

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

Applying the PIE X lens to digitalized
automotive and smart mobility experiences

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1. Life X-verse and the PIE X lens

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

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A new wave of value creation is emerging in the world, that goes beyond the technology-intensive eras of the Industrial Revolution. (See Figure 1.)

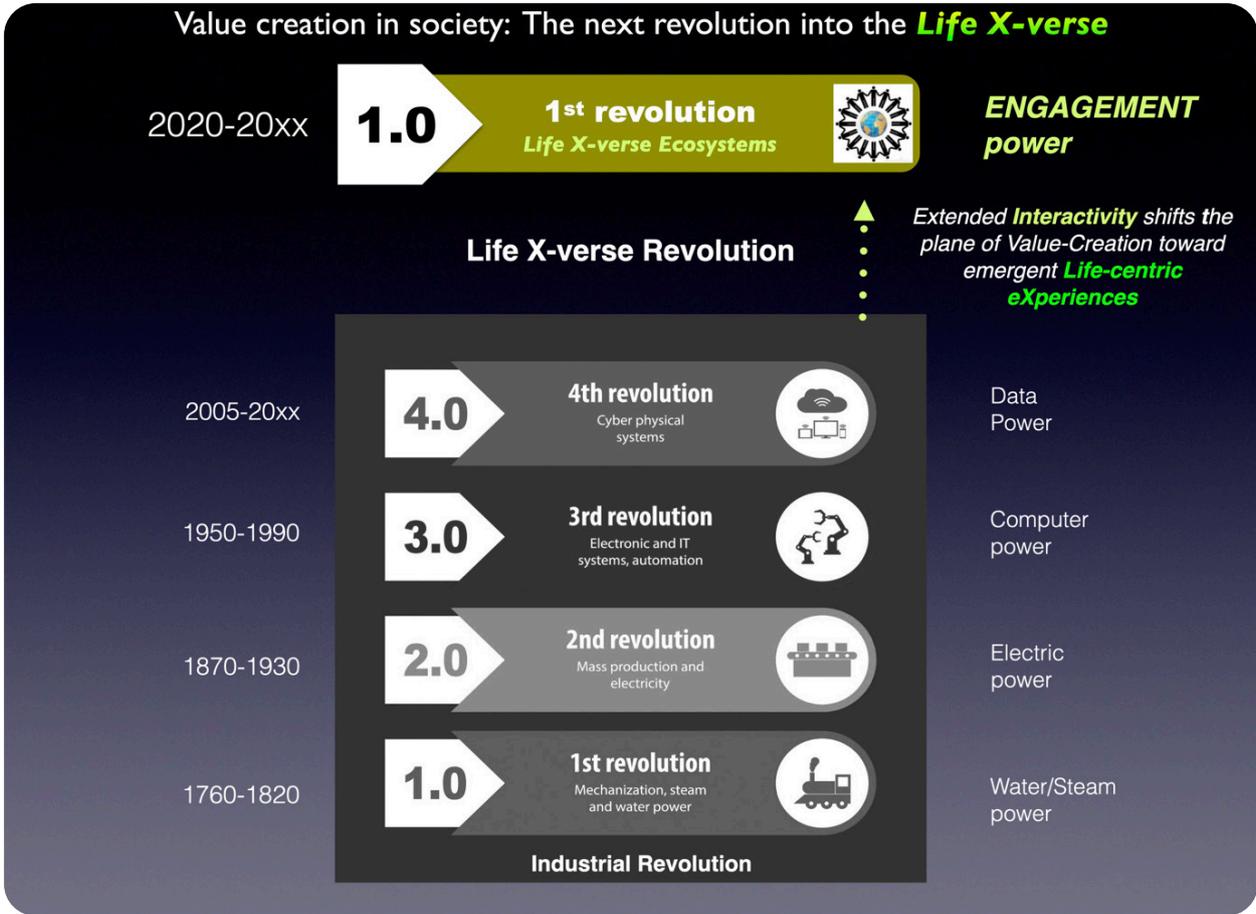


Figure 1: Life X-verse Revolution (Source: Venkat Ramaswamy; picture adapted from Britannica)

“Life X-verse” puts humanity and life experiences of value ahead of technology. The universe of experience environments and new eXperiences that emerge from engagements of experiencers in digitalized interactive ecosystems, constitutes the life X-verse. In it, value creation is de-centered and democratized. Technology leverage becomes experience-centric, even as its innovation becomes ecosystem-centric.

In the Life X-verse, as the digitalized transformation of business has accelerated rapidly, enterprises deliver customer outcomes across multiple fulfilment channels, engage employees with hybrid ways of working, manage suppliers’ operational discontinuities, collaborate with partners in business networks and rapidly develop digitalized offerings of smart connected products and processes in interactive ecosystems, all the while co-creating life-experiences of value with individuals in their lived-journey engagements.

A new lens is required to visualize experience-centric ecosystem innovation and multi-stakeholder value creation opportunities (and challenges) in the life X-verse. The PIE X (Platforms, Impacts, Engagements,

eXperiences) lens helps visualize opportunities and challenges for risk-managed experience-centric innovation and multi-stakeholder value creation in interactive ecosystems of the life X-verse. (See Figure 2).

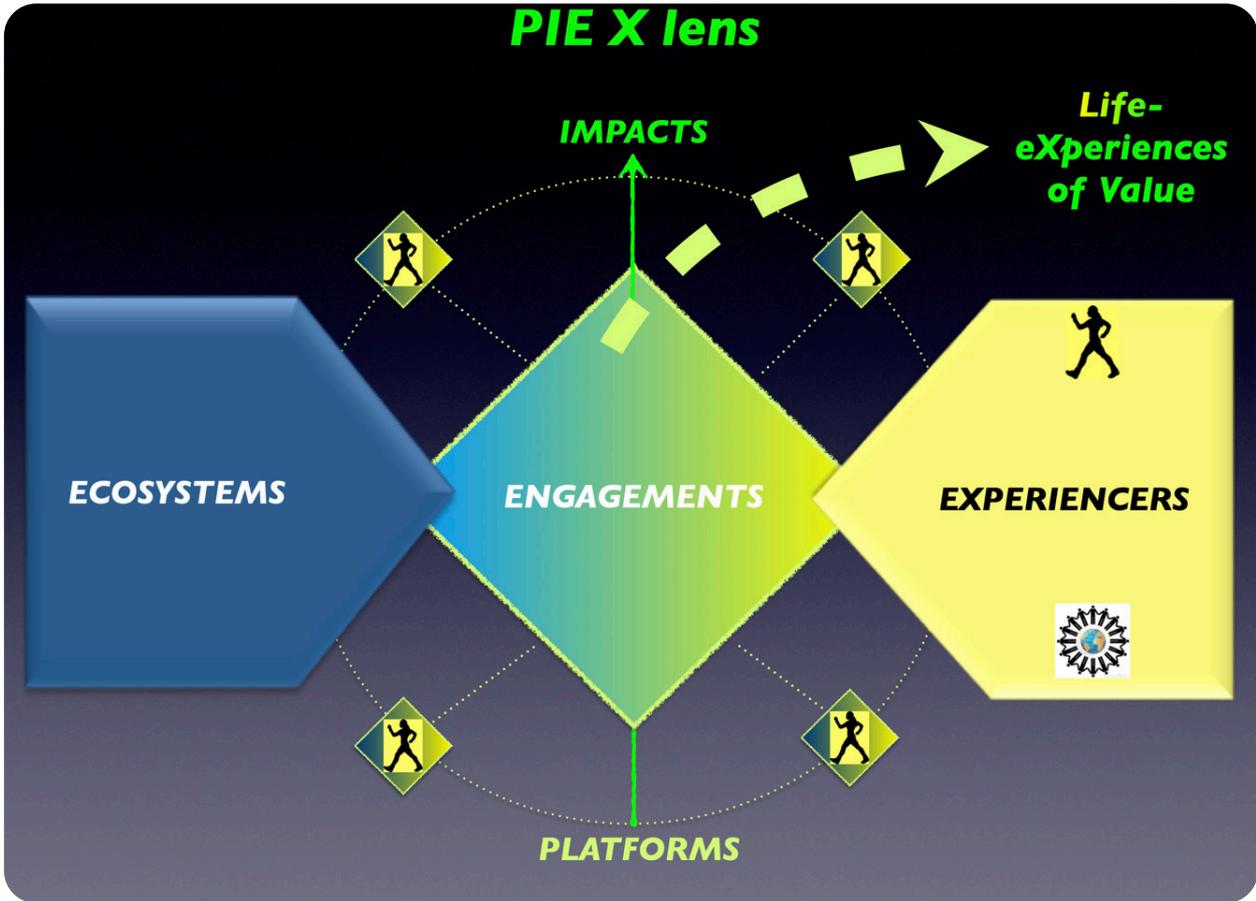


Figure 2: PIE X lens (Source: Venkat Ramaswamy)

The life X-verse and PIE X lens provide a new way to describe and understand the ongoing digitalized transformation of enterprises, offerings, and value creation. Others too, have similarly provided their own framework / language. For instance, in order to become digitally resilient and embrace innovation, Deloitte suggests that enterprises should be focused around experiences (creating interactions for all stakeholders), insights (data and analysis), platforms (information management), connectivity (information flow and networking), and integrity (driving purpose, security and trust).

Even if enterprises do not understand or see it, they are operating in the life X-verse. They experience major transformational shifts taking place in the X-verse along five different loci of value creation: locus of interaction, locus of innovation, locus of value, locus of strategy, and locus of performance. (See Figure 3.)

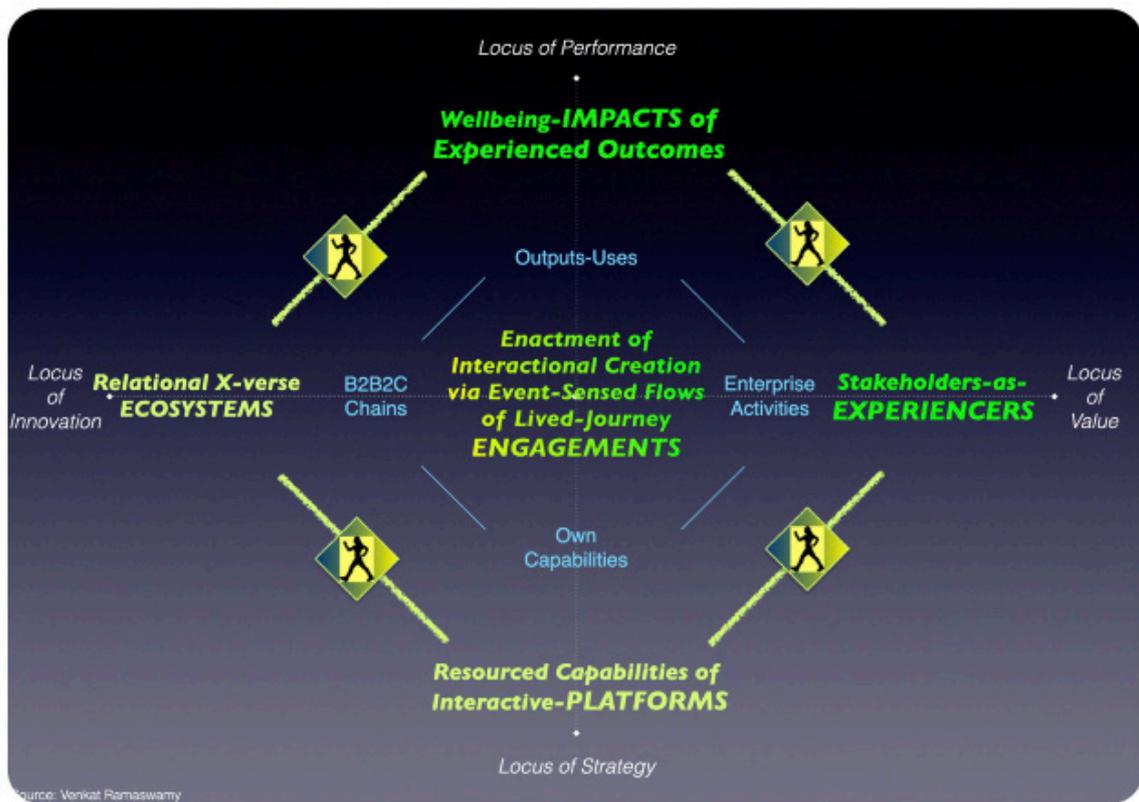


Figure 3: Transformational shifts in value creation in the Life X-verse (Source: Venkat Ramaswamy)

Enterprises visualize strategic opportunities and manage risks at every moment of engagement of an experienter in an interactive life X-verse ecosystem. Rather than merely focusing on the activities in the value chain, they need to consider the lived-journey of engagements of all stakeholding individuals-as-experienters in relational ecosystems, and the experiences that emerge from extended interactivity via new digital interfaces – from pure reality to mixed reality to pure virtuality.

Industry cloud-based platforms must be leveraged by enterprises to configure a digital fabric of experience environments across interactive ecosystems, entailing datafication, softwarization, and AI, and powering new business configurations, offerings, and operational activities. See Figure 4 to visualize how enterprises create digitalized interactive ecosystems of lived-journey engagements.

Life X-verse Ecosystem Engagements

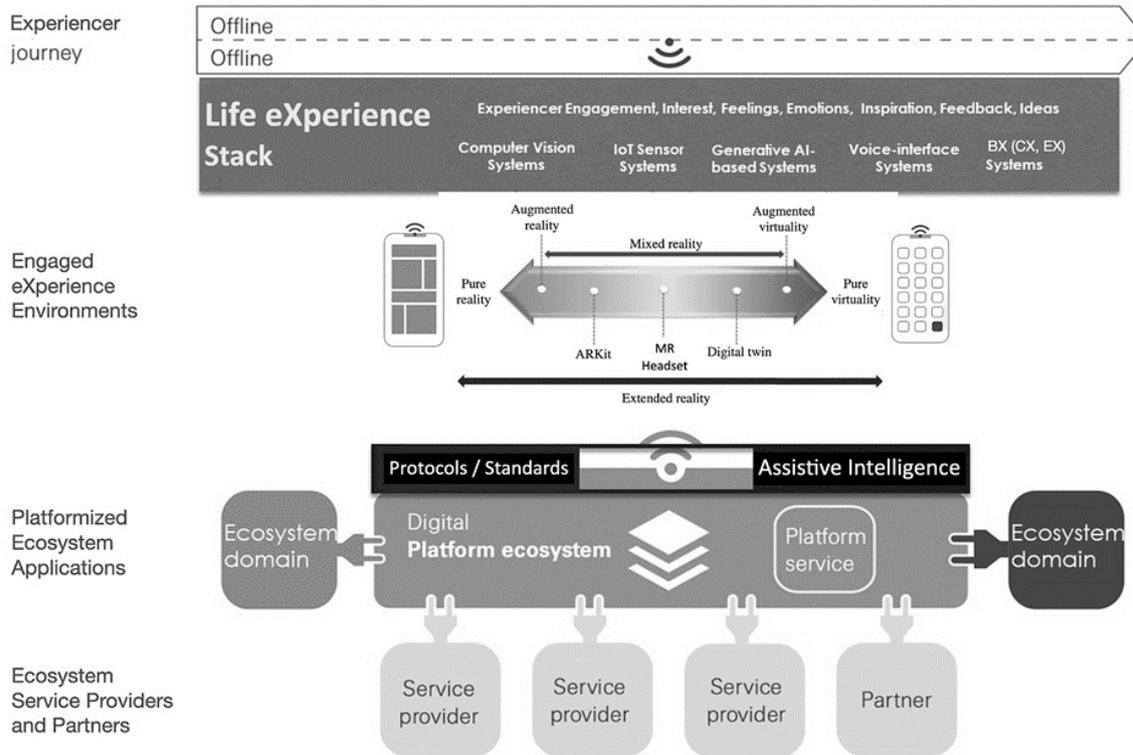


Figure 4: Digitalized ecosystems of lived-journey engagements (Source: Adapted from Swiss Re)

Enterprises can no longer continue to measure their success only in terms of profits, revenues and earnings per share, but go beyond to include the ecological, personal, social, cultural, and economic wellbeing of all stakeholders. They have to create value together with stakeholding individuals as experiencers-creators. The resourced capabilities of various connected platforms create a new basis of efficiency for enterprises – as costs come down rapidly on one hand and enterprises create unique impact on the other, they can redeploy capital into a flywheel of value creation. They enable the creation of impacts at speed (time taken for impacts), scale (the extent of impacts), and scope (the domains of impacts).

As an enterprise applies the PIEX lens, it engenders value to various focal stakeholders – the focal experiencers, to the focal hybrid teams, to focal partners, and to other stakeholders. (See Figure 5.) While the opportunity size of the pie of value increases dramatically, there is also an increase in potential risks – cybersecurity risks of the digital platforms, privacy risks in the engagement of the experiencer, etc. These risks have to be managed well. Thus, it becomes important to thoughtfully configure risk-managed flows of lived-journey engagements in interactive X-verse ecosystems.

