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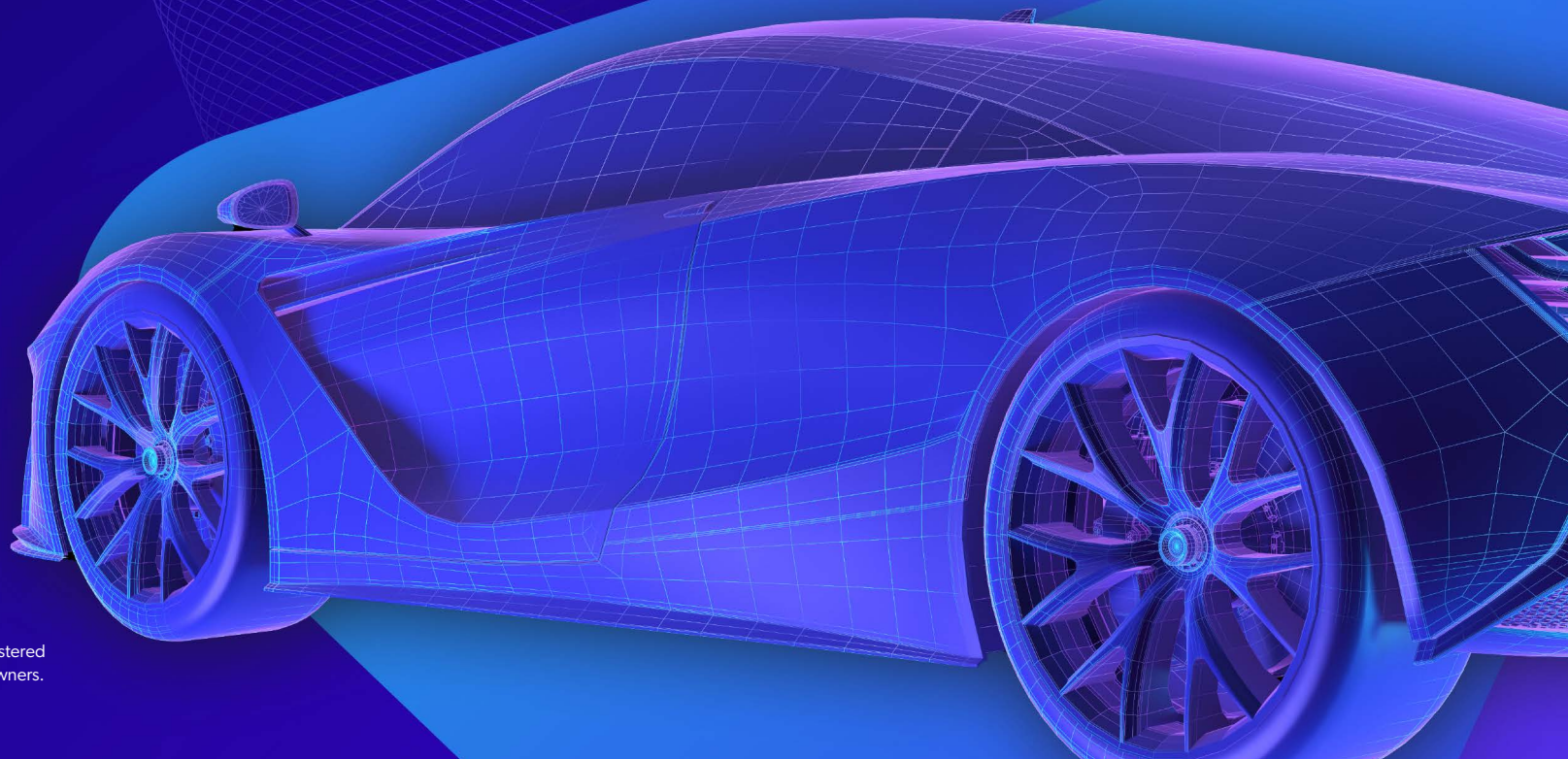
2025 State of Automotive Software Development Report

What Are the Top Concerns Impacting Automotive Software Development?

Jill Britton
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Introduction

Welcome to the 2025 State of Automotive Software Development Report

This year, over 650 automotive development professionals around the world provided responses to questions regarding current practices and emerging trends within the automotive software industry.

Our findings show that quality continues to be the leading key area of concern for automotive software professionals, as seen in the 2024 report. Last year, we attributed this to the geographical expansion of our survey to include more respondents from the Asia-Pacific region, who cited quality as their top concern; however, this year quality became the leading concern for North America and Africa, and a rising concern for other regions.

Safety, meanwhile, has returned to the second leading area of concern over security, which briefly outpaced safety in 2024. Safety proved to be especially important this year as new artificial intelligence (AI) and machine learning (ML) technologies are being applied to connected and autonomous vehicles. With the rise in AI/ML, functional safety standards focused on eliminating risk in vehicle systems are being reshaped to identify the challenges of functionally safe AI systems. A new standard, ISO/DPAS 8800, "Road vehicles — safety and artificial intelligence" has been recently published specifically for systems encompassing AI, describing measures to assure the safety of the AI system and its decision-making during operation.

While quality was the leading area of concern overall for respondents this year, keeping code quality high when written by a generative AI tool was of least concern for AI in vehicle software development. However, improving software quality was still the leading reason for using development tools, such as static analysis.

Electric vehicles (EVs) have become more established across the automotive industry, but the market is variable. A majority of survey respondents this year indicated that they are at least somewhat impacted by EV design, but whether they were extensively working on EVs or working on some EV components varied by region. For now, North America appears to lead in EV driving their design, but that could change. Even as some automotive companies look at scaling back EV production, sales continue to rise globally, with China leading EV sales growth in 2024. This could partly explain why, more broadly, maintaining industry competitiveness was the leading market condition our survey respondents plan to focus on in 2025.

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The current state of the global economy continued to have the greatest market impact on automotive software professionals this year. While maintaining industry competitiveness was the leading strategy for those with economic concerns, one trend we saw throughout this year's report was the emphasis on investing in employees and training them in security, compliance, and DevOps best practices. Many automotive employers are outsourcing talent and resources globally, even as return-to-office policies are being instated, and hybrid working is increasing. Training automotive software employees will be key for teams with compliance requirements and large, complex code bases across a globally distributed workforce.

We hope this information will help your development teams innovate faster and improve quality — while maintaining compliance for safety and security.

 Thank you to everyone who participated in the survey!

Jill Britton

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2025 Market Conditions

Market conditions impacting automotive software professionals increased this year overall, with respondents selecting more than one condition affecting them.

Of all the market conditions that have most impacted automotive organizations, the global economy continued to be a leading concern among respondents (50%).

This year, changes in human resources also made a big impact, with many automotive employers outsourcing talent and resources globally (34%). The impact of ongoing conflict worldwide for automotive organizations creates further challenges for automotive professionals, ranking third (31%) as a top market condition affecting the industry, followed closely by supply chain challenges (28%).

WHAT MARKET CONDITIONS HAVE MOST IMPACTED SOFTWARE DEVELOPMENT FOR YOUR ORGANIZATION?

