An EV Market Pandemonium: Navigating the Supply Chain Disruptions

VoltDrive Motors

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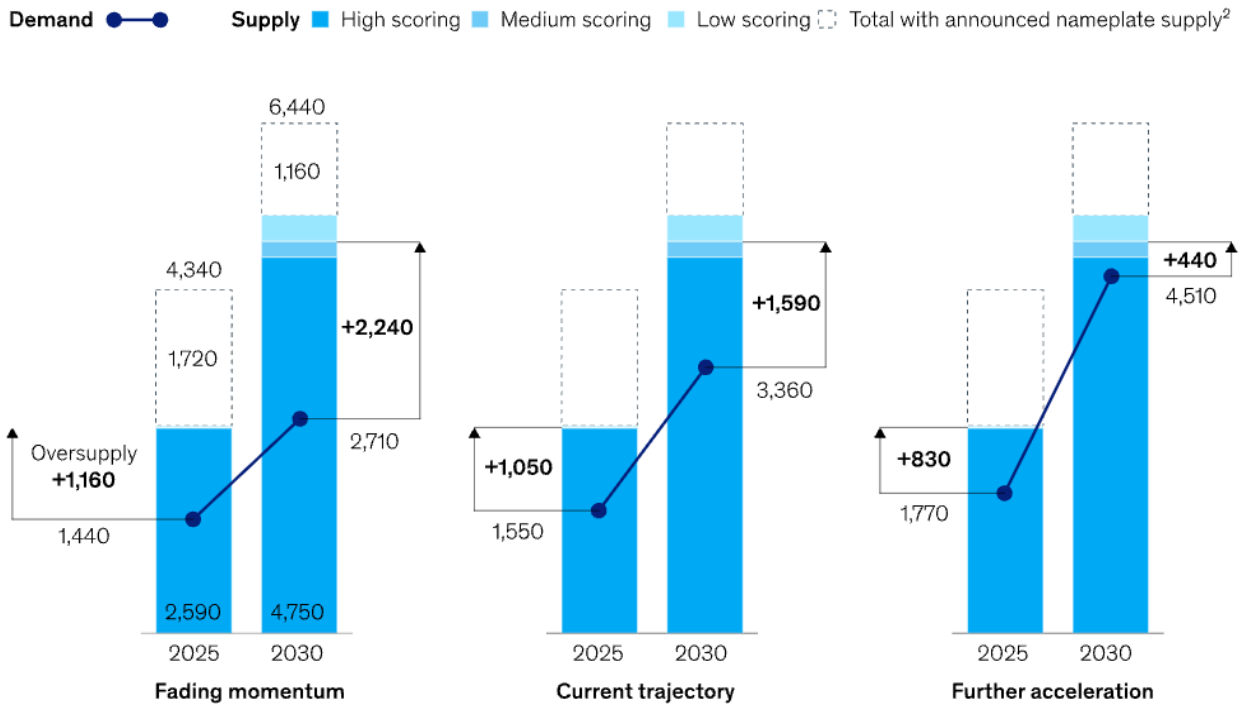
Context

Objectives

- We were hired by VoltDrive to fix a supply-side battery and semiconductor shortage, as well as strengthen their position among competitors
- Our work focuses on 5 main issues
  - Supply chain diversification
  - Competitive positioning
  - Sustainability and ESG
  - Risk management
  - Customer impact

Global Lithium-Ion Battery Supply

- Net global supply is far outpacing demand, as battery makers expand to accommodate the upcoming advance in EV demand
- Innovations in energy density and mass production are bringing the price-per-KWh down to $100/KWh by 2025 and $50/KWh by 2030



¹A scoring system evaluates likelihood of realization based on a set of factors, including company experience, intellectual property, revenue streams, and offtake plans.
²All announcements, including plants that are operational, under construction, and in early and advanced planning stage.
Source: Consumer Electronics 2025 © 2025 Euromonitor International Limited, all rights reserved; Light Vehicle Production Forecast, S&P Global Mobility, Apr 4, 2025; McKinsey Battery Insights; McKinsey Energy Storage Insights; vehicle specifications per McKinsey analysis

https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/the-hidden-trends-in-battery-supply-and-demand-a-regional-analysis

Price Forecasts

- Battery prices are continually dropping
- Expecting price per KWh to drop below $80 in China and $100 for the rest of the world
- Price parity across gas-powered vehicles will soon be achieved
  - Forecasting an exponential increase in demand as middle-income and lower-income consumers switch over to electric
  - European EV market set to grow 68% this year, with BEVs expected to grow the most

Supply Chain Diversification

Regional Diversification

- Problem: 70% of batteries sourced from a single Asian supplier → major production bottleneck
- Strategy: Onboard additional battery suppliers in Europe, North America, and Asia (at least 2 suppliers per region)
- Benefits
  - Reduces reliance on a single supplier
  - Lowers environmental and geopolitical risk
  - Shortens lead times, decreases shipping delays, and mitigates logistics disruptions
  - Provides flexibility to shift orders between suppliers based on capacity and reliability
- Implementation
  - Start with smaller volume contracts to test quality and reliability
  - Establish criteria for supplier selection: quality, ESG compliance, capacity, and proximity
  - Develop a regional supplier matrix to align sourcing with target markets
- Key takeaway: Geographic and multi-supplier diversification creates a resilient supply chain and ensures more predictable production schedules

New Lithium-Ion Battery Suppliers

- Northvolt (Sweden)
  - Circular economy focus with low-carbon footprint and battery recycling initiatives
  - Primary European supplier; near-market proximity reduces lead times and logistics, minimized environmental costs
  - Newer European player; production ramp-up may be slower than established suppliers
  - Higher cost base compared to Asian suppliers due to European labor and regulatory/environment
- Lithion Battery (North America)
  - Builds full-stack battery systems with in-house engineering, design, and testing for use-cases
  - Independent of major EV OEM-joint-ventures, giving VoltDrive more flexibility in negotiations and less competition for allocation
  - Capability to produce custom cells/packs means VoltDrive could specify chemistries/form-factors aligned with its battery innovation strategy
  - Ensure volume scale + automotive-grade cell validation meet VoltDrive EV production demands
  - Verify that chemistry, form-factor and quality (e.g., automotive-grade, high cycle life, safety) match VoltDrive's battery architecture

New Semiconductor Suppliers

- Taiwan Manufacturing Semiconductor Company (TMSC)
  - Manufactures high-performance automotive semiconductors with proven quality
  - Acts as global backup for critical semiconductor supply
  - Highly competitive allocation, so lead times must be carefully managed
- Infineon Technologies
  - Provides microcontrollers, power semiconductors, and sensors for EVs
  - Regional manufacturing facilities ensure timely delivery
  - Primary semiconductor partner for European operations; reduces import risk
- ON Semiconductor Corporation
  - Vertical production chain
  - Having supplier with broad manufacturing footprint mitigates risk of single-site disruption
  - VoltDrive must monitor lead-times, certification (automotive grade), and compatibility of modules with VoltDrive's specific powertrain architecture (e.g., voltage level, cooling, and form-factor)