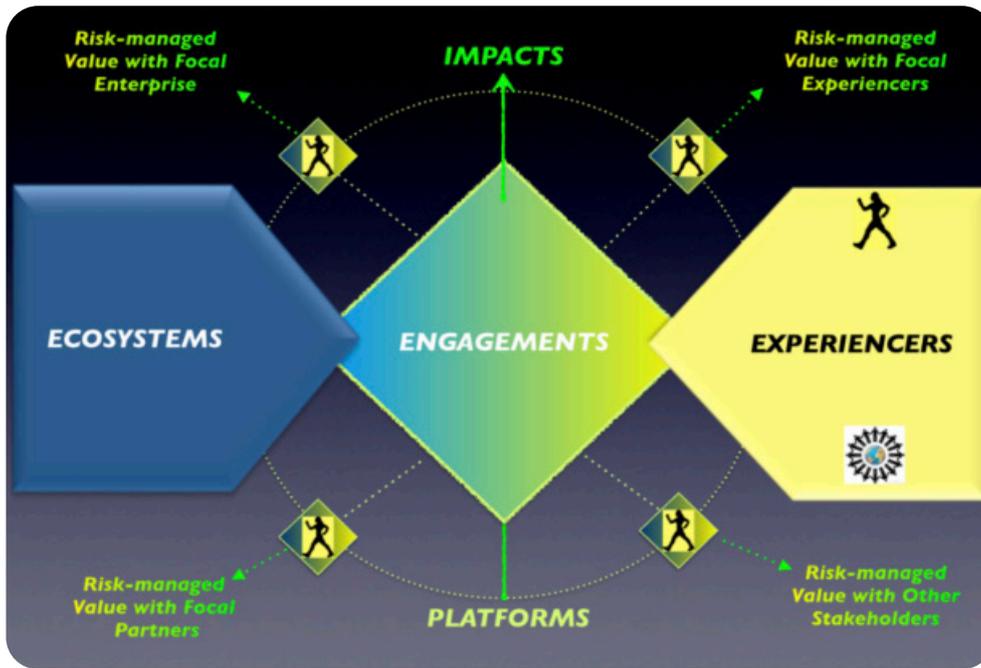


Figure 5: PIE X lens of X-verse innovation and multi-stakeholder value creation in interactive ecosystems
(Source: Venkat Ramaswamy)

The use of the PIE X lens occurs in a virtuous cycle of expansive design and co-innovation, together with stakeholders. (See Figure 6.) As part of applying the PIE X lens to every aspect of their business, enterprise managers will have to consider the appropriate levers for risk-managed X-verse innovation and co-creation unique value in their focal eXperience ecosystems.

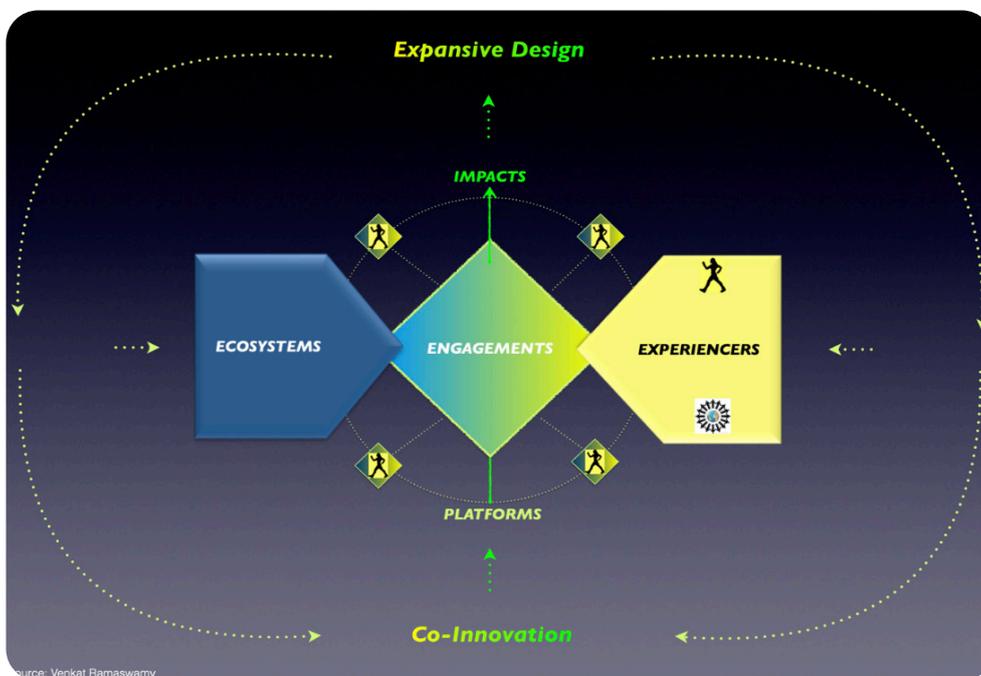


Figure 6: Leading eXperience-verse Ecosystem Innovation and Value Co-Creation to Sustainably Impact Stakeholder Wellbeing (www.venkatramaswamy.com)

These levers (with the prefix “R-”denoting “Risk-managed”) correspond to Ecosystems (R-GELI), Experiencers (R-SCIM), Engagements (R-DART), Platforms (R-APPI), and Impacts (R-CITI), in a virtuous cycle of Expansive Design (R-BEST) and Co-Innovation (R-PLAT) – in focal eXperience ecosystems of application. (See Figure 7).

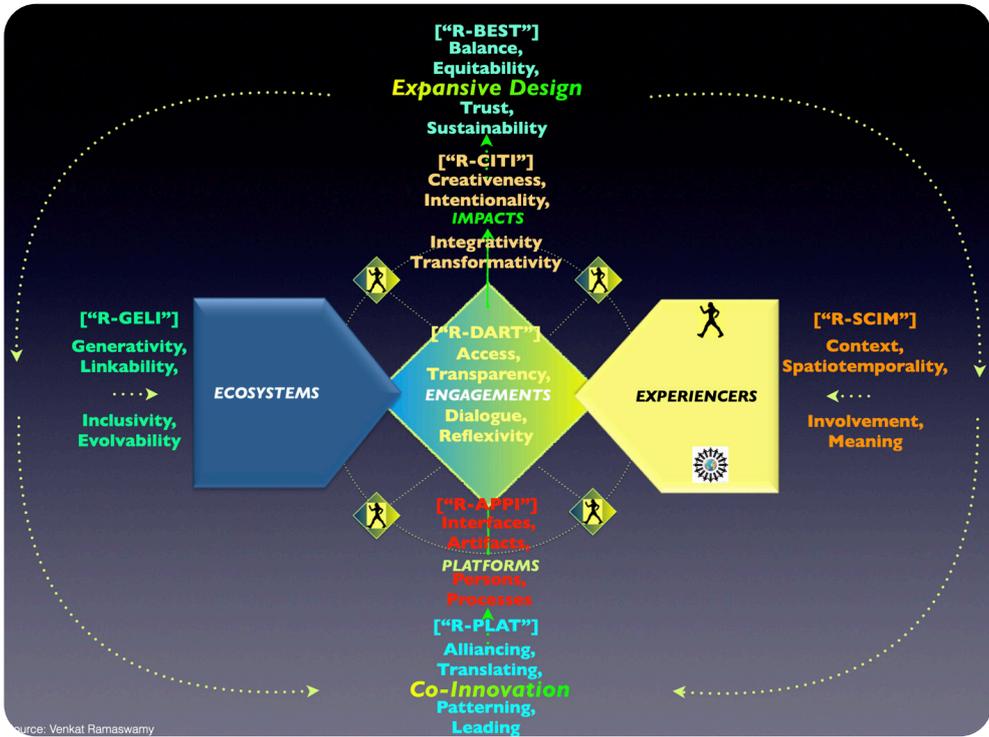


Figure 7: Risk-managed levers for PIE X lens innovation and expanding value creation with stakeholders as experiencers, innovators, and creators (Source: Venkat Ramaswamy)

Taken together, these levers support a new Complex Adaptive Relational Event (CARE) enterprise ecosystem X-verse architecture – one that brings ecosystem fluidity in enacting interactional creation via event-sensed flows of lived-journey engagements through the PIE X lens.

Conventional enterprises need to look at their business through the PIE X lens, discover new opportunities for value creation and innovation, and make the shifts from blue to green (as shown in Figure 8), to become a co-creative living enterprise. Taken together, not just at an individual shift level, but collectively, from blue to green, these shifts represent a sea change in how we see innovation and value creation.

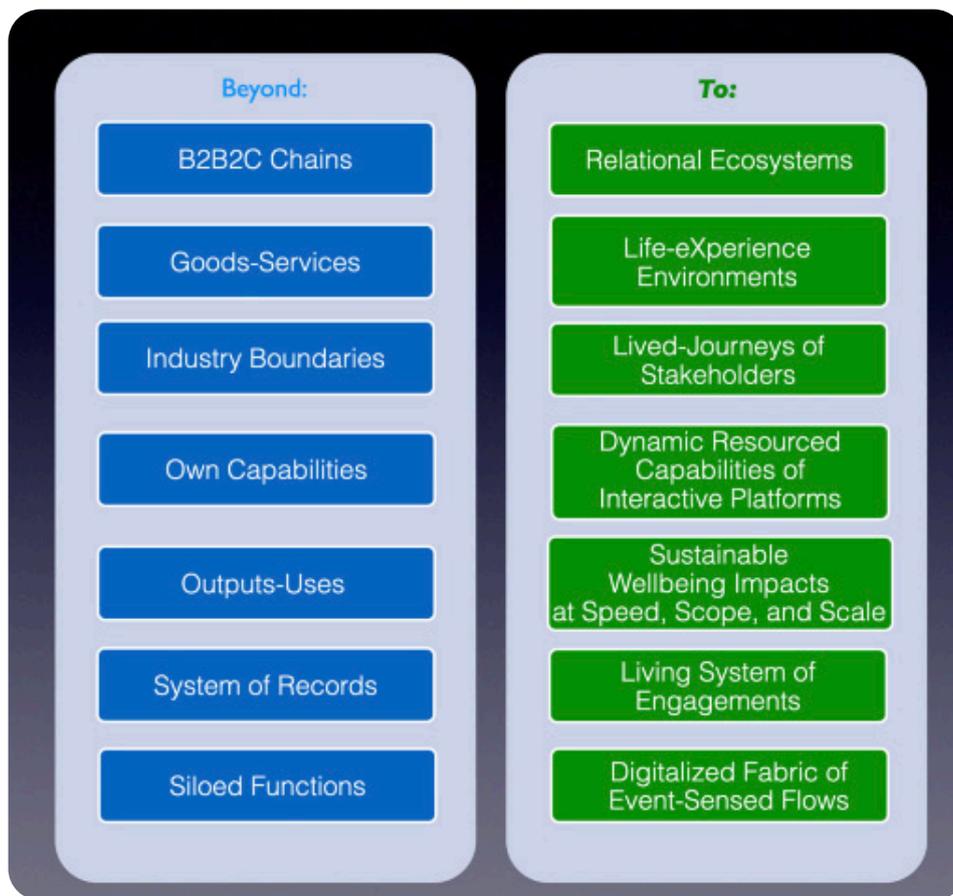


Figure 8: Beyond conventional organizations to co-creative living enterprises in the Life X-verse
(Source: Venkat Ramaswamy)

We can define “co-creative living enterprises” in the life X-verse thus (see Figure 9):

A Co-Creative Living Enterprise

- is a ‘living-system’ enterprise that acts upon event-sensed flows of lived-journey engagements in life-eXperience ecosystems,
- mediated by resourced capabilities of interactive platforms entailing complex adaptive relational ecosystem capabilities,
- engendering geo-biological, cognitive-psychological, socio-cultural, and economic wellbeing impacts,
- through risk-managed value co-creation with all stakeholders as creator-experiencers across private-public-plural sectors.

Figure 9: What is a Co-Creative Living Enterprise? (Source: Venkat Ramaswamy)

They find ways to bring together Nature, Economy, Society, and Technology, across the private, public, and plural sectors, in a balanced, equitable, trustworthy, and sustainable manner. This requires expansive design and co-innovation with stakeholders, in a virtuous cycle as shown in Figure 10.

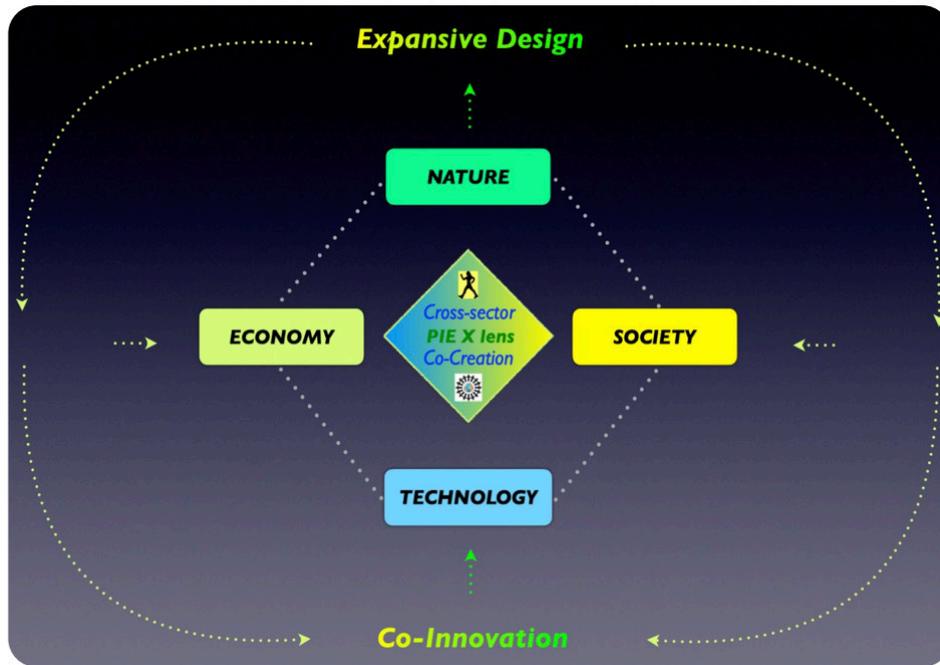


Figure 10: NEST-empowered PIE X lens innovation and value creation (Source: Venkat Ramaswamy)

NEST-empowered ecosystems are starting points that motivate shift beyond tech intensity in a boundaryless, softwarized, datafied world to engagement power and Life X-verse. The PIE X lens is really about (re) configuring eXperience environments in a NEST-empowered ecosystem to interactionally create risk-managed value.

Building NEST-empowered X-verse ecosystems in the future requires going beyond “doing well by doing good” to “doing even better for ourselves by doing well for others.” By creating more value with others, the “win more–win more” nature of co-creation simultaneously generates sustainable developmental wellbeing-impacts. Private-public-plural sector X-verse innovation and value co-creation have the potential to balance the so-called ‘invisible hand of free markets’ with the ‘visible hand of governments and civil society’, together with stakeholder expectations of more responsible, responsive, and effective enterprises, and coevolving better states of infrastructure, governance, development, and sustainability. Ultimately, co-creative living enterprises have the power to transform our reality of the world. They can guide this personal, organizational, economic, and societal transformation. It is a “way of becoming” toward a world full of creative life-eXperience possibilities.

In this report, we will study the **automotive and mobility ecosystem X-verse**, and apply the PIE X lens to digitalized smart mobility and automotive experiences.

2. Visualising the automotive and mobility ecosystem Xverse

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

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The shift towards digitalized automotive and smart mobility ecosystems

110 years ago, Henry Ford launched the industry's first moving car assembly line at the Highland Park Plant in Detroit, Michigan, in 1913. A rope-and-pulley system moved the Model T car down a line of workers, each with a specific task, and cut down the assembly time by more than half.¹ The world of automobiles has undergone a dramatic transformation from this Industrial Revolution 2.0 era of shopfloor automation to today's digitalized world characterised by innovations in autonomous driving, connectivity, electrification of vehicles, and shared mobility. See Figure 11.²

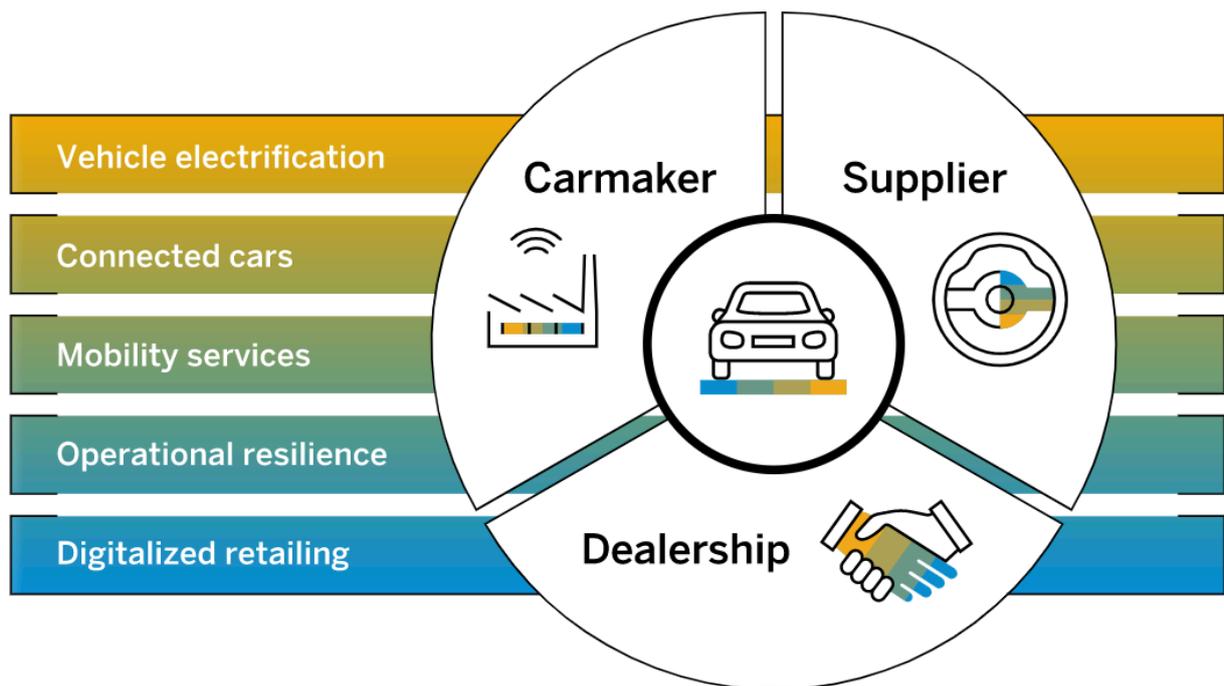


Figure 11: Automotive digital transformation (Source: SAP)

The trend towards sustainability is influencing the automotive industry's push towards vehicle electrification. The industry is focused on EV manufacturing and adoption, and meeting the consumer demand for electric or hybrid vehicles. Cars are increasingly becoming software-on-wheels. Companies are exploring the connected car horizon, with technologies ranging from autonomous vehicles (AVs) to advanced driver assistance systems (ADAS). Auto OEMs are driving sustainability through other means as well such as mobility as a service. The cars need not be bought in a traditional way; instead, consumers get a range of shared mobility options (such as e-hailing, P2P car sharing / riding, shared micro-mobility etc.).

