Sept. 2025

MOBILITY AT A CROSSROADS

/ Special Report:

Driving Mobility Transformation Through the 4S Framework

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EXECUTIVE SUMMARY

The 4S Mobility Framework

The mobility ecosystem is at a critical inflection point. Technological disruption, changing consumer expectations, urban transformation, and evolving regulations are fundamentally reshaping how people and goods move. This document presents the 4S Framework

- **Safe, Secure, Sustainable, and Seamless Mobility** -

a strategic blueprint for navigating this transformation.

WHY TRANSFORMATION IS URGENT

Traditional mobility models are under unprecedented pressure from converging forces:

+ User expectations are evolving rapidly, with declining brand loyalty, a shift from ownership to access models, and younger generations embracing multimodal, experience-focused mobility.
+ Technology acceleration is transforming vehicles from mechanical products to software platforms while new entrants redefine industry boundaries.
+ Urban environments are being redesigned around people rather than cars, with cities worldwide implementing car-free zones, mobility-as-a-service platforms, and integrated transport planning.
+ Regulatory landscapes are increasingly complex, with divergent standards across regions, intensifying data governance requirements, and a shift toward outcome-based frameworks.
+ Growing geopolitical tensions and trade wars are causing increasing instability and uncertainty.
+ Industry profitability is under mounting pressure and the window for proactive transformation is rapidly narrowing.

FOUR KEY CHALLENGES HINDERING EFFECTIVE RESPONSE

Despite unprecedented innovation, the mobility sector faces structural challenges that limit its ability to adapt:

I. Consumer Disconnection: Development remains oriented around vehicles rather than users, creating a growing gap between what's offered and what's valued.

II. Output-Focused Metrics: Traditional measurement focuses on volume and features rather than outcomes that matter to users and communities.

III. Reactive Decision-Making: Legacy governance systems struggle with the speed and complexity of today's mobility landscape.

IV. Outdated Collaboration Models: Partnerships haven't evolved to match the interconnected nature of modern mobility solutions.

THE 4S FRAMEWORK
| A Blueprint for Transformation

The 4S Framework provides a practical guide for rethinking how mobility is conceptualized, measured, and delivered:

/ Safe

Ensuring physical, financial, and psychological security for all mobility users.

/ Secure

Protecting data, people, privacy, and systems from evolving threats.

/ Sustainable

Delivering environmental, social, and financial durability.

/ Seamless

Creating integrated, frictionless mobility experiences.

This approach requires fundamental shifts in four key dimensions:

1. Starting with Consumer Needs

+ Align around shared user-centric principles.
+ Design for complete mobility journeys, not just vehicle experiences.
+ Employ continuous feedback to track evolving preferences.

2. Measuring Mobility Outcomes

+ Define success through real-world impact, not product specifications.
+ Map features directly to measurable outcomes.
+ Balance functional performance with emotional connection.

3. Proactive Decision-Making

+ Implement structured frameworks connecting strategy to decisions.
+ Embrace adaptive planning and lifecycle reviews.
+ Normalise course correction as a strength, not a failure.

4. Ecosystem-Wide Collaboration

+ Move from transactional relationships to outcome-driven partnerships.
+ Establish inclusive platforms for cross-sector innovation.
+ Share non-competitive assets to accelerate progress.

MOVING FORWARD
| The 4S Mobility Initiative

SBD Automotive is launching the 4S Mobility Initiative as a non-profit initiative to catalyse industry-wide transformation. This initiative offers multiple engagement pathways:

Core Team
Co-develop shared metrics, requirements and implementation frameworks

Project Partners
Participate in cross-sector pilots to test, refine, and validate 4S metrics

Membership Community
Access exclusive research, events, and peer networking

Integration Support
Embed 4S principles within organisational processes

By aligning around this shared framework, stakeholders across the mobility ecosystem can navigate disruption more effectively, create greater value for users and communities, and build more resilient business models for the future.

The 4S Framework represents not just a response to change, but an opportunity to fundamentally reimagine mobility for the 21st century.

CONTRIBUTORS

This study brings together insights from industry experts alongside SBD's 28 years of experience to present a strategic framework for leading through transformation. We would like to thank our sponsors along with all those who have contributed towards our key findings.

/Sponsors

/ Key Contributors

"When technology truly works, customers don't notice it - they just experience safe, secure, sustainable, and seamless mobility."
- Håkan Samuelsson (Chief Executive Officer, Volvo)

"Mobility is a team sport. Location intelligence provides the connective tissue, supplying the common trusted data layer that enables every ecosystem player - from vehicles and infrastructure to cities and people, to work together toward a truly safe, sustainable, and seamless future."
- Mike Nefkens (Chief Executive Officer, HERE Technologies)

"Speed is the auto industry's make-or-break factor today. From design to testing, we must compress timelines to match rapidly evolving consumer tastes. But beyond that, we need to optimize the entire enterprise for velocity. Swift decisions, execution, and experimentation are now more critical than any technical hurdle."
- Ozgur Tohumcu (General Manager Automotive, AWS)

"The biggest opportunity in improving the safety, security, sustainability and seamlessness of cars will come from cutting across data silos – that will require a new type of collaboration."
- Steve Jenkins (Vice President Tech Strategy, Magna Electronics)

"In-car safety features like AACN have a huge potential to save lives, but delivering on that promise requires a new type of collaboration between the automotive and public sectors."
- Matt Carter (Chief Executive Officer, Intrado)

"The next great improvement in mobility outcomes will come from breaking down the silos that have traditionally held back organizations and teams from working together."
- Jessica Rosenworcel (Executive Director, MIT Media Labs)

"The Automotive sector has largely been technology driven for the last 80 or so years, transforming to a truly mobility ecosystem designed around changing consumer needs will require a different approach."
- Jason Cracker (Founder & Director, Future Mobility Board)

“The technology behind autonomous vehicles is no longer the limiting factor—it’s here, it’s proven, and it’s ready. What comes next is adoption, and that means putting people at the heart of the journey.”

- Bob Bateman (Manager of Research and Advanced Engineering at Nissan)

“The difference between a successful and an unsuccessful connected car program is how closely an OEM understands and designs towards specific consumer outcomes. ”

- Niklas Florén (Chief Executive Officer, WirelessCar)

“Purpose and profit are not opposites. Anchored in purpose, OEMs can collaborate to deliver safe, secure, sustainable, seamless mobility.”

- Kristen Siemen (Former Chief Sustainability Officer at GM)

“The automotive industry faces unprecedented technological and competitive disruption, yet often develops in silos disconnected from the evolving mobility ecosystem. True success requires balancing technical innovation with human-centered experiences that respond to consumers' digital expectations and global realities.”

- Steve Bell (Chief Analyst, Omdia)

“China’s unmatched combination of massive user demand and digital-native supply has created a self-reinforcing ecosystem that accelerates AI+SDV innovation at unprecedented speed. This powerful dynamic is compelling global OEMs to embrace user-centric, co-creative ways of working, making China the epicenter of the industry’s transformation.”

- Peter Zhou (Founder of TCC KOLs, Executive Vice Chairman of CEIBS)

“Inclusive design grounded in the lived experiences of disabled people isn’t just about doing what’s right, it’s doing what is necessary to ensure that future mobility does not deepen existing transport inequalities.”

- Rebecca Posner (Director, Research Institute for Disabled Consumers)

“Inclusive AV design must extend beyond age and disability to consider gender, culture, income, and geography — otherwise, many will face transport exclusion.”

- Cyriel Diels (Deputy Director, Intelligent Mobility Design Centre, Royal College of Art)

/ Authors

Andrew Hart (Chief Executive Officer, SBD Automotive)

A globally recognized thought leader and innovator, Andrew joined SBD Automotive in 2004. During his tenure, Andrew has worked across many of SBD's teams and regions. He has led successful strategic advisory engagements with senior executives at more than 50 automotive manufacturers and suppliers on a global basis.

Alain Dunoyer (Strategic Leader, 4S Mobility)

As an expert in ADAS and vehicle autonomy, I believe the future of transportation hinges on a fundamental shift in perspective. My approach aligns with the 4S Mobility framework (https://www.4smobility.com), focusing on outcome-driven solutions and prioritizing the user experience to transform how the automotive industry innovates and makes decisions.

