higher percentage of automotive supply chains report collaborating with customers on demand synchronization. Yet, on the whole, supply chain planning is done primarily within the organization. Only 26 percent collaborate with customers to a significant extent, as compared to 77 percent who use internal sales and operations planning processes.

.....  
“We need closer customer integration and collaboration in order to quickly get true demand.”

*Supply chain executive,  
Swedish supplier*

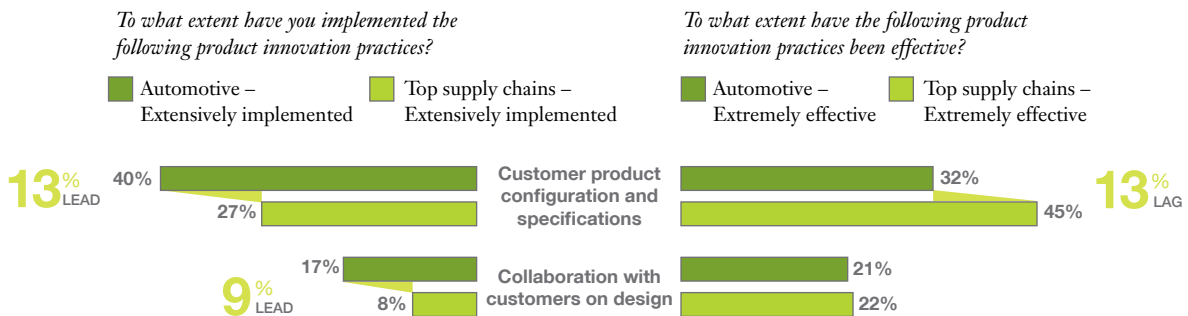
.....

In terms of customer collaboration on product innovation, automotive supply chains fare much better (see Figure 5). Compared with top supply chains, significantly more automotive supply chains support customer product configuration and specifications. Similarly, twice as many auto companies collaborate extensively with customers on product design.

In context, these findings suggest that automotive companies' ability to collaborate effectively with customers is inversely related to the speed and frequency of the interaction required. In other words, automotive supply chains excel at periodic customer collaboration. But when realtime, transaction-level interaction is required, the industry's collaborative capabilities fall short. Although it may be difficult for light vehicle OEMs to create these capabilities because of the size and varying levels of IT capabilities among their dealers, other automotive companies should seize the opportunity to connect with large customers and dealers.

**FIGURE 5 AUTOMOTIVE COMPANIES SURPASS TOP SUPPLY CHAINS IN IMPLEMENTING COLLABORATIVE PRODUCT INNOVATION**

But they still need to focus on raising the effectiveness of these practices.





## CUSTOMER COLLABORATION IN THE SMARTER SUPPLY CHAIN

The smarter automotive supply chain uses greater instrumentation and interconnectivity to improve products and supply chain operations as well as to gain consumer insight. Historically, dealers and service/repair shops possessed the most information about the consumer, with OEMs and suppliers having the least. However, with a smarter supply chain, more information is shared across the network.

With online communities, embedded systems, connected automobiles and online vehicle configuration and ordering, the smarter supply chain has more information about consumers and how they use their vehicles than ever before. More importantly, it has intelligent analytics to synthesize and use this wealth of information.

For example, a heavy equipment maker might instrument its vehicles to electronically transmit performance data. This information would flow directly into product development to improve quality and reduce warranty costs. Analysis of the information would allow the manufacturer to predict equipment failures and notify customers of the need for preventative maintenance, helping reduce their service costs and avoid business disruptions. Instrumented and interconnected vehicles create a host of new opportunities for services-based businesses, like fleet management, which typically provide steadier revenue streams than products.

The smarter automotive supply chain also addresses rising customer demand for configurable products. Its vehicles are designed to be tailored – either during manufacturing or upon arrival at the dealer. Because the smarter supply chain is appropriately flexible and interconnected, customers can adjust an order until just a few days before manufacturing begins.



## GLOBALIZATION PROGRESS IMPEDED BY OPERATIONAL ISSUES

.....

“We agree that global operational efficiency needs to be pursued ahead of local operational efficiency. However, our current level of resource (infrastructure, manpower, capability, etc.) cannot fully support global operational efficiency.”

*Supply chain executive,  
Korean supplier*

.....

In the IBM Global CEO Study 2008, we learned that automotive is one of the most global industries – second only to electronics.<sup>5</sup> Indeed, the automotive industry has been at the forefront of establishing global infrastructure. As other industries begin to catch up, they are struggling with some of the same operational issues automotive supply chain executives have faced for some time: namely, quality and delivery reliability. These two issues are the top challenges across our entire sample and within automotive as well.