We are also witnessing transformations across all functions of the automotive OEMs – in ensuring they have resilient supply chains (for example, to avoid shortages of chips or EV components), digital retailing (for example, contactless buying and online dealerships), and proactive servicing (for example, predictive maintenance, over-the-air car updates).

Indeed, the needs and preferences of end users are acting as powerful catalysts in shaping the mobility ecosystems. See Figure 12. ³

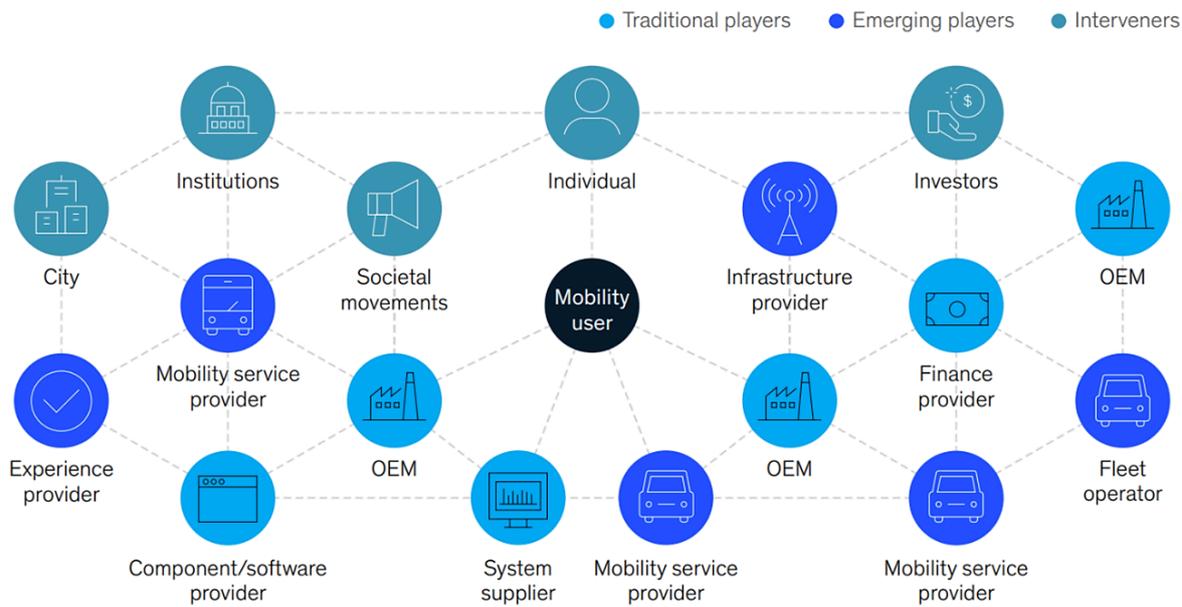


Figure 12: Illustrative mobility ecosystem (Source: McKinsey Center for Future Mobility)

The traditional players such as the automotive OEMs and their Tier 1 / 2 suppliers will continue to exist and play an important role. But new types of emerging players become part of the mobility ecosystem. For instance, due to Ford’s partnership with Google, beginning in 2023, Ford and Lincoln models will be powered by Android Auto operating system, with Google apps and services built in. Thus, new digital experiences will be offered to consumers inside the Ford car. There are also interveners in the mobility ecosystem – players such as the city administration. For instance, Toyota Woven City is building the future fabric of life in a city as a test course for mobility. ⁴

See Figure 13 for an illustrative technology-player led mobility ecosystem. ⁵

The tech-companies may provide more sophisticated offerings related to AVs and connected cars. They may also collaborate with non-automotive players to develop new and innovative offerings, such as insurance solutions, public infrastructure (such as EV charging stations) or healthcare / grocery solutions.

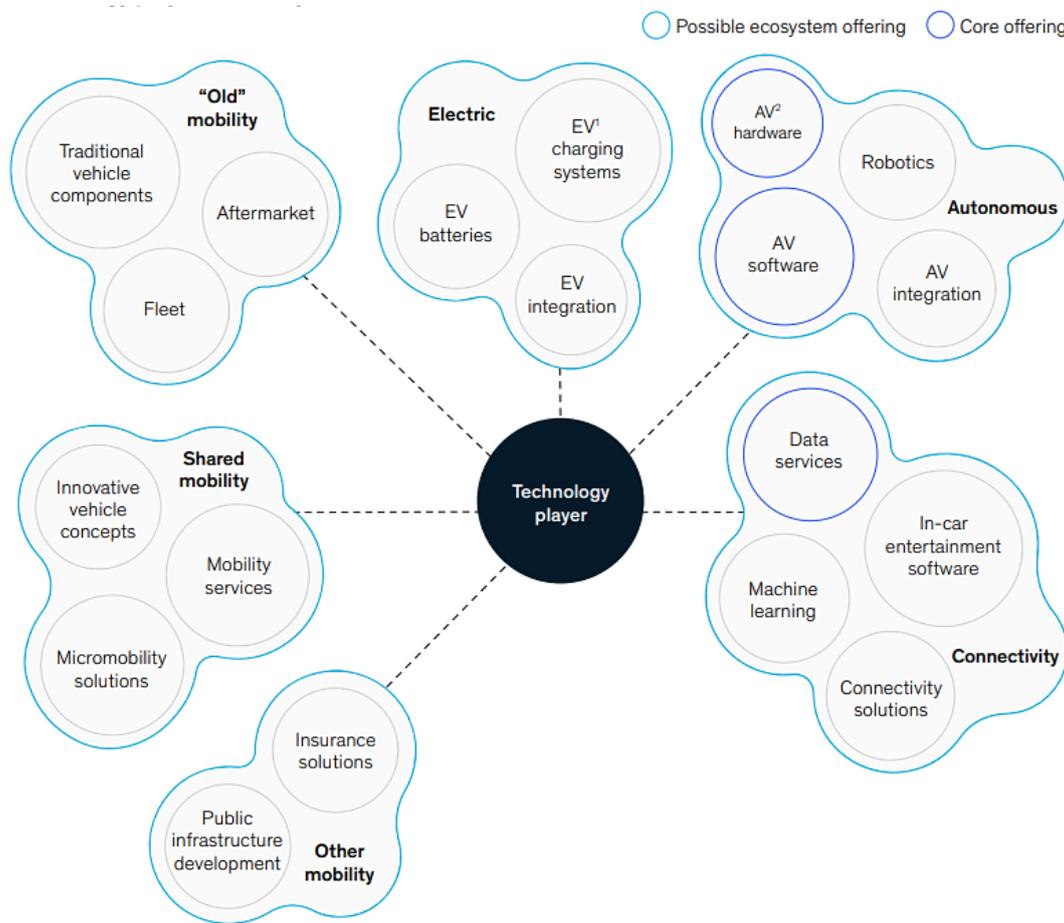


Figure 13: Illustrative technology-player led mobility ecosystem
(Source: McKinsey Center for Future Mobility)

Transformational shifts in the mobility ecosystem X-verse

Let us now understand some key transformational shifts that take place in the automotive and mobility ecosystem X-verse. Enterprises need to visualize strategic opportunities and manage risks at every moment of engagement of an eXperiencer in a digitalized interactive X-verse ecosystem. Rather than merely focusing on the activities in the value chain, enterprises now have to consider the lived-journey of engagements of all stakeholding individuals-as-experiencers and the extended reality of experiences that emerge from their interactions via new digital interfaces – from pure reality to mixed reality to pure virtuality.⁶ Moreover, enterprises can no longer continue to measure their success only in terms of profits, revenues and earnings per share, but go beyond to include the personal, social, cultural, ecological and economic wellbeing of all stakeholders.⁷

The major transformational shifts taking place can be viewed along five different loci of value creation: locus of interaction, locus of innovation, locus of value, locus of strategy, and locus of performance (as seen earlier in Figure 3).⁸

Locus of Interaction

The locus of interaction shifts beyond ‘industry boundaries of goods and services’ to ‘experience environments’—interactive system-environments of emergent experiences via event-sensed flows of data, content, and service exchange. The experiences happen in moments of lived-journey engagements between the enterprise (e.g., an automotive OEM) and the experiencer (e.g., a consumer). Earlier the locus of interaction was centred on the auto OEM, and predominantly from the auto OEM to the consumer. For instance, the auto OEM had a fixed set of finished goods and services that the consumer picked from. In the life X-verse, the consumer may be learning about brands from a number of different sources – online, across multiple channels, from her social network, virtual worlds, etc. How does the OEM help the consumer personalize the experience given this context? Such a personalization falls under interactional creation via event-sensed flows of engaged shopping and consumption environments of experiences.

In order to provide a touchless delivery experience, Tesla leaves test-drive vehicles in parking lots at its locations, each with its unique QR code posted in the window. Customers scan the code, enter their information and get started on a test drive without talking or even seeing a Tesla employee.

BMW’s Connected Drive allows the user to control in-car comfort, entertainment and security, and manage multiple facets of her daily life—from configuring at-home devices to booking services—all while on the road. BMW brought on board key strategic partners (such as Tmall Genie, Alibaba AI Labs) to expand ConnectedDrive’s connected services and experience ecosystem.⁹

Lynk & Co is an European company that aims to be at the apex of mobility, sustainability, and connectivity. Its electric plug-in hybrid SUV is offered through a flexible car-membership model and purchase contract. Its in-car app is built with Azure Communication Services and Microsoft Teams, and enables users to seamlessly join Teams meetings on the go, thus reimagining the car as a work space.

Locus of Innovation

The locus of innovation shifts beyond ‘B2B2C chains’ of goods and services to ‘relational X-verse ecosystems’. Earlier a consumer had to go to a physical dealership to shop. The emphasis was on the physical distribution of goods and services into the dealership environment. Value got created through the chain of activities in bringing goods and services to the dealer’s location. The COVID-19 pandemic accelerated changes in this landscape.

Under its Merc from Home program, customers can book their Mercedes-Benz online and get it delivered at their doorsteps. ‘Live Mercedes-Benz Consultation Studio’ is set-up for personalised product demonstration and consultation. Mercedes-Benz User Experience (MBUX) is an intelligent voice assistant, and acts as a

concierge in the dashboard that caters to a wide range of driver and passenger needs. By leveraging a variety of biometric technologies, it also provides a new level of personalization and security that are quickly accessed using voice.¹⁰

GM Marketplace is the industry's first in-car commerce platform and connects users with various brands. For example, if the driver clicks on the Fuel icon, petrol stations appear in the vicinity of the vehicle. If 'Coffee Time' is selected, a further dialogue appears for locating a café and then a menu for selecting a particular beverage. If one has decided to pick up and drink the coffee on the go, payment can also be made immediately via Mastercard from the car. The platform is designed to be open so that other interested companies can get involved.¹¹

Locus of Strategy

In the lifeX-verse, the locus of strategy shifts beyond 'own capabilities' to 'resourced capabilities of interactive-platforms'. Digitally native enterprises have been shaking up traditional industries by using platformized business models entailing interactive resourced capabilities that transform impacts of customer and other stakeholder experienced outcomes. They are continuously expanding the scope of enterprise capabilities via digitalized experience ecosystems, as they scale existing interactive experience value creation opportunities.

For instance, Volkswagen created a 100% subsidiary, CARIAD, to develop its automotive software. It works on VW.OS automotive operating system, connecting with VW's automotive cloud, consolidating technological platform solutions for data-driven business models and group innovation. CARIAD develops innovations through various collaborations, and holds stakes in 15 automotive technology companies, such as diconium or Wireless Car that are focusing on different digitization aspects of cars. For instance, it collaborates with Bosch on the Automated Driving Alliance to make partially and highly automated driving suitable for volume production. It also collaborates with Microsoft on Volkswagen Automotive Cloud and an Automated Driving Platform (see Figure 14).¹²

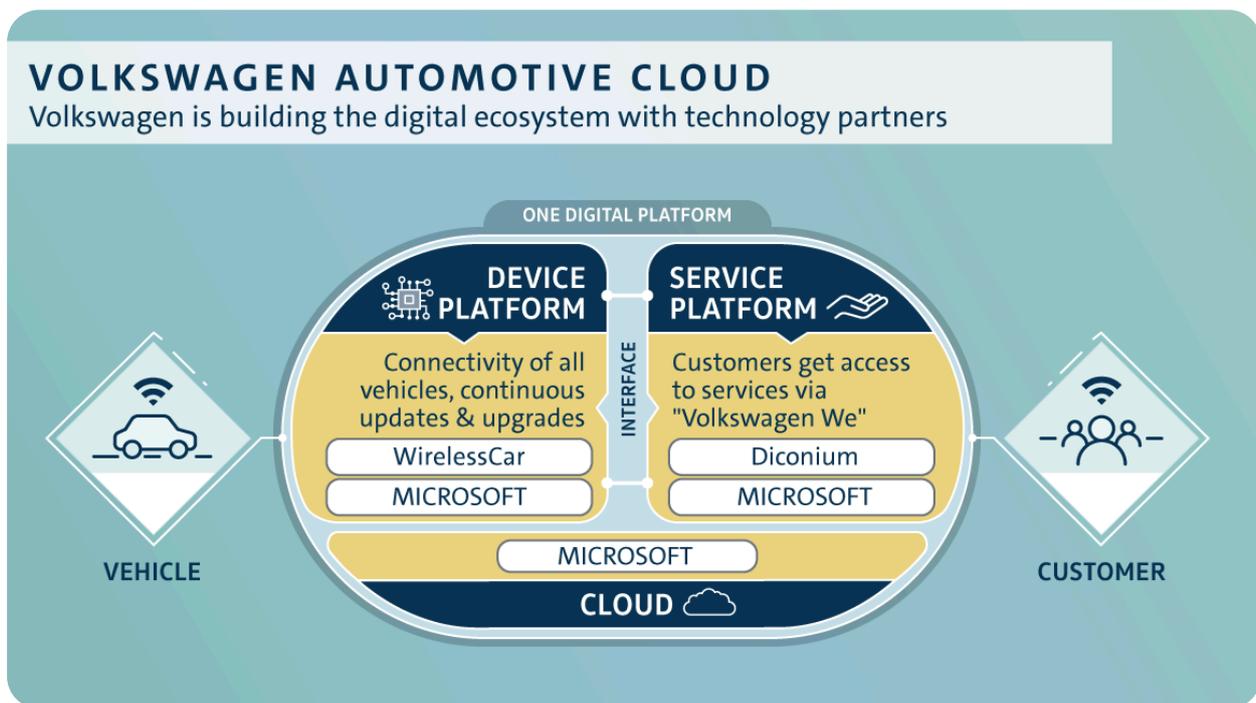


Figure 14: Volkswagen automotive cloud (Source: Volkswagen)

The 'Wireless Car' is about the networking of cars. It includes an e-commerce solution, in which all the offers and services will be available. Thus if a Volkswagen customer wants to go to Munich, her car will drive her to the train station, where she will get on the train; and in Munich another Group vehicle will then be waiting for her.¹³

Locus of Value

In the life X-verse, the locus of value shifts beyond 'activities of enterprises' to 'interactivity of all stakeholders-as-experiencers', i.e., the interactive experiences of stakeholders as creators of value in their own lived-journeys of engagements. Consider how insurance and technology (InsurTech) have converged to create new digitalized experiences of value in the automotive sector. In the car insurance sector, for instance, telematics products are being leveraged to understand how a person is driving, and based on the data potentially lower their insurance premiums and enhance customer value.