Jennifer Barsky (Adviser, 4S Mobility)

With over two decades of global experience, Jennifer has designed systems-level solutions across 25+ countries. At Nike, she built cross-sector partnerships leveraging $100 million to empower adolescent girls worldwide, and at the World Bank Group she led initiatives in financial inclusion, gender equity, and sustainable development.

INTRODUCTION

THE INFLECTION POINT: WHY MOBILITY MUST TRANSFORM NOW

The mobility ecosystem is at an inflection point.

The automotive industry, historically a pillar of mobility, now faces an existential challenge where its past achievements no longer guarantee future viability. This moment is especially pivotal because brewing trends are accelerating in unison: digital technologies are advancing exponentially, geopolitical tensions are reshaping global supply chains and market access, and user values and needs are rapidly evolving towards a new mobility ecosystem.

Globally, Governments are mandating decarbonisation, with the EU set to ban new petrol and diesel car sales by 2035 (European Commission, 2021), and the United Kingdom moving even faster with a planned 2030 ban (UK Department for Transport, 2025). Nearly 60 other countries have announced similar targets (BloombergNEF, 2024). Cities such as Oslo, Barcelona, and Paris are also restricting car use to promote cleaner, more liveable environments, introducing low-emission zones, car-free districts, and dynamic street reallocation programs. These shifts are reshaping not just mobility policy, but also consumer expectations for accessible, sustainable urban living.

Simultaneously, car makers, tech companies and startups are redrawing the landscape with major investments in autonomy, connectivity, battery innovation, and platform-based services.

Traditional industry boundaries are dissolving, and new competitors are continuously emerging in step with rapid technological advances.

These changes are not merely technological; they represent a fundamental paradigm shift in how people perceive, access, and use mobility in the 21st century. As electrification and shared mobility go mainstream, the automotive industry in particular faces a future where the legacy strengths of stable demand, predictable lifecycles, and brand loyalty are no longer guaranteed.

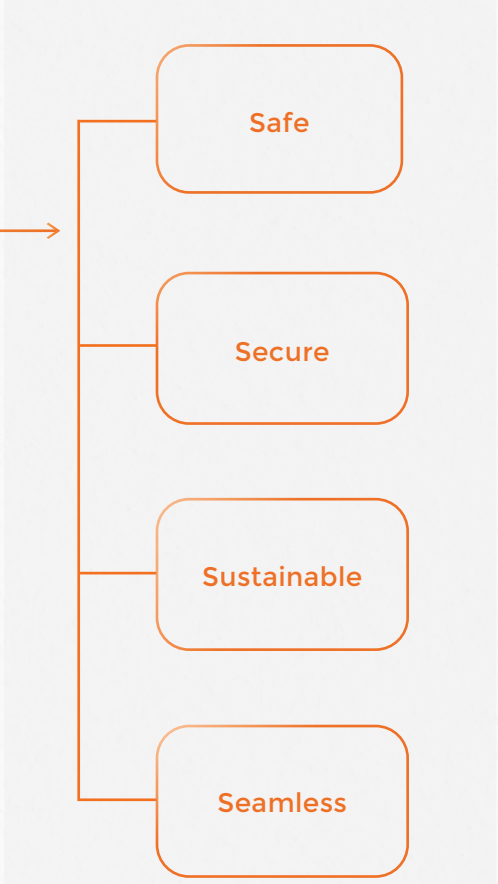
The gap between societal needs and industry capabilities is widening. As the pace of change accelerates, many established organisations remain slow to adapt, constrained by rigid hierarchies, long development cycles, and limited flexibility in software implementation or sustainability initiatives. Traditional mobility providers risk being outpaced not just by agile competitors, but by the evolving expectations of users and the communities they serve. Profitability is already under pressure, with industry margins declining from from 7.4% in 2017 to 5.1% in 2023 (McKinsey, 2025).

This is not just a business challenge; it's a test of mobility's essential role in society. For over a century, transportation systems have enabled economic growth and social connection.

> *"The automotive industry has been through major disruptions before, but this feels different. Technology, consumer needs, business models, regulations and eco-systems are all changing simultaneously and faster than ever before."*
>
> *Andrew Hart, CEO at SBD Automotive*

INTRODUCING THE 4S MOBILITY FRAMEWORK

In response to these challenges, this study presents the 4S Mobility Framework - a comprehensive approach for navigating disruption and maintaining relevance in a rapidly evolving ecosystem. Built around four key dimensions:



The framework provides:

- A consumer-centric blueprint that reorients development around user needs rather than technological possibilities.
- Outcome-based metrics that measure meaningful impact rather than just features or outputs.
- Decision frameworks that enable proactive, agile responses to change.
- Collaborative models that harness the power of ecosystem partnerships.

By aligning around these principles, stakeholders across the mobility landscape can transform disruption into opportunity and shape a more inclusive, resilient mobility future. The following sections will explore the major disruptive forces at work before detailing how the 4S Framework offers a practical pathway forward.

THE FOUR MAJOR DISRUPTIONS RESHAPING THE MOBILITY LANDSCAPE

The mobility ecosystem is undergoing historic transformation, shaped by four disruptive forces that signal a break from legacy models. These forces are driven by evolving user expectations, rapid technological innovation, new participants, and a shifting regulatory landscape. Understanding these dynamics is essential to shaping an effective strategic response that benefits all stakeholders- from individual travellers to businesses and communities.

Disruption 1

FROM OWNERSHIP TO EXPERIENCE | Shifting User Behaviour

People across diverse demographics are rethinking mobility, with major shifts emerging in brand loyalty, ownership models, and generational values that signal a profound departure from traditional automotive paradigms.

Declining Brand Loyalty and Generational Shifts

Traditionally rooted in habit and heritage, brand loyalty is eroding as new generations reshape mobility preferences. In the United States, loyalty for new car purchases fell below 50% in 2022, reaching a decade low (S&P, 2022), while globally, a majority of consumers intend to switch to another brand next time they are in market (Deloitte, 2025).

> *"In 10 short years, we've seen the average number of brands considered by car buyers rise from 2.5 to 5.9"*
>
> *Patrick Fuller, Head of Insight, Sophus3*

They actively express their individual needs and preferences through social media and online review platforms, publicly sharing experiences that can significantly influence others' purchasing decisions. According to some estimates, more than 83% of car buyers use online channels for initial research (EY, 2023.)

This transformation is particularly pronounced among younger generations. Recent research reveals that younger generations are shaping transformative change in mobility preferences and behaviours:

Multimodal by Default: Individuals aged 16–27 use an average of 3.8 transport modes weekly, compared to just 1.9 for those over 60, reflecting a growing embrace of car-light lifestyles (4S Global Mobility Survey, 2024).

Digital-First Expectations: Gen Z and Millennials, shaped by seamless digital experiences, demand the same from mobility-intuitive interfaces, personalisation, and continuous improvement through updates.

Delayed Milestones: Many young adults delay or forego traditional car ownership milestones. Driving licence acquisition rates have declined among 16-24 year-olds in many developed markets compared to previous generations. In the U.S., the share of teenagers with driver's licenses in the 16-19 age group declined from 64% in 1995 to just under 40% in 2021 (US Department of Transportation).

Values-Based Choices: Environmental and social considerations strongly influence mobility decisions among younger cohorts. According to a study by Kantar, 20% of Millennials prioritize sustainability when choosing a car, compared to 11% of Boomers (Kantar, 2024).

Openness to New Entrants: Younger users show significantly less attachment to established automotive brands, being 36% more likely to consider vehicles from technology companies or new manufacturers (Marketing Charts, 2022).

The Shift from Ownership to Access

This generational shift is accelerating changes in ownership models. Vehicle ownership is no longer a default aspiration, particularly among urban dwellers. Rising costs, urban density, digital lifestyles, and evolving values are driving people toward flexible, pay-per-use mobility options.

Globally, 25% of respondents in the 2024 4S Global Mobility Survey say they don't expect to own a car in the future. Ride-hailing, car-sharing, subscription services, and public transport improvements are gaining traction across demographic groups.

Remote work further accelerates the trend. With fewer commutes, especially among knowledge-based workers, the need for a personal vehicle has declined. As hybrid and remote models persist, vehicle usage continues to shift, with shared and on-demand mobility reshaping user-brand interaction.

These shifts represent more than temporary trends, they signal a fundamental recalibration of the relationship between people and mobility that will reshape markets and urban environments for decades to come.