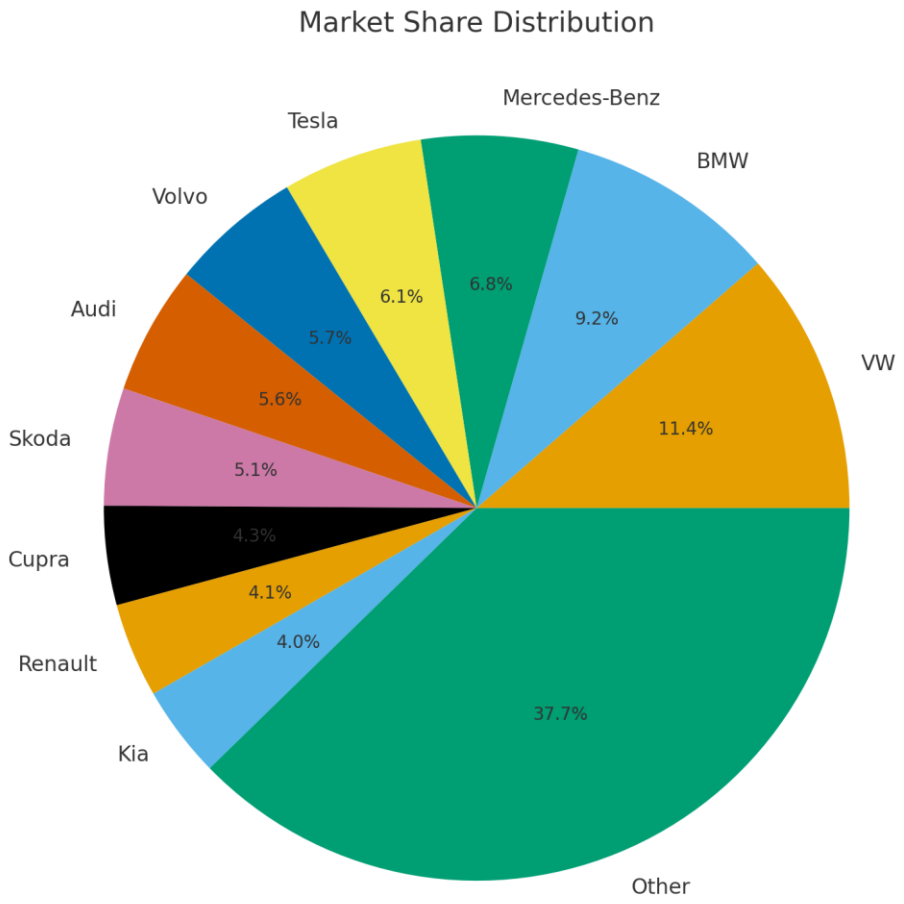
Strategic Partnerships/Joint Ventures

- Battery Joint Ventures
  - Form co-investment agreements with battery manufacturers, sharing VoltDrive's proprietary battery IP in exchange for dedicated production lines
  - Secures guaranteed supply, stabilizes costs, enables faster innovation, and accelerates production to meet backlog and demand spikes
- Chip Consortiums
  - Collaborate with semiconductor firms to design EV-optimized chips
- Vertical Integration (Long Term)
  - Invest in partial ownership of raw material supply (e.g., lithium or nickel mines) or recycling facilities to build a closed-loop ecosystem
  - Controlling resilience through price cycles, stronger margins, better strategic value for future partners/investors

Competitive Positioning

European EV Market Competitors

- Volkswagen
- BMW
- Mercades-Benz
- Tesla
- Volvo
- Audi

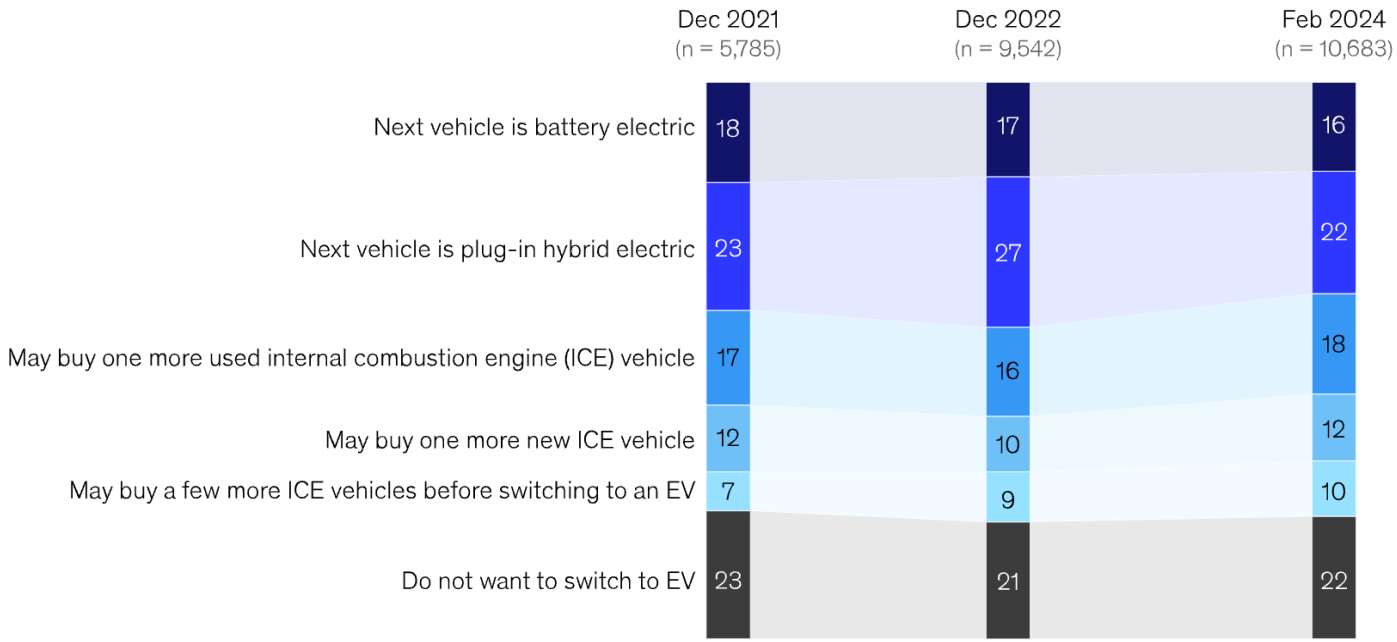


Market Trends

- Decrease in tax credit has led to decreased revenues in North America (expired Sept. 30, 2025)
- Reduction in European company subsidies and policy reversals, resulting in less production; may be a good time to expand and take market share
- Consumers are more willing to buy EVs with faster charging rates, many cite charging as their number 1 concern. Polls emphasize universality, availability, and speed
- Consumers are willing to accept longer wait times, up to 12 weeks, for custom, 'build-to-order' cars, reducing the effect of our backlog
- Majority of consumers in both Europe and North America cite quality as their main concern

European EV Preference

Powertrain considerations for next vehicle purchase, % of European non-EV[1] owner respondents