Lemonade, the insurtech startup, launched Lemonade Car insurance, building on its acquisition of Metromile, which augmented its substrate of experience-oriented technology capabilities that it had built from the ground up with its property and casualty insurance offerings. Powered by telematics and architected to learn from the data it generates, with Metromile's proprietary data and machine learning algorithms, Lemonade Car insurance seeks to get better and more efficient at quantifying and underwriting risks, with "precision pricing". In doing so, it breaks the conventional trade-off between contextualization and efficiency, by design.

Locus of Performance

In the life X-verse, the locus of performance goes beyond just profitable ‘outputs-uses’ to ‘sustainable wellbeing-impacts’ that encompasses the objectives of all purpose-driven organizations.

Toyota’s Woven City initiative will feature multiple types of above- and below-ground human-centered movement and navigation. The definition of mobility goes well beyond cars and transportation to well-being for all. Toyota has defined 12 distinct areas of daily life to further empower people, and has forged partnerships for co-innovations in these areas. For instance, it is partnering with Eneos for carbon-free hydrogen energy, with NTT for smart-city platform, and with Nissin for healthy living.¹⁴

Mahindra aims to be a purpose-driven brand, and it aspires to be a leading company for its ESG commitments – to be planet positive (greening its operations, decarbonising the industry and rejuvenating nature), people positive (enabling its associates, communities and customers), and trust positive (commitment to its shareholders, partners, and investors).

Let us now apply the PIEX lens to some real-world digitalized automotive and mobility ecosystem experiences, and see how enterprises in these industries are embracing the Life X-verse and providing smart connected ecosystem-offering experiences.

3. Digital transformations and co-innovations powering new automotive and mobility ecosystem experiences

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

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Tesla Inc.

Tesla, with its sustainability-focused mission and sources of competitive differentiation that include its engineering expertise, vertically integrated business model and a focus on user experience, has truly revolutionized the automotive industry. Elon Musk says, “Our goal when we created Tesla a decade ago was the same as it is today: to accelerate the advent of sustainable transport by bringing compelling mass market electric cars to market as soon as possible.”¹⁵ Tesla’s mission states: “Our purpose is to accelerate the world’s transition to sustainable energy. In pursuit of this goal, we build products that replace some of the planet’s biggest polluters—while trying to do the right thing along the way.”

Tesla, rather than viewing itself as just an automotive company, envisages itself as designing and manufacturing a complete energy and transportation ecosystem – “building a world powered by solar energy, running on batteries and transported by electric vehicles.” See Figure 15.

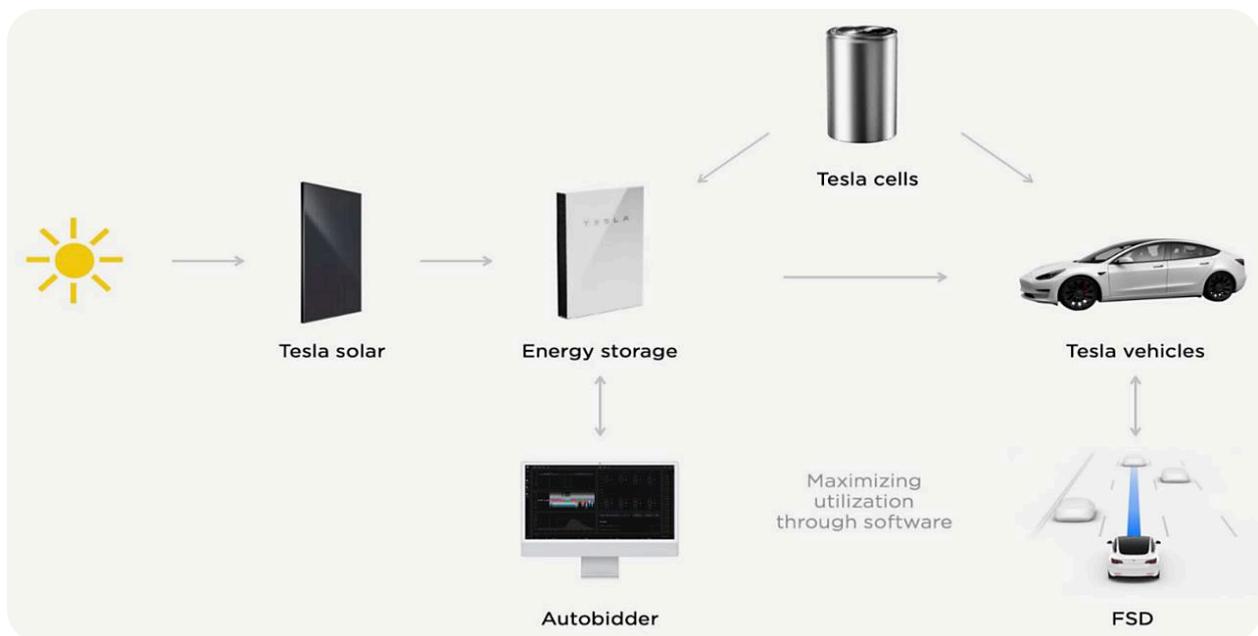
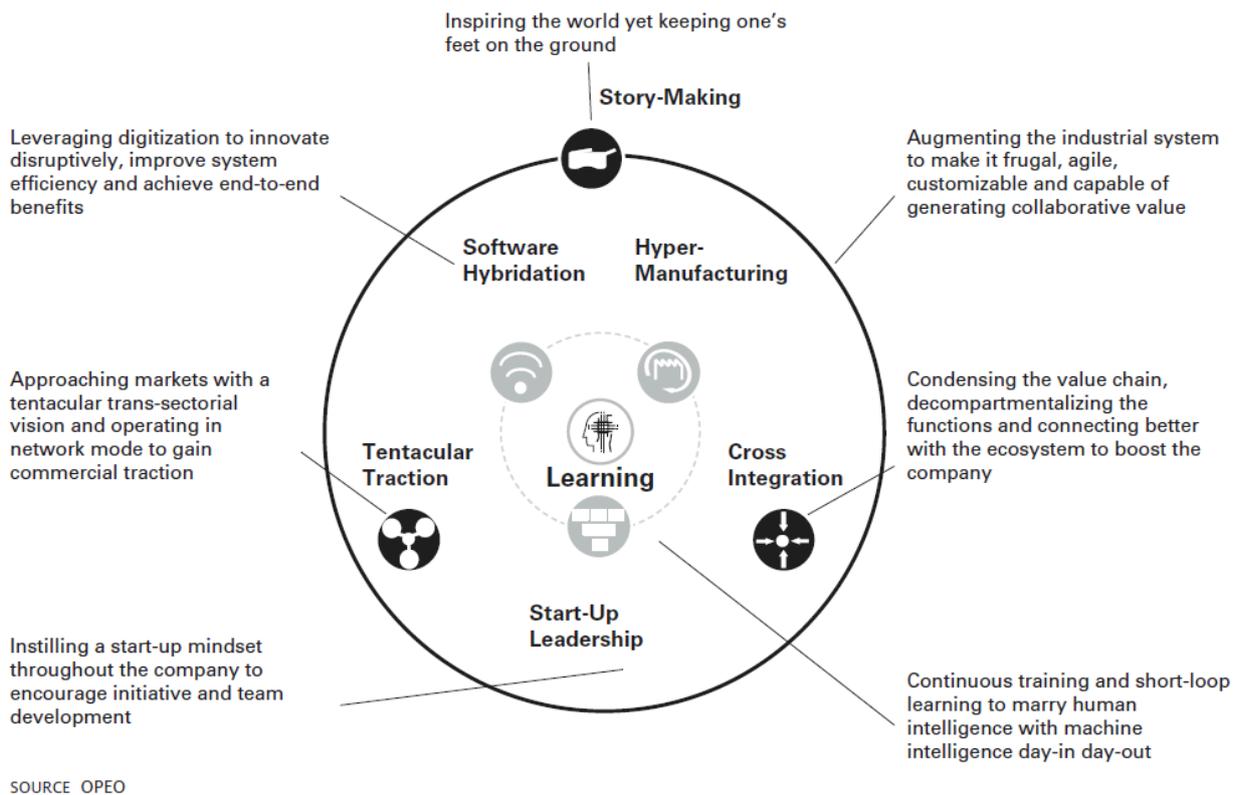


Figure 15: Tesla operating in energy and transportation ecosystem (Source: Tesla)

Tesla used the battery technology it developed for electric cars to create its Powerwall product, which offers energy savings and power backup for homes. Over time, the objective is to get Tesla customers to use its car to tie into a broader energy network connected to people’s homes and to other automobiles via smart grids. In this regard, Tesla has talked about futuristic ideas such as i) an autonomous Tesla ride-hailing network, ii) interpersonal rental service where people can sublet their autonomous vehicles to one another. Tesla also plans to explore other business-ecosystem adjacencies – it is applying its AI learnings from self-driving technology to the field of robotics, and developed Optimus, a robotic humanoid, in 2022.

In his book, “The Tesla Way: The disruptive strategies and models of Teslism”, Michael Valentin describes a system, based on the Tesla model, that features seven principles: cross-integration; software hybridization;

story-making; tentacular traction; start-up leadership; hyper-manufacturing; and human and machine learning (see Figure 16).¹⁶ Let us examine a few of these principles.



SOURCE OPEO

Figure 16: The seven principles of Teslism (Source: OPEO)

1. Cross-integration: Condensing the value chain, decompartmentalizing the functions and connecting better with the ecosystem to boost the company.
 - ▶ Unlike its automotive competitors who depend and cultivate a very strong supplier network (of multiple tiers), Tesla manufacturers most of its components internally, including its dashboards and even seats. It acquired industrial automation expert Grohmann to gain internal control over the relevant vehicle manufacturing technology. Tesla manufactures locally a very high proportion of its vehicle's total value, including basic electronic components, where its competitors have traditionally subcontracted such manufacturing en masse abroad.
 - ▶ Teams inside Tesla are co-located and work in a truly decompartmentalized fashion, with geeks and 'blue collars' coexisting on the shop floors, with seemingly no distinction between functional levels. Tesla brings the 'scrum' model of problem solving from the world of tech-startups to the automotive industry.
 - ▶ Tesla's ecosystem thinking is evident in its model for public charging. It has a growing global network of Tesla Superchargers, which are its industrial-grade, high-speed vehicle chargers (in early 2019, Tesla owned and operated over 1,300 charging stations and nearly 11,000 "Superchargers" (charge points) exclusively for drivers of Tesla vehicles¹⁷). Where possible, Tesla co-locates Superchargers with its solar and energy storage systems to reduce costs and

promote renewable power. Supercharger stations are typically placed along well-travelled routes and in and around dense city centres to allow vehicle owners the ability to enjoy quick, reliable charging along an extensive network with convenient stops. In November 2021, it began to offer Supercharger access to non-Tesla vehicles in certain locations in support of its mission to accelerate the world's transition to sustainable energy. Tesla also works with a wide variety of hospitality, retail and public destinations, as well as businesses with commuting employees, to offer additional charging options for its customers.¹⁸

2. Software-hybridation: Leveraging digitization to innovate disruptively, improve system efficiency and achieve end-to-end benefits.

- ▶ Tesla models are designed first as computers that also possess a mobility function. Such an architecture enables the interconnection of all components, from powertrains to inside functions. It is designed like a piece of software, and thus allows for vehicles to be improved over time as upgrades arrive. Tesla's Model S is one of the few vehicles in the marketplace to have improved during its lifespan (braking systems, energy consumption, driverless system, etc).
- ▶ Simulation is so extensive that Tesla only requires a minimum number of physical tests when validating, for example, its crash technology. Tesla was only using around 15 beta vehicles for testing purposes, versus more than 250 at Toyota.
- ▶ Like in the software world, user experience is kept central to product design. Thus, when the Model S was designed, even though a very-large tablet size was not readily found in the automotive components industry, Tesla decided to have it as the central console because such a design could create a wow customer experience.

3. Learning: Continuous training and short-loop learning to marry human intelligence with machine intelligence, day-in day-out.

- ▶ A software-defined Tesla uses advanced analytics to analyse its driver's behaviour and the functioning of its vehicle. For instance, Tesla analyses when human-drivers take over from autopilot mode and uses machine learning to advance its autonomous driving technology.¹⁹
- ▶ Tesla offers its car owners an insurance product that uses metrics of real-time driving behaviour such as aggressive turning, hard braking, and unsafe following distance, to determine customers' insurance rates.²⁰
- ▶ Tesla START is an intensive training program providing individuals with the skills necessary for a successful technician role at Tesla. It partners with 13 colleges across the country to integrate Tesla START into automotive, collision and manufacturing curriculums to provide individuals with a smooth transition from college to full-time employment. In 2022, Tesla had over 200 graduates from Tesla START programs.²¹

Let us examine the platform play at Tesla more closely. It has developed platform capabilities for delivering

self-driving technologies, charging solutions and other features and services, through solutions like Autopilot, Full Self-Driving (FSD), Supercharger network and infotainment offerings.

Tesla vehicles are integrated with 'Advanced Sensor Coverage', providing up to eight surround cameras with 360 degrees of visibility at up to 250m of range. These cameras are complemented with 12 ultrasonic sensors that allow for the detection of hard and soft objects. The onboard computer, known as Hardware 3, processes the volumes of incoming data using an in-house neural network, which is used to train the Tesla Autopilot self-driving model. The vehicle enables real-time data processing to allow it to effectively and safely navigate obstacles on the road while providing riders with a refined and safer experience.²² Tesla is also developing additional computer hardware to better enable the massive amounts of field data captured by its vehicles to continually train and improve these neural networks for real-world performance. Currently, Tesla offers in its vehicles certain advanced driver assist systems under its Autopilot and FSD options, although at present the driver is ultimately responsible for controlling the vehicle.

The Tesla vehicles are IoT cars, and all of them have at least a 2G cellular connection to the Internet. Through this connection the company continuously improves the car by updating its onboard model and application in a process called Over-the-air (OTA) updates. In 2015, Tesla drivers woke up to a major, new capability accessible through their phone – they could summon their car, and it would be waiting outside their door. Consider in January 2014, the US Traffic Safety Administration issued two recall notices, one for GM and one for Tesla, both related to fire hazards. GM had to recall 370,000 pickups into its dealers for repair, while Tesla quickly issued an OTA update to the 30,000 vehicles affected. When TSA accepted the fix, Tesla had redefined the meaning of a recall.²³

The intimate customer relationship that is enabled by IoT allows Tesla to experiment with new business models – it has disintermediated the car dealer and sells directly to the customers. Tesla's vehicle sales channels currently include its website and an international network of company-owned stores. In some jurisdictions, Tesla also has galleries to educate and inform customers about its products, but such locations do not transact in the sale of vehicles. Such a model enables Tesla to better control costs of inventory, manage warranty service and pricing, educate consumers about electric vehicles, maintain and strengthen the Tesla brand and obtain rapid customer feedback.

This disintermediation goes beyond just the selling process. Tesla provides service for its EVs at its company-owned service locations and through Tesla Mobile Service technicians who perform work remotely at customers' homes or other locations. The connectivity of its vehicles also allows Tesla to diagnose and remedy many problems remotely and proactively. Thus, compared to traditional automobile manufacturers and their dealer networks, Tesla has faster response times and more optimized logistics and inventory.

Consider the automobile aftersales market – if one sold an internal combustion engine vehicle in 2021, one could expect to make about \$36,000 off the vehicle over its lifetime in terms of parts, maintenance, and

servicing. With an EV that drastically came down to around just \$6,000, a six-fold reduction in the traditional aftersales profits.²⁴ How do EV OEMs make up the money? It is through software sales, a phenomenon which has been described as the "iPhonification" effect. Just as Apple makes significant revenues through sales of apps after it has sold an iPhone, similarly Tesla expects its customers to purchase additional paid options and features, such as FSD or rear heated seats, through the Tesla app or through the in-vehicle user interface.

One of the unintended customer consequences of shifting capabilities from hardware to software is the ability of Tesla to remove certain car features. Customers who bought second-hand Teslas saw the disappearance of autopilot / self-driving features.²⁵ Similarly, when a Tesla EV is written off by an insurer, Tesla stops supporting the vehicle by denying it access to the Supercharge network, even if the consumer managed to fix the car. Another unintended consequence of such control mechanisms from Tesla has been the creation of a Tesla EV "jailbreak" service, similar to Apple iPhone jailbreaks – customers turn to Tesla repair specialists to reinstall removed paid-for features and more.

One intended and positive consequence for Tesla is their impact on sustainability. In 2021, the global fleet of Tesla vehicles, energy storage and solar panels enabled its customers to avoid emitting 8.4 million metric tons of CO₂e (equivalent to over 20 billion miles of driving).²⁶

Ford Motor Company

In May 2021, Ford unveiled its strategic transformation program, Ford+. As the company claims, "It's our roadmap to determine Ford's trajectory for the next 10-15 years – creating the single biggest opportunity to create value for the company since Henry Ford scaled the Model T." Central to this plan are electric vehicles, which Ford wants to comprise around half of its global sales by 2030, connected cars and new revenue streams via subscriptions and digital services.

It created three new businesses – Ford Model e, Ford Blue and Ford Pro.

1. Ford Model e will be its center of innovation and growth, to create electric vehicles and digital experiences.
2. Ford Blue's mission is to deliver a more profitable and vibrant internal combustion engine (ICE) business
3. Ford Pro addresses the market for commercial vehicles and services.