As a result, supply chain executives across industries are not achieving the benefits they anticipated from their global supply chains. In fact, only one-third of automotive supply chains report improved overall performance as a result of globalization.

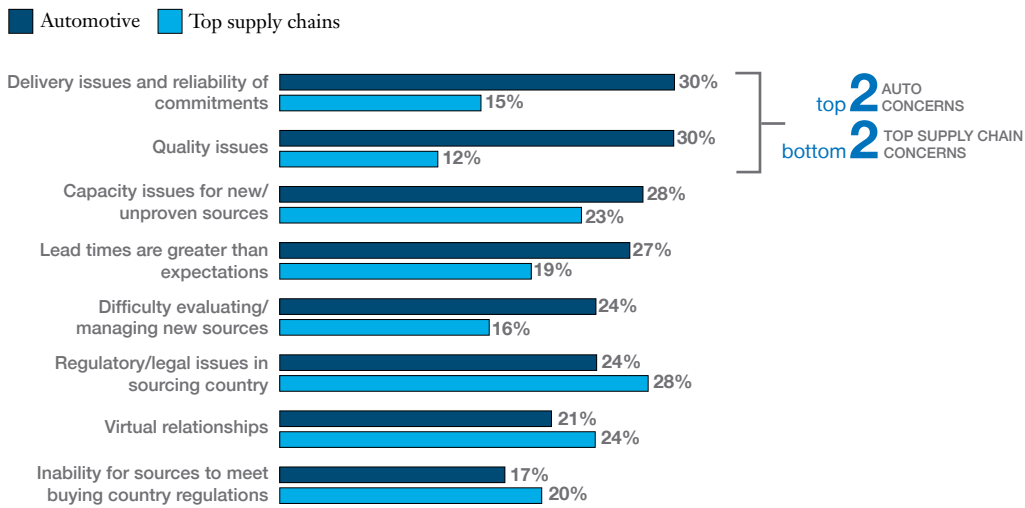
In contrast, nearly 60 percent of top supply chains report that globalization has improved their overall performance. Additionally, they expect to have delivery reliability and quality issues largely under control within the next three years (see Figure 6).



**FIGURE 6 THE FUTURE AGENDA FOR AUTOMOTIVE AND TOP SUPPLY CHAINS IS DRAMATICALLY DIFFERENT**

To capitalize on their substantial global investments, automotive companies must solve key operational issues.

*What are your major challenges in regard to global sourcing and global operations?*



.....

“In the early stages, we handled the cultural and operational challenges of globalization very poorly. We still act very domestic today; it’s difficult to change behavior.”

*Supply chain executive, US OEM*

.....

Their top future concerns are more advanced business issues: the regulatory and legal challenges of an international supply network and the organizational and cultural obstacles posed by increasingly virtual relationships.



## GLOBAL INTEGRATION IN THE SMARTER SUPPLY CHAIN

The smarter automotive supply chain is focused on integrating its global supply chain. This includes integrating the product lifecycle management and enterprise resource planning systems of all its partners. In addition, collaboration, knowledge sharing and social networking tools help close distance gaps and build “people” networks across the extended value chain.

To facilitate integration, the smarter supply chain establishes common processes and terminology. For example, “ship” means the same thing in Mexico as it does in Singapore, and production schedule adherence is calculated the same way at every plant.

Instead of running each facility separately, the smarter supply chain manages resources globally – matching demand with sourcing and manufacturing capacity around the world. Through intelligent business analytics, it tracks and synthesizes demand and supply trends, evaluates complex “what if” scenarios and acts based on the most likely outcomes.

These insights – combined with supply chain flexibility – allow the smarter supply chain to adjust sourcing and production planning to optimize operations globally. This intelligence makes a global available-to-promise function viable.



# THE EVOLVING ROLE OF THE CHIEF SUPPLY CHAIN OFFICER

## MANAGING A SMARTER SUPPLY CHAIN

In automotive companies, the highest-ranking supply chain executive is more likely to report directly to the CEO (52 percent as opposed to 46 percent across all industries). In addition, nine out of ten automotive supply chain executives have responsibility for strategy, planning and operational execution.

Yet, a comparison between automotive and top supply chain companies shows some stark differences in executives' functional responsibilities (see Figure 7). A negligible percentage of automotive supply chain executives oversee nontraditional functions such as risk mitigation and new product design. In fact, top supply chains surpass the automotive industry by more than a three-to-one margin in most of these emerging areas of responsibility.

Given these contrasts, automotive Chief Supply Chain Officers should consider whether their current goals require them to have a broader scope of responsibility. For example:

Eight out of ten automotive supply chain executives struggle with end-to-end visibility...	<b>But</b>	...only 15 percent are responsible for manufacturing and just 7 percent manage post-sales functions
Risk management is a major challenge for 57 percent of automotive supply chains...	<b>But</b>	...just 7 percent of executives have a risk management function reporting to them
More than half are concerned about rising customer demands...	<b>But</b>	...a mere 4 percent oversee product design and customer management

.....