[1]Electric vehicle.
Source: McKinsey Mobility Consumer Pulse Surveys

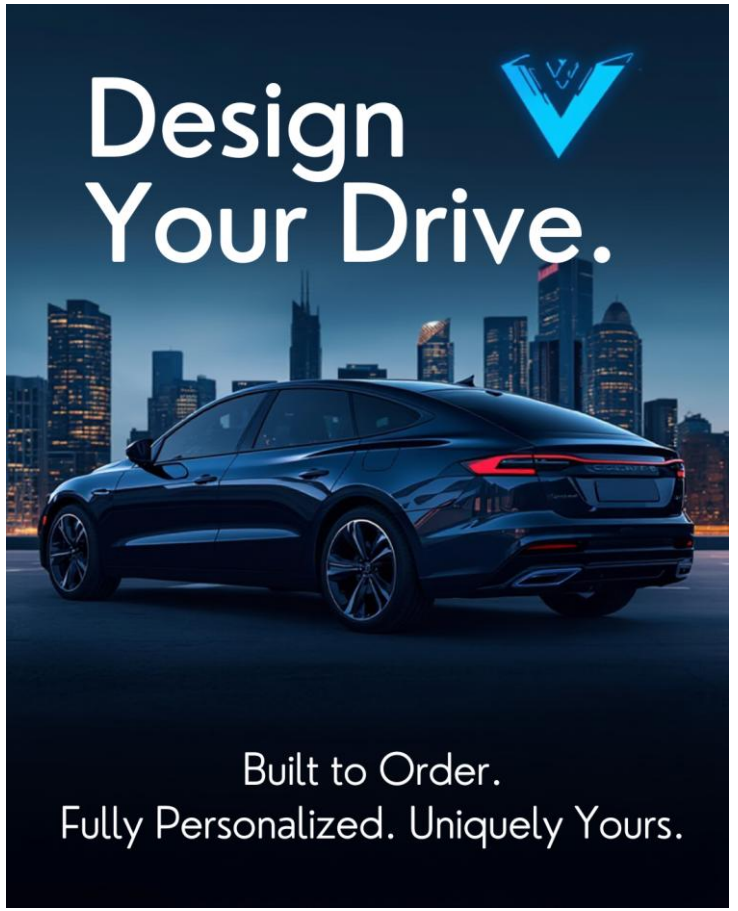
McKinsey & Company

Customization Campaign

- VoltDrive should focus on customization, quality, and customer satisfaction to further specialize in the luxury market
- Higher quality demands higher prices
  - Consumers are willing to pay more for perceived quality increases in safety, fuel efficiency, and technological advances
- Social media is more important than ever: 36% of EV consumers were influenced by digital news and social platforms
- VoltDrive's innovative battery technology is key to increasing market share; **quality** will make customers "switch over"
- Adding new features to our current EVs, publicize our enhanced technology to make our EVs more custom-tailored

Mockup Social Media Post

- Two ad mockups emphasizing innovation and customization
- Customer polls show 55% agree that quality is no longer tied to brand name, making now the perfect time to gain market share



ESG & Sustainability

Environmental Impact

Mining & Purification

Emissions and environmental damage from mining account for 30% of our total impact. Main sources are land clearance and mineral purification

Our suppliers demand local mineral sources, further reducing emissions

Battery Supplier

Our diversified suppliers will be held to heightened emissions standards

Semiconductor Supplier

Shipping emissions will be minimized by utilizing localized suppliers

Manufacturing

Being 100% devoted to renewable energy sources can reduce our impact even further

Environmental Impact

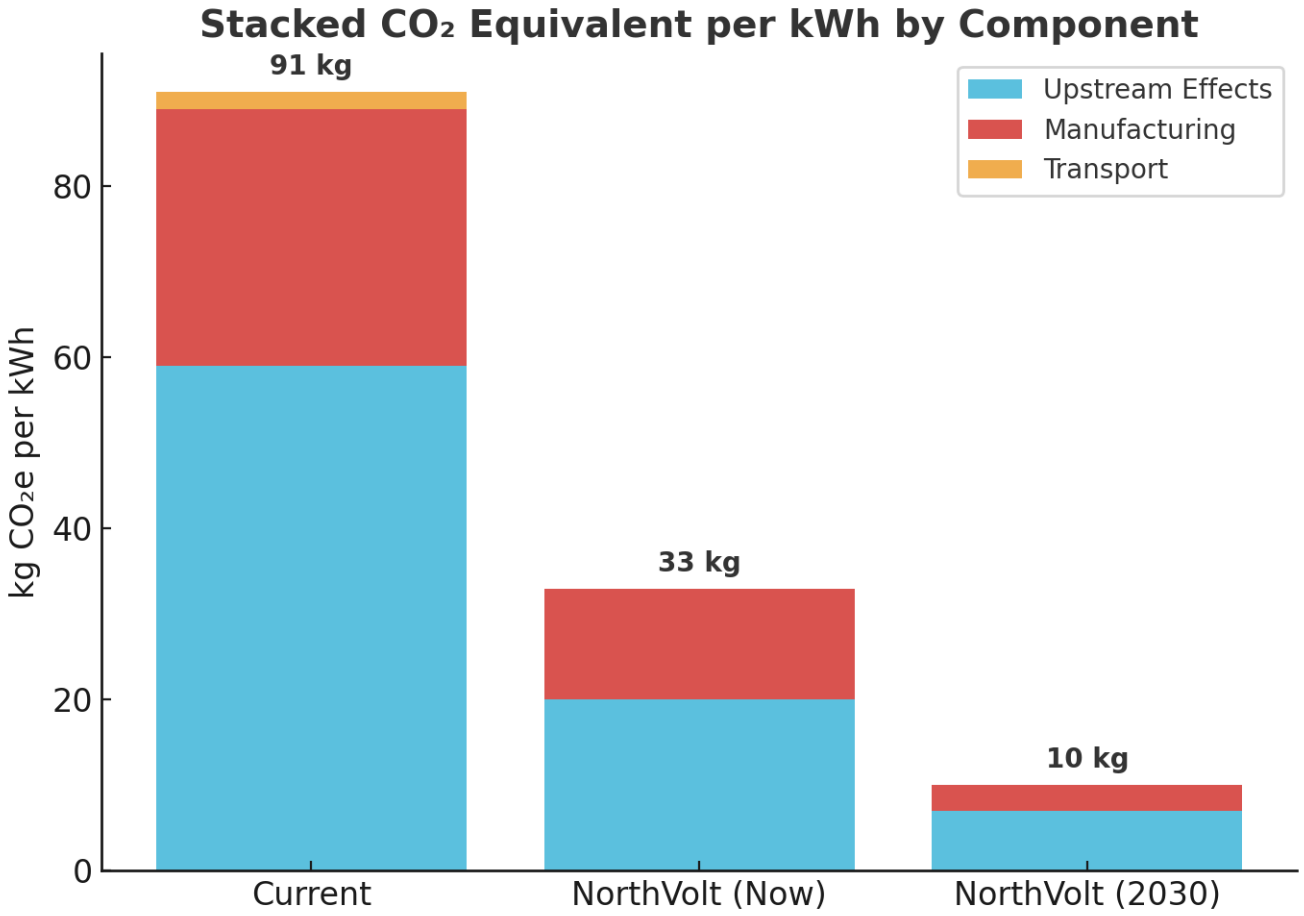
In-House Manufacturing

Mining & Purification		Manufacturing
Emissions and environmental damage from mining account for 30% of our total impact. Impact will be reduced by purchasing from IRMA certified mines	Cutting out the battery manufacturer middleman will nearly halve our shipping emissions, as battery delivery is no longer necessary.	By purchasing directly from mineral plants, we gain more control over their ethical and environmental standards.