Ongoing conflict worldwide
31%
2024 - 14%

Global economy
50%
2024 - 35%

Shift to remote /hybrid workforce
25%
2024 - 21%

Outsourcing talent and resources globally
34%
2024 - N/A

Opening new locations and expanding offices
20%
2024 - N/A

Supply chain challenges
28%
2024 - 26%

Other
4%
2024 - 4%
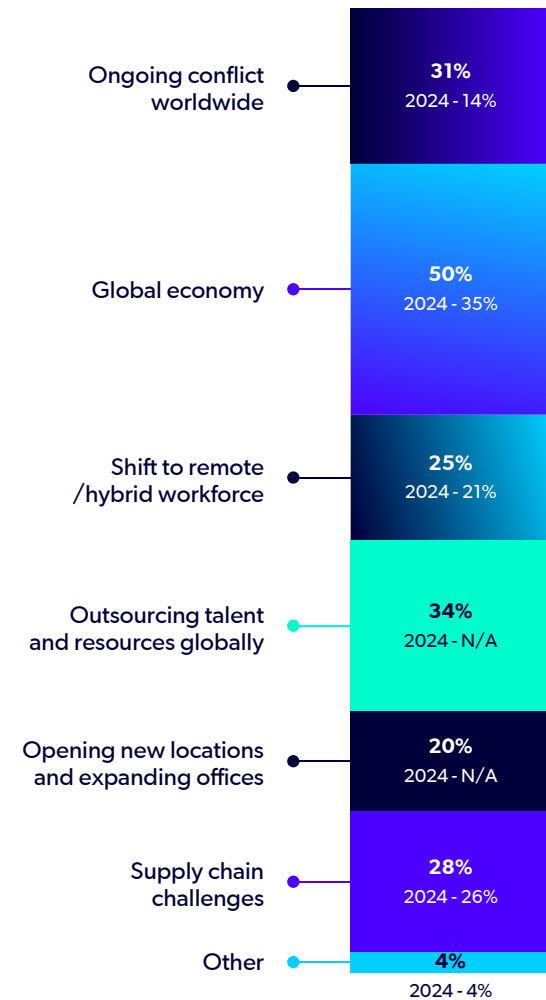
Region

The global economy was the most pressing market concern for a majority of respondents across most regions, with the exception of the few respondents from Africa, who were slightly more concerned about the ongoing conflict worldwide. Many regions are also outsourcing talent and resources globally, which is affecting them more than the shift to a remote or hybrid workforce. Breaking this down into individual role, engineers/developers were more concerned about outsourcing talent and resources globally (41%) than directors/managers (29%).

Region	Ongoing conflict Worldwide	Global economy	Shift to remote/hybrid workforce	Outsourcing talent and resources globally	Opening new locations and expanding offices	Supply chain challenges	Other
North America	19%	24%	14%	19%	11%	12%	1%
Europe/UK	13%	30%	13%	19%	8%	16%	1%
Middle East	16%	29%	13%	16%	9%	16%	1%
Africa	22%	20%	16%	18%	13%	9%	2%
Asia	13%	26%	10%	18%	10%	20%	3%
Oceania	N/A						
Latin America	8%	23%	23%	8%	8%	15%	15%

- Ongoing conflict Worldwide
- Global economy
- Shift to remote/hybrid workforce
- Outsourcing talent and resources globally
- Opening new locations and expanding offices
- Supply chain challenges
- Other

Organization Type

The global economy was a top market concern for Tier 1, Tier 2, and Tier 3 suppliers, while OEMs were most concerned about the ongoing conflict worldwide.

Organization Type	Ongoing conflict Worldwide	Global economy	Shift to remote/hybrid workforce	Outsourcing talent and resources globally	Opening new locations and expanding offices	Supply chain challenges	Other
OEM	25%	23%	11%	16%	7%	18%	0%
Tier 1	13%	29%	13%	19%	9%	16%	1%
Tier 2	12%	27%	15%	18%	14%	12%	2%
Tier 3	20%	20%	16%	17%	13%	13%	1%

- Ongoing conflict Worldwide
- Global economy
- Shift to remote/hybrid workforce
- Outsourcing talent and resources globally
- Opening new locations and expanding offices
- Supply chain challenges
- Other

Hybrid Working Continues to Be the New Norm Amid Return-to-Office Mandates

Continuing the trend from last year's survey, hybrid working still seems to be the work model of choice for organizations and employees in 2025. There was also a 4% increase in working in an office and a 4% decrease in working exclusively from home/remote compared to the 2024 report.

In the automotive space, Toyota announced early this year that starting in September 2025, it will require North American salaried workers to RTO four days a week, Monday through Thursday, regardless of workers who have moved away from company locations. This mandate is in contrast with hybrid policies set forth by Ford and Mercedes-Benz, both of whom allow for more flexible schedules and choice for salaried employees. In 2022 Bosch introduced Smart Work to empower employees. In Japan, for example, team members can decide the ratio of on-site and remote work.

Many factors and considerations come into play when it comes to how and where employees work, including region. People in European countries, for example, typically spend less time and money on commuting to work, while people in the US are more dependent on private vehicles, spending 5% more on average than their European counterparts, according to 2023 European Union data.

LinkedIn's 2024 *Global State of Remote and Hybrid Work* report, which analyzed work trends in France, Germany, India, US, and UK, found that hybrid work continued to be the norm, but there was a growth in remote roles in Germany, UK, and US, especially for small companies (< 250 people). Fully onsite work was more dominant in France and India, but hybrid work remained popular in those countries. The LinkedIn report also found that international companies were more likely to hire remote than domestic companies.

Our survey results show that automotive professionals located in Europe/UK and Latin America lead in the percentage of those practicing hybrid working, while those in North America and Asia have the most respondents working in an office.

Time will tell whether we will hear of more cases of full RTO over fully remote work. A recent report by Pearl Meyer of 300 HR professionals and other leaders showed mixed results on the impact of RTO on employee morale: 37% said that RTO improved morale, while 42% reported diminished morale.

This mixed morale impression could be why, despite some shift toward RTO, hybrid work remained steady year over year at 54% for our automotive survey respondents. For now, hybrid work continues to be the new norm and may be the best of both worlds, accounting for more fruitful collaboration opportunities while maintaining flexibility and employee satisfaction.

As we continue to navigate workplace flexibility coming out of the COVID-19 uncertainty, organizations and workers are still seeking a balance that would allow for increased productivity while benefiting from flexible scheduling, cost savings, and widening the global talent pool.

DOES YOUR DEVELOPMENT TEAM MAINLY:

Work in an office
40%
2024 - 36%

Hybrid working
54%
2024 - 54%

Work exclusively from home/remote
6%
2024 - 10%
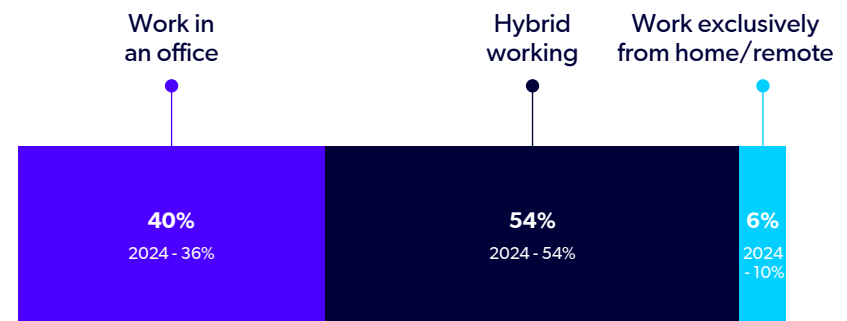
2025 Leading Market Challenges

Automotive organizations are facing many competing challenges in 2025. Similar to last year, respondents were most concerned with "maintaining industry competitiveness" (58%), a 28% increase year over year. "Maximizing existing resources" (49%) also increased significantly by 31% as the second top concern, and "educating existing talent" rose by 28% as the third top challenge.

This year's survey introduced a new challenge, "modernizing tech stack" (30%). "Making compliance easier" (27%) also saw an increase this year over "mitigating software recalls" (20%).