“The Chief Supply Chain Executive is becoming more and more of a people integrator, as well as a culture and process integrator.”

*Supply chain executive,  
Italian supplier*

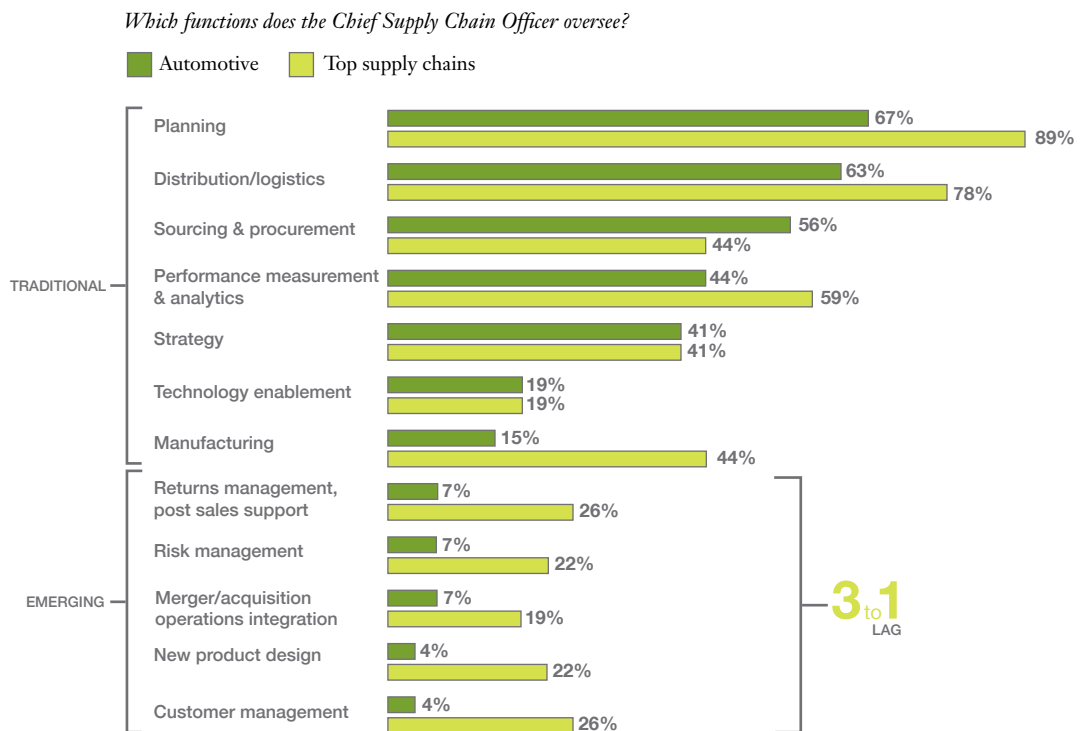
.....

.....  
 “Supply chain executives need to become more integrated with the rest of the business. We’re currently seen as an afterthought.”  
 .....  
*Supply chain executive, British OEM*  
 .....

Where their span of control is limited, automotive supply chain executives will have to compensate with even greater collaboration and personal influence.

Indeed, automotive supply chain executives face some critical choices: Will they maintain their traditional roles or assume more strategic responsibilities? Will they focus exclusively on making existing supply chain operations faster and more cost-effective? Or will they push their supply chains further ahead by making them more flexible and more supportive of growth strategies?

**FIGURE 7 AUTOMOTIVE SUPPLY CHAIN EXECUTIVES TEND TO HAVE TRADITIONAL RESPONSIBILITIES**  
 Increased collaboration, risk sharing and other cross-enterprise best practices may involve changes to the breadth of supply chain executive responsibility.



## CONCLUSION

Currently, automotive companies are embroiled in a worldwide industry transition. Nearly everything about their businesses is changing – their products and services, where and how they're sold, the degree of governmental involvement, even the fundamental business models of the industry.

At the center of this massive change is the automotive supply chain. For automotive companies, emerging from this period of transition as healthy, vibrant businesses depends in large part on how their supply chains adapt. Greater speed and efficiency will help, but won't be enough. Automotive supply chains need fact-based intelligence to predict which future scenarios are most likely to occur – and the flexibility to get repositioned before they do. Now more than ever, smart wins.

## ACKNOWLEDGMENTS

We would like to thank the automotive supply chain executives from around the world who generously shared their time and insights with us. We'd also like to acknowledge the contributions of the IBM team who worked on the Automotive Industry Edition of the Global Chief Supply Chain Officer Study: Gary Cicerini, John Farrell and Kalman Gyimesi.

## ABOUT IBM GLOBAL BUSINESS SERVICES

With business experts in more than 170 countries, IBM Global Business Services provides clients with deep business process and industry expertise across 17 industries, using innovation to identify, create and deliver value faster. We draw on the full breadth of IBM capabilities, standing behind our advice to help clients implement solutions designed to deliver business outcomes with far-reaching impact and sustainable results.

## THE IBM INSTITUTE FOR BUSINESS VALUE

The IBM Institute for Business Value, part of IBM Global Business Services, develops fact-based strategic insights for senior business executives around critical industry-specific and cross-industry issues.

## FOR FURTHER INFORMATION

To find out more about this study or to discuss the smarter automotive supply chain in more detail, please send an e-mail to the IBM Institute for Business Value at [iibv@us.ibm.com](mailto:iibv@us.ibm.com), or one of the contacts below:

Global	Sanjay Rishi	<a href="mailto:sanjay.rishi@us.ibm.com">sanjay.rishi@us.ibm.com</a>
Japan	Makoto Kaneko	<a href="mailto:LC064311@jp.ibm.com">LC064311@jp.ibm.com</a>
AP (except Japan)	Jeffrey Wang	<a href="mailto:jwang@cn.ibm.com">jwang@cn.ibm.com</a>
Northern Europe	Karsten Nagel	<a href="mailto:karsten.nagel@de.ibm.com">karsten.nagel@de.ibm.com</a>
Southern Europe	Olivier Payraud	<a href="mailto:olivier.payraud@fr.ibm.com">olivier.payraud@fr.ibm.com</a>
Americas	John Farrell	<a href="mailto:john.farrell@us.ibm.com">john.farrell@us.ibm.com</a>
IBM Institute for Business Value	Kalman Gyimesi	<a href="mailto:gyimesi@us.ibm.com">gyimesi@us.ibm.com</a>

## NOTES AND SOURCES

- 1 “The Smarter Supply Chain of the Future: IBM Global Chief Supply Chain Officer Study.” IBM Institute for Business Value. January 2009. <http://www.ibm.com/supplychainstudy>
- 2 The term, top supply chain, used throughout this paper refers to the subset of our overall study population that was featured in: Friscia, Tony, Kevin O’Marah, Debra Hofman and Joe Souza. “The AMR Research Supply Chain Top 25 for 2008.” AMR Research. 2008.
- 3 “Current Economic Climate Drives Changes in Auto Ownership, Purchase Plans, According to Polk.” R.L. Polk & Co. Press Release. March 23, 2009. [http://usa.polk.com/News/LatestNews/2009\\_0323\\_auto\\_purchase\\_plans.htm](http://usa.polk.com/News/LatestNews/2009_0323_auto_purchase_plans.htm). As noted by Polk, the average length of vehicle ownership is increasing.
- 4 “The IBM Secure Trade Lane solution.” IBM Corporation. [http://www-03.ibm.com/industries/global/files/Secure\\_Trade\\_Lane\\_solution\\_brief\\_11\\_06.pdf?re=government&sa\\_message=title=the\\_ibm\\_secure\\_trade\\_lane\\_solution](http://www-03.ibm.com/industries/global/files/Secure_Trade_Lane_solution_brief_11_06.pdf?re=government&sa_message=title=the_ibm_secure_trade_lane_solution)
- 5 “The Enterprise of the Future: IBM Global CEO Study, Automotive Industry Edition.” IBM Institute for Business Value. December 2008. [http://www-935.ibm.com/services/us/gbs/bus/pdf/gbe03122-usen\\_autoceo.pdf](http://www-935.ibm.com/services/us/gbs/bus/pdf/gbe03122-usen_autoceo.pdf)



© Copyright IBM Corporation 2009

IBM Global Services  
Route 100  
Somers, NY 10589  
U.S.A.

Produced in the United States of America  
May 2009  
All Rights Reserved

IBM, the IBM logo and [ibm.com](http://ibm.com) are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. If these and other IBM trademarked terms are marked on their first occurrence in this information with a trademark symbol (® or ™), these symbols indicate U.S. registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at [ibm.com/legal/copytrade.shtml](http://ibm.com/legal/copytrade.shtml)

Image cover and page 4 image © 2008 asbl Atomium / Artists Rights Society (ARS), New York / SABAM, Brussels.

Image page 19 © Centre Pompidou, 2008 / Architects: R.Piano, R.Rogers.

Other company, product and service names may be trademarks or service marks of others.

References in this publication to IBM products and services do not imply that IBM intends to make them available in all countries in which IBM operates.