Northvolt: Case Study

By sourcing our batteries from local suppliers, we also reduce materials transport emissions, constituting an estimated 2 kg per KWh

Current CO2 equivalent value is 89 kg per KWh, with 59 kg per KWh from upstream effects.



Northvolt and similar companies have a CO2 equivalent of 33 kg per KWh, a decrease of 63%. They aim to decrease this to 10 kg/KWh by 2030

Environmental Impact: Semiconductors

- Small global production share in Europe by about 8-10 percent
- Specific chemicals and gases used to manufacture semiconductors are restricted under F-gas regulations and PFAS bans
- Breakthrough: New development in synthetic diamond semiconductors, which minimize the manufacturing process
  - Provide strong thermal and electrical performance for EVs
  - High versatility, can be used in other EV features such as longer vehicle range, faster charging, and extended battery life

Navigating Supply Chain Disruptions:
Emissions & Environmental Impact

- Political/economic considerations may prevent us from buying from certain suppliers
- If our primary, sustainable suppliers are unavailable, we may be forced to buy from secondary, dirtier suppliers:
  - To mitigate emissions, we will demand traceability and due diligence from **all** suppliers. Effective CO2 per KWh must be below 50 kg
  - Supply-side emissions will be outlined in our partnerships. Proprietary Li+ technology will reduce net emissions through increased efficiency, a benefit borne by both us and our suppliers. Increased efficiency will reduce the effect of a supply shock

Navigating Supply Chain Disruptions:
Social Impact

- Buying from IRMA 100-certified mines and suppliers will minimize our social impact: TFM in the DRC is currently undergoing an audit and expects certification by the end of the month
- Nickel, Lithium, and Cobalt mining are less volatile and prone to fewer abuses:
  - We will demand traceability and IRMA certification from all suppliers

Risk Management

Objectives

1. Ensure continuity of production
2. Reduce supply chain vulnerability
3. Maintain financial stability
4. Minimize customer delays and protect brand reputation
5. Build long-term supply chain flexibility

Risk Identification

Supply

- Lithium-ion battery and semiconductor shortages
- Single-source dependency
- Tier-2/3 supplier instability

Operational

- Production line shutdowns
- Lead time disruptions
- Logistics delays

Financial

- Rising battery and chip prices
- Working capital increases
- Emergency sourcing premiums

Geopolitical and Regulatory

- Trade tensions
- Export restrictions
- New EU sustainability or localization requirements

Competitive

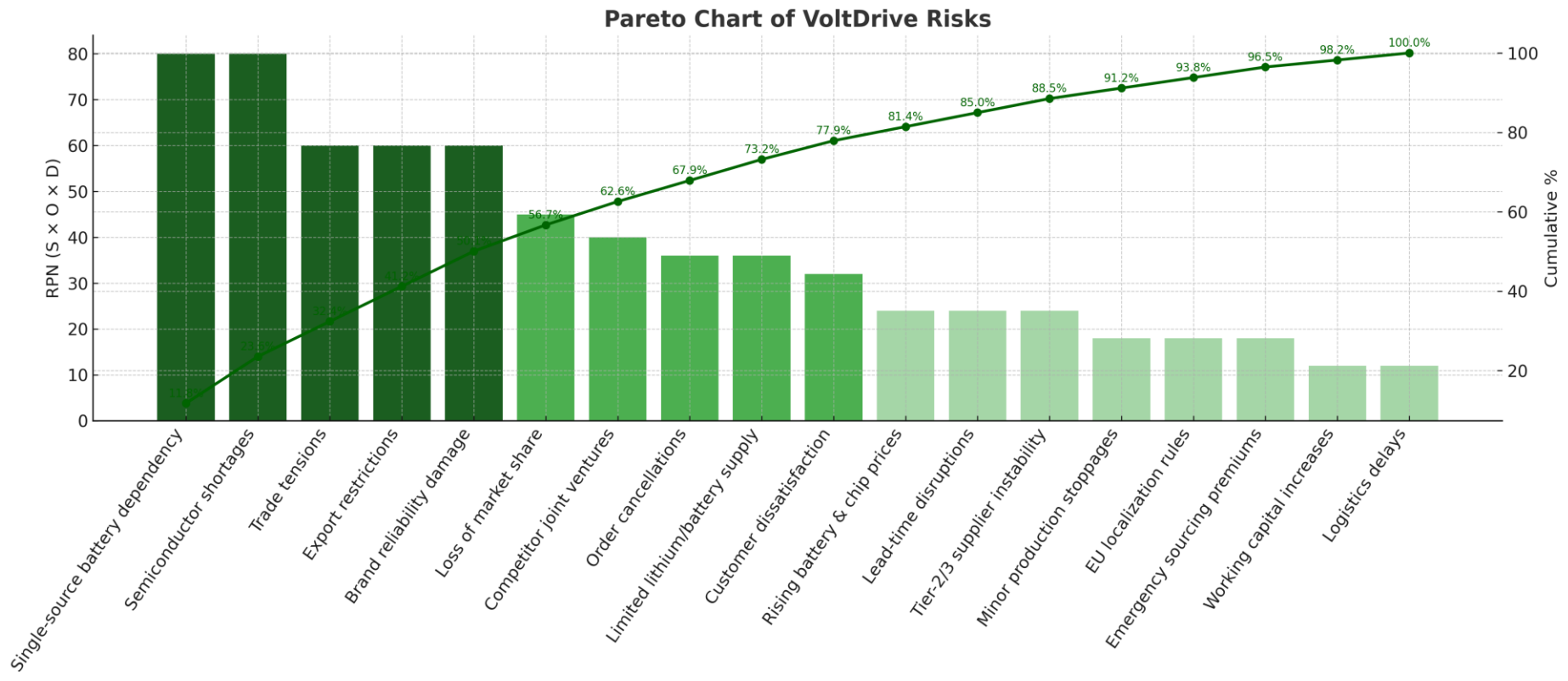
- Competitor joint ventures
- Loss of market share

Customer

- Customer dissatisfaction
- Order cancellations
- Brand reliability damage

Risk Assessment

RPN = Severity × Occurrence × Detection; Higher bars indicate higher priority risks



Risk Assessment

Risk	Severity (S)	Occurrence (O)	Detection (D)	RPN (S×O×D)
Single-source battery dependency	5	4	4	80
Semiconductor shortages	5	4	4	80
Trade tensions	5	3	4	60
Export restrictions	5	3	4	60
Brand reliability damage	5	3	4	60
Loss of market share	5	3	3	45
Competitor joint ventures	5	4	2	40
Order cancellations	4	3	3	36
Limited lithium/battery supply	4	3	3	36
Customer dissatisfaction	4	4	2	32
Rising battery & chip prices	3	4	2	24
Lead-time disruptions	3	4	2	24
Tier-2/3 supplier instability	3	2	4	24
Minor production stoppages	3	3	2	18
EU localization rules	3	3	2	18
Emergency sourcing premiums	3	2	3	18
Working capital increases	2	3	2	12
Logistics delays	2	3	2	12

Risk Response Development

Purpose	Governance (COSO ERM)	Execution (SCRM)
Why it's needed	Defines risk appetite and oversight	Fixes supply-chain vulnerabilities
What it covers	Strategic, financial, and operational	Supply risk and SCOR processes
What it solves	Enterprise-level clarity	Actual supply bottlenecks

Risk Review

- Review risk responses
- Update risk metrics and dashboards
- Lessons learned and adjustments
- Incorporate new data from supplier performance and market trends
- Adjust mitigation strategies based on changing conditions

Cost Efficiency/Supply Chain Resilience

- Shift: "Cost is King" --> "Resilience at all costs"
  - Key Drivers: COVID-19, Climate Risks, Automation & Robotics, Intensifying Competition, etc.
- Many companies adopting manufacturing/sourcing networks that flex in response to disruption
  - Geographical diversification, joint ventures, contracted manufacturing
- For example, according to BCG, foreign auto companies in the electric vehicle (EV) segment invested more than $35 billion in the US from 2021 through 2024

Cost & Resilience Timeline

Present Day

Regional Diversification
+
Joint Ventures
+
Chip Consortiums

North American Market Expansion
+
Possible Vertical Integration

INCREASE: Costs in lithium batteries and semiconductors due to supply chain disruption.

INCREASE: Opportunity costs from vehicle backlog.

INCREASE: Initial small, volume contracts for quality testing drive costs up.

DECREASE: Additional inputs from supplier diversification reduces vehicle backlog.

DECREASE: Joint ventures and chip consortiums decrease production costs.

INCREASE: Vertical integration prompts R&D costs + possible acquisition costs.

DECREASE: Supply cost reduces from established diverse supplier network & from in-house manufacturing.

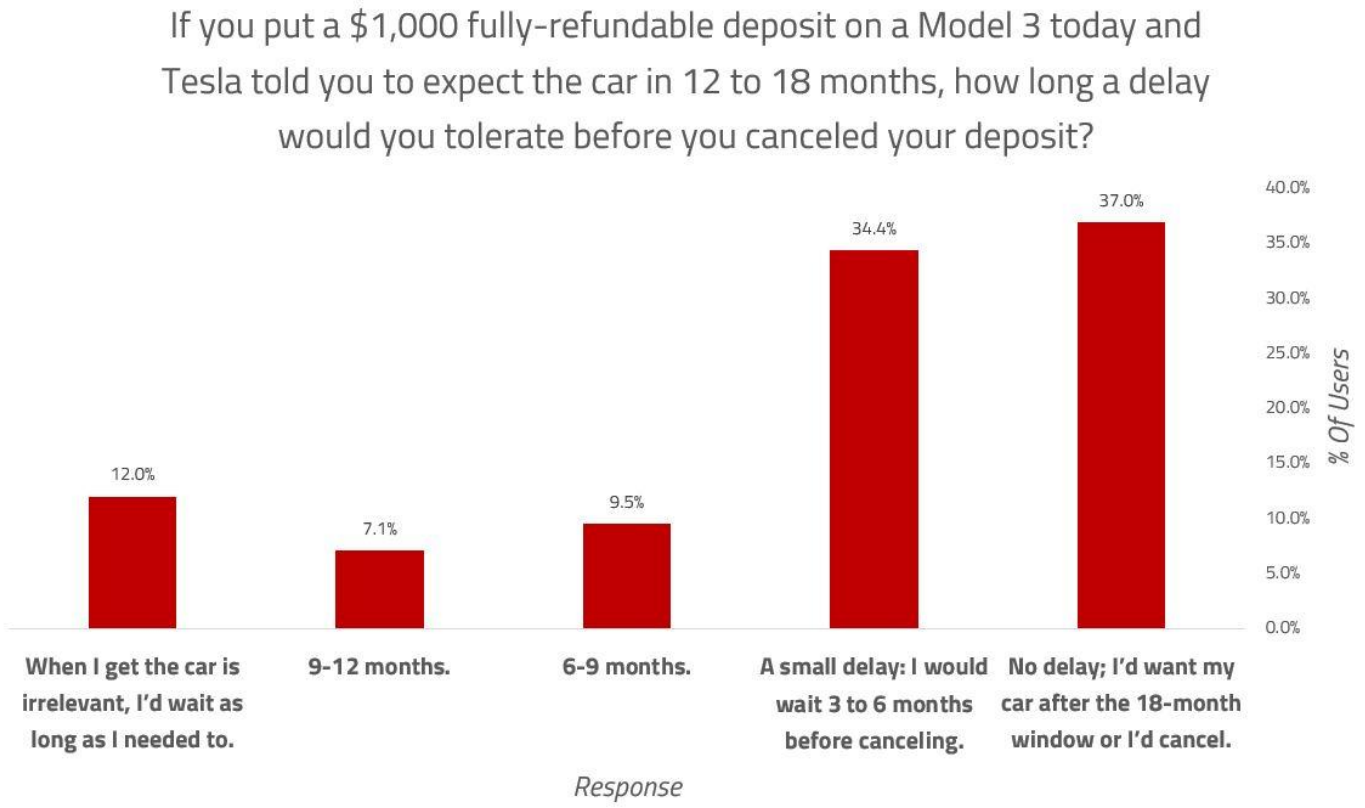
Balancing Cost Efficiency & Resilience

- Clearly, the added supply chain resiliency from regional diversification comes at the expense of cost efficiency.
  - For example, "testing" new suppliers demands more costly, smaller volume contracts.
- To maximize resiliency, and minimize cost, VoltDrive must prioritize regionally diverse suppliers with joint venture opportunities.
  - Rivian 5-year battery deal with LG Energy Solution Arizona, trimming sourcing and production costs and reducing battery pack assembly processing by 45%.
- Ideal Battery Candidate: Lithion Battery
  - Independent of major EV OEM-joint-ventures - room for joint venture opportunities
  - Capability to produce custom cells/packs - aligns with VoltDrive's innovative batteries.
  - U.S. based location, while tariff heavy, aligns with VoltDrive's goal for North American Expansion and fulfills regional diversification requirements.

Customer Impact

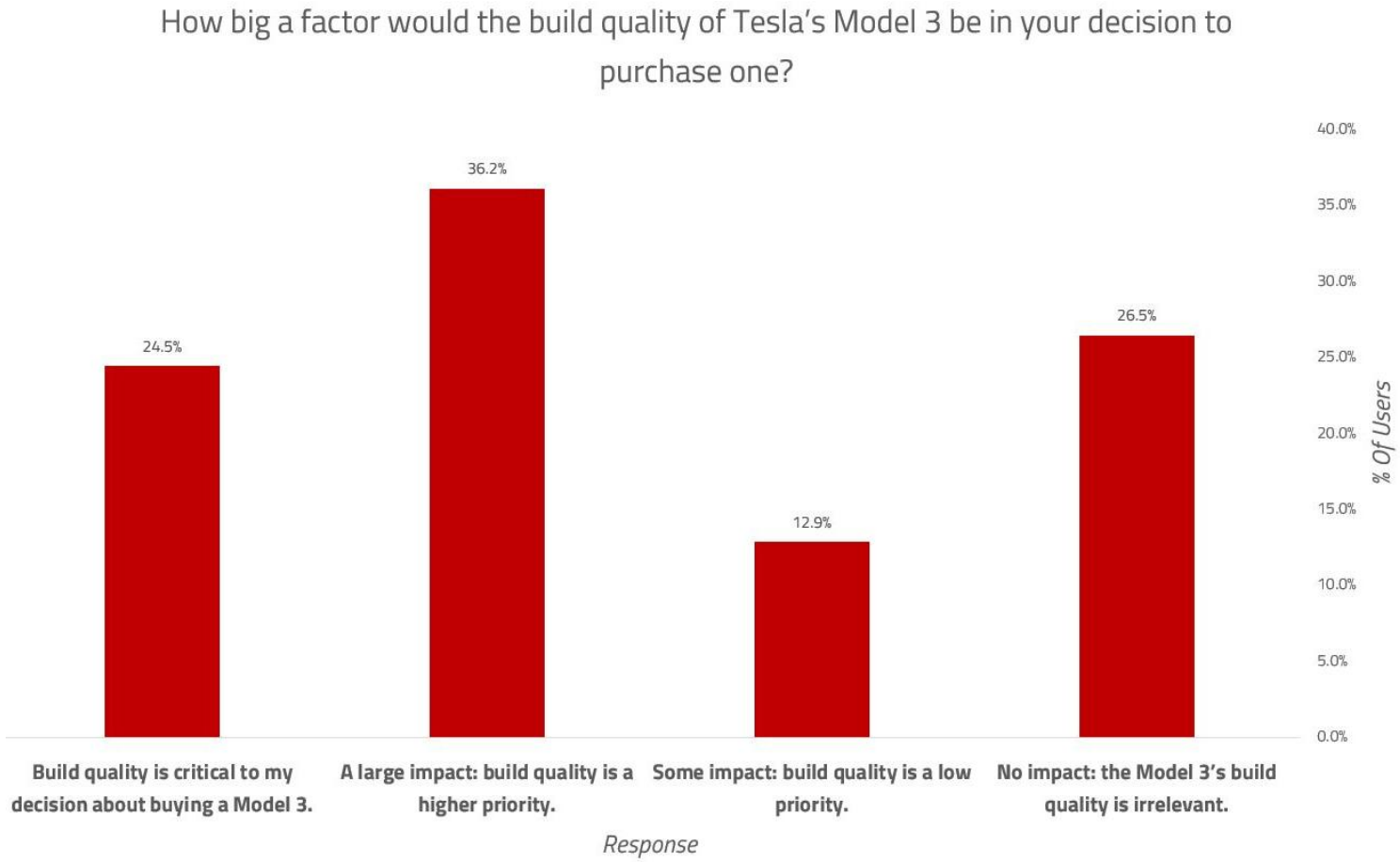
Competitor Analysis: Tesla

- Tesla Model 3 customer polls reveal most are unwilling to tolerate **major delays**: many would cancel in the first few months
- However, customers are still willing to tolerate **long wait-times.**



Competitor Analysis: Tesla

- Polls also reveal that 60% of Model 3 customers cite build quality as a major priority
- Sacrificing build quality to clear backlog may be unpalatable: Negative customer retention



Communication Strategies

Active Strategies

Press release:
General, active acknowledgement

Pros:
- All customers receive information at the same time, impersonal
- Smaller overhead

Cons:
- Future customers may be deterred
- Customers may panic

Email/personal notification:
Customer specific, active acknowledgement

Pros:
- Can be personalized; depending on customization, allows room for changes to reflect ongoing production delays

Cons:
- Large analysis overhead, may be inaccurate
- Consumers may feel targeted/misled by previous production timelines

Social Media Post:
General, active acknowledgement

Pros:
- Impersonal
- Much smaller overhead
- Younger generations check social media more often

Cons:
- Future customers may be deterred
- Customers may panic
- Feels ‘unprofessional’
- May not be accessible for older generations.

Communication Strategies

Passive Strategies

Account-specific, app timelines estimates:
Specific, passive acknowledgement

Pros:

- Less likely to elicit strong reactions, thus can be updated more often

Cons:

- Proactive customers may feel unsatisfied or misled
- May update many times, leading to psychological effect of unreliability
- Older generations may struggle

Social Media Chat/Online Chat:
Specific, passive acknowledgement

Pros:

- Much lower overhead

Cons:

- Proactive customers may feel unsatisfied or misled
- Many customers may not know at all
- Older generations may struggle

Communication Channels

Comparison

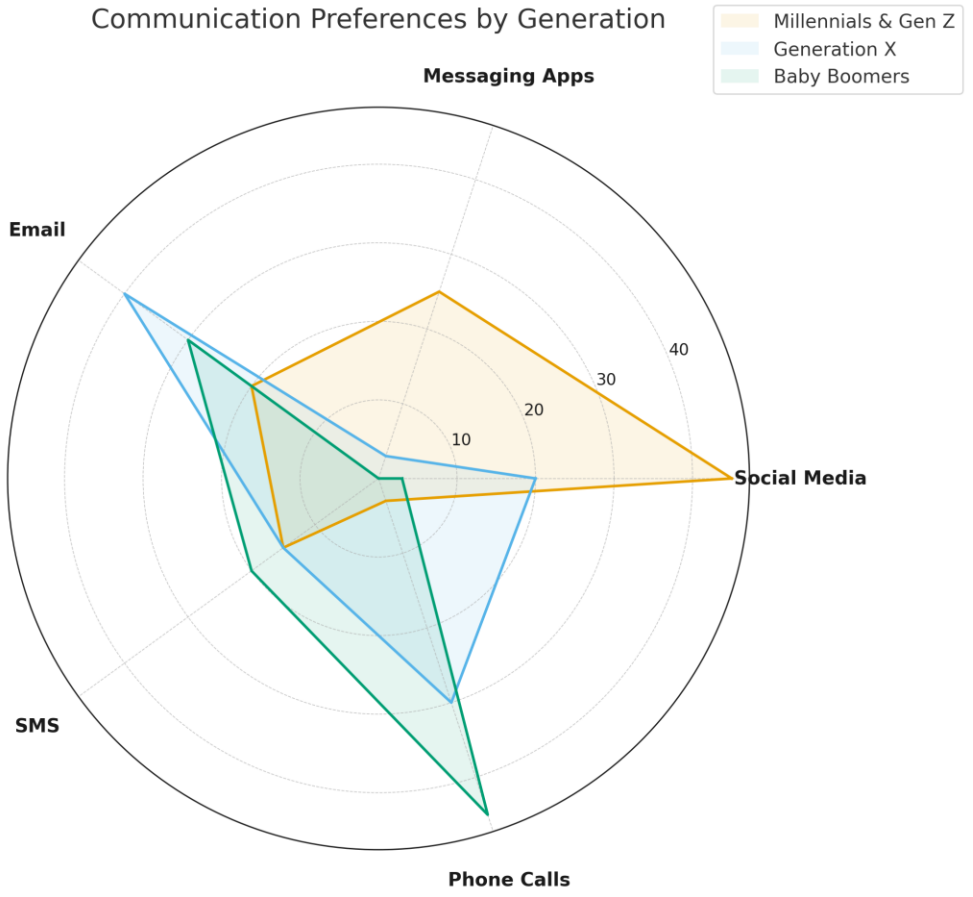
Strategy:	Specificity:	Alarm Risk:	Overhead:	Professionality:	Reputational risk:
Press Release	Bad	Bad	Okay	Good	Bad
Email	Okay	Okay	Bad	Good	Good
Phone call	Okay	Okay	Bad	Good	Good
SMS/Push Notif	Okay	Okay	Bad	Good	Good
Portal Update	Good	Good	Okay	Okay	Good
Online chat	Okay	Good	Good	Bad	Good
Social Media Post	Bad	Good	Good	Bad	Bad

- Bad
- Okay
- Good

Communication Channels

Age Grading

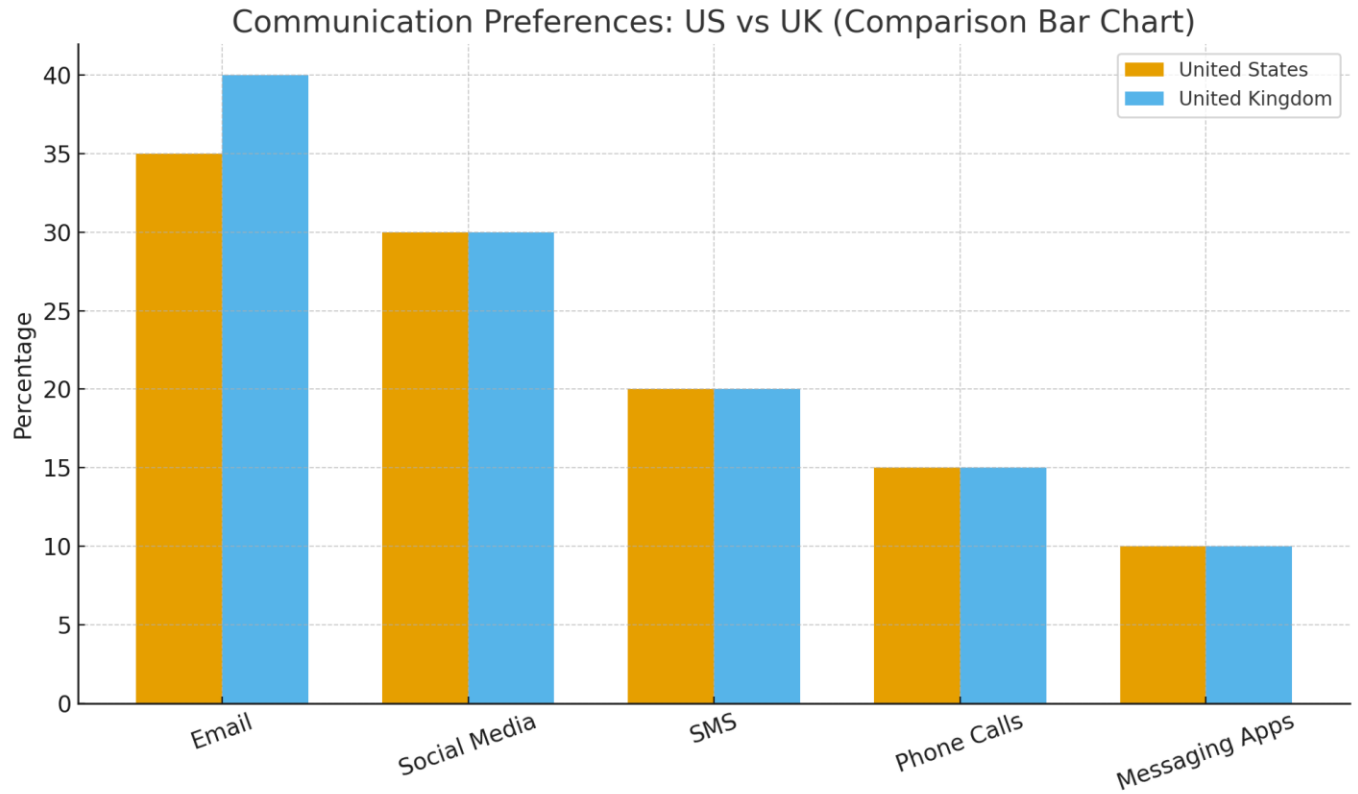
- Generally, older generations are less open to newer communication channels like Social Media and Apps, while newer generations are unwilling to use ‘outdated’ methodologies like email and phone calls.
- SMS and Messaging apps are the clear losers; fewer than 25% max of any generation prefer them.



Communication Channels

By Country/Continent

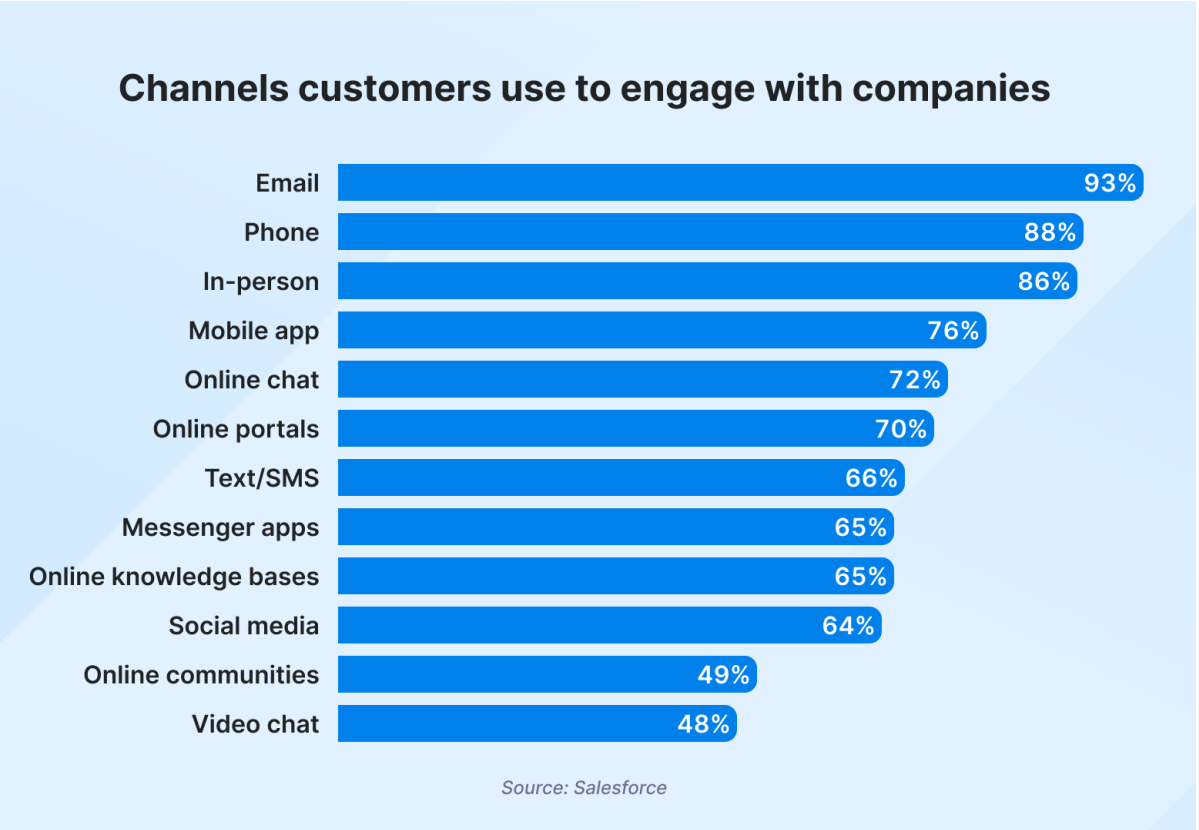
Email is the most preferred in both countries, but is slightly more common in the UK. Likely reflects differing demographics.



Channels seem mostly the same between continents, indicating current European methods may be reused.

Communication Strategies

- A few communication channels can cover majority of customers.
- Age grading and demographic trends mean some customers prefer different channels than others.



Managing Customer Expectations

- Many customers are willing to stay with a brand despite long wait times, to get the car of their choice
  - Our research indicates that **excessive delays** and **notifications** tend to **destroy brand trust**, whilst customers prioritize **fewer delays**, **transparency**, and **accountability**
  - Therefore, VoltDrive should focus on estimating **conservative delays**,and providing **up-to-date** alerts
- Key Communication Channels: **email**, **phone calls**, and an **app**
  - We are targeting baby boomers, Gen X, and millennials/gen Z respectively

Solving VoltDrive's Customer Attrition

Fast-Track

Flexibility

Incentives/Compensation

Notifications

Customer Service

Mobile/Online Analytics

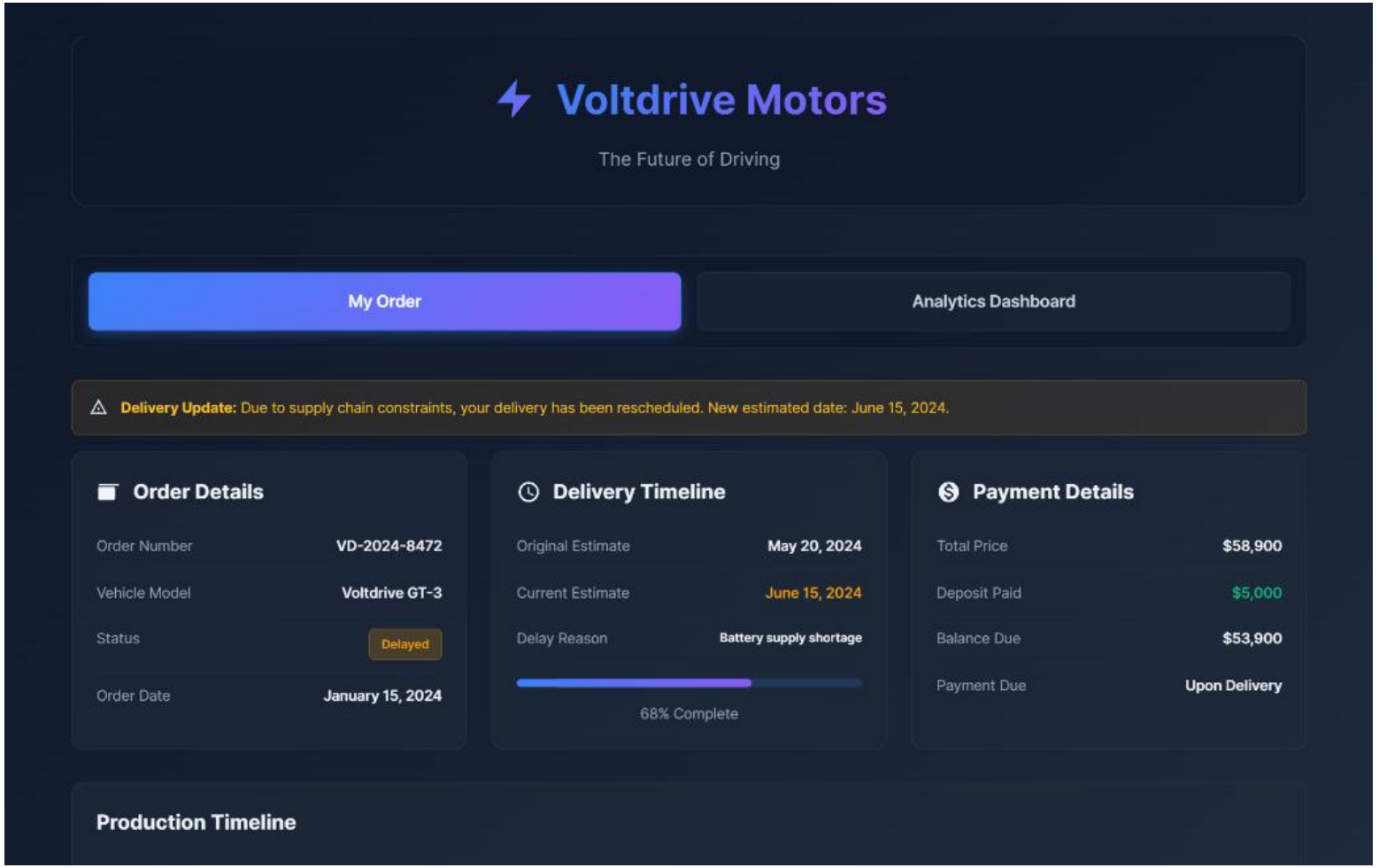
Minimizing Attrition

Short-Term Strategies (Next 3-9 Months)

- Delivery fast-track for priority segments
  - Long-standing reservations
  - New markets
- Flexibility for custom-orders
  - Modify configurations that have shorter lead times
  - Switch to in-stock models without penalties
- Incentives and compensation package
  - Discounts
  - Free servicing vouchers
  - Accessory bundles
  - Temporary loaner vehicles for severely delayed orders

App Mockup

- App/Webapp mockup, will both provide order updates and estimates
- Developer mode will provide clickstream analytics and charts



Minimizing Attrition

Long-term Strategies

- Notifying customers on delayed orders & delivery timelines
  - Customers can decide to get specific components that are ready to be delivered
  - Customers could also choose to delay order in exchange for monetary compensation
- Building a culture founded on customer service
  - Rewarding customers who make regular purchases by offering exclusive discounts on all types of sales
  - Integrating live chatbots and personal assistants on the line to answer customer concerns/inquiries
- Open website, mobile app analytics to view user engagement
  - Use Azure as database, retrieve and query data with HTTP, using built-in functions to view and make analysis charts for what customers are most interested in off data
  - Scalable (computing), flexible (supports many frameworks), and secure (cloud-based)

Conclusion