Maximizing existing resources
49%
2024 - 18%

Educating existing talent
42%
2024 - 14%

Maintaining industry competitiveness
58%
2024 - 30%

Mitigating software recalls
20%
2024 - 6%

Making compliance easier
27%
2024 - 6%

Modernizing tech stack
30%
2024 - N/A

Other
3%
2024 - 2%
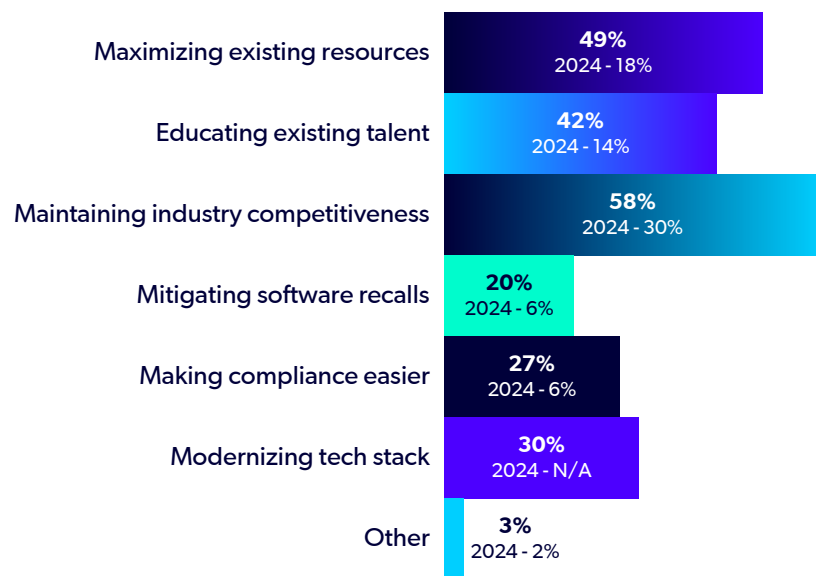
Organization Type

When looking at the individual leading challenges by organization type, Tier 1 (28%) and Tier 2 (25%) suppliers were most concerned about "maintaining industry competitiveness." Tier 3 (26%) suppliers were most concerned about "educating existing talent," compared to 2024 when they were more concerned about "maximizing existing resources." This year OEMs (30%) were most concerned about "maximizing existing resources" over industry competitiveness, whereas last year OEMs were more evenly split between those two top challenges.

It is interesting to note that in the survey results, directors/managers were more focused on maintaining industry competitiveness overall. Engineers were also interested in remaining competitive; however, the engineers/developers prioritized maximizing existing resources above other challenges. Functional safety/security officers and compliance officers were most interested in educating existing talent.

	Maximizing existing resources	Educating existing talent	Maintaining industry competitiveness	Mitigating software recalls	Making compliance easier	Modernizing tech stack	Other
OEM	30%	11%	24%	8%	12%	15%	0%
Tier 1	21%	19%	28%	8%	11%	13%	0%
Tier 2	17%	22%	25%	12%	12%	12%	0%
Tier 3	18%	26%	21%	12%	12%	11%	0%

- ● Maximizing existing resources
- ● Educating existing talent
- ● Maintaining industry competitiveness
- ● Mitigating software recalls
- ● Making compliance easier
- ● Modernizing tech stack
- ● Other

The Leading Concerns in Automotive Software and Technology Development

We identified five key areas of concern in automotive software development:

1. Quality
2. Security
3. Safety
4. Team Productivity
5. Testing

Based on the results, quality continues to lead as the top concern at 29%, which is the new trend in both 2024 and 2025 after the expansion of the survey to the Asia-Pacific region. However, since last year, quality is now also a top concern for North America and Africa, and only safety takes precedence over quality in respondents from Europe/UK.

Last year, security outpaced safety overall, but this year safety (28%) has returned to second place over security (22%) in third place. This year-over-year shift could be due to the rising concerns over artificial intelligence and functional safety in vehicle software development and design.

Team productivity and testing remained at a similar level of concern as last year, but the specific concerns about productivity and testing did see some changes that align with the overall trends in 2025.

Software quality remains the top concern in automotive software development, followed closely by safety and security.

WHAT IS YOUR BIGGEST CONCERN IN AUTOMOTIVE SOFTWARE AND TECHNOLOGY DEVELOPMENT TODAY?

3%
2024 - 6%

8%
2024 - 9%

10%
2024 - 10%

29%
2024 - 29%

28%
2024 - 22%

22%
2024 - 25%

- Quality
- Safety
- Security
- Team Productivity
- Testing
- Other (please specify)
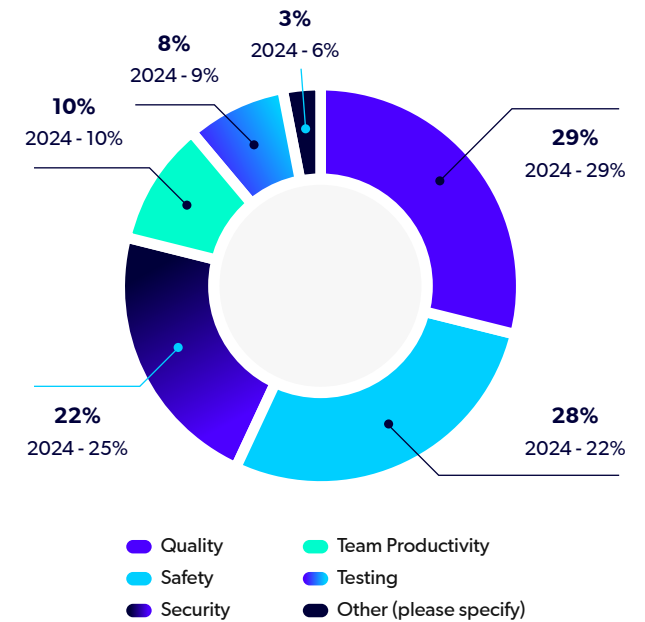
Quality

General

29% of those surveyed cited quality as their top concern in automotive software development, which is consistent with last year's report. "Our codebase is too complex" (28%) and "our testing efforts are not exhaustive—and we do not have time to test more" (27%) continued to be the leading quality concerns.

Still others had difficulty "[enforcing] coding best practices" (21%), consistent with last year's responses, and only a handful of respondents found "peer code reviews [to be] inconsistent" (8%).

Both leading concerns saw increases over last year — what is interesting to note is the divide between experience levels. Software quality concerns have more to do with the experience of the engineer than the quality of the code itself. As engineers become more experienced, the complexity of the codebase becomes less of a concern. Similarly, enforcing coding best practices depends on experience. Testing resources are the most challenging for those engineering teams with the most experience. These quality concerns shed light on the heightened focus on developer training and maximizing resources this year and illustrate where the gaps lie for each experience level.

WHICH BEST DESCRIBES YOUR QUALITY CONCERNS?