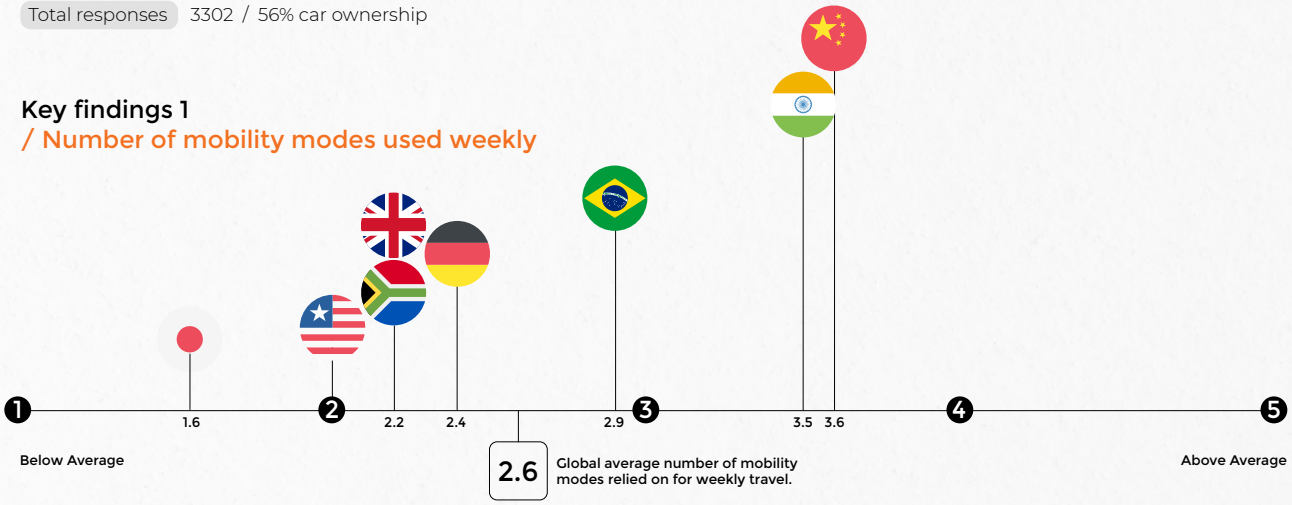
Chart: 4S Survey results shows differences in attitudes towards mobility by demographic subgroup

Chart 1/ 2024 Mobility Survey

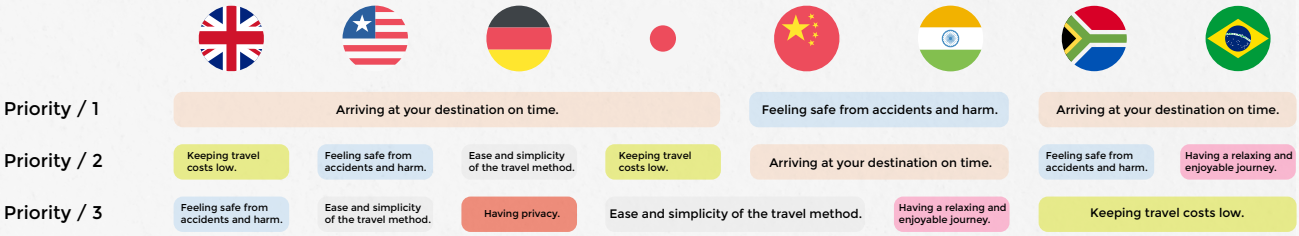
Data by SBD

Fielded November/December 2024
Type Online
Total responses 3302 / 56% car ownership

Key findings 1
/ Number of mobility modes used weekly



Key findings 2
/ Different needs (top 3 grouped)



Key findings 3
/ Friction of ownership (agree & strongly agree combined)

>75% Agree or Strongly Agree

									Average
Public transportation, ride-sharing, and other options make it easier for me to get by without a car.	57.5%	45.7%	47.3%	31.6%	81.0%	74.0%	64.5%	66.1%	66.1%
Owning a car is increasingly expensive due to rising costs of driving license, fuel, insurance, or repair.	78.7%	73.8%	73.0%	76.4%	79.5%	75.7%	81.3%	82.2%	82.2%
Car ownership feels less convenient with challenges like parking, traffic, or maintenance.	60.4%	44.5%	49.3%	50.3%	67.0%	65.1%	50.0%	66.3%	66.3%
In the future I will not need to own a car.	35.8%	24.1%	25.5%	32.8%	26.0%	32.0%	18.0%	23.1%	23.1%

Disruption 2

BEYOND MECHANICAL TO DIGITAL | Technology's Transformation of Mobility

Technology is not just changing how vehicles are powered, built, and experienced, it is redrawing the entire mobility ecosystem.

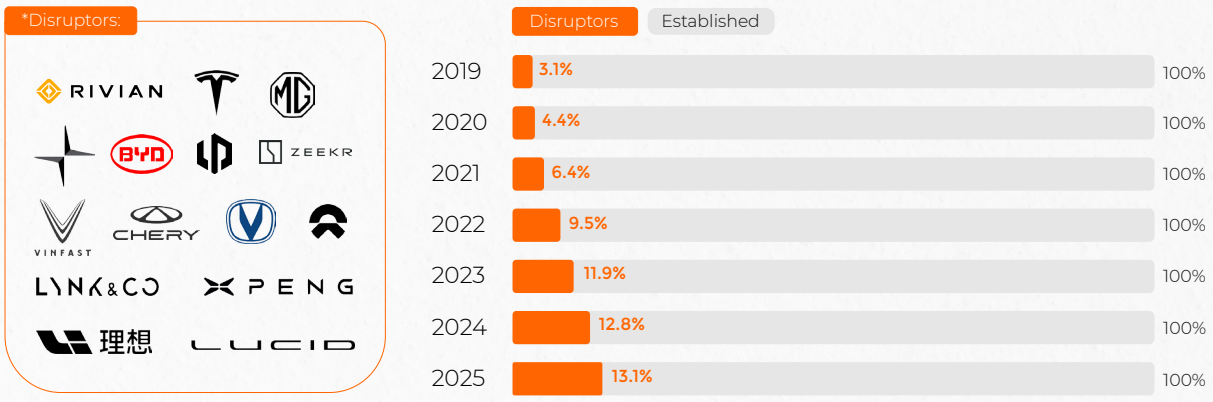
Shifting Competitive Dynamics and Ecosystem Realignment

Electrification, software-defined platforms, and autonomous systems are transforming both products and eco-systems. Traditional linear value chains are yielding to decentralised ecosystems shaped by new entrants, cross-sector partnerships, and software-first innovation. Today's mobility landscape encompasses vehicle manufacturers alongside platform providers, AI specialists, digital service firms, transport operators, and many other types of organisations.

Chinese brands have gained substantial global market share, accounting for 44% of global Electric Vehicle (EV) sales in 2024 (BloombergNEF, 2024) , alongside controlling over 70% of global EV battery production capacity. This signals not only shifting global influence but also the emergence of new operational models built on speed, data integration, and agility. Tech companies and startups are increasingly leveraging software and services to redefine mobility development and delivery.

Chart 2/ Evolution of OEM Market Share

Data by GlobalData. | SBD



This transformation spans four critical fronts-electrification, software-defined vehicles, autonomous systems, and advanced manufacturing-each requiring sustained investment and strategic collaboration. These shifts demand new technical skills, with reskilling programmes needed to equip the workforce for digitally defined vehicle development and next-generation EV servicing.