It plans to achieve transformative outcomes such as:²⁷

- ▶ Launching Blue Oval Intelligence: Ford's next-generation, cloud-based platform for integrating electrical, power distribution, computing and software systems in connected Ford and Lincoln vehicles.
- ▶ Having nearly one million vehicles that are capable of receiving over-the-air (OTA) updates – scaling to more than 30 million OTA-capable vehicles on the road by 2028.

- ▶ Strengthening customer relationships, mobility, and accessibility with digitally enabled tools like FordPass and Lincoln Way, as well as incorporating online ordering, simplified financing and renewal options, vehicle pickup and delivery, and mobile repairs to better serve our customers.
- ▶ Speeding detection and resolution of quality issues using connected data – helping to raise customer satisfaction and lower warranty costs.
- ▶ Deploying distinctive technology like BlueCruise hands-free driving and Ford Pro’s VIIZR Field Service tool and EV charging solutions to improve the user experience – and to capitalize on what is projected to be a \$20 billion market for such services by 2030.

Beyond the significant transformation of its business and operations, Ford+ also entails an important shift in the mindset of the company. Jim Farley, CEO of Ford Motor Company, highlights the big changes that Ford faces as part of its new strategy: “The biggest transformation for us is to a software services–dominated company and brand. We have to invest in electric architectures and build software know-how in the company. And we need to integrate that know-how in ways we’ve never had to before.... When we have the ability to update our products dynamically with software, the customer relationship is no longer episodic. It’s every day.”²⁸

See Figure 17 for a snapshot of the key principles that Ford+ fosters.

Ford+	
Distinctive products and solutions Always-on relationship with customers Ever-improving user experience	
 Turn around automotive operations, compete like a challenger	 Care for each other
 Treat customers like family	 Capitalize on our strengths
 Create must-have products and services	 Disrupt ourselves
 Simplify everything	 Partner for expertise and efficiency
 Modernize everywhere	 Lead the electrification revolution in areas of strength

Figure 17: Ford+ strategy (Source: Ford)

The principles of i) distinctive products and solutions, ii) always-on relationship with customers, and iii) ever-improving user experience have necessitated that Ford embrace digital technologies and co-innovations in a deep and significant way throughout the company. Let us explore these principles in action in the context of a few initiatives at Ford.

Development and launch of Mustang Mach-E

The Ford Mustang Mach-E, its first all-electric SUV, was introduced in 2019 and soon became the second highest selling EV in the US. The way the car was developed was different and unique in Ford.

In collaboration with the design advisory firm, IDEO, Ford had established a global design lab network, called D-Ford, with teams around the world focusing not on products, but on customers. Ford wanted to be more intentional and comprehensive with the diffusion of ideas, and had put in place a robust, enterprise-wide learning program to give everyone at Ford access to the design tools and design thinking skill sets.

The Mustang Mach-E came through a development process grounded in human-centered design, focused entirely on customer needs and desires. Its development team, called Team Edison, was made up of broad expertise, including members leading the design, charging strategy, infotainment, and marketing of electric vehicles.²⁹

Keeping customer needs at the forefront, Ford augmented the EV infrastructure available to them. For example, it worked with LG Energy Solution to improve battery supply for the Mustang Mach-E, expanding capacity three times over 10 months in 2022, and is expected to more than double originally contracted volumes by 2023.³⁰

Mustang Mach-E customers have access to the BlueOval™ Charge Network, which is the largest public charging network for electric vehicles in North America with more than 20,500 charging stations (70,000 thousand plugs).³¹ Ford stitched together a network of ecosystem partners such as Shell Recharge, Electrify America / Canada, EV Connect and others, where Ford customers can avail no-cost charging (up to 250 kWh). Ford also introduced subscription services to customers to avail discounted rates for charging at partner charging stations.

Digital technologies have been leveraged to enhance the user's experience. For instance, Mustang Mach-E customers can locate BlueOval Charge Network stations using the FordPass App or their in-vehicle SYNC 4A navigation. They can leverage the FordPass Power My Trip feature to map the most cost-effective charging route for their next trip.

Digital platforms, such as Adobe Experience Cloud, proved useful when it came to the launch of the Mustang Mach-E. Due to COVID, the sales process was shifted completely online – from registering interest, to purchasing and vehicle customisation. Customers were invited to virtual showrooms and provided with

in-depth content around the vehicle's functions and features, replicating the test-drive experience at a dealership. Ford also started an 'online marketplace', where customers could buy products or services such as service plans and car accessories.³²

Ford Pro business offerings

Ford's new commercial entity, Ford Pro, offers its customers a range of vehicles including ICE, hybrid-powered models, and electric vehicles. It also provides digital services that are integrated into the vehicles and help customers better manage their fleets, reduce costs and optimise efficiency as they transition to electric vehicles.³³

Ford Pro has developed an Upfit Integration System (UIS), a first-to-market digital solution that is introduced in Europe on the all-new Transit Custom vehicles. It allows aftermarket equipment makers with improved access to vehicle's electrical system, and also enables conversions to be controlled via the 13-inch SYNC 4 touchscreen rather than bolt-on switchgear.³⁴

Previously, many upfitters (third party vehicle hardware / equipment makers) had to hack into the existing wiring harness to access power and integrate safety lockout functions and controls. Often, they had to modify the cab area or splice into factory wiring to fit controls. With the newly implemented integration system, upfitters have access to more than 150 signals from the truck with attendant schematics and interfaces. Additionally, cloud-based software connects to the UIS, allowing equipment makers to add digital buttons that allow drivers to control their equipment from inside the truck. It also allows for remote monitoring by fleet managers – for instance, to track temperature in refrigerated vehicles carrying pharmaceuticals or food. Such digital solutions improve the efficiency, reliability and safety of vehicle modifications and customisations.

Ford Pro Mobile Service, by using specially-converted vans to bring Transit Centre capability to customers' depots and driveways, helps save businesses the cost and downtime of workshop visits.

The Ford Pro platform of software and connected services includes end-to-end charging solutions, management tools such as Ford Pro Telematics, the FordPass Pro app, and the FORDLive connected uptime system. Ford Pro Intelligence is a cloud-based platform powering digital services to support commercial customer fleets.

Using Ford's telematics platform and connected vehicle data, Fuel Advisor analyzes routes, tracks fuel consumption in real-time, and recommends where/when to refuel to save the most money. Fuel Advisor is an always-on tool, delivering value to customers long after their purchase.

FORDLive is a complimentary service being rolled out for all operators of Ford connected commercial vehicles, designed to reduce the number of breakdowns, enable fewer visits to dealer workshops, and

achieve quicker servicing and repair times. The FORDLive uptime specialists utilise a constant feed of live data from Ford's dealer and roadside assistance network to track each vehicle's repair progress and respond to emerging issues. Projections show FORDLive can reduce downtime by up to 60 per cent.³⁵

Ford has co-innovated a number of solutions with partners to enhance the experience of its customers:³⁶

- ▶ Launched VIIZR, a field-service tool for small-business customers built on the Salesforce platform
- ▶ Signed a five-year agreement with Stripe, the economic-infrastructure company, to scale Ford's always-on, e-commerce capabilities for customers
- ▶ Established Canopy, a joint venture with ADT, to develop an AI-based camera technology for professional security monitoring of customers' vehicles.

AI-powered production of Ford's manual assembly lines

Consider the assembly lines in a manufacturer. While the general impression is that most modern factories are highly automated, a study by A.T. Kearney and Drishti finds that 72% of factory tasks are still performed by people.³⁷

Given the human factor, mistakes happen or productivity varies between individuals. Traditionally, manufacturers use time and motion studies for operations management. This typically involves industrial engineers being physically present and recording times spent on each step in a shopfloor and conducting subsequent analysis of the data sample to identify bottlenecks and opportunities for improvement. However, 43% of managers indicated they were not confident in the data.³⁸

Can technology be leveraged to improve such a manufacturing line experience? If a worker makes a mistake in the assembly of an automotive component, say a brake pad, this error may only be discovered at a much later stage by the consumer. Is there any way for the worker to get real-time feedback? Can line supervisors be empowered to make modifications on their lines to improve productivity, rather than wait for industrial engineers to look for improvements on a quarterly basis? Then, manufacturers can improve their overall productivity.

Ford has implemented Drishti, an AI solution, to digitize manual processes on its assembly line. Drishti gives manufacturers a "second brain" or "third eye" to power them to higher throughput, better quality and more efficient results. The solution places cameras all around the assembly line to monitor the activities of workers and stream processes at every workstation. It uses computer vision and deep learning to perform action-recognition, instead of only object-recognition – i.e., continuously observe a video stream and interpret actions that are taking place.³⁹

The impacts of Drishti on the manufacturing line are immense.

- ▶ Like spell check function in Microsoft Word, it offers a near real-time feedback to the worker when it detects an error on the assembly line.⁴⁰ Individual worker productivity will go up and will help the

worker become more competitive against automation.

- ▶ Drishti also allows line supervisors to make small changes continuously and perform rapid A/B testing at scale on the factory floor.
- ▶ It makes videos searchable, and allows for adding time and motion data, annotations and tags to the raw videos. Thus, if a factory discovers that a few components in a particular batch has some defects, then locating the specific shopfloor tasks is as easy as searching for videos on YouTube.
- ▶ While there many positive aspects of the Drishti technology, one area of perceived concern was privacy – the identity of workers were captured in the video feed. Drishti incorporated this feedback and introduced a feature to blur the workers in the video footage.

NIO Inc.

NIO Inc., whose Chinese name, “蔚来” (wei lai), translates to future, is a pioneer in China in the premium smart electric vehicle market. NIO's mission is to shape a joyful lifestyle, and it aims to build a community starting with smart electric vehicles to share joy and grow together with users. It encapsulates its mission in this equation - "NIO = user enterprise value * community mode * high-end smart electric vehicle".⁴¹

Consider a typical car purchasing experience at NIO. experience store. Unlike typical automotive dealers who establish large spaces in the outskirts, NIO open stores inside shopping malls. This is similar to Tesla's strategy in China. An “experience store” is only about 2,000 square feet showcasing only 2 or 3 models inside. Communication between customers and salespeople are emphasized in this space and extra car models are parked in mall parking lots for test drives.

Once the customer decides to purchase the car, the sales representative will help the customer to personalize their vehicle. The customization interface on the phone/computers in the shop allows the customer to choose the exterior and interior colour, tire outlines, battery plans, loan plans, and other features. The interface is so user-friendly that customers can do this personalization on their own too.

Once the order is completed, the customer pays a deposit through Wechat Pay. The sales representative then creates a Wechat group of 6-8 people including the customer, an NIO customer service ambassador, delivery specialist, and finance specialist. Anytime the car owner has a question he/she can text in the group chat and expect instant reply from the NIO staff. It takes 6-12 weeks for NIO to deliver the car, at their specific “delivery centers” in each city, in which customers can finalize their payments, licenses, insurance and drive the new car home. New NIO staff including maintenance service personnel and repair specialists are added to the Wechat group and they may answer any questions that the new car owner might have in the future. Also, given that NIO sells directly to customers without any intermediary (dealership), it engages with its customers through its app too.

For NIO customers, the journey doesn't end when the purchase is made. They become a part of its community – by leveraging other services such as NIO Power, NIO Houses and NIO Life.

- ▶ NIO Power is a mobile internet-based power solution with extensive networks for battery charging and battery swap facilities. Enhanced by Power Cloud, it offers a power service system with chargeable, swappable and upgradable batteries to provide users with power services catering to all scenarios.
- ▶ NIO Houses, at 30 locations across China, are luxurious community spaces for NIO members to relax, work, and share memorable experiences as a community. The NIO House offers customers services such as a café, library, conference room, and even childcare.
- ▶ Through NIO Life, consumers can purchase lifestyle products. NIO has brought 500+ designers across the world on to its platform to introduce well-designed products into their customers daily life.

NIO vehicles are integrated with NOMI, a voice activated AI companion that personalizes each individual's experience. NOMI transforms the user experience within the vehicle from a transportation method into a traveling digital living space. NOMI is able to adapt to user preferences, setting wheel positions and seat heights when drivers approach the vehicle, opening/ closing windows, snapping selfies, shuffling playlists, and other things that vastly improve the average user experience. As of May 2021, NOMI had reached over 200 million interactions.

Outside the vehicle, the NIO app is designed to be a one stop platform for its customers. It enables consumers to buy and customise their vehicles, allows for chat between customers and NIO employees, provides news shared by NIO staff and other users, and provides access to NIO Power and NIO Life. Only NIO House is not yet integrated into the app, which may be another powerful way for NIO to drive a phygital (physical and digital) engagement with its customers.

As of July 2021, the NIO app had 367,000 active monthly users, more than the next two Chinese EV manufacturers (XPeng and LiAuto) combined. Through the app, users are able to request a NIO service specialist to pick up their car for valet charging, 24/7. When users plan trips through the NIO app or use the NOMI AI, trips can be optimized to recommend charging routes. The app allows users to shop at NIO Life, with equal number of car owners and non-owners buying lifestyle products. More than 80% of NIO customers participate in online or real-life community activities, using NIO points / credits. These are awarded in the app, based on four dimensions of engagement: community interaction, community development, efficiency improvement, and special contributions, and involve activities such as sharing articles, utilizing services, reducing carbon footprint, and referring others.

Indeed, this innovative process of owner-referral has been finetuned successfully by NIO. Since the delivery of its first vehicle in 2018, NIO has built an online community of enthusiastic owners, who act as the spokespeople for the company and the cars. Existing owner referrals accounted for more than 45% of its

cars sold in 2019.⁴² However, there are risks too associated with such a co-creative process.

For instance, two divergent owner-groups emerged online after an NIO driver died in a car crash in August 2021. It was reported that the car accident happened on the highway when the driver turned on the NIO NOP (Navigate On Pilot) auto-driving function. An NIO driver posted a “joint statement”, and supported by 500 users, in the NIO APP community accusing NIO of misleading customers regarding its NOP systems, and that it was only an assisted driving system that required constant attention from the driver, whereas it was promoted as an autonomous driving system by NIO. However, a second group comprising nearly 4,000 car owners later posted against this joint statement, and claimed that the statement did not represent them. These conflicting opinions, that have been publicly aired, will have an impact on other community engagements and NIO has to carefully manage such risks.

Co-innovations in mobility ecosystem

Let us consider some more examples of co-innovations embraced by enterprises in the mobility ecosystem.

PSA France – Free2move connected services

The PSA Group in France, through its venture Stellantis, has created a connected service called Free2move. This aims to create a new ecosystem around the topics of data services, smart services and mobility. See Figure 18. PSA is partnering with Huawei’s IoT platform OceanConnect to create a Connected Vehicle Modular Platform, and the solutions are offered for download as apps via established iOS or Android stores.⁴³ In some ways, this is similar to Ford’s FordPass app.



Figure 18: Free2move apps and partners (Source: “The Digital Transformation of the Automotive Industry”)

PSA has built an open innovation platform, and relies heavily on crowdsourcing to create solutions. It publishes a large number of APIs from the connected service's development environment – vehicle signals such as oil temperature, tire pressure or even movement data. PSA has also created an open developer environment that also provides documentation, blogs for exchanging experiences and support functions.

India's ONDC protocol-based Kochi Open Mobility Network (KOMN)

We have seen the emergence of platform businesses that help bring together diverse buyers and sellers in domains such as e-commerce platforms (such as Amazon, Flipkart etc.), food delivery services, and ride-hailing services (such as Uber, Ola, etc.). There are also some systemic challenges with respect to such closed-loop business models.

The winner-takes-it-all nature of the business leads to a concentration of power in a few successful digital platforms. These platforms become a store or keeper of value, with lock-in effects for participants in their network. While these platforms may be efficient, they suffer from nurturing closed loop ecosystems, where network participants cannot migrate between platforms with ease. For instance, a consumer on Uber platform can book only drivers on it, and not from another platform such as Lyft. Further, Uber offers the complete set of activities required to complete the transaction – consumer and driver onboarding, driver quality control, payments etc.

The contrast between a closed platform-centric and an open network-centric e-marketplace is shown in Figure 19. In the open network, services are unbundled – in a transaction, the driver and consumer side activities can be unbundled and taken up by different entities. For instance, service providers like telcos and banks, who have a large number of digital customers for their core products / offerings, may offer additional e-ride services to their existing customers or employees. The telcos and banks need not worry about onboarding drivers for their e-ride offering and will leverage the services of all drivers / ride-sharing companies who have published their digital catalogues using the ONDC protocol.

ONDC is not a platform or an application. Instead, it is an open-network, is protocol-driven, and based on open-source interoperable specifications. It is similar to other protocols such as Simple Mail Transfer Protocol (SMTP) for emails, Hypertext Transfer Protocol (HTTP) for the World Wide Web, and Unified Payment Interface (UPI) for the payment systems.

The earliest pilot on ONDC, the Kochi Open Mobility Network (KOMN), was launched in October 2020 to bring about interoperability among different mobility service providers – taxis, bus, ferry and so on. KOMN currently has Yatri App (which has 1200+ registered taxi drivers, recorded 15,000+ customer searches, and supports hundreds of taxi rides per week) and Stayhalo Telegram bot (which enables customers to book cabs in Kochi and view Kochi Metro Rail schedules).