8%
2024 - 9%

8%
2024 - 16%

27%
2024 - 24%

8%
2024 - 7%

21%
2024 - 21%

28%
2024 - 23%

- Our codebase is too complex.
- It is difficult to enforce coding best practices.
- Peer code reviews are inconsistent.
- Our testing efforts are not exhaustive—and we do not have time to test more.
- I do not have quality concerns.
- Other (please specify).
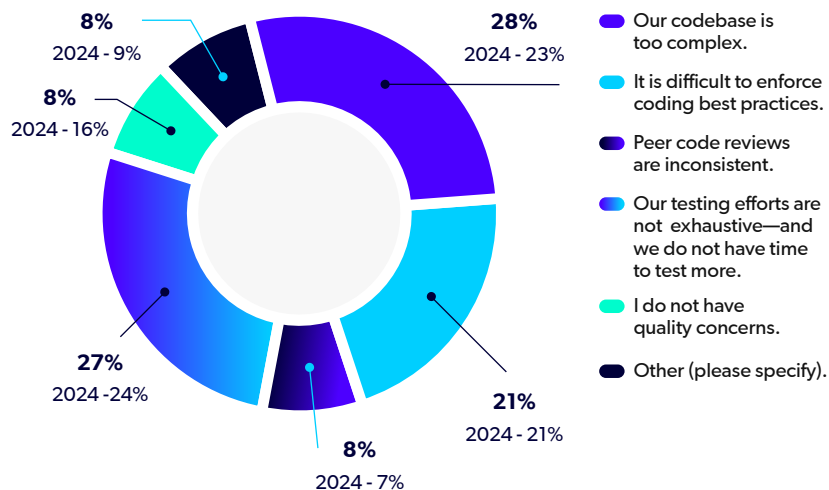
Respondent Experience Level

Respondents with less than 1 year of experience were most concerned with the codebase being too complex (57%), which increased by 14% since last year. Those with 1-3 years of experience also expressed this as their top concern (45%). Respondents with 3-5 years of experience had the most difficulty enforcing coding best practices (29%). The most experienced automotive professionals with 5+ years were more concerned about their testing efforts not being exhaustive, and not having time to test more.

	Codebase too complex	Difficult to enforce	Peer code reviews	Testing efforts	No quality concerns	Other
Less than 1 year	57%			4% / 0% / 17%	9%	13%
1-3 years	45%	13%	8%	11%	13%	10%
3-5 years	24%	29%	21%	21%	2%	3%
5-10 years	18%	33%	4%	37%	6%	2%
More than 10 years	16%	18%	8%	37%	14%	7%

- Our codebase is too complex.
- It is difficult to enforce coding best practices.
- Peer code reviews are inconsistent.
- Our testing efforts are not exhaustive — and we do not have time to test more.
- I do not have quality concerns.
- Other

Region

Respondents from most regions cited their codebase being too complex as the top quality concern. Enforcing coding best practices also proved challenging to those in Africa, North America, and Europe/UK; while respondents in the Middle East, Asia-Pacific, and Latin America said that testing resources were a top quality concern.

North America	41%	24%	8%	19%	6% 2%
Europe/UK	28%	25%	6%	22%	11% 8% 0%
Middle East	29%	14%	29%	14%	14%
Africa	18%	36%	10%	18%	18% 0%
Asia	13% 14% 11%	43%	10%	9%	
Oceania	N/A				
Latin America	50%	50%			0%

- ● Our codebase is too complex.
- ● It is difficult to enforce coding best practices.
- ● Peer code reviews are inconsistent.
- ● Our testing efforts are not exhaustive — and we do not have time to test more.
- ● I do not have quality concerns.
- ● Other
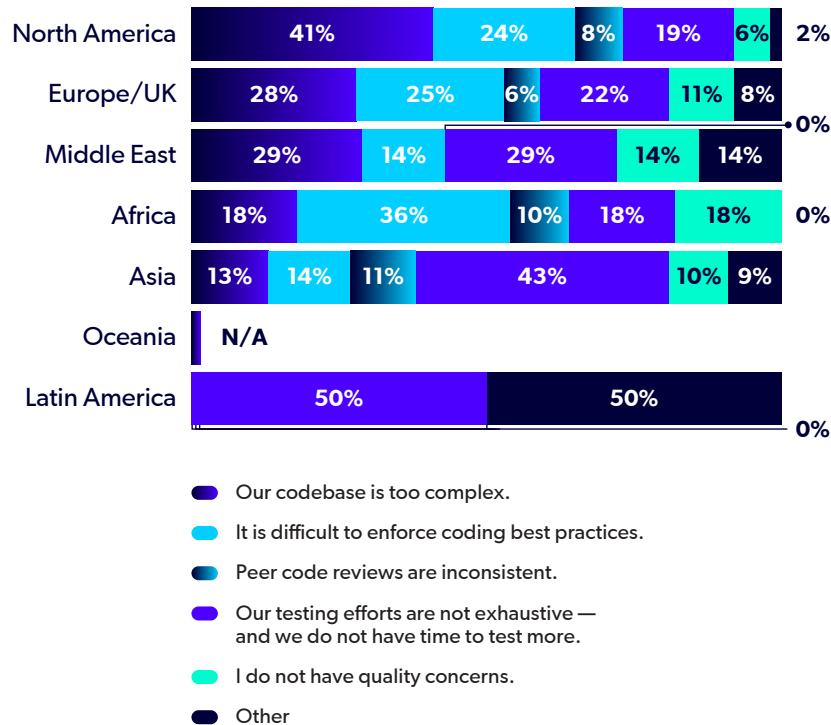
Organization Type

Quality challenges differed, depending on the type of automotive organization. The top concern for OEMs was the complexity of their codebase — likely, this is because in our survey results there were more respondents with less than 3 years of experience from OEMs than any other organization type. Interestingly, codebase complexity concerns were also leading for Tier 3 suppliers. Tier 1 suppliers were most concerned with testing efforts and resources, while Tier 2 suppliers were most concerned with enforcing coding best practices.

OEM	55%	9%	9%	17%	7% 3%
Tier 1	13%	33%	5%	35%	8% 6%
Tier 2	16%	34%	16%	31%	3% 0%
Tier 3	41%	24%	11%	24%	0% 0%

- ● Our codebase is too complex.
- ● It is difficult to enforce coding best practices.
- ● Peer code reviews are inconsistent.
- ● Our testing efforts are not exhaustive — and we do not have time to test more.
- ● I do not have quality concerns.
- ● Other
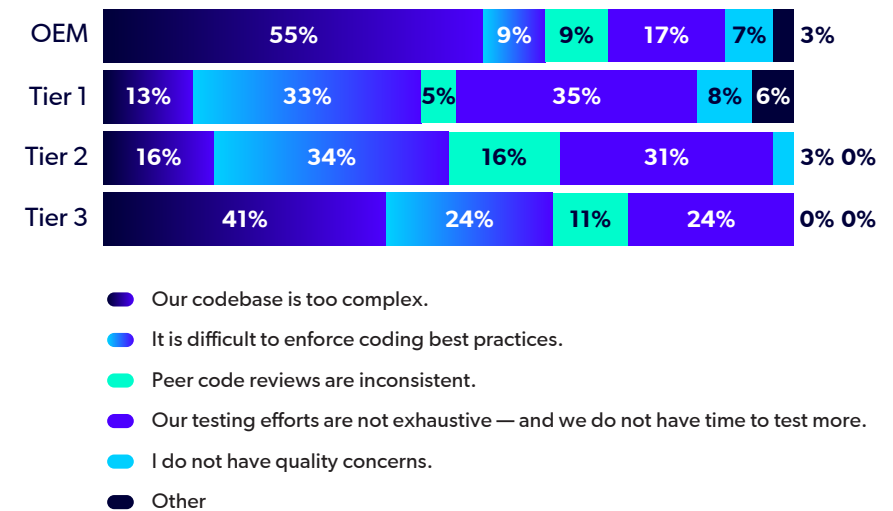
Automotive Development Focus (NON-EV)

When breaking down the responses by automotive development focus, the leading quality concerns for many areas was "testing efforts [not being] exhaustive and [they] do not have time to test more." Chassis and safety, AD/autonomous drive, and ADAS/driver assistance leaned more toward their "codebase [being] too complex" as the top concern. Powertrain, meanwhile, was most concerned with "[difficulty enforcing] coding best practices."