Electrification

The shift to EVs represents one of the industry's most complex undertakings. Success depends on investment in:

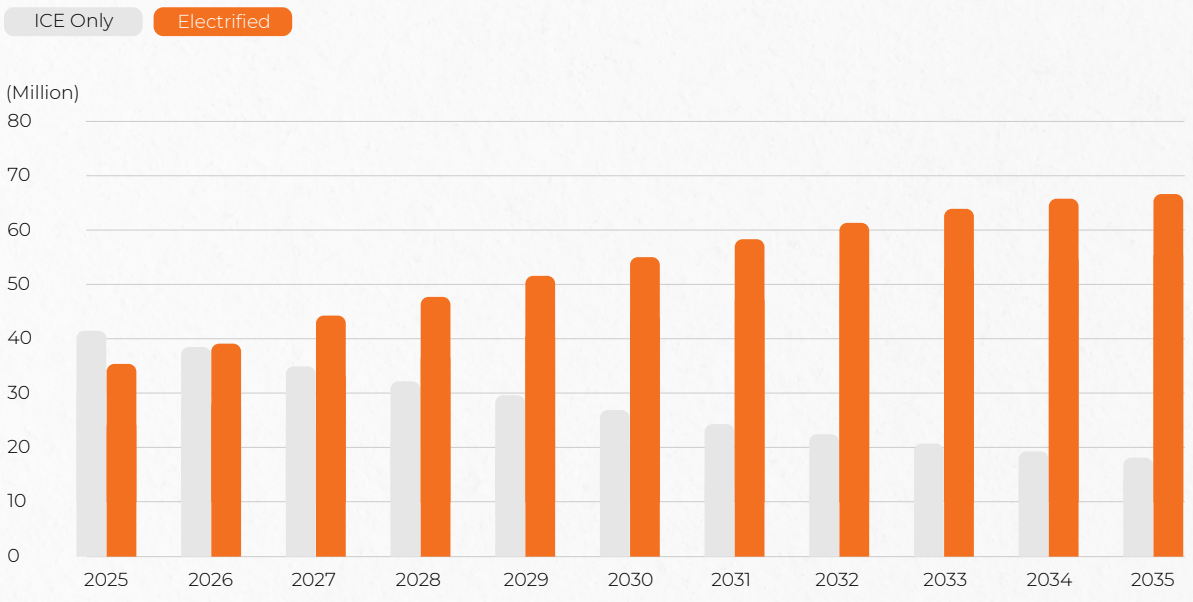
R&D and Manufacturing: Next-generation battery technologies, electric powertrains, lightweight materials, and new architectures, while retooling plants for EV production.

Charging Infrastructure: Public and private charging networks addressing "charging anxiety" through coordinated investment and urban planning.

Sustainable Supply Chains: Ethical sourcing of lithium, cobalt, and other critical materials, with transparency becoming a competitive differentiator.

Chart 3/ 10 year global forecast of new car sales: ICE vehicles versus electrified vehicles

Data by GlobalData.



Software-Defined Vehicles (SDVs)

SDVs mark a shift from hardware-centric vehicles to digital platforms evolving through software updates, AI, and connectivity. This transition requires investment in:

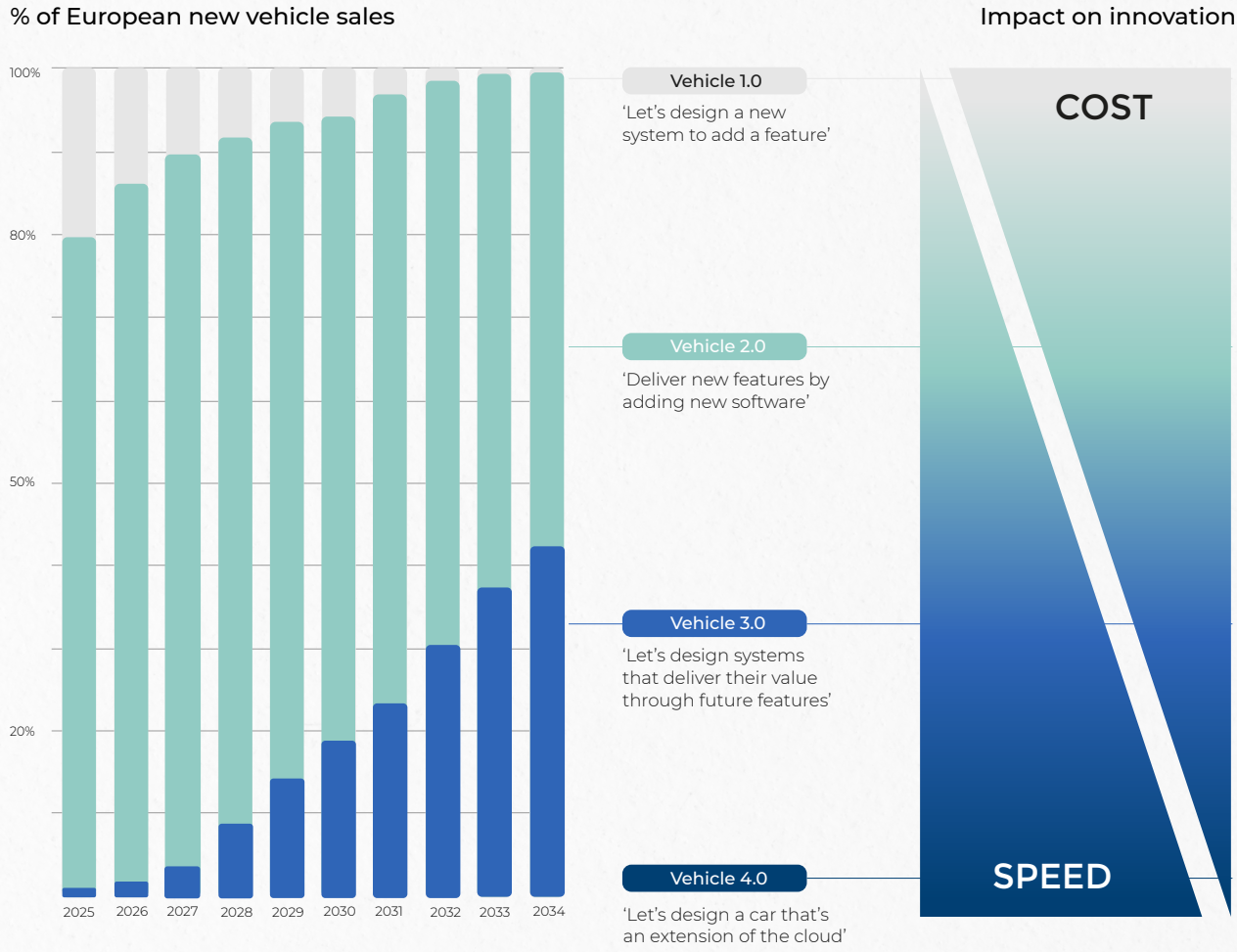
Next-Generation Architectures: Replacing distributed, hardware-bound systems with flexible, software-first platforms by centralising computing power and enabling architectures supporting seamless updates and AI-driven optimisation.

Advanced Software Development: Cloud-native development, edge computing, and AI-powered automation supported by agile workflows and continuous deployment for dynamic feature delivery.

Cybersecurity & Data Governance: Robust frameworks protecting high-volume data streams while ensuring compliance with evolving regulations like GDPR and data localisation laws.

Chart 4/ 10-year market share forecast of different levels of SDV sophistication

Data by SBD



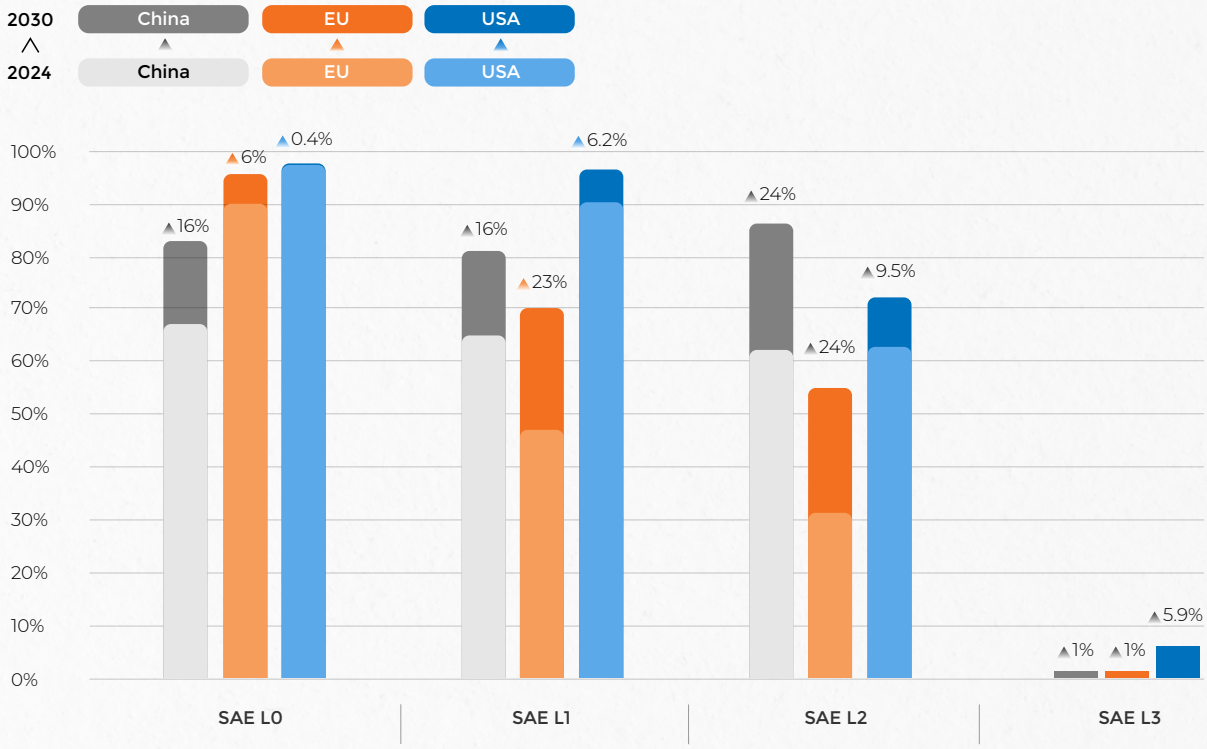
Autonomous Driving

This ambitious mobility frontier blends AI, sensors, mapping, and systems integration. Building safe, scalable autonomy depends on:

+ **AI and Perception:** High-performance neural networks, sensor fusion (LiDAR, radar, cameras, high-definition maps), and explainable AI for complex environment interpretation.
+ **Connectivity and V2X:** Ultra-low-latency data exchange through infrastructure and cloud platforms for real-time awareness between vehicles and surroundings.
+ **Regulation and Validation:** Collaboration with standards bodies, safety validation protocols, and ethical frameworks for AI decision-making.
+ **Operational Models:** Fleet deployment systems addressing remote supervision, predictive maintenance, and customer onboarding.

Chart 5/ 2030 growth forecast of Level 0-3 ADAS-enable vehicles.

Data by SBD



Advanced Manufacturing

Manufacturing is evolving into a smart, connected, data-driven system through:

+ **Advanced Robotics:** Precision-capable robots and collaborative humanoids assisting on mixed production lines, increasing flexibility and efficiency.
+ **AI-Driven Optimisation:** Real-time analytics predicting failures, fine-tuning workflows, and improving yield.
+ **Digital Twins:** Virtual modelling for testing, layout optimisation, and predictive maintenance.
+ **Industrial IoT:** Connected devices enabling monitoring, quality control, and supply chain synchronisation through unified data platforms.

Disruption 3

REIMAGINING URBAN SPACE | A New Era for City Living

Reshaping Cities Beyond Car Dependency

For over a century, mobility planning has centred on the private automobile, particularly in Europe and North America. Urban infrastructure, land use, and resource allocation have prioritised vehicle movement and storage at the expense of other transport modes and public spaces. Now, a profound shift is underway as cities expand and confront the limits of car-centric development.

By 2050, nearly 70% of the global population will live in urban areas (UN Habitat, 2022), intensifying pressure on transport systems and public space. This urbanisation trend coincides with peak car - the observed plateau or decline in per capita vehicle use across developed markets. In the UK, vehicle kilometres per capita peaked in 2002 and remain below that level despite population growth (UK Department for Transport, 2023). Similar patterns are seen in Germany, where car use per capita has stabilised since the early 2000s, and in the U.S., where vehicle miles traveled per person have largely plateaued since 2005 (German Federal Ministry of Transport, 2022; US Department of Transportation).

Cities worldwide are now reimagining mobility through integrated approaches that prioritise people over vehicles:

+ **Human-Scale Urban Design**: The "15-minute city" concept exemplified by Paris and Melbourne places essential services within walking or cycling distance, reducing transport demand and improving neighbourhood vitality.
+ **Reclaiming Public Space**: Barcelona's "superblocks" and London's Low Traffic Neighbourhoods represent systematic efforts to reallocate street space from vehicles to pedestrians, cyclists, and community uses.
+ **Strategic Densification**: Transit-oriented development in cities like Copenhagen and Singapore aligns population density with public transport networks, enabling car-free or car-light living patterns.
+ **Digital Integration**: Smart city initiatives in Seoul and Helsinki use data and connectivity to optimise transport flows and enable seamless multimodal journeys through unified planning and payment platforms.

These physical transformations are complemented by technological and service innovations. One of the most striking trends is the pronounced leadership of emerging economies in multimodal transportation adoption - surpassing many developed nations

in both pace and scale. Global mobility patterns are fundamentally reshaping, with emerging markets at the forefront of this transformative shift:

+ **Integrated MaaS Platforms**:

  Cities like Helsinki and Zurich are pioneering Mobility-as-a-Service (MaaS) systems that unify public transport, shared vehicles, and micromobility through single digital interfaces (City of Helsinki). In India, Yulu integrates shared electric bikes with mobile payments and public transport, addressing last-mile connectivity in cities like Bengaluru.

+ **Mobility Without Movement**:

  Digital connectivity is increasingly eliminating the need for physical travel. Remote work, telemedicine, and digital services are creating a parallel dimension of mobility where access to opportunities no longer requires transportation.

+ **Reimagined Public Transport**:

  Next-generation bus rapid transit (BRT) systems and on-demand public transport services are blurring the lines between public and private mobility, with cities like London and Singapore deploying dynamic routing and flexible capacity models. In Kenya, BasiGo is rolling out electric buses in Nairobi, combining sustainability with modern public transport solutions. In Rwanda, Volkswagen's mobility project in Kigali integrates ride-hailing and EV assembly to create a localized transport ecosystem.

+ **Micromobility Networks**:

  Purpose-built infrastructure for e-scooters and e-bikes is expanding rapidly, with Paris adding over 1,000 kilometres of dedicated cycling lanes and experiencing a 54% increase in cycling journeys since 2019 (City of Paris). Other global cities like Bogotá and New York have followed suit, rapidly scaling protected bike networks and integrating micromobility into broader urban mobility plans.

+ **Autonomous Transportation**:

  Controlled deployments of robotaxis and autonomous shuttles in geofenced urban areas - from Phoenix to Guangzhou - signal the emergence of new models of shared, efficient urban mobility. In Vietnam, Xanh SM, the country's first electric taxi company, is scaling rapidly across Southeast Asia, hinting at future autonomous integration.

Case Study/
Utrecht's Merwede District

Project Overview:

- Major urban regeneration project in Utrecht's Merwede district.
- Planned for approximately 12,000 residents in 6,000 homes.
- Aims to establish new benchmarks for sustainable urban development nationally and internationally.
- Transforms a 24-hectare former industrial site.
- A flagship initiative within Utrecht's broader "Healthy Urban Living" strategy.

Key Feature/ Car-Free Mobility:

- Features a radical car-free mobility concept.
- Prioritizes pedestrians and cyclists.
- Drastically limits private vehicle ownership through a low parking norm (0.3 per dwelling).
- Relies on shared mobility hubs, extensive bicycle infrastructure (21,500 parking spaces), and high-quality public transport connections.

Community and Amenities:

- Targets a diverse community through a planned housing mix:

  30% social rental units /
  25% mid-market/affordable units /
  45% private sector units

- Includes a comprehensive range of amenities within walking distance: schools, shops, healthcare, cultural, and recreational facilities.

Challenge 1

POLICY IN TRANSITION | Regulatory Evolution in a Complex World

The policy environment shaping mobility has become increasingly complex as governments balance innovation with public trust, safety, and sustainability. This creates both implementation challenges and opportunities to align industry development with societal outcomes (OECD, 2021).

Geopolitical Tensions and Trade Disruption

Global supply chains face mounting pressure from tariffs, export controls, and protectionist policies. Tariffs, for example, aren't just an added cost; they often trigger the painful process of tearing down existing supply chains and building them back up elsewhere, a monumental undertaking that can cripple businesses. This is further complicated by the accelerating trend of geo-political decoupling, as major trading blocs form, forcing nations caught in the middle to struggle to remain independently aligned.

Components and technologies that cross multiple borders before final assembly are particularly vulnerable to localized trade disruptions and political tensions. Recent developments, including the shift from NAFTA to USMCA and tightening technology export restrictions to regional manufacturing requirements, have increasingly complicated cross-border mobility strategies.

Industry Politicisation

The automotive sector increasingly finds itself at the intersection of sensitive political discussions around manufacturing jobs, supply chain security, and environmental policy. This heightened scrutiny subjects mobility companies to greater public attention, with consumers increasingly making purchasing decisions influenced by their values and affiliations.

Climate and Regulatory Divergence

Climate-related regulation varies significantly across markets. While the EU mandates strict emissions deadlines and vehicle electrification targets, other jurisdictions favour more gradual, market-driven approaches. This regulatory divergence creates friction around incompatible standards for emissions, autonomy, and charging infrastructure, challenging efforts to scale innovation globally.

Debt and Demographics

Governmental debt, already crushing after the Great Recession and amplified by pandemic-era spending, is making it much harder for nations to invest in the critical infrastructure, education, and innovation necessary for future growth. Compounding this challenge are ageing demographics across many advanced and even some developing economies. As populations age and birth rates decline, workforces shrink, placing immense strain on social security and healthcare systems. This demographic shift further complicates growth opportunities and creates significant economic distortions, as consumption patterns change, labor shortages emerge, and public finances face unsustainable pressures, all impacting the global flow of goods and services.

Data Governance and Digital Regulation

Connected vehicles and mobility platforms face an increasingly stringent digital regulatory landscape. The European Union's General Data Protection Regulation (GDPR) and China's vehicle data localization laws require organizations to implement region-specific compliance frameworks to manage personal and mobility-related data securely and lawfully (European Union, 2016; Cyberspace Administration of China, 2021). With more stringent data definitions emerging, manufacturers and service providers struggle to balance data utilisation with compliance requirements and consumer trust.

The fundamental questions of who owns and controls vehicle-generated data-whether driver, platform, manufacturer or regulator-remain largely unresolved, creating uncertainty for service commercialisation, service delivery, and long-term platform strategy.

The Challenge of Policy Unpredictability

Since 2015, policy volatility has remained persistently high, compounded by global crises from pandemics to trade wars and regional conflicts. In many cases, it is not regulation itself but its unpredictability that poses the greatest challenge. Frequent policy shifts undermine investments made under earlier assumptions and limit the ability to plan with confidence.

Evolution Toward Outcome-Based Regulation

Amid regulatory tightening, mobility governance is evolving from narrow vehicle standards to comprehensive frameworks addressing broader system outcomes:

+ **Multi-Stakeholder Approaches:** Regulatory development increasingly involves collaboration between government, industry, and community stakeholders-including disability advocates, environmental groups, and vulnerable road user representatives. This collaborative approach helps ensure innovation addresses societal needs rather than merely advancing technical capabilities.
+ **Safety as Public Health:** Mobility safety is increasingly treated as a public health challenge rather than merely a technical compliance issue. Vision Zero policies are reshaping how safety is measured and prioritised (World Health Organization, 2021).
+ **Standardised Data Exchange:** Common frameworks for mobility data sharing are emerging to facilitate everything from kerb management to transportation system oversight, enabling collaboration through standardized protocols while addressing data protection concerns (NACTO, 2019).
+ **Climate and VMT Frameworks:** Beyond emissions standards, regulatory structures now address vehicle miles traveled (VMT) reduction, urban transport integration, and broader climate impacts. These frameworks represent a shift from component-level regulation to system-level outcomes.

The shared challenge for regulators and industry stakeholders is building governance systems that adapt to rapidly evolving technology while maintaining flexible and consistent frameworks (Docherty et al., 2018). Success depends on approaches that balance innovation with predictability for safety, sustainability, and equity (World Economic Forum, 2020).

MANAGING DISRUPTION

The Need for a New Framework

For generations, the automotive industry has driven economic growth and social connection, but the transformation underway is structural, global and accelerating. Despite unprecedented innovation, much of the industry still relies on outdated benchmarks that no longer reflect what truly matters to consumers or society.

What's missing isn't technology-it's alignment. Without a shared understanding of value, billions risk being misallocated in pursuit of features and capabilities that fail to address evolving needs. Industries like digital finance and renewable energy have advanced by establishing common frameworks, now mobility must do the same.

Our analysis reveals four critical challenges holding the industry back from maintaining its economic and societal relevance:

Challenge 1

CONSUMER DISCONNECTION

Legacy development models remain oriented around vehicles rather than the people who use them, creating a disconnect between innovation and actual needs. In today's environment of evolving preferences and increasing multimodality, success demands a shift from a product-first mindset to strategies aligned with comprehensive mobility experiences.

Key barriers include:

+ Strategic decisions occurring far from consumer interactions, creating blind spots.
+ Innovations reflecting technical possibilities rather than consumer priorities.
+ A vehicle-centric lens that overlooks broader mobility journeys.

Challenge 2

OUTPUT-FOCUSED METRICS

Traditional metrics like sales volume or feature counts offer limited insight into satisfaction, usability, or long-term engagement. An outcome-centric approach aligns innovation with what truly delivers value across consumer, societal, and environmental dimensions.

Key barriers include:

+ Volume-focused measurements failing to capture quality of experience.
+ Lack of shared success metrics causing divergent priorities across teams.
+ Fragmented data obscuring how features perform in real-world contexts.

Challenge 3

REACTIVE DECISION-MAKING

As the industry shifts from hardware-driven engineering to software-defined platforms, legacy governance systems face growing strain. Organisations risk either slowing under complexity or acting without strategic clarity.

Key barriers include:

+ Cross-functional teams with divergent priorities struggling with shared workflows.
+ Balancing profitable legacy products with investment in emerging technologies.
+ Increasing complexity pushing teams into reactive rather than strategic modes.

Challenge 4

OUTDATED COLLABORATION MODELS

While the need for collaboration is widely recognised, current models often fall short of the complexity and speed demanded by next-generation mobility.

Key barriers include:

+ A rapidly expanding ecosystem creating new coordination challenges.
+ Service-based business models requiring new approaches to risk-sharing.
+ Tensions between intellectual property protection and open innovation.

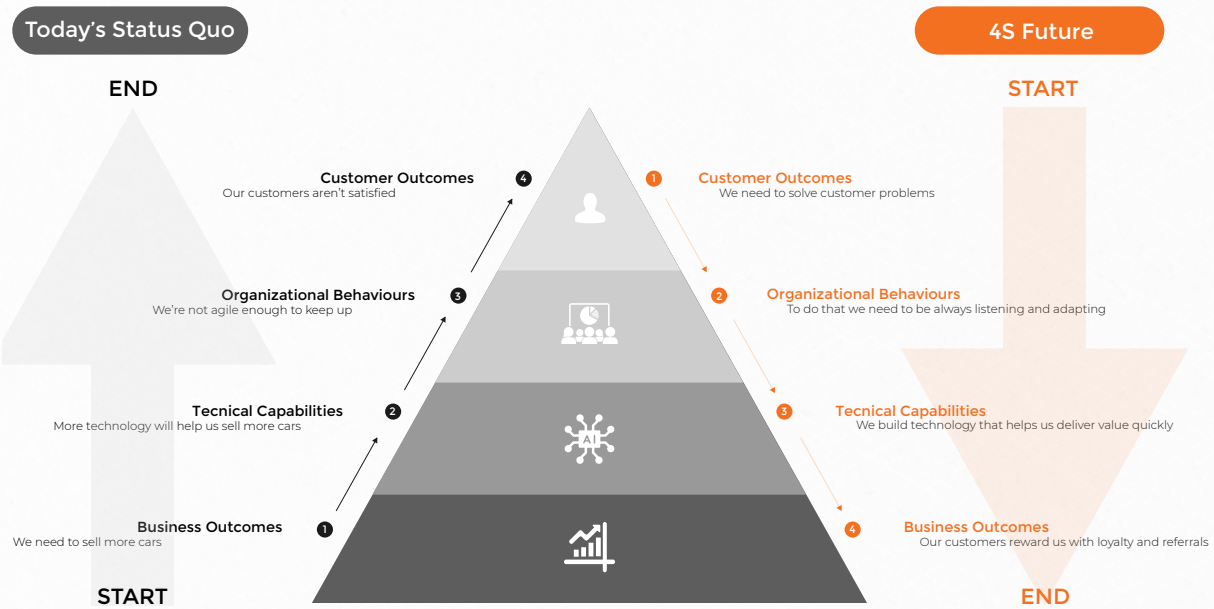
The scale and speed of these challenges demands a fundamentally new approach-one that can align stakeholders around a shared vision while providing practical tools for transformation.

THE 4S FRAMEWORK

A Blueprint for Transformation

In response to these challenges, the 4S Framework provides a practical guide for rethinking how decisions are made, grounded in consumer needs and future mobility outcomes that are resilient and responsive to emerging challenges. The framework focuses on aligning internal strategy and metrics with the core goals of safety, security, seamless experience, and sustainability.

Graphic 1/ The 4S Framework calls for a shift in mindset across four dimensions



STARTING WITH CONSUMER NEEDS

> *"Technology is no longer the main barrier holding back the industry – it's building it in a way that resonates with vehicle owners and travelers, solving real problems along the way."*
>
> *Ozgur Tohumcu*

Traditional automotive models designed around vehicles rather than people can create blind spots that lead to reactive decision-making, overcomplicated features, and shrinking profitability. To remain competitive, companies must shift to a mobility-first approach centred on how people experience movement.

A successful shift requires putting consumers at the center of every decision. This means:

+ **Shared Principles:** Align teams and partners on a clear consumer-first framework (e.g. the 4S Mobility Principles) that guides every decision.
+ **Real-Time Insights:** Use connected data and continuous feedback to track evolving consumer needs in the real world and inform timely, relevant innovation.
+ **Universal Design:** Ensure mobility solutions are inclusive by design, enabling safe, secure, sustainable, and seamless access for users of all abilities.
+ **Journey-Centric Approach:** Optimize for the entire mobility experience, not just the features and the car itself.
+ **Personalization:** Deliver tailored mobility solutions that adapt to individual lifestyles, life stages and shifting expectations.
+ **Co-Creation:** Involve consumers in the design and innovation process, not just as end users, to shape what gets built and why.

Embedding these principles builds stronger relationships, drives smarter investment, and creates solutions that deliver both commercial and societal returns.

MEASURING MOBILITY OUTCOMES

> *"When technology truly works, customers don't notice it - they just experience safe, secure, sustainable, and seamless mobility."*
>
> *Håkan Samuelsson*
>
> *"Our data tells a clear and consistent story: consumers reward mobility that is safe, secure, sustainable, and seamless."*
>
> *Steve Bell*

Traditional metrics like sales volume or feature counts offer limited insight into what creates real value. An outcome-centric approach aligns innovation with satisfaction, competitiveness, and broader impact.

This means shifting from outputs to measuring what counts to support better decisions across the ecosystem:

+ **Balanced Outcomes**: Design for both emotional connection and functional performance. Hedonic and pragmatic outcomes together drive loyalty and impact.
+ **Collaborative Success Definitions**: Co-create outcome goals with cross-functional teams and consumers to ensure alignment between internal initiatives and real-world needs.
+ **Feature-to-Outcome Mapping**: Tie features and services directly to the outcomes they are meant to deliver, using tools like the 4S Global Mobility Survey to track relevance.
+ **Live Tracking and Feedback**: Use real-time data from connected vehicles, apps, and consumer feedback to measure impact and refine offerings dynamically.

By embedding outcome-based metrics, organisations can ensure that innovation consistently supports measurable returns across consumer, societal, and environmental dimensions.

PROACTIVE DECISION-MAKING

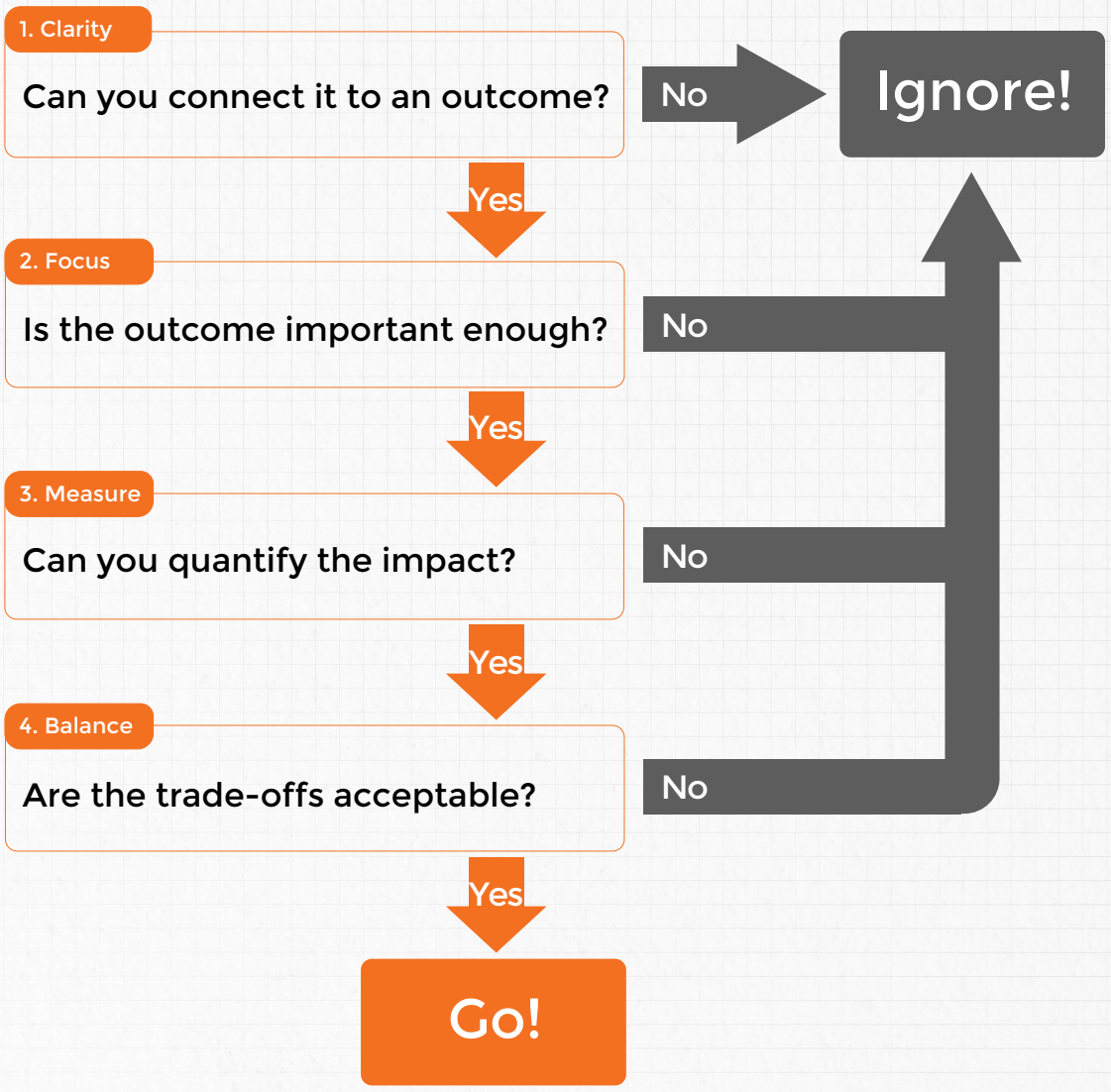
> *"The technology behind autonomous vehicles is no longer the limiting factor - it's here, it's proven, and it's ready. What comes next is adoption, and that means putting people at the heart of the journey. Projects like evolvAD are vital because they don't just test the tech-they test how it fits into real communities across. If we want autonomous vehicles to be seen, trusted, and used, we must work hand-in-hand with the public to ensure these innovations meet their needs, earn their confidence, and enhance their everyday lives."*
>
> *Bob Bateman*

> *"Location intelligence must be more than delivering precision - it must create trust that it will help deliver safe, secure, sustainable and seamless mobility."*
>
> *Mike Nefkens*

Reactive decision-making must evolve into proactive, outcome-focused decision systems guiding commitments towards initiatives with clear, valuable, and achievable outcomes through four critical evaluation stages:

+ **Clarity:** The first stage assesses whether a proposed action or idea links directly to a specific, tangible outcome. If this clarity cannot be established, the decision is to not proceed, preventing wasted effort on ill-defined objectives.
+ **Focus:** Assuming a clear outcome, the next stage assesses its strategic importance. This stage ensures resources and attention are primarily directed towards objectives that significantly contribute to core goals, filtering out initiatives with lesser strategic impact.
+ **Measure:** The third stage assesses whether the potential impact of the outcome, and progress towards it, can be effectively quantified. Measurability is essential for ongoing informed decision-making and objective evaluation; its absence should lead to reconsidering the initiative.
+ **Balance:** Finally, the decision involves carefully weighing the anticipated benefits against all inherent trade-offs. A "go" decision at this stage requires a compelling value proposition where benefits clearly justify the costs and compromises.