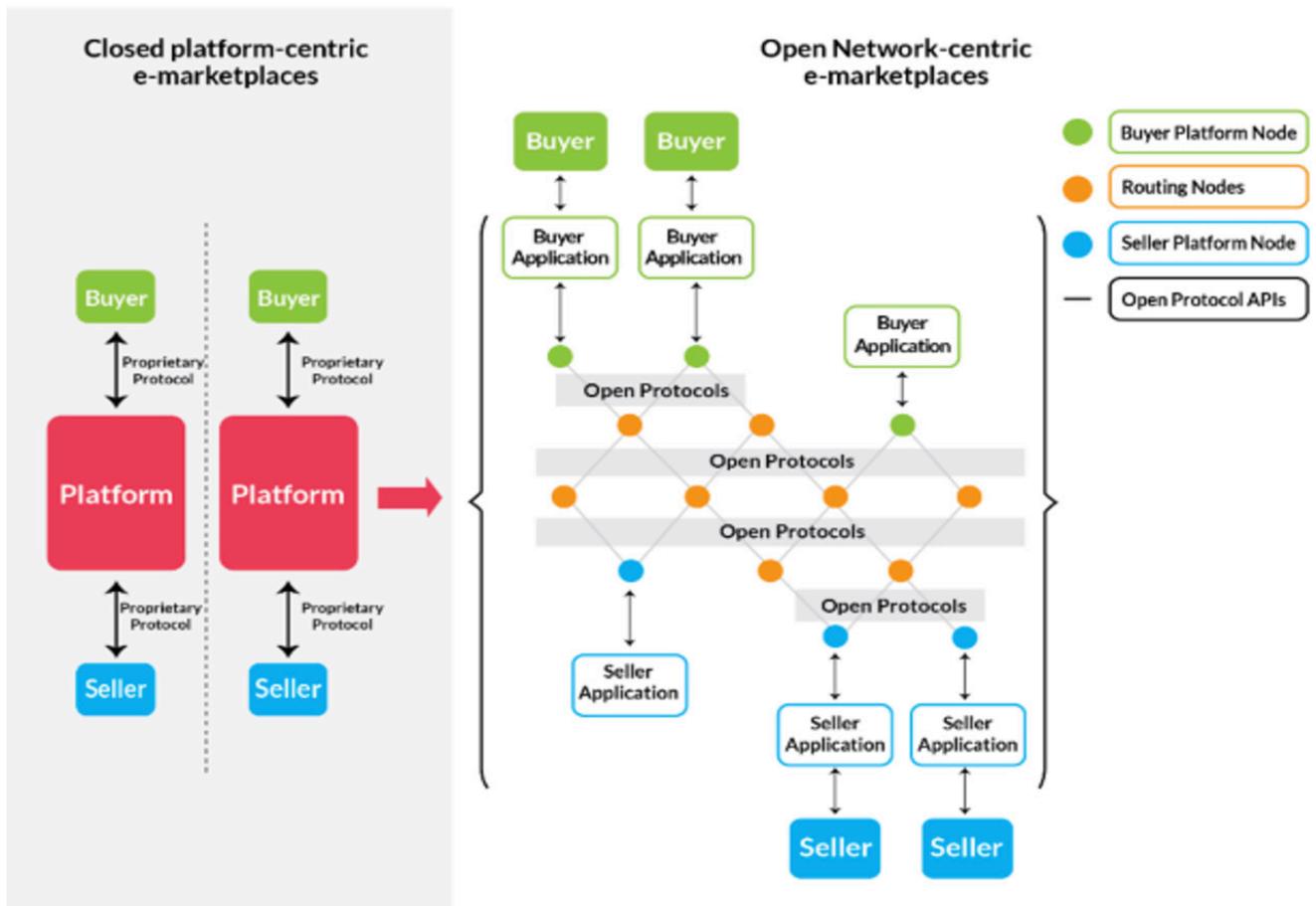


Figure 19: Closed platform-centric Vs Open network-centric e-marketplaces (Source: ONDC)

Toyota – Kinto mobility services

KINTO Europe, a joint venture between Toyota Motor Europe and Toyota Financial Services, manages Toyota’s new mobility services across the region. Kinto was the third brand in the company’s history, after Toyota and Lexus, and shows the seriousness of the mobility ecosystem to Toyota. Kinto includes the following mobility services:⁴⁴

- ▶ KINTO One is an all-inclusive leasing service that has been launched in seven European markets (as of 2020). It is a mid-size player in the fleet management market, with a fleet of more than 100,000 vehicles.
- ▶ KINTO Share provides wide range of car sharing services, from corporate to public and residential customers, operating in Ireland, Italy, Denmark, Spain and Sweden.
- ▶ KINTO Flex is a short-term, flexible vehicle subscription service, allowing KINTO customers to enjoy the full range of Toyota and Lexus vehicles, enhancing the freedom of car ownership by offering access to various car types throughout the year, serving users’ taste and needs.
- ▶ KINTO Join is a new corporate car-pooling solution for employees to create their own private transportation network, launched in Norway and Italy.

-
- ▶ KINTO Go, a multi-modal aggregator which coordinates journey planning, public transport ticketing, parking, taxi services and events, is already achieving good results in Italy and plans are under way for its expansion in the short term.

The key challenges / aspects that Kinto has to contend with in order to be successful in the mobility services ecosystem include:⁴⁵

- ▶ Toyota has about 3000 dealers in Europe, and Kinto has to create a new value chain where these dealers are able to play an important role – offering both the vehicles as well as mobility services.
- ▶ In order to build a mobility services platform and provide data-driven customer experiences, Toyota would have to develop capabilities in software and data analytics.
- ▶ Kinto has achieved profitability in a services business model involving not only Toyota brands of cars but also other brands.

Michelin – Connected services and solutions around tires

Michelin is positioning itself as a key player in connected mobility, by offering connected services and solutions around tires for an “All Sustainable” future.⁴⁶ By 2030, the Group aims to make between 20% and 30% of its revenue in activities other than tires: around and beyond tires.⁴⁷

It focuses on three areas:

- ▶ Fleet management – makes its clients’ operations safer, productive and sustainable with a range of services for vehicle (including electric, and even hydrogen mobility), tire and driver management. Watèa by Michelin is a tailor-made electric mobility solution for light commercial vehicle fleets.
- ▶ Connected Services Platform – It connects fleets to trustworthy service providers, and digital optimization of maintenance services and commercial processes
- ▶ Mobility Intelligence – Michelin DDi (Driving Data to Intelligence) specializes in analyzing driving data and behaviours for solutions that contribute to safer and greener mobility. Its approach is based on three strategic pillars: improving driver behaviour, road infrastructure quality and vehicle technologies. Truckfly is a free application, available in France, that helps the mobility of truckers, improves their quality of life and working conditions, and enables them to find a job.

SAP – Co-innovation mobility ecosystem initiatives

SAP Co-Innovation Lab, established in 2007, is a developer network spanning 16 locations worldwide. It works with SAP’s global ecosystem of customers, partners, and startups to develop solutions, and has delivered more than 1,000 co-innovation projects over the years.⁴⁸ One such project is with GS1, a non-profit organization, to develop a blockchain for tire safety (see Figure 20).⁴⁹

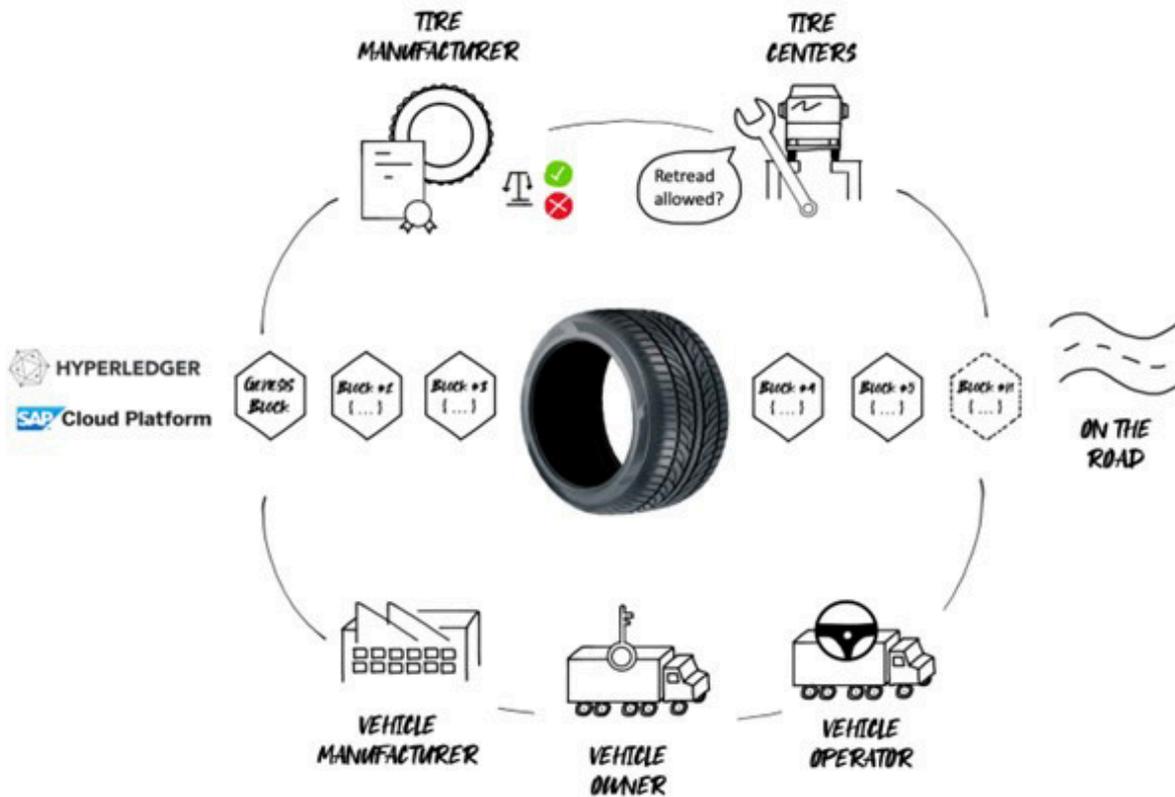


Figure 20: Closed platform-centric Vs Open network-centric e-marketplaces
(Source: SAP Co-Innovation Lab)

Globalization has made cross-border shipping commonplace, and trucks are covering thousands of kilometres every week. Due to wear, tire treads must be renewed on a regular basis. The co-innovation project, TWAREG, has developed a solution to identify overused truck tires and approve tire repair. Each tire is equipped with an RFID device that uniquely identifies the tire, while the blockchain records the tire mileage and service activities. It provides warrantors with trusted information on an individual tire's history.

SAP has co-innovated with a number of other partners in the mobility ecosystem. ChargeX provided the first intelligent, multi-socket charging solution for EVs. It allows multiple electric cars to charge simultaneously. The SAP E-Mobility solution helped ChargeX lower time spent on daily charge-point operations and improve customer satisfaction with intuitive user interface and straightforward, automated processes. Zoox, a subsidiary of Amazon, uses flexible and scalable manufacturing solutions from SAP to build its fully autonomous, purpose-built vehicle fleet. Its robotaxi is transforming the ridesharing ecosystem – passengers can request a ride from this driverless taxicab via their smartphones.⁵⁰ In July 2022, Zoox was certified to the existing US Federal Motor Vehicle Safety Standards.

Catena - X automotive network

Catena-X is the first European, collaborative, open data ecosystem for the automotive industry of the future, linking global players into end-to-end value chains. Catena is Latin for chain, the individual links of which

must interlock and hold firmly together. And X represents the participating stakeholders.⁵¹

The Catena-X Automotive Network was initiated by a number of pioneering companies (including BMW, Mercedes Benz, SAP and others) and first publicly announced at the German government's Digital Summit in December 2020. It received funding of around 100 million euros from the government as part of the “Future Investments in the Vehicle Industry” program.

The Catena-X association launched a proof-of-concept of Catena-X in mid-2022 with ten specific use cases, and is based on the Gaia-X European cloud (see Figure 21). Through its operating company, Cofinity-X, which includes ten partners from the automotive value chain, it onboards manufacturers and suppliers as users and helps them take the initial steps, such as logging their carbon footprint and using the business partner database.

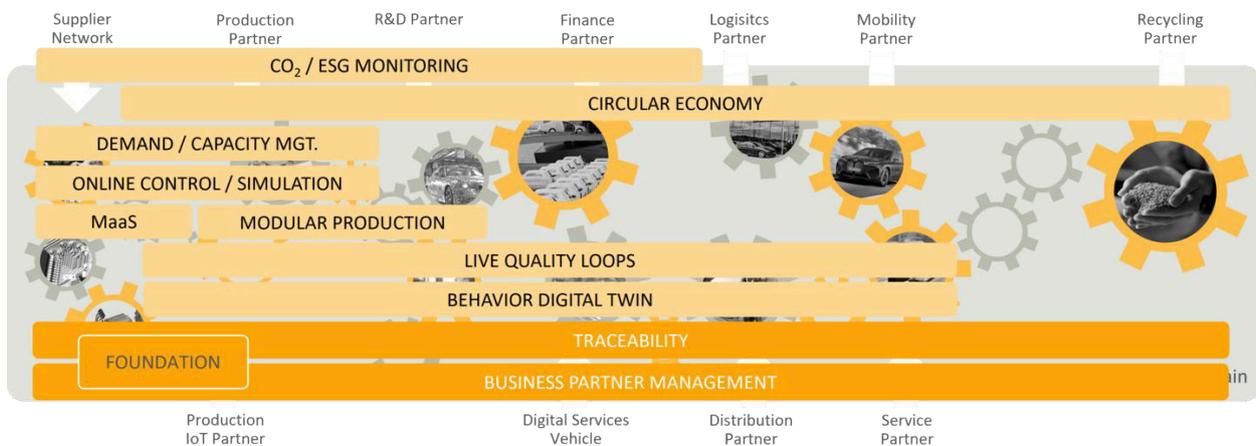


Figure 21: Catena-X use cases (Source: Catena-X)

Let us understand a few of these use-cases in greater detail – traceability, circular economy and CO₂ monitoring.

Traceability – A continuous data chain across the automotive value chain – from raw material extraction to the manufacturing – will result in a large marketplace. Catena -X will help companies identify supply bottlenecks at an early stage by making it easier for them to query availability across supply chains. It will also enable better purchasing power in material procurement – for instance, collaborating automotive OEMs on Catena-X would be in a better bargaining position as compared to other industrial sectors in procuring chips.

The BMW Group used satellite data and big data analytics in a pilot project to gain in-depth transparency in a leather supply chain all the way back to the origin of the raw material. 50 leather sub-suppliers and 9,000 farms were identified and linked to satellite, geospatial and supply chain data in Catena-X, enabling real-time monitoring in selected world regions. This transparency is required for compliance / regulations with respect to environmental and social sustainability standards.⁵²

Circular economy – Catena-X can make the circular economy less complex. Enterprises can easily find out information regarding presence and quantity of raw materials in specific components. The exchange of data via Catena-X helps determine whether a part should be recycled or reprocessed.

CO2 monitoring – Catena-X helps carbon footprints become more readily measurable. Up to now, average values have been used for this purpose. In future, actual values will become transparent across the entire value chain.

Catena – X will work only if the participating members share relevant data. One of the biggest challenges with respect to such b2b data sharing is the lack of compatibility between datasets. Each enterprise stores data in their proprietary format, and even if they share the data, it would not make sense at an aggregate level. Another challenge, especially when dealing with SMEs, is the complexity of the data-sharing process. Catena – X has developed a pioneering approach to unify all needs From SME to large corporations and providers of services & apps. It is architected for data interoperability and sovereignty, and leverages an Eclipse Dataspace Connector (EDC) for easy exchange of data. See Figure 22.

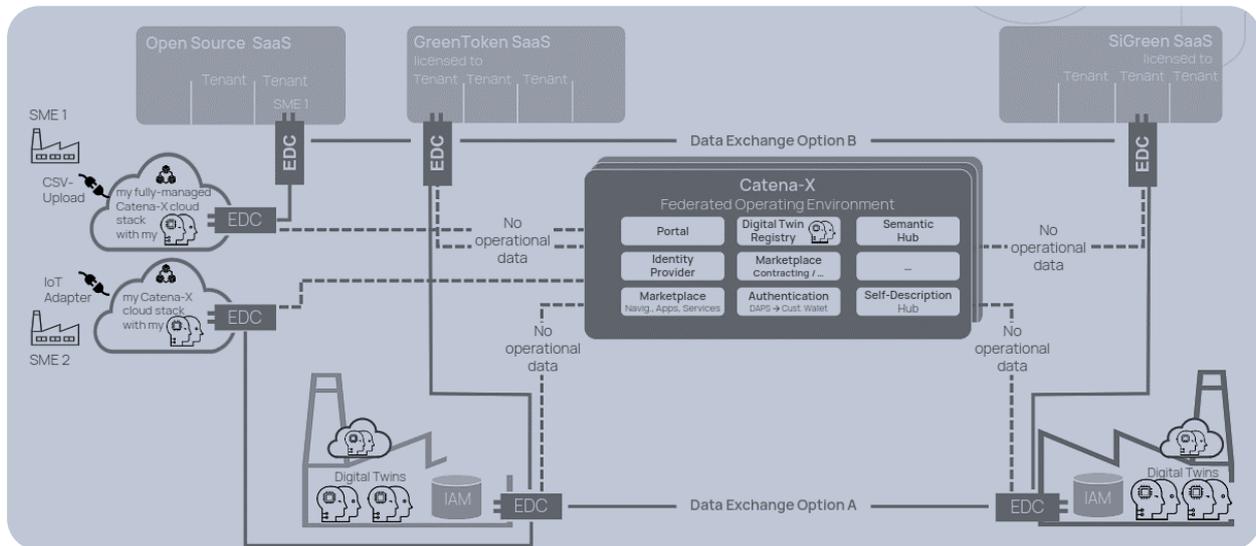


Figure 22: Catena-X architecture (Source: Catena-X)

4. X-verse ecosystem co-innovation and stakeholder value co-creation at Mahindra & Mahindra

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

Applying the PIE X lens to digitalized automotive and smart mobility experiences

As we saw in the above examples, the transformational shifts to the X-verse require going beyond the conventional loci of interaction, value, innovation, strategy, and performance. The PIE X lens helps do this by visualizing platforms (and underlying protocols) in interactive ecosystems, whose environments of engagements are intentionally configured for enactment of interactional creation. Such enactment entails the interactive agency of eXperiencers coming together with the interactive structures of ecosystems. It requires socio-technical architectures that are purpose-built based on event-sensed flows of lived-journey engagements. Valuable impacts must be sustainably amplified at speed, scale, and scope. This requires adaptive design of enhanced networks of capabilities across private-public-plural sector eXperiencer ecosystems. It entails ongoing co-innovation of risk-managed solutions with stakeholders, and leading organizational change ecosystemically, so as to bring about “all-win more” developmental transformation of markets, economies, and society at large.

Let us consider the enterprise transformation of Mahindra and Mahindra, a large India-headquartered, global automotive OEM.

The Mahindra Group was established in 1945 in India. It is one of the largest and most admired multinational federation of companies (with consolidated revenues of INR 901,710 million and profits (PAT) of INR 65,770 million in FY22). The Group, spread across 22 businesses, is the world's largest tractor company by volume, enjoys a leadership position in farm equipment, utility vehicles, information technology and financial services in India, has a strong presence in renewable energy, agriculture, logistics, hospitality and real estate, and employs 260,000 people in over 100 countries.

Mahindra and Mahindra (M&M) is a flagship company of the Mahindra Group. M&M's core business is in mobility and farm products and solutions, including SUVs, pickups, commercial vehicles and tractors, to electric vehicles, two-wheelers, gensets and construction equipment. Over 75 years of its existence, Mahindra has demonstrated a spirit of innovation and anti-fragility. In the 1970s, when the petrol prices shot up in India due to a global oil crisis and their cars-demand crashed, Mahindra innovated by modifying its tractor diesel engine to be used in their passenger vehicles and made it a source of competitive advantage. Similarly, when Mahindra found that it had excess capacity in its tractor engine plant, it developed a highly successful allied business, Powerol, that used these engines to power diesel generator sets for power generation. On similar lines of innovation, its Scorpio range of vehicles grew out of the challenge to develop a world class SUV, at a fraction of the cost of such development in the West. In the aftermath of the COVID-19 pandemic, Mahindra has doubled down on its focus on digitalisation and emerging technologies such as EVs to transform its business, bring in efficiencies and offer innovative products and solutions to its customers, partners and employees. Let us take a look at this digital transformation of Mahindra.

FUTURISE – a digital transformation of Mahindra

In FY2022, under the theme of Futurise, Mahindra articulated its ambition to lead in three pillars – outperform financially, lead ESG, and be future-ready. Under being future-ready, it aims to elevate customer experience through digitisation, and fuel businesses of the future with its ‘Born Electric Vehicles’ vision. See Figure 23 for Mahindra’s vision for a tech-enabled redefinition of the future.

 MADE MAHINDRA ADVANCED DESIGN EUROPE	 EV TECH CENTRE	 DIGITAL TRANSFORMATION	 DIFFERENTIATED BRAND EXPERIENCE
Authentic design with global appeal	<ul style="list-style-type: none"> • Tech partnerships • 2025-30 BEV roadmap • Software hub at Bengaluru • Leverage MRV for PD 	<ul style="list-style-type: none"> • Customer journey • Software for HMI • New business models • Agile supply network 	<ul style="list-style-type: none"> • Purpose-based brands • Best-in-class CX • Wow products • Platform commonality

BEV- Born Electric Vehicle | MRV- Mahindra Research Valley | PD- Product Design | HMI- Human-Machine Interface | CX- Customer Experience

Figure 23: Redefine the future (Source: Mahindra and Mahindra)

Mahindra has undertaken a number of digital initiatives to enhance their automotive customer buying experience. It has deployed immersive 3D visualiser using WebGL tech for customers to virtually experience XUV700, a high-end SUV. Owners also get an interactive manual with the ‘With You Hamesha’ service app. Its integrated automotive web-based platform 'auto.mahindra.com' is enabled with an innovative chatbot feature for swift query resolution and transactions.

Mahindra has also streamlined its processes at dealerships. It has rolled out a more agile CRM platform across 439 dealerships pan-India, introduced SalesGenie Nxt App to help them manage processes like enquiry management, test drive, quotation, and booking seamlessly. It has also leveraged technology to allow for real-time data integration of call centre and dealer agents to share leads. Their 'World of SUVs' format of next-generation dealerships provides convenience to customers by integrating the virtual world with the real on a phygital platform. Embedded screens and immersive virtual reality with mirror display, Wi-Fi connected customer lounges and specially trained relationship managers provide an immersive customer experience.

Similarly, Mahindra has leveraged digital technologies to transform the agri and farmer experience front too. Krish-e is Mahindra’s farming-as-a-service vertical (see Figure 24). It has launched 3 apps – Krish-e, Krish-e Rental, and Krish-e Nidaan – that offer differentiated and farmer focused advisory and rental services, and aims to increase farmers' income through digitally enabled services across the complete crop cycle. In order to enable such an offering,

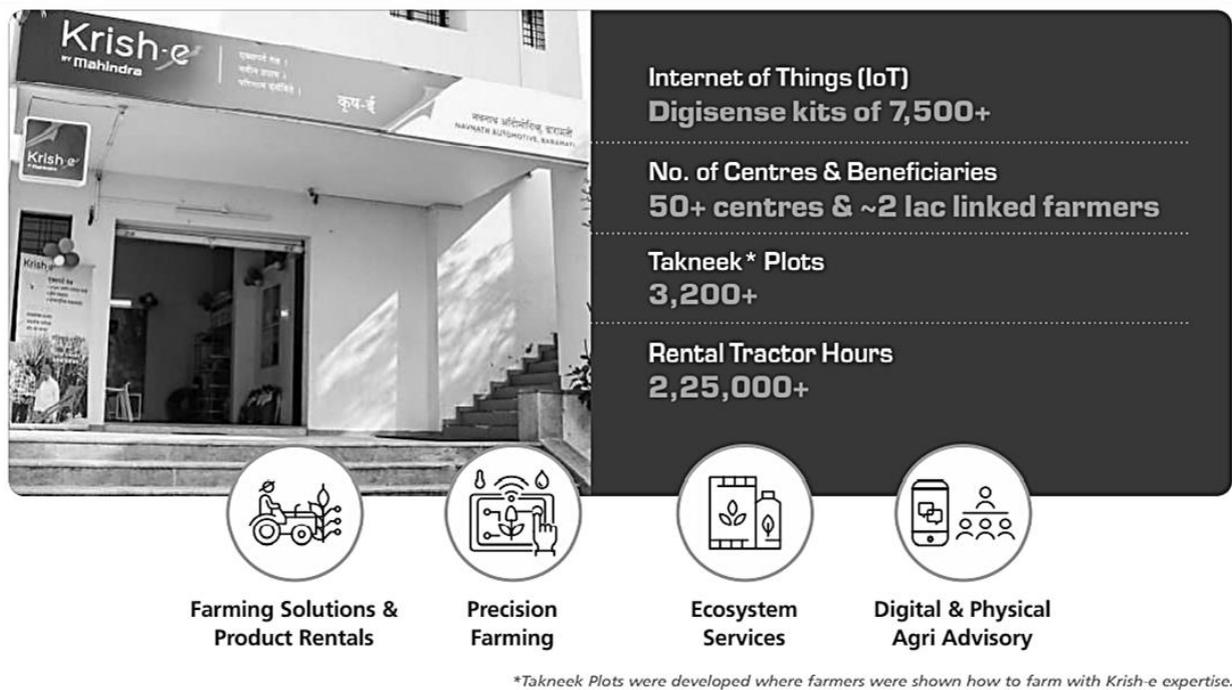


Figure 24: Krish-e farmer-as-a-service offering (Source: Mahindra and Mahindra)

Mahindra has made strategic investments in Resson – a Canadian predictive analytics company, Gamaya – a Swiss hyperspectral image analytics company, and Carnot – an Indian AI-enabled agri IoT company. DigiSense 4G is Mahindra’s next-gen AI-driven open-architecture solution, that helps farmers track their tractors and control their farming activities remotely. The mPragati app provides access to DigiSense features like live location, fuel levels, etc., to its tractors and farm machinery customers. These agri solutions are similar to the ones from Land O’Lakes and ITC that we saw in our previous report on retail and agri X-verse.

Not only its sales and customer experiences, Mahindra is also leveraging technologies to transform its manufacturing capabilities. It has connected critical machines across 8 plants across India through the in-house developed platform, Drona, to ensure better productivity, increased machine availability and improved efficiency. Using advanced AI / ML models that capture over 1,000 data points, ranging from supplier parts to on-road performance, Mahindra can predict and score the performance of its engines with an accuracy of 99.6%. Such models help reduce the testing time and improve quality. It is also running AI / ML models in their automated painting process to help set the right conditions to achieve the best possible output.

Mahindra has extended the principle of customer experience to their manufacturing plants too. It has leveraged Industry 4.0 technologies to create over 3,000 digital interfaces across the plants to enable high visibility and detail. Of these, more than 500 touch points directly contribute to assuring quality and customer experience.

Mahindra is harnessing technology to create more compelling new products, and is betting big on EV

technology. For its Born Electric portfolio of SUVs, it is focusing on driving partnerships along with leveraging internal R&D and innovation capabilities of its research facilities at Mahindra Research Valley, EV Tech Centre, Mahindra North American Technical Centre, and UK Design Centre (M.A.D.E.).

All these initiatives will undoubtedly help Mahindra become future-ready and meet its financial performance goals by offering superior products, services and experiences. It aims to be a purpose-driven brand, and Mahindra aspires to be a leading company for its ESG commitments. See Figure 25 for a list of FY22 ESG commitments of Mahindra.



Figure 25: ESG commitments of Mahindra, FY22 (Source: Mahindra and Mahindra)

Mahindra aims to be planet positive (greening its operations, decarbonising the industry and rejuvenating nature), people positive (enabling its associates, communities and customers), and trust positive (commitment to its shareholders, partners, and investors). It has estimated to have delivered USD 4 billion worth of social impact.

For instance, on the planet positive front, Mahindra & Mahindra was the first company globally to commit to doubling its energy productivity through the EP100 initiative (a global initiative led by the international non-profit Climate Group, bringing together over 120 energy smart businesses committed to measuring and reporting on energy efficiency improvements). It has also committed to having all its locations certified as 'Zero Waste' by 2030. On the trust positive front, Mahindra has been disclosing information to all stakeholders for over 14 years through its GRI-based sustainability reporting. Since FY18, it has been sharing information through its Annual Integrated Report based on International Integrated Reporting Council (IIRC) Framework. In F22, Mahindra invested over INR 970 million in various social projects in the areas of girl child education (Project Nanhi Kali), skilling of youth (Mahindra Pride Schools and Classrooms), environment rejuvenation (Project Hariyali) and prosperity of farmers (Project Prerna Krishi Mitr).

Mahindra recognises and measures as part of its annual reporting value created by leveraging multiple types of capital – not just financial capital, but also manufactured, intellectual, human, social & relationship and natural capital. See Figure 26 for Mahindra's value creation model.

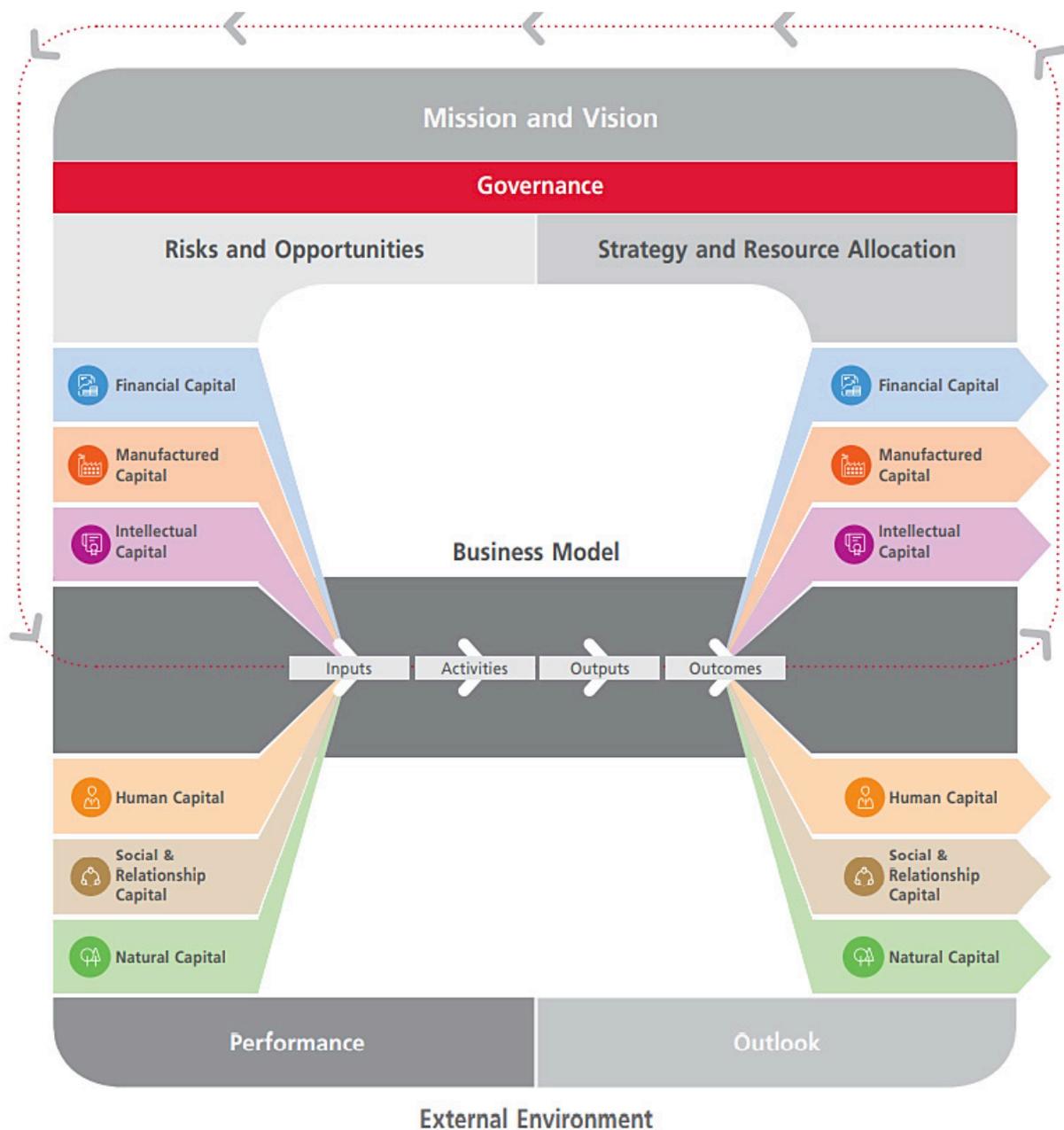


Figure 26: Value creation model (Source: Mahindra and Mahindra)

Mahindra also identifies and monitors “materiality”, which are material issues that impact, directly or indirectly, its economic, social or environmental sustainability, and the value created or delivered to its stakeholders over short, medium or long term. See Figure 27 for Mahindra’s materiality matrix for the automotive and farm equipment sectors. It periodically evaluates its material issues to introspect as well as shape the future course of action across the triple bottom line – social, environmental and financial.

Materiality Matrix Automotive Sector



BUSINESS



ENVIRONMENT



SOCIAL

PARAMETERS OF HIGH IMPORTANCE

Cost control and Profit Margin
R&D impetus
Fuel Efficiency
Risk Assessment and Compliance
Market/Product competition
Sustainable Mobility
Product Quality
Supply chain Optimisation
Logistics Optimisation and Sustainable Logistic
Emerging Markets Needs

End of Life Management
Water Intensity
Energy Efficiency
Recyclable/Recycled Material
Waste Generation
Climate Change and GHG Emissions
Tail pipe emissions reduction
Life Cycle Management

Customer Satisfaction
CSR Management
Employee Productivity
Health and Safety
Product Safety
Training and Education
Gender Diversity
Grievance Mechanisms

Materiality Matrix Farm Equipment Sector



BUSINESS



ENVIRONMENT



SOCIAL

PARAMETERS OF HIGH IMPORTANCE

Cost control and Profit Margin
R&D impetus
Fuel Efficiency
Farm Tech Prosperity (Farmer Prosperity)
Risk Assessment and Compliance
Solution Selling Beyond Products
Product Quality
Soil Health
Supply chain Optimisation
Logistics Optimisation & Sustainable Logistics
Dealer Management
Market/Product competition

Water Intensity
Energy Efficiency
Recyclable/Recycled Material
Waste Generation
Climate Change and GHG Emissions
Water Availability

Customer Satisfaction
CSR Management
Employee Productivity
Health and Safety
Grievance Mechanisms
Supplier Satisfaction/Relationship
Training and Education
Gender Diversity
Talent Retention and Succession Planning

Figure 27: Materiality matrix for automotive and farm equipment sectors (Source: Mahindra and Mahindra)

The first step in determining material issues is stakeholder identification, followed by the development of an engagement mechanism in order to communicate with them on a regular basis. Mahindra has developed varied mechanisms of stakeholder engagement, involving their customers, employees, partners, dealers, suppliers and investors. See Figure 28.

STAKEHOLDER GROUP	ENGAGEMENT CHANNELS
 GOVERNMENT/ REGULATORY AUTHORITIES	Environmental compliance, policy consultations
 EMPLOYEES	Conferences, workshops, publications, newsletters & reports, online portals, feedback surveys and one-on-one interactions, employee involvement in CSR activities
 CUSTOMERS	Interviews, personal visits, publications, mass media & digital communications, feedback camps, plant visits and support programmes
 SUPPLIERS & DEALERS	Supplier & vendor meets, workshops & training, audits, policies, IT-enabled information sharing tools, and recognition platforms
 INVESTORS/ SHAREHOLDERS	Annual report, sustainability report, press releases, investor presentations, corporate website, quarterly and annual results, ESG calls
 LOCAL COMMUNITIES	CSR activities
 EDUCATIONAL INSTITUTES/ UNIVERSITIES	Technical collaborations, capacity building, research

Figure 28: Stakeholder engagement channels (Source: Mahindra and Mahindra)

The foundations for meaningful dialogue with these stakeholders hark back a co-creation movement that emerged in Mahindra a decade back.

A co-creation movement of organizational transformation in Mahindra

In August 2010, Naveen Chopra, then senior general manager and head of Plant Quality for the Automotive Division of Mahindra, one of India's largest vehicle manufacturers, attended a seminar on the topic of the co-creation paradigm of value creation conducted by one of us (Venkat Ramaswamy). Co-creation emphasizes the need for creative collaboration and enhanced communication and co-ordination among stakeholders, and Naveen was constantly striving to improve precisely these practices across the five operating sites of Mahindra's Automotive Division.

Naveen decided to experiment with co-creation thinking by applying its principles first in the quality function. In September 2010, he drafted a short presentation on co-creation thinking, sharing it initially with his immediate colleagues and then with his wider quality team across the five plants. Central to co-creation thinking is engaging external and internal stakeholders—including customers, employees, suppliers and dealers--to create value together through platforms of engagements and environments of interactions, purposefully designed and configured to address the interests and needs of participating individuals.

As Head of Quality, he was already collaborating with multiple functions of the business, such as manufacturing, marketing and customer service, in a quest to enhance and enrich the company's quality culture. He himself began to engage employees as stakeholders in internal experience sharing sessions. Simultaneously, Naveen started to tackle the practicalities of communicating co-creation thinking more widely, together with a core team representing different functions—including dealer channel, training, manufacturing, and supply chain management. They put together several examples of co-creation in action, and also communicated more precisely how it worked in practice.

For example, they explained that it was not about just getting feedback but it also involved sharing experiences and experiential learning. An early success was when the team decided to form a small group of engineers, each with about 10 to 25 years of specialist automotive experience, and enable them to pass on their knowledge and expertise to dozens of younger colleagues. The team identified specific stakeholding individuals from the pool of engineers who could benefit from this type of knowledge sharing.

The team established an engagement platform—in this case, “live” monthly workshops—where the whole group could meet to share knowledge and experiences. These were led by a voluntary cadre of experienced engineers who took on the role of trainers. The meetings were more than just about talking shop. To be effective, they required an honest approach from all participants, based on mutual respect, openness and the willingness to experiment. Typically, a workshop would focus on a specific theme, with one or two seasoned engineers passing on their expertise to their junior colleagues.

Between workshops, the groups would document their learning and jointly create an internal training module on the subject, which could be run at any time and updated as necessary. Throughout the month the team focused on making workshop design changes by asking participants how their experiences could be improved and how the platform could be more valuable.

In just two to three months, the platform had enabled specialized knowledge sharing and training to be rolled out at high speed with hardly any extra cost to the company. This early success was soon appreciated at senior management levels within Mahindra. In the ensuing 18 months, around 50 similar modules were created, with 400 to 500 employees benefiting. Says Naveen: “Using traditional classroom training methods, this would have taken us ten years.”

In the case of suppliers, the joint team first considered how supplier meetings could improve mutual understanding, cooperation and collaboration. If supplier capability could be augmented, it was reasonable to expect that quality would improve too, with both parties “winning more.” Instead of taking the traditional approach of first finding fault with the suppliers and urging them to take corrective action, efforts were made to consider how they interacted with Mahindra. Suppliers were encouraged to share their experiences. There was initially some suspicion among suppliers about the dialog process, which was natural because Mahindra was their customer, but by the end of 2010, some 80 suppliers were on board, with this effort producing the

desired results.

In the case of dealers, as with the suppliers, traditional meetings were reformed into a more effective engagement platform, with emphasis placed on seeing issues from the dealers' perspective and supporting them. Further, stakeholders who were typically not part of the quality conversation, such as auto repair mechanics, were involved in sharing their knowledge – about vehicle defects, failure modes and problem-solving solution, and they also were invited to Mahindra's plants. Again, both Mahindra and the dealers reaped the benefits, from addressing vehicle defects to shaping new product features, including more productive relationships and faster cycle times. Some dealers initiated co-creation thinking in their own businesses. As a result, defects for top dealers reduced significantly. New diagnostics for dealer technicians and new product knowledge enhancement through training sessions on focused topics resulted in getting service right the first time, while also gaining a better understanding of part failures based on actual field experiences.

By early 2011, word of Naveen's success with co-creation was spreading within Mahindra, with other area executives beginning to see its potential to transform their own functions. As momentum continued to build, a co-creation workshop for about 350 people was held in May 2011 where several individuals shared their experiences. Several people beyond the core team took the lead in conducting sessions. Some executives who were exposed to co-creation thinking at this event began acting on it, in areas as diverse as sustainability and social impact.

Then, in the next Global Program for Management Development (GPMD) program in early August 2011, the core team shared their experiences with several other leaders from within the Mahindra extended enterprise. By the end of August 2011, six more executives had become co-creation champions, some of whom had begun to embed early co-creation thinking into activities they were spearheading. In particular, a culture of co-creation had begun to spread in the extended supply chain network. The head of manufacturing in the automotive division became an ardent co-creation champion. He enlisted his own core team, beginning with an experimental program in engagement of contract labour. Through this program, by asking contract employees for ideas and giving them the ability to self-organize, the Mahindra officers had been able to achieve their quality-related goals more consistently. The manufacturing team then tackled core areas in the production process, including redesigning the manufacturing shop floors by setting up internal platforms of engagements.

Further, co-creation began to spread in the extended supply chain network. This was crucial to the success of Mahindra Automotive because an automobile typically has more than 5,000 parts, with Mahindra manufacturing core components such as the engine, transmission, and body in its plants and with as much as 70 percent of parts coming from a network of suppliers. While Mahindra engages primarily with Tier 1 suppliers who provide sub-assemblies and systems, Tier 1 suppliers in turn procure components from Tier 2 suppliers. However, these Tier 2 suppliers are small to medium enterprises with limited resources and skills, often with traditional practices and lacking exposure to modern methods. Following the co-creation

workshops, Mahindra began involving over 400 tier 1 suppliers – both officers and operators – in “co-creation competitions,” inviting the best entries to share their “Kaizen, Pokayoke, and Quality Control” stories, first with Mahindra senior management and then across the Tier 1 network.

The popularity of this program was a positive surprise for Mahindra management, which assumed that the suppliers would be hesitant to share practices with each other. In reality, however, the alternate thinking of learning by sharing facilitated by Mahindra began to spread as Tier 1 suppliers starting seeing the power of creating value together as an example of “win more-win more.” Once this took root, Tier 1 suppliers began to engage Tier 2 suppliers, inviting Mahindra to participate as well. For Mahindra this was a unique opportunity to promote comprehensive holistic growth and the improvement of Tier 2 suppliers’ productivity, quality, cost, delivery, safety and morale. And so, Mahindra enabled a “supplier cluster” platform of co-creation engagements at the Tier 2 level – facilitated by Tier 1 suppliers – bringing together groups of five to 15 co-located Tier 2 suppliers manufacturing similar products for a common shared purpose of improvement and for achieving agreed deliverables. This has also resulted in transforming the culture of Tier 2 suppliers, working together with Tier 1 suppliers and positively affecting quality and delivery at the Tier 1 level, and subsequently enhancing automotive quality overall at Mahindra. Over 10,000 supplier personnel were involved, with about 30 clusters having been formed, and over 50 lean management projects executed.

In November 2011, the company held an event involving over 1,000 Mahindra employees, suppliers, dealers and even its other non-traditional stakeholders, such as banks and educational institutions. As a step toward wider societal responsibility, the principles and successes of Mahindra’s co-creation journey were shared with this broad spectrum of business and social stakeholders. In turn, local banks and schools learned to create platforms to engage their own stakeholders.

Mahindra next began to harness the power of technology and social media to move the crucial engagement platforms beyond face-to-face workshops, to achieve wider geographical and enterprise ecosystem impact. For a widely diversified conglomerate like Mahindra, further development of digital forums enabled the enterprise ecosystem to scale co-creation and share its best practices and make its principles, methods and tools more easily accessible throughout its many functions and divisions.

Mahindra achieved a balance between co-creation and the management systems of the conglomerate enterprise, through co-creation champions at the corporate level in other areas. For instance, leaders who were engaged with many different internal functions in developing a collective corporate identity, Mahindra Rise, were co-opted. Mahindra also engaged change-makers across India through a societal engagement platform (www.sparktherise.com). Further, Mahindra undertook co-creative engagement of manufacturing operators in training, competency enhancement of employees, and talent development of officers. Likewise, platforms for co-creative new product development began to involve the marketing and branding functions together with communities of consumers, including the launch of new vehicles.

Thus, the culture of co-creation became part of Mahindra's DNA, and continued to evolve. Anand Mahindra says, "The co-creation mantra is now embodied in the three basic tenets of the Mahindra Group –accepting no limits, thinking alternatively, and driving positive change in everything we do." Naveen Chopra, Mahindra's first co-creation champion, is now Head of Product Development & Component Development and Material Management, Mahindra Trucks & Buses, and is continuing on his co-creation journey.

Mahindra as a co-creative living enterprise

What makes Mahindra a living enterprise? In the course of its digital transformation journey, we can see Mahindra has undertaken the following six steps.

1. Identify key stakeholders and increase their willingness to engage. In 2012, Anand Mahindra, chairman of Mahindra Group, articulated a vision of creating Mahindra as a reflective organization. Reflective Conversations Community (RCC) is a cultural transformational intervention in the Mahindra Group aimed at creating higher levels of employee engagement and better connect with stakeholders. By 2021, more than 2,600 employees had benefited from instructor-led workshops and have made use of digital solutions to strengthen their reflective conversation skills.
2. Set up platforms purposefully designed to engage individuals more co-creatively, with environments of interactions configured around people's "lived" experiences. The scope of interactions allowed by the platform gradually increase as the intensity of value creation increases, allowing the co-created outcomes resulting from the platform to be more valuable to stakeholding individuals. For instance,
3. Identify and support new co-creation champions. Co-creation initiatives have less chance of scaling up and succeeding without other co-creation champions to "fan the spark and spread the fire of positive energy." The ability to scale co-creation transformation enterprise-wide and in the ecosystem in which it operates depends upon identifying and supporting influential new champions of change in related parts of the enterprise ecosystem.
4. Expand the circle of stakeholders and joint value creation opportunities. Initiating ecosystem-wide change requires expanding the circle of stakeholders, thus revealing new opportunities to bring together sets of stakeholders and communities. Enabling them to engage together can create new co-creative capacities in the enterprise ecosystem.
5. Deepen the impact and enable the viral spread of "win more-win more" value creation in the enterprise ecosystem. A key to effective implementation involves linking together platforms and their environments of interactions across value chain activities. In scaling co-creation in the enterprise ecosystem, interactive and experience-based technology not only helps to make co-creation communities more generative, but also more inclusive.
6. Engage stakeholders across private, public, and plural sectors to amplify wellbeing-impacts for the benefit of all. As individuals' and partnering enterprises' joint interests expand, they create value together through a multitude of channels and interactions. Jointly building co-creative capacities of an enterprise's ecosystems increasingly entails a convergent engagement across private, public and plural sectors.

The payoffs of building co-creative living enterprises include greater creativity and productivity, lower costs, lower employee turnover, new business models and new sources of stakeholder and enterprise value. To do this, organizations must design and support engagement platforms – both face-to-face forums and online discussions – that offer stakeholders the opportunity to debate, discuss, and establish priorities and participate fully.

Our analysis also reveals certain newer opportunities for Mahindra to further embrace the spirit of being a living enterprise. For instance, the predominant value creation model, as reflected in Figure 26, is still based on “inputs, activities, outputs and outcomes”. Even when it considers experiences, it is mainly focused on “customer experiences”. As we have seen, experiences emerge at every point of engagement of every stakeholder (customer, partner, employee etc.) and Mahindra and its experience-environments. Adopting an experience-centric perspective in innovation and value creation across the entire stakeholder ecosystem, as we saw in the Microsoft example, can further transform Mahindra toward becoming a full-fledged co-creative living enterprise across the entire ecosystem of experiences in which it operates.

As Anand Mahindra noted: “In the decade since co-creation was mooted, technological platforms have enabled human engagement at deeper levels and on an infinitely broader scale. As a consequence, businesses can and must expand their strategies to encompass a profitable engagement with all stakeholders. The powerful idea that ‘we can do even better for ourselves, if we do well for others’ encompasses the way that successful organizations will contribute to wealth, welfare, and wellbeing in society.

5. Conclusion

AUTOMOTIVE AND MOBILITY ECOSYSTEM X-VERSE INNOVATION

**Applying the PIE X lens to digitalized
automotive and smart mobility experiences**

In this report, we explored the automotive and mobility ecosystem X-verse innovation and applied the PIE X lens to digitalized automotive and smart mobility experiences.

In section 1, we introduce the concepts of “**Life X-verse**” and “**PIE X**”. “Life X-verse” puts humanity and life experiences of value ahead of technology. The universe of experience environments and new eXperiences that emerge from engagements of experiencers in digitalized interactive ecosystems, constitutes the life X-verse. A new lens is required to visualize experience-centric ecosystem innovation and multi-stakeholder value creation opportunities (and challenges) in the life X-verse. The PIE X (Platforms, Impacts, Engagements, eXperiences) lens helps visualize opportunities and challenges for risk-managed experience-centric innovation and multi-stakeholder value creation in interactive ecosystems of the life X-verse.

In section 2, we looked at how the automotive industry is embracing the digitalized world characterised by innovations in autonomous driving, connectivity, electrification of vehicles, and shared mobility. We then viewed the major transformational shifts taking place in automotive enterprises along five different loci of value creation: locus of interaction, locus of innovation, locus of value, locus of strategy, and locus of performance. We saw examples of transformations at **Tesla, BMW, Lynk, Mercedes Benz, GM, Volkswagen, Lemonade, Toyota and Mahindra**.

In section 3, we explored detailed examples of digital transformations and co-innovations powering new automotive and mobility ecosystem experiences. **Tesla**, in order to fulfil its purpose of accelerating the world’s transition to sustainable energy, has reimaged the energy and transportation ecosystem. And is building a world powered by solar energy, running on batteries and transported by electric vehicles. We then looked at **Ford** which is undertaking its biggest transformation since Henry Ford scaled Model T. Central to its Ford+ strategy are electric vehicles, which Ford wants to comprise around half of its global sales by 2030, connected cars and new revenue streams via subscriptions and digital services. Next, we saw how **NIO**, a pioneer in the Chinese premium smart electric vehicle market, is looking to create a joyful lifestyle for its customers and how it is driving deeper engagements with them by building phygital communities.

We then studied exemplars of co-innovations in the mobility ecosystem – **PSA France** and its Free2move connected services, India’s **ONDC** protocol-based Kochi Open Mobility Network, Toyota’s **Kinto** mobility services, **Michelin** and its connected services and solutions around tires, **SAP**’s co-innovation mobility ecosystem initiatives, and **Catena – X** automotive network.

In section 4, we examined in detail how Mahindra & Mahindra is leveraging X-verse ecosystem co-innovation and stakeholder value co-creation to transform itself and become next generation co-creative living enterprises in the X-verse.

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**Applying the PIE X lens to digitalized
automotive and smart mobility experiences**

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