Focus	Codebase too complex	Difficult to enforce best practices	Peer reviews inconsistent	Testing not exhaustive	No quality concerns	Other
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	56%	16%	3%	21%	2%	2%
ECU/ECM	21%	29%	2%	34%	2%	12%
Powertrain (non-EV)	18%	27%	13%	21%	6%	15%
AD/Autonomous Drive	31%	23%	11%	20%	9%	6%
Access Control and Comfort Systems	19%	29%	0%	32%	10%	10%
ADAS/Driver Assistance	30%	21%	10%	30%	2%	7%
Infotainment Systems	22%	13%	13%	37%	6%	9%
LIDAR	20%	10%	10%	40%	10%	10%
Connected Car and V2X	20%	20%	13%	37%	3%	7%
Instrument Clusters/HVAC/Lighting	23%	19%	10%	42%	6%	0%
Dealer Management	29%	29%	14%	7%	0%	21%
Diagnostic	24%	24%	24%	10%	0%	18%
Manufacturing	19%	26%	37%	11%	0%	7%
Supply Chain	14%	22%	14%	14%	22%	14%
3D Visualization/Digital Twins/Immersive Design	21%	11%	16%	26%	5%	21%
N/A	8%	23%	8%	23%	0%	38%

Legend:
- Our codebase is too complex.
- It is difficult to enforce coding best practices.
- Peer code reviews are inconsistent.
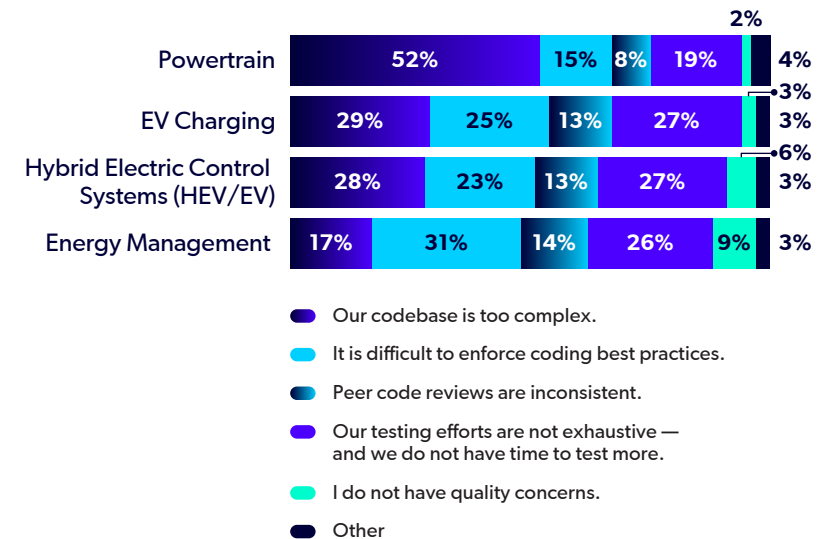- Other
- I do not have quality concerns.
- Our testing efforts are not exhaustive — and we do not have time to test more.

Automotive Development Focus (EV)

For electric vehicle components, the "codebase [being] too complex" was the biggest quality concern for Powertrain, EV charging, and hybrid electric control systems. "[Difficulty enforcing] coding best practices" was the larger concern for energy management.

Focus	Codebase too complex	Difficult to enforce best practices	Peer reviews inconsistent	Testing not exhaustive	No quality concerns	Other
Powertrain	52%	15%	8%	19%	2%	4%
EV Charging	29%	25%	13%	27%	3%	3%
Hybrid Electric Control Systems (HEV/EV)	28%	23%	13%	27%	6%	3%
Energy Management	17%	31%	14%	26%	9%	3%

Legend:
- Our codebase is too complex.
- It is difficult to enforce coding best practices.
- Peer code reviews are inconsistent.
- Our testing efforts are not exhaustive — and we do not have time to test more.
- I do not have quality concerns.
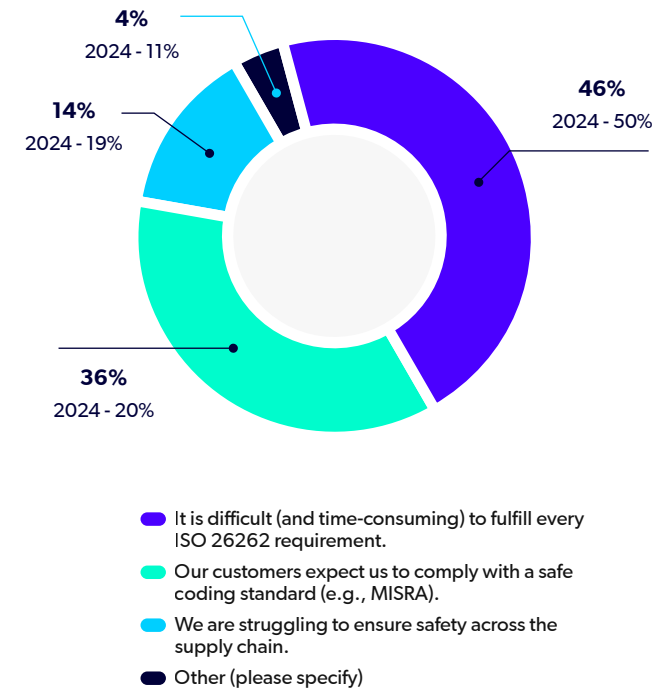- Other

Safety

General

28% of those surveyed cited safety as their top concern in automotive software development, returning to the second-most top concern over security after 2024 with a 7% increase.

When asked about specific safety concerns, "it is difficult (and time-consuming to fulfill every ISO 26262 requirement" remained the top issue, but slightly fewer respondents are reporting this to be the case. However, compared to 2024, respondents in 2025 expressed a 16% jump in customer expectations for "[complying] with a safe coding standard (e.g., MISRA)," returning to a similar percentage from the 2023 report the previous year (34% in 2023 and 36% in 2025).

This large increase reflects the many changes in coding standards that have occurred over the past year. MISRA, for example, recently published MISRA C:2023 and MISRA C++:2023, in the first full new editions since 2012. MISRA is constantly reviewing its rules and guidelines and is releasing MISRA C:2025 this year.

MISRA remains the leading coding standard automotive developers use. In a later section of this report, 53% of respondents said they use MISRA.

WHICH BEST DESCRIBES YOUR SAFETY CONCERNS?

4%
2024 - 11%

14%
2024 - 19%

46%
2024 - 50%

36%
2024 - 20%

- It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.
- Our customers expect us to comply with a safe coding standard (e.g., MISRA).
- We are struggling to ensure safety across the supply chain.
- Other (please specify)
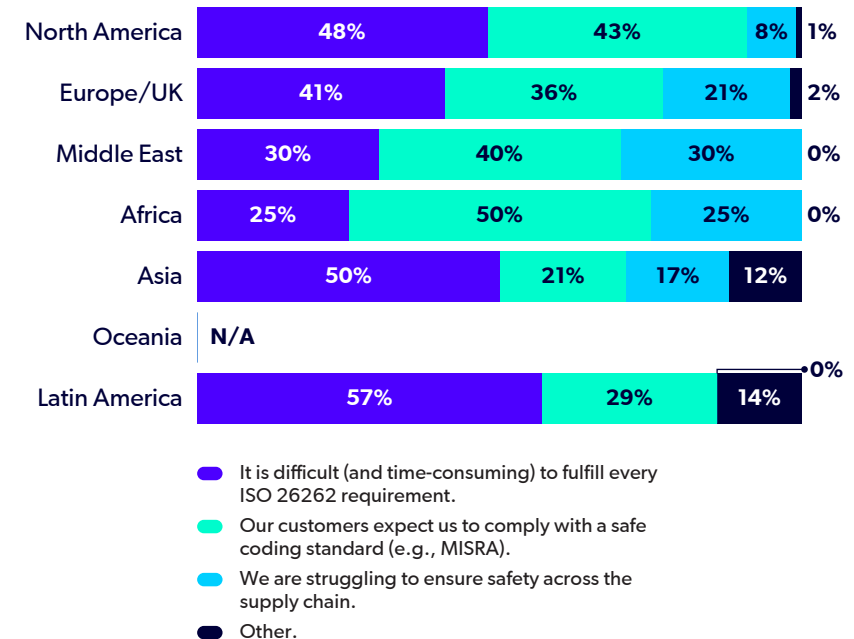
Organization Size

Respondents from Small organizations were most concerned with their customers expecting "[compliance] with a safe coding standard (40%), while Medium, Large, and Enterprise organizations were most concerned with "[fulfilling] every ISO 26262 requirement".

	It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.	Our customers expect us to comply with a safe coding standard (e.g., MISRA).	We are struggling to ensure safety across the supply chain.	Other.
Small (Less than 100 employees)	33%	40%	15%	12%
Medium (101-999 employees)	43%	41%	15%	1%
Large (1000+ employees)	63%	24%	5%	8%
Enterprise (10,000+ employees)	48%	29%	23%	0%

- It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.
- Our customers expect us to comply with a safe coding standard (e.g., MISRA).
- We are struggling to ensure safety across the supply chain.
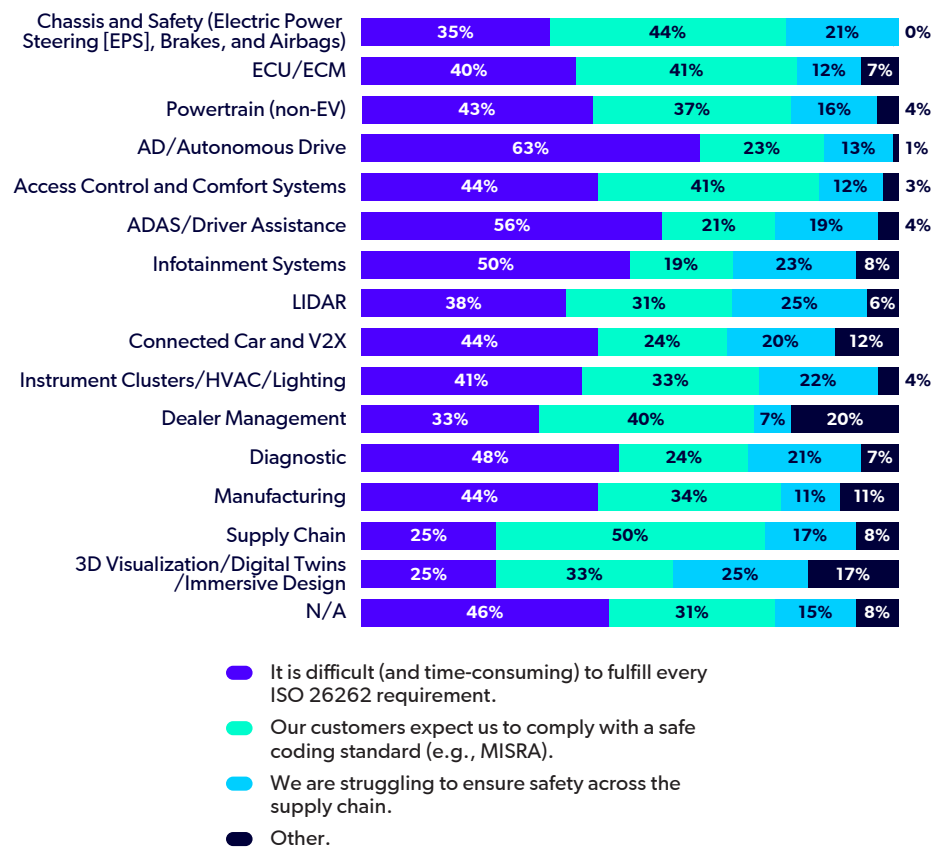- Other.

Region

When examining the collected responses by region, the majority of regions found it most difficult and time-consuming to "fulfill every ISO 26262 requirement, similar to 2024. Those few respondents from the Middle East and Africa said they were more concerned about "customers [expecting them] to comply with a safe coding standard," also consistent with last year's report.

	It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.	Our customers expect us to comply with a safe coding standard (e.g., MISRA).	We are struggling to ensure safety across the supply chain.	Other.
North America	48%	43%	8%	1%
Europe/UK	41%	36%	21%	2%
Middle East	30%	40%	30%	0%
Africa	25%	50%	25%	0%
Asia	50%	21%	17%	12%
Oceania	N/A			
Latin America	57%	29%	14%	0%

- It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.
- Our customers expect us to comply with a safe coding standard (e.g., MISRA).
- We are struggling to ensure safety across the supply chain.
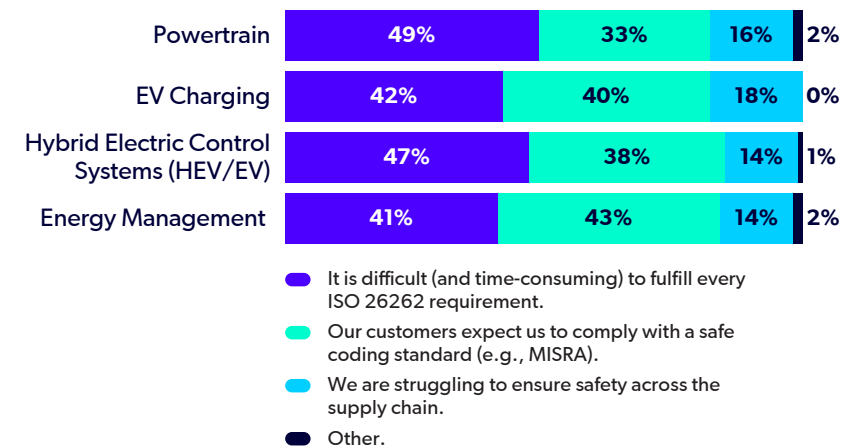- Other.

Automotive Development Focus (NON-EV)

The top safety concern in many areas of automotive development focus was how "difficult (and time-consuming) [it is] to fulfill every ISO 26262 requirement." However, "customers [expecting] us to comply with a safe coding standard" was the greater concern for Chassis and Safety, ECU/ECM, Dealer Management, Supply Chain, and 3D Visualization/Digital Twins/ Immersive Design.

Category	It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.	Our customers expect us to comply with a safe coding standard (e.g., MISRA).	We are struggling to ensure safety across the supply chain.	Other.
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	35%	44%	21%	0%
ECU/ECM	40%	41%	12%	7%
Powertrain (non-EV)	43%	37%	16%	4%
AD/Autonomous Drive	63%	23%	13%	1%
Access Control and Comfort Systems	44%	41%	12%	3%
ADAS/Driver Assistance	56%	21%	19%	4%
Infotainment Systems	50%	19%	23%	8%
LIDAR	38%	31%	25%	6%
Connected Car and V2X	44%	24%	20%	12%
Instrument Clusters/HVAC/Lighting	41%	33%	22%	4%
Dealer Management	33%	40%	7%	20%
Diagnostic	48%	24%	21%	7%
Manufacturing	44%	34%	11%	11%
Supply Chain	25%	50%	17%	8%
3D Visualization/Digital Twins /Immersive Design	25%	33%	25%	17%
N/A	46%	31%	15%	8%

- It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.
- Our customers expect us to comply with a safe coding standard (e.g., MISRA).
- We are struggling to ensure safety across the supply chain.
- Other.