Graphic 2/



Applying these four stages enables organizations to more effectively identify and prioritize worthwhile opportunities. They are also integral to align strategic goals with key decisions, necessary insights, and measurable outcomes. They foster adaptive planning through scenario-based approaches, allowing teams to pivot as new information arises. Effective frameworks replace a "launch and forget" mentality with ongoing lifecycle reviews of performance and impact, normalizing iteration and constructive course correction as intelligent responses to change. Furthermore, they incorporate stakeholder-aware design, anticipating the needs of consumers, partners, and regulatory bodies. By implementing these integrated practices, organizations can consistently deliver value and maintain crucial adaptability in the face of evolving needs and technologies.

ECOSYSTEM-WIDE COLLABORATION

> *"The next great improvement in mobility outcomes will come from breaking down the silos that have traditionally held back organizations and teams from working together."*
>
> *Jessica Rosenworcel*

The future of mobility demands partnerships that span traditional boundaries. As transportation becomes more digital, distributed, and service-led, collaboration must evolve in scale, scope, and structure.

Success depends on partnerships that are intentional, structured, and dynamic:

+ **Requests for Outcomes**: Replace prescriptive RFPs with goal-based briefs that invite partners to co-develop solutions. Disruptors, especially in China, are leading this approach, accelerating innovation and shared accountability.
+ **Live Co-Creation Platforms**: Use emerging tools like AI and digital twins to support real-time iteration across stakeholder groups.
+ **Expanded Networks**: Establish inclusive platforms that bring together diverse participants from automakers to urban planners and community groups.
+ **Open Source Collaboration**: Scale innovation by sharing non-competitive assets across traditional boundaries.

Together, these four dimensions of the 4S Framework enable organisations to deliver mobility solutions that are resilient, relevant, and inclusive, creating value for businesses, users, and society.

Case Study/

4S Mobility in Action

Organized by:

4S Mobility | Future Mobility Board

Supported by:

ELM MOBILITY
CATAPULT Connected Places
Centre for Connected & Autonomous Vehicles
CENSUS Cybersecurity Engineering
CONJURE
Motability Foundation
Coventry University
DIGITALDEALERSHIP
HALLMARK ENGINEERING GROUP
informa
JLR
ntdc national transport design centre
ncat
Osborne Clarke
RiDC
NISSAN
RNIB See differently
Royal College of Art
SMMT DRIVING THE MOTOR INDUSTRY
SBD
SENTION
SILVERPEAK
TRL
IP asset PARTNERSHIP
SODA Software Defined Auto

The Challenge

The Problem:

The nascent autonomous vehicle (AV) industry currently lacks standardized, universally accessible user experiences. This poses significant risks for inconsistent adoption, potential safety concerns, and exclusion of diverse user groups, particularly those with specific needs.

Our Objective:

To proactively define the critical elements for an optimal, inclusive, and universally accessible autonomous vehicle user experience, ensuring AVs serve the broadest possible population from their launch.

Our Approach: The Collaborative Workshop

Methodology:

A focused, multi-stakeholder design thinking workshop.

Location:

Smart Mobility Living Lab, London – a state-of-the-art facility conducive to innovation and collaboration.

Process:

+ User-Centric Deep Dive: Focused on understanding diverse user needs, pain points, and aspirations related to autonomous mobility.

+ Structured Ideation: Employed proven design thinking techniques to generate a broad spectrum of ideas and solutions.

+ Collaborative Synthesis: Facilitated cross-sector discussions to synthesize insights and prioritize key requirements.

Key Stakeholders: The Power of Diverse Expertise

Participants: 38 highly engaged attendees.

Organizational Breadth:

Representing 25 leading organizations.

Multi-Sectoral Representation:

Spanning 5 critical sectors within the mobility ecosystem. This diverse representation ensured a holistic understanding of the challenges and opportunities.

Key Results & Achievements

Comprehensive Insights:

Generated a remarkable *262 distinct ideas and identified critical user needs*, forming a robust and detailed foundation for future design and development.

Measurable Success Metrics:

Established *21 foundational Key Performance Indicators (KPIs)*, providing concrete metrics for evaluating the accessibility, safety, comfort, and overall user satisfaction of autonomous vehicle experiences.

Consortium Formation for Action:

Successfully identified and initiated the formation of a dedicated consortium for a pivotal project proposal: *"Co-created Universal Design Requirements for Autonomous Vehicles."* This marks a significant step from ideation to actionable implementation.

Proven Collaborative Model:

Demonstrated the immense value and feasibility of a multi-stakeholder, collaborative approach in addressing complex, cross-cutting challenges in the autonomous mobility sector.

CONCLUSION

Joining the 4S Mobility Initiative

The 4S Framework represents a new vision for mobility transformation that requires collective action from across the ecosystem. While SBD has developed this initial blueprint in collaboration with founding partners, bringing it to life demands collaboration, co-investment, and shared commitment to creating mobility systems that are Safe, Secure, Sustainable and Seamless.

BRINGING 4S TO LIFE | A Call for Partners

SBD is launching the 4S Mobility Initiative as a non-profit endeavour to catalyse industry-wide transformation. We invite stakeholders to join this movement through multiple pathways:

Core Team

Become a core team of the 4S Consortium by contributing financial resources, expertise, and organisational commitment to developing shared metrics and implementation frameworks.

Project Partners

Participate in cross-sector pilots to test, refine, and validate 4S metrics in real-world contexts, helping establish industry standards that drive meaningful outcomes.

4S Membership Community

Join our emerging community of leaders with access to exclusive research, events, and peer networking focused on leveraging 4S principles within organisations.

Integration Support

Work with SBD's experts to integrate 4S thinking into your leadership teams, decision-making processes, and strategic planning cycles.

CREATING VALUE THROUGH COLLABORATION

The 4S Mobility Initiative represents both an opportunity to reshape mobility for the better and a practical pathway to competitive advantage across the ecosystem:

Vehicle Manufacturers & Suppliers

+ Define next-generation metrics that align with genuine consumer needs rather than following outdated benchmarks.
+ Gain early market insights through collaborative research and shared learning across the mobility landscape.
+ Position at the forefront of consumer-centric mobility by actively engaging in the development of industry-leading standards.

Government & Policymakers

+ Shape emerging mobility metrics by ensuring public sector perspectives are incorporated into framework development.
+ Access industry pilot insights to inform policy decisions and infrastructure investments with real-world implementation data.
+ Build relationships with innovators committed to sustainable, inclusive mobility solutions that benefit urban environments.

Technology & Platform Providers

+ Co-create assessment frameworks that validate solutions against meaningful mobility outcomes that matter to users and communities.
+ Build strategic connections with established industry players through structured collaboration opportunities.
+ Demonstrate commitment to responsible innovation through participation in an industry-leading initiative focused on sustainable growth.

Research & Policy Organizations

+ Contribute research-based perspectives to validate 4S metrics and methodologies.
+ Translate findings into policy guidance, helping bridge implementation insights with regulatory and governance frameworks.

International Organizations & Civil Society

+ Leverage 4S to foster dialogue and collaboration with private sector innovators and contribute global perspectives to the 4S Framework.

TAKING ACTION

The 4S Mobility Initiative offers multiple ways to engage

Support the development of shared frameworks and metrics through financial contributions to the non-profit 4S Mobility Initiative.

Become a Donor

Register for membership in the 4S knowledge community for access to research, events, and peer connections.

Join the Community

Facilitate the integration of 4S principles within your organization's decision frameworks and strategic processes.

Commission 4S Integration

Contribute to ongoing 4S research programmes exploring consumer needs, emerging technologies, and implementation case studies.

Participate in Research

The time for transformation is now. By joining the 4S Mobility Initiative, you not only position your organisation at the forefront of change - you help shape a mobility future that delivers genuine value for users, communities, and the planet.

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4smobility.com

Contact us today to discuss how you can participate in this groundbreaking initiative.

Find out more | Request a briefing | Join the 4S Group

Remember to share this study with colleagues

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