



Daring to be first

How auto pioneers are taking the plunge into blockchain

Executive Report

Automotive



In this report

Blockchain's expected impact on automotive business models and functional areas

How automotive first movers are leveraging blockchain today

Recommended actions for seizing blockchain opportunities in automotive

How IBM can help

Today's vehicles are evolving from a mode of transport to also serve as a new kind of moving data center with onboard sensors and computers that capture information about the vehicle. Using such real-time data, IBM helps auto executives provide new services that the connected consumer needs and expects from the vehicle experience. Our combined strength in manufacturing and depth of global automotive expertise can help address consumer concerns about safety and quality. Innovative technologies such as Watson for analytic capabilities can meet original equipment manufacturer (OEM) and supplier needs, including products and services that are more secure and reliable to enable higher brand loyalty and customer satisfaction. Please visit [ibm.com/industries/automotive](https://www.ibm.com/industries/automotive).

Betting on blockchain

Autonomous vehicles, new mobility business models and personalized consumer experiences are just some of the innovative opportunities driving change for today's automotive organizations. However, inefficiencies still exist in the industry's business networks – inefficiencies that could be tackled through blockchain. With its promise of more secure, traceable transactions and better access to and transparency of information, blockchain has the potential to strengthen trust and collaboration among businesses, consumers and even vehicles. Though blockchain use is in its infancy in the automotive arena, a handful of companies are pioneering its adoption. To avoid being left behind, other automotive companies can take lessons from these Auto Pioneers and quickly assess their own blockchain opportunities.

Introduction

The advantages blockchain can bring to the automotive ecosystem, both in facilitating collaboration among participants and enabling capabilities for new mobility business models, have gotten the attention of automotive executives. In addition to enabling a single source of data, blockchain can facilitate device-to-device transactions, smart contracts, and real-time processing and settlement. For the automotive industry, this translates into improvements and operational efficiencies in areas such as supply chain transparency, financial transactions between ecosystem participants, authenticating access to cars, and customer experience and loyalty.

Sitting at the core of these various objectives is information. In many cases today, this information is imperfect. It might be missing or incomplete, inaccessible because it's housed in separate systems or only exists in manual form, or at risk from hackers or other intrusions. This results in additional processing time and costs, as well as increased risk for the business. A distributed ledger technology, blockchain offers a more transparent and secure way to conduct business. Information held on a blockchain exists as a shared – and continually reconciled – database.

In addition, blockchain technology can help advance new industry business models, such as those related to alternative ownership, car usage and rewards programs, and other mobility services that create brand attractiveness and loyalty. For example, Porsche is testing blockchain applications directly in vehicles, including locking and unlocking the vehicle via an app, granting temporary access authorizations and exploring new business models based on encrypted data logging.¹ Blockchain capabilities, such as authenticating customers and tracking usage across multiple mobility services, enables brands to deliver personalized experiences aimed at creating customers for life.



62%

of surveyed executives say blockchain will be a disruptive force in the automotive industry within three years



54%

of surveyed executives expect new business models to influence investments in blockchain



54%

of Auto Pioneers will implement their first commercial blockchain network at scale within the next three years

Despite the technology's potential, the automotive industry is still in the very early stages of applying blockchain to its business and product networks. To gain a better understanding of the industry's current views on and future plans for the technology, the IBM Institute for Business Value, in collaboration with Oxford Economics, surveyed 1,314 automotive executives across 10 functional areas and 10 countries. (For more information about the research, see the *Study methodology* section.) According to our research, only a small number of OEMs and suppliers are currently ready for blockchain or have blockchain solutions that are ready for commercial use. As mobility services such as ecommerce become more prevalent and marketplace participants seek to transact business through the vehicle, the industry could find itself ill-equipped to meet their needs.

The good news is that our research did reveal a group of companies that are forging ahead. We call them the Auto Pioneers (see page 3 sidebar: *Auto Pioneers*). Knowledgeable about blockchain, these companies are exploring blockchain opportunities. Some of the Auto Pioneers are ready for blockchain today, while almost all of them plan to invest in the technology in the next few years. In this report, we share insights into the potential opportunities for blockchain in automotive, identify what actions set Auto Pioneers apart and offer recommendations for automotive companies to start their own blockchain journeys.

Unlocking the potential of blockchain

Although a majority of respondents are not yet experimenting with blockchain, the industry does recognize its potential impact: Two-thirds of the executives (61 percent of OEMs and 62 of percent suppliers) tell us blockchain will be a disruptive force in the industry within the next three years. As blockchain networks begin to engage and integrate with other business networks, opportunities to provide new services and generate new revenue streams will emerge.

Doing business in the automotive ecosystem is complex, and the information flow is error-prone (see page 4 sidebar: *The automotive ecosystem*). For instance, the shipment of vehicles from factory to dealership typically involves many participants, including OEMs, logistics services providers, port authorities and shipping companies. Information is held in disparate, unconnected systems, and paper processes are still prevalent. These participants' abilities to transact with each other are hampered by information friction points throughout the process. This results in:

Imperfect information. Logistics participants in the transaction don't have access to the same information. Too often, information may also be incorrect or inconsistent, leading to bad decisions or transport delays during reconciliation.

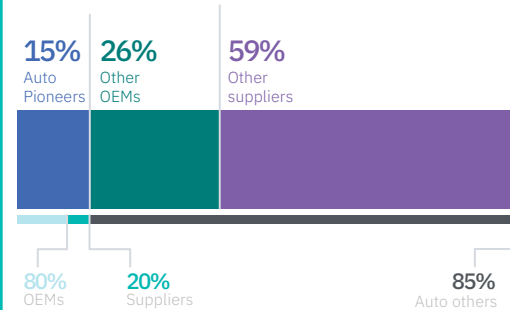
Information risks. Technological risks to information, from hacking to cybercrime and privacy concerns, are on the rise. These incur growing costs, as well as damage to brand reputations.

Auto Pioneers

Auto Pioneers are defined according to the following two criteria:

- Respondents report familiarity with their organization's blockchain strategy
- Respondents report that their companies are in one of the following adoption stages: experimenting, piloting or implementing.

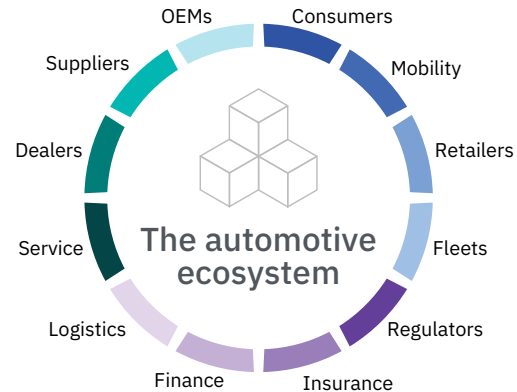
Auto Pioneers represent only 15 percent of all the automotive organizations surveyed. Eighty percent of the Auto Pioneers are OEMs, and 20 percent are suppliers.



The automotive ecosystem

The automotive industry has evolved into a sophisticated ecosystem that includes traditional industry incumbents, ancillary industries such as logistics and insurance, new mobility entrants and consumers. What was once a very simple linear structure of suppliers, OEMs and dealers, whose primary focus was building and selling vehicles, has evolved into a web of traditional and non-traditional companies across multiple industries, all with goals to provide solutions for how people move around and improve their mobility experiences.

On top of that, consumers now have a greater role in the ecosystem as active participants, influencing how they will own or use vehicles, what types of personalized functions and features they want available while in the vehicle, and even how the vehicle can be a connected device that links them to other areas of their life.



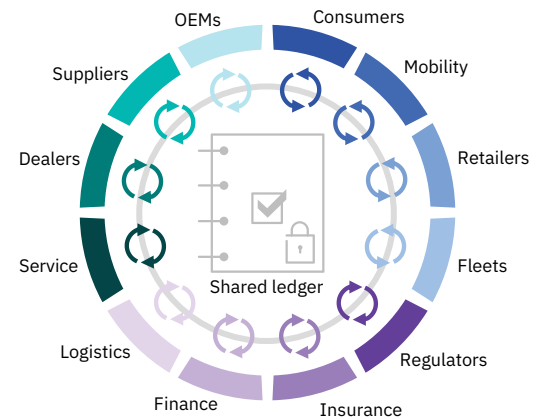
Inaccessible information. The potential value of abundant data and information is greatly constrained by the technical challenges of storing, processing, sharing and analyzing it. Also, some information still exists in manual form. As a result, much of it is not collected or remains inaccessible.

Blockchain can shift the information paradigm from error-prone to value-add. It uses a replicated ledger that is shared by all participants instead of each participant having its own individual, private version (see Figure 1). Information becomes a lifetime history of an asset (such as a vehicle) or transaction and is transparent to all. Transactions are recorded and cannot be changed, and companies can keep their processes private as information is permissioned only to those who need it.

Automotive executives surveyed tell us blockchain can have a high impact on improving information friction points. Fifty-five percent of OEMs and 47 percent of suppliers say implementing blockchain will improve imperfect information in their business networks, while 52 percent of OEMs and 40 percent of suppliers tell us that information risks can be improved. Finally, 43 percent of OEMs and 29 percent of suppliers say blockchain will improve the ability to access information needed for a particular transaction.

Figure 1

Blockchain offers a single source of information that is transparent to all participants



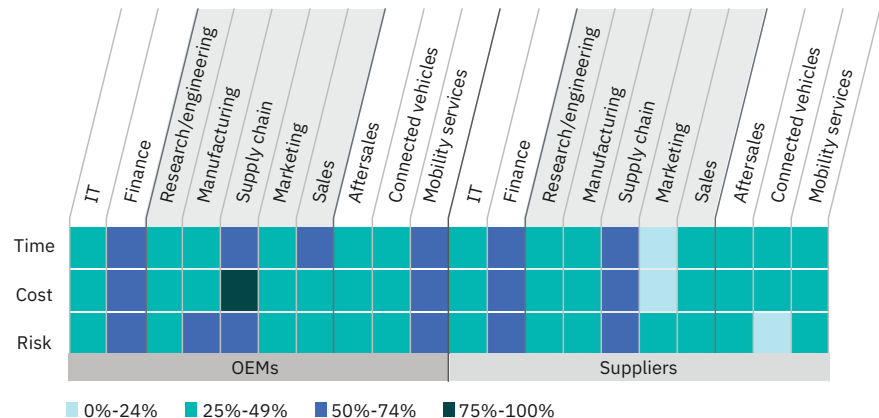
Mahindra aims to transform supply chain financing with blockchain²

As a diverse federation of businesses ranging from automotive to agriculture, Mahindra is uniquely positioned to leverage the benefits of a blockchain-enabled solution for supply chain finance. Mahindra and IBM are working to create a cloud-based, blockchain-enabled common platform for Mahindra Finance’s supplier to manufacturer transactions, allowing all parties to view transactions in real time, driving trust and transparency through the supply chain. This cloud-based application is one of the first such blockchain-enabled projects of its kind in India outside of traditional banking. This initiative aims to deliver immense value to customers and would also help Mahindra Finance to design and deliver new products.

Automotive executives also see opportunities for improvements in key functional areas affected by information frictions (see Figure 2). In automotive companies, virtually all these areas face business challenges to improve time, reduce cost and lessen risks on a daily basis. When we asked all executives surveyed about the impact blockchain can have on reducing frictions in the ten functional areas included in our survey, finance, supply chain and mobility services came out on top for both OEMs and suppliers. Below are examples of challenges faced in these areas:

Finance – OEMs and suppliers are operating in multiple geographies and legal jurisdictions and often lack fully connected financial payments systems. Extensive paper processes and manual data entry and reviews contribute to human error, disputes, extended settlement periods and high transaction processing costs.

Figure 2
Auto executives expect blockchain to impact operational metrics in key functional areas



Supply chain – Thousands of parts go into the assembly of a vehicle. The inability to track and verify the parts can result in parts that do not work properly when they are integrated with others. Performance issues and customer dissatisfaction can then occur.

Mobility services – Car-sharing services are unable to expand beyond a handful of key cities due to high operating costs. Vehicle cleaning, maintenance and delivery are contracted out to third parties that use traditional means (phone, email and spreadsheets) to manage key tasks and work in ways that are high touch, high cost and prone to human error. Also, one-way trips that do not start and finish at the same location add complication and cost to operations.

The global data clearly revealed finance, supply chain and mobility services as top areas where blockchain could reduce frictions. However, when we looked at data by country, we also found aftersales among the high-rated areas for OEMs in China, Germany and Mexico. We attribute this to the fact that part traceability throughout the lifecycle of a vehicle is very limited, which means counterfeit parts could be used by service centers in some markets. This could ultimately damage a brand's reputation if the counterfeit parts underperform or cause accidents.

“Fraud identification prevention and violations occurring in the supply chain can be reduced, which will benefit the overall process cycle.”

VP, Research/Engineering, India OEM

Koopman embraces blockchain to improve supply chain visibility³

Koopman Logistics Group, which specializes in logistics for the automotive industry (transportation, storage and value-added services), wanted to digitize existing paper-based logistics processes. To help decrease administrative costs and increase supply chain transparency for its OEM customers, the company turned to blockchain. Koopman is piloting the use of blockchain technology to build a trusted solution for new and used vehicle logistics that helps eliminate paperwork, improve visibility, reduce fraud, accelerate deliveries and cut supply chain costs.

Forging new business models

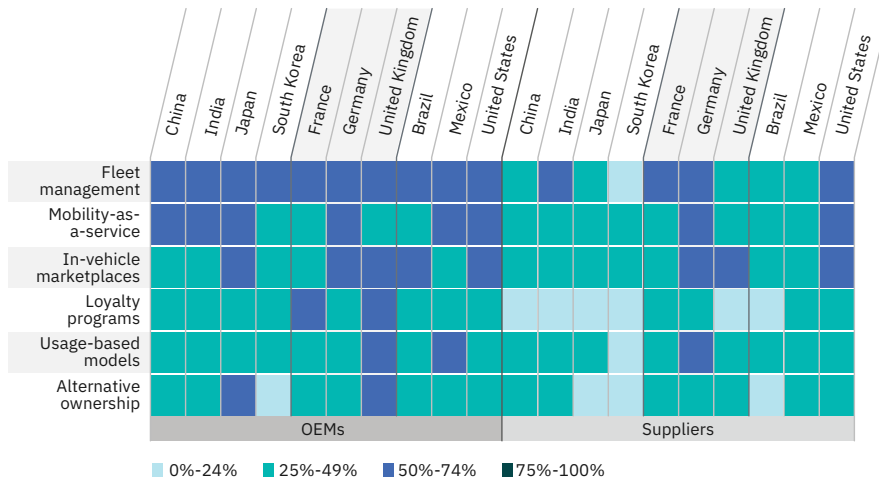
Improvements related to information management, transaction transparency and collaboration between business partners can help promote trust and expedite the implementation of new business models. Fifty-six percent of OEMs and 52 percent of suppliers agree that the blockchain investments their companies choose to make will be highly influenced by the opportunity to develop new business models.

Companies that provide mobility services such as car sharing and on-demand ride sharing need to securely operate their fleets of vehicles. Blockchain can be the mechanism to manage smart contracts, authenticate access to vehicles and capture mobility usage, while eliminating waste and streamlining processes.

At least half of the executives in each country tell us that blockchain solutions can have a high impact on fleet management services (see Figure 3). Mobility-as-a service, usage-based models and other variations of new mobility require information sharing, financial payments, participant authentication and transaction tracking among mobility service providers, consumers and even vehicles. Compared to suppliers, OEMs see a stronger opportunity for blockchain in these new business models, likely because they are more directly involved with the consumers who will use the services.

The ability to transact payment for various products and services from the vehicle through an e-commerce platform is already becoming available to consumers and automotive companies. According to both OEMs and suppliers, blockchain can impact the security of these in-vehicle marketplace transactions, as well as the transparency of the transactions between marketplace participants.

Figure 3
Auto executives expect blockchain to impact business models in a number of areas

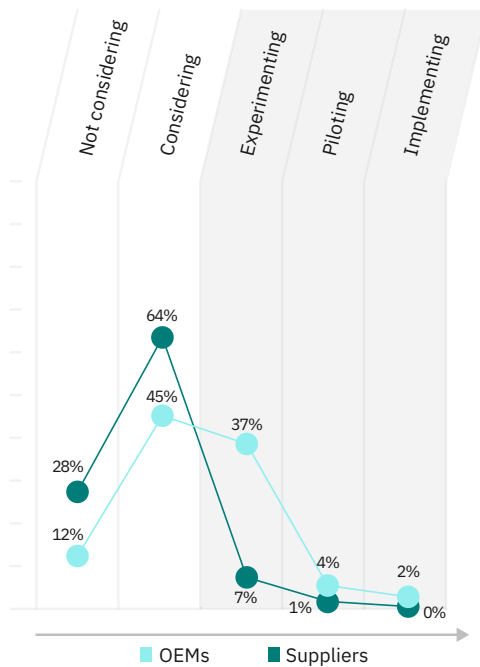


OEMs in Japan and the United Kingdom also indicate that alternative ownership models can benefit from blockchain since the technology allows for more secure user identification and authentication, financial transactions for payments and user information for personalization. OEMs and suppliers in Germany highlight usage-based models for blockchain solutions, which can help track vehicle usage and driver performance for pay-as-you-go insurance and other usage-based services.

Figure 4

Most auto executives are only considering or experimenting with blockchain networks

Phases in adoption of blockchain networks



Paving the way for blockchain

Because the automotive industry is in the very early stages of implementing blockchain at commercial scale, only a small portion of executives say their organization is ready. OEMs are a little more advanced, with 32 percent of OEMs ready compared to only 10 percent of suppliers.

Part of the issue is that many executives lack a general understanding of their organizations' blockchain strategies. Thirty-nine percent of OEM and 51 percent of supplier respondents are only slightly aware of their organizations' strategies. Another issue relates to perceived barriers cited by automotive executives: 37 percent of OEMs and 42 percent of suppliers cite insufficient skills as a concern. Doubts about the security of blockchains are a concern for 31 percent of OEMs and 44 percent of suppliers. Finally, the ability to overcome regulatory constraints concerns 42 percent of OEMs and 33 percent of suppliers.

Even so, more OEMs than suppliers are taking action – though most of the action is still in the experimentation phase (see Figure 4). And 12 percent of OEM and 28 percent of supplier executives say their companies are not even considering blockchain yet, further proof the industry as a whole is in the very early stages of developing blockchain networks.

However, the group of companies we dubbed the Auto Pioneers are charting the course for others. The Auto Pioneers report much higher organizational readiness, with 56 percent ready for blockchain. Auto Pioneers also have a greater perception of the readiness of blockchain solutions, with 60 percent saying blockchain solutions are mature and market ready versus 32 percent of other OEMs and 39 percent of other suppliers.

Investing in the possibilities

Auto Pioneers will be more aggressive in their future blockchain investments. Ninety-five percent plan to make moderate to significant investments in blockchain solutions over the next three years, while 56 percent of other OEMs and only 26 percent of other suppliers have similar plans.

In line with higher blockchain investments, Auto Pioneers expect greater returns on their investments (ROI) and a shorter period of time to recover. Thirty-seven percent expect to achieve an ROI of 11 percent or greater. This compares to 11 percent of other OEMs and 27 percent of other suppliers. Sixty-nine percent of Auto Pioneers expect to break even in the first three years versus 29 percent of other OEMs and 20 percent of other suppliers.

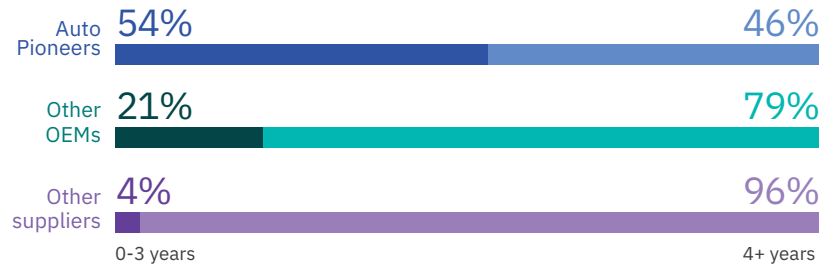
The aggressive investments planned by Auto Pioneers should lead to more rapid implementation of commercial blockchain networks. In fact, more than half of the Auto Pioneers plan to implement their first commercial blockchain network within the next three years (see Figure 5).

“We are currently using this technology to improve supply-chain monitoring and traceability. Also, we will deploy experts to evolve the best solutions using this technology for our company.”

VP, Mobility, U.K. OEM

Figure 5*Auto Pioneers have more aggressive blockchain implementation timeframes*

Timeframe to implement first commercial blockchain solution



The lag in progress of the other OEMs and other suppliers puts the efficiency of their business networks at risk. It also means they may not have a voice in the early work to define processes, standards and regulations for blockchain networks.

Evolving blockchain networks

Blockchain offers great opportunities, but the success of networks depends on willing and ready participants, necessary capabilities and demonstrated value. While willingness does not necessarily equal readiness, Auto Pioneers have a higher expectation of the readiness of their ecosystem partners than the other OEMs and other suppliers. According to 36 percent of Auto Pioneers, their ecosystem partners are ready for blockchain compared to 20 percent of other OEMs and 14 percent of other suppliers.

For the purpose of this study, we separated blockchain participants into two types. Active participants are those that would engage during the execution of an event. Enabler participants are those that provide the solutions, standardization and structure to enable a blockchain network.

When we asked respondents to indicate which active participants are most important to their organizations' blockchain success, supply chain, finance and mobility services participants were rated the highest (see Figure 6). This makes sense, as these were also identified as the areas with the highest opportunity for improvements with blockchain. As expected, the Auto Pioneers place an even higher importance on these participants.

Figure 6

Auto executives rate the importance of various participants to their blockchain success

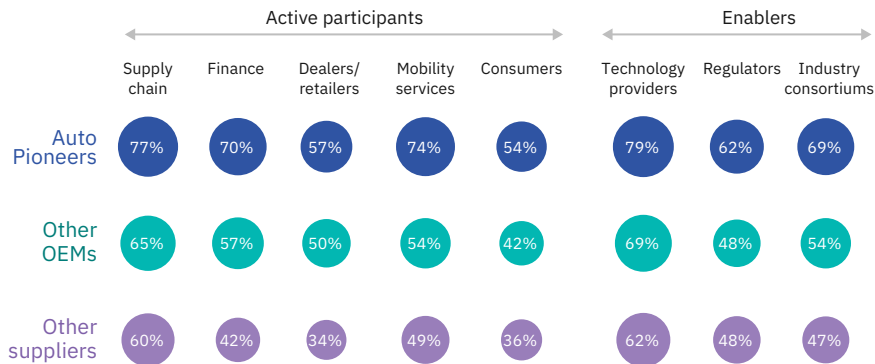
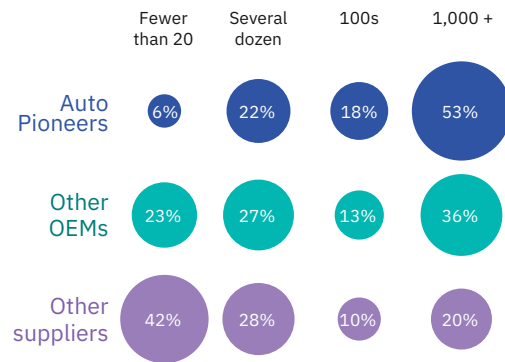


Figure 7

Auto Pioneers anticipate more trusted entities in their networks

Number of trusted entities in the blockchain network



In terms of enablers, technology providers were rated the highest within all three groups – Auto Pioneers, other OEMs and other suppliers. Automotive executives look to technology providers to deliver the blockchain solutions and platforms required on a global scale. Next in line for Auto Pioneers and other OEMs, industry consortiums will play a key role in developing standards and processes for operating blockchain networks. For example, the Mobility Open Blockchain Initiative (MOBI) is a group of industry companies and technology providers working together to develop and promote standards (see page 15 sidebar: *Mobility Open Blockchain Initiative*).

We also asked respondents about their expectations regarding the number of trusted participants in their blockchain-based business networks and found significant variations between the groups (see Figure 7). Auto Pioneers envision much larger networks, with 53 percent anticipating networks with thousands and even unlimited numbers of participants. As mobility business models like car sharing and mobility-as-a-service mature, networks could have virtually unlimited participants when including consumers and vehicles. On the other hand, other suppliers see the opposite for their networks, as 42 percent anticipate less than 20 participants in their networks. But as suppliers become more involved in offering mobility capabilities, they likely will see the size of their networks increase as well. Until the commercial application of blockchain networks in the automotive industry evolves, we will continue to see a wide variation in expectations.

Finally, the majority of respondents overall agree that automotive companies need to have control over their business networks. Eighty-five percent of Auto Pioneers indicate the need for more control and other OEMs and other suppliers are close behind with 65 percent each.

Recommendations

Whether used to help secure information on car usage against hacking, enable financial payments at toll booths, provide traceability of parts in the supply chain or administer smart contracts for the various participants in finished vehicle distribution, blockchains can be an extremely powerful technology for automotive organizations. The question for automotive organizations is: Where do we start and who do we start working with?

Automotive companies can start by carefully evaluating where blockchains can provide the greatest gains and where they can't. They can then consider who should be in their business networks, remembering that participants need to see and understand the value of participating. Agreeing on a standard for doing business in a blockchain-based business network is important.

Doing nothing is really not an option; the needs and benefits are there. The pace of industry innovation will not slow down, and companies that wait risk falling behind. The realization that effective collaboration between business partners can open the door to new business models and revenue streams is already pushing Auto Pioneers to take action.

We recommend executives consider three questions and associated actions to help determine where they can extract value from blockchains and how they can get started.

Where are we experiencing friction in our business network?

First movers and early adopters can position themselves for quicker returns and sharper competitiveness by leveraging blockchain efficiencies.

- Identify the most compelling use cases by considering which frictions hold you back and tie up significant working capital and resources.

Mobility Open Blockchain Initiative⁴

IBM is collaborating with BMW, Bosch, Ford, General Motors, Groupe Renault and a number of other companies on a new transport organization called the Mobility Open Blockchain Initiative (MOBI). The group will explore the use of blockchain to help make mobility safer, more affordable and more widely accessible. MOBI will explore how blockchain can be used in the new digital mobility ecosystem to meet customer demands. Some of MOBI's initial projects will focus on secure mobility commerce; usage-based mobility pricing and payments; and vehicle identity, history and usage.

Daimler creates new cryptocurrency to award drivers⁵

Daimler AG has launched a new blockchain-based cryptocurrency called MobiCoin. The currency is part of the company's initiative to reward drivers for eco-friendly driving habits. Drivers who receive MobiCoins will be able to leverage them for VIP tickets for events such as the MercedesCup Final or Fashion Week in Berlin.

-
- Experiment in discrete areas where the attributes of blockchains drive rapid impact.
 - Use design thinking to simplify the user experience and create agile proofs of concept to drive rapid adoption.

Can we achieve network-wide standards?

Success in blockchain adoption will depend not on who has the best technology or app, but who can build the strongest network.

- Explore the role of alliances and consortia and how profit pools might be redistributed and then decide on your network role.
- View the blockchain as the new business environment and collaboration as the optimal way of working.
- Consider with whom you should partner to create the optimal business networks, including existing associations as well as newly established entities.
- Collaborate broadly to achieve globally accepted standards.

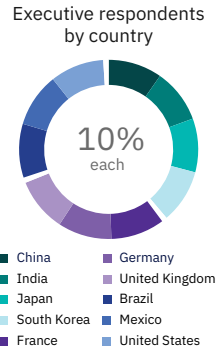
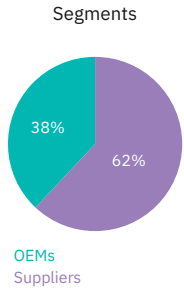
How can we scale with new revenue models?

Although implementing new technologies may be daunting, understand how they can help your business profit and scale quickly.

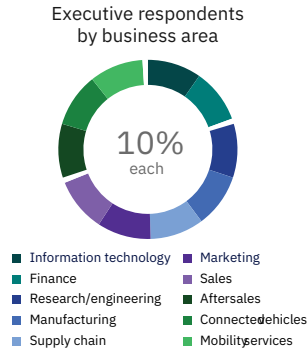
- As business models are disrupted by blockchains, think through how you can make money in new ways, such as consumption-based pricing, licensing and micro-charges and payments.
- Explore how new blockchain-based services and apps can replace or complement and scale existing revenue models.
- Experiment by joining emerging online marketplaces for mobility, parts and service.

Study methodology

To understand the state of blockchain in automotive, we surveyed 1,314 senior level executives around the world. We purposely targeted for a consistent spread across countries and business areas.



Note: Executive respondents were at the SVP/VP/director level



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Related IBV publications

Fieres, Julian, Dele Atanda, and Oliver Gahr. "Blockchain for mobility services: Personalized mobility through secure data." IBM Institute for Business Value. January 2018.

[ibm.biz/blockchainmobility](https://www.ibm.biz/blockchainmobility)

Atanda, Dele, Stanley Yong, and Shyam Duraiswami. "Tokens for personal mobility: Enabling automated transactions in real time." IBM Institute for Business Value. June 2018. [ibm.biz/tokenmobility](https://www.ibm.biz/tokenmobility)

Martin, Andrew, Shyam Nagarajan, Veena Pureswaran, and Smitha Soman. "Building your blockchain advantage: Fresh insights on how to create value, scale fast and open new markets." IBM Institute for Business Value. November 2018.

[ibm.biz/blockchainbizmodel](https://www.ibm.biz/blockchainbizmodel)

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Notes and sources

- 1 Trego, Linda. "Porsche Brings blockchain to cars." Autonomous Vehicle Technology. March 2, 2018. <https://www.autonomousvehicletech.com/articles/714-porsche-brings-blockchain-to-cars>
- 2 Shah, Anish. "Disrupting supply chain financing with blockchain at Mahindra." IBM Blockchain blog. March 21, 2017. <https://www.ibm.com/blogs/blockchain/2017/03/disrupting-supply-chain-financing-mahindra/>
- 3 "Koopman." IBM Case Studies. IBM website, accessed November 12, 2018. <https://www.ibm.com/case-studies/koopman-blockchain-logistics>; "First vehicle delivery in a fully digitalised process." Koopman press release. April 5, 2018. <https://www.koopman.eu/en/news/koopman-provides-supply-chain-visibility>
- 4 Middleton, Chris. "Ford, Renault, GM, BMW, IBM cofound MOBI blockchain consortium." Internet of Business. May 2, 2018. <https://internetofbusiness.com/ford-renault-gm-bmw-ibm-co-found-mobi-blockchain-consortium/>
- 5 Smith, Bryan. "Daimler AG launches MobiCoin; a cryptocurrency that rewards eco-friendly driving." Coin Insider. March 6, 2018. <https://www.coininsider.com/daimler-ag-mercedes-benz-mobicoin/>

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