Automotive Development Focus (EV)

In areas of electric vehicle development focus, respondents in most areas said that "[fulfilling] every ISO 26262 requirement" was their overall concern. The Energy Management area, in contrast, was somewhat more concerned with "[complying] with a safe coding standard" due to customer expectations.

Category	It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.	Our customers expect us to comply with a safe coding standard (e.g., MISRA).	We are struggling to ensure safety across the supply chain.	Other.
Powertrain	49%	33%	16%	2%
EV Charging	42%	40%	18%	0%
Hybrid Electric Control Systems (HEV/EV)	47%	38%	14%	1%
Energy Management	41%	43%	14%	2%

- It is difficult (and time-consuming) to fulfill every ISO 26262 requirement.
- Our customers expect us to comply with a safe coding standard (e.g., MISRA).
- We are struggling to ensure safety across the supply chain.
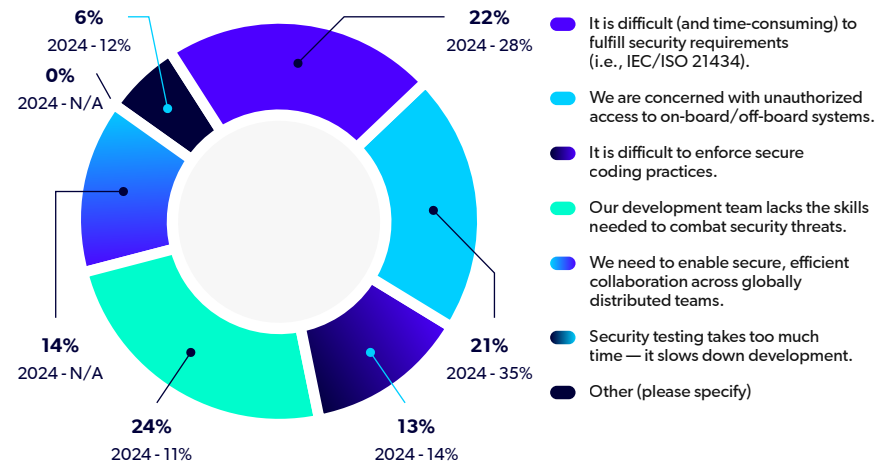- Other.

Security

General

22% of those surveyed cited security as their top concern in automotive software development. Comparing the results to last year's report, the top security concern changed from concerns with "unauthorized access to on-board/off-board systems) to teams "[lacking] the skills needed to combat security threats" (24%), a 13% increase over last year.

This response underlines an overall trend this year, which emphasizes the need to maximize existing resources and educate existing talent to not only remain competitive, but to keep software both safe and secure.

Some respondents (22%) who cited security as their top concern still find it "difficult (and time-consuming) to fulfill security requirements." While security standards like IEC/ISO 21434 are relatively new, those automotive professionals required to meet compliance requirements are increasing — since last year, there was a 14% increase in respondents who are required to comply with IEC/ISO 21434. Shoring up developers' security skillsets will continue to help automotive software development teams to fulfill security requirements and enforce secure coding practices across the organization.
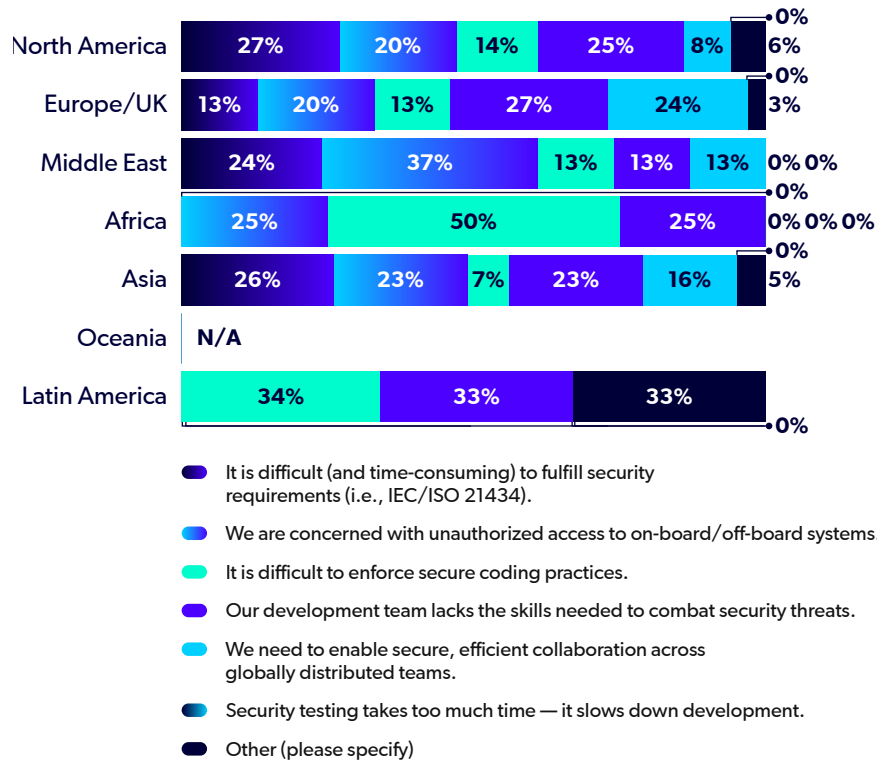
WHICH BEST DESCRIBES YOUR SECURITY CONCERNS?

6%
2024 - 12%

0%
2024 - N/A

22%
2024 - 28%

14%
2024 - N/A

24%
2024 - 11%

21%
2024 - 35%

13%
2024 - 14%

- It is difficult (and time-consuming) to fulfill security requirements (i.e., IEC/ISO 21434).
- We are concerned with unauthorized access to on-board/off-board systems.
- It is difficult to enforce secure coding practices.
- Our development team lacks the skills needed to combat security threats.
- We need to enable secure, efficient collaboration across globally distributed teams.
- Security testing takes too much time — it slows down development.
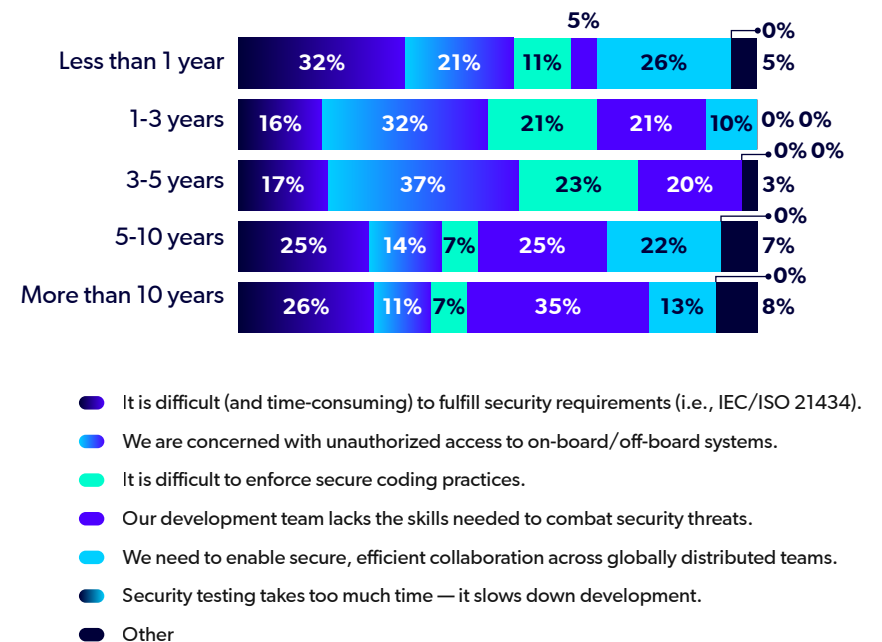- Other (please specify)

Region

When looking at the collected responses by region, North America, the Middle East, and Asia-Pacific regions seem to be having greater concerns over fulfilling security requirements, which may mean that respondents in those regions are not aware of the steps and best practices needed for compliance with such requirements.

Regions across the globe have distinct security concerns, and each one can be effectively addressed through the implementation of a secure software development lifecycle.

Region						
North America	27%	20%	14%	25%	8%	0% 6%
Europe/UK	13%	20%	13%	27%	24%	0% 3%
Middle East	24%	37%	13%	13%	13%	0% 0%
Africa	25%	50%	25%			0% 0% 0%
Asia	26%	23%	7%	23%	16%	0% 5%
Oceania	N/A					
Latin America	34%	33%	33%			0%

- ● It is difficult (and time-consuming) to fulfill security requirements (i.e., IEC/ISO 21434).
- ● We are concerned with unauthorized access to on-board/off-board systems.
- ● It is difficult to enforce secure coding practices.
- ● Our development team lacks the skills needed to combat security threats.
- ● We need to enable secure, efficient collaboration across globally distributed teams.
- ● Security testing takes too much time — it slows down development.
- ● Other (please specify)

Respondent Experience Level

Automotive software professionals with less experience were generally more concerned about being able to "fulfill security requirements." Those in the middle range, with 1-3 years and 3-5 of experience, were more concerned with "unauthorized access to on-board/off-board systems." Whereas respondents with the most experience, 5+ years, were more concerned with security training and their teams "[lacking] the skills needed to combat security threats."

Experience						
Less than 1 year	32%	21%	11%	26%	5%	0% 5%
1-3 years	16%	32%	21%	21%	10%	0% 0%
3-5 years	17%	37%	23%	20%		0% 0% 3%
5-10 years	25%	14%	7%	25%	22%	0% 7%
More than 10 years	26%	11%	7%	35%	13%	0% 8%

- ● It is difficult (and time-consuming) to fulfill security requirements (i.e., IEC/ISO 21434).
- ● We are concerned with unauthorized access to on-board/off-board systems.
- ● It is difficult to enforce secure coding practices.
- ● Our development team lacks the skills needed to combat security threats.
- ● We need to enable secure, efficient collaboration across globally distributed teams.
- ● Security testing takes too much time — it slows down development.
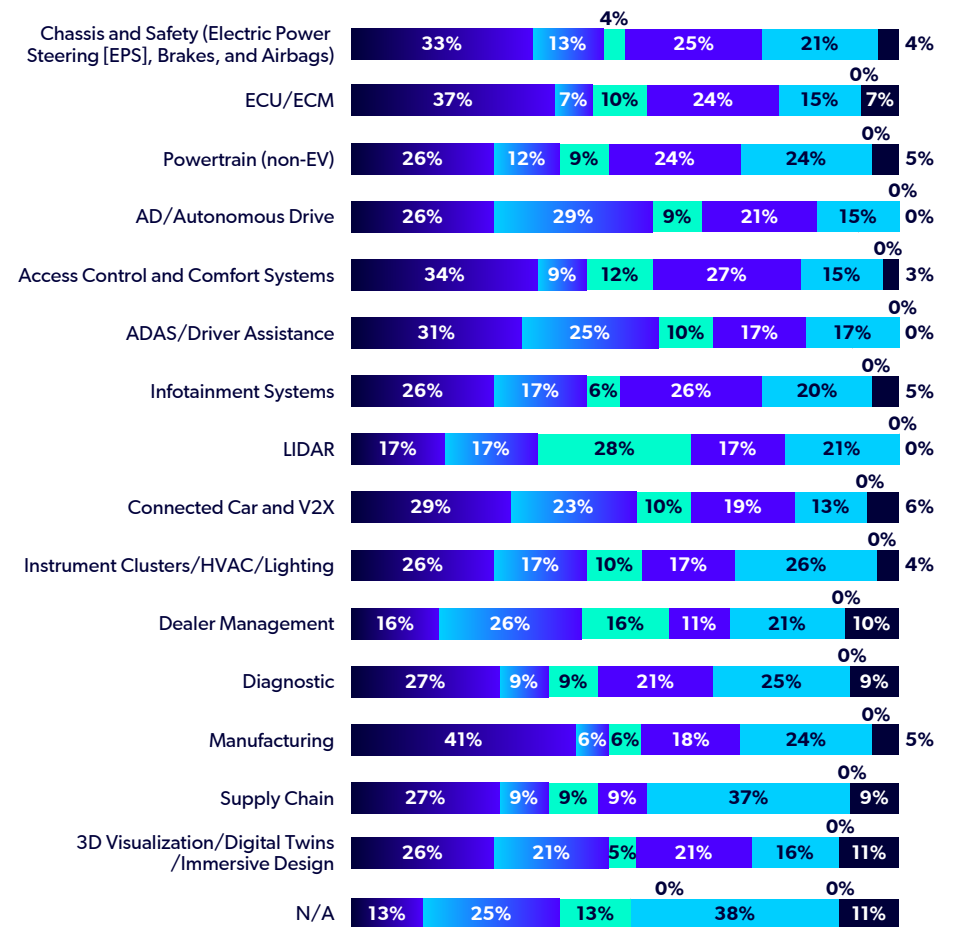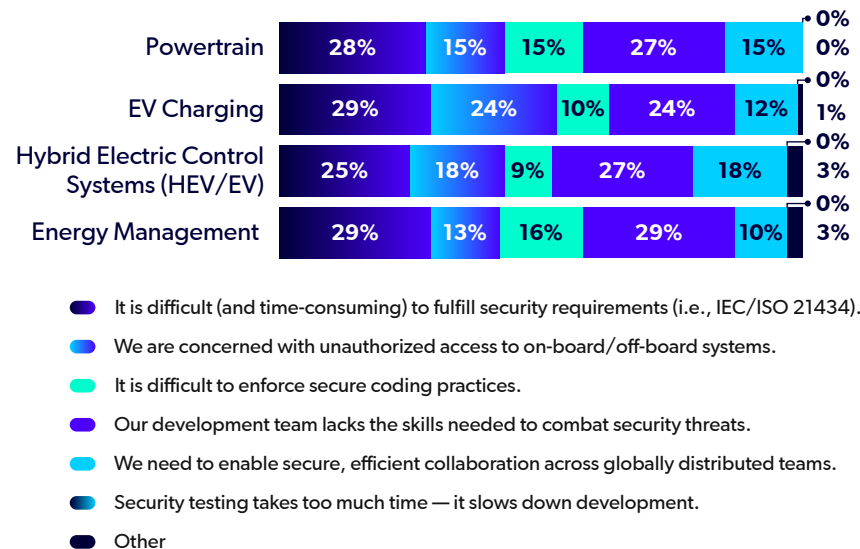- ● Other

Automotive Development Focus (NON-EV)

When looking at the collected responses by automotive development focus, the difficulties "[fulfilling] security requirements" was a top concern among respondents in most non-EV areas.

Respondents working on LiDAR were more concerned about "[enforcing] secure coding practices," while those working on Infotainment were split between "[fulfilling] security requirements" and their teams "[lacking] the skills needed to combat security threats."

Those with Supply Chain concerns cited "[needing] to enable secure, efficient collaboration across globally distributed teams" above other concerns.

Automotive Focus	It is difficult (and time-consuming) to fulfill security requirements	We are concerned with unauthorized access to on-board/off-board systems	It is difficult to enforce secure coding practices	Our development team lacks the skills needed to combat security threats	We need to enable secure, efficient collaboration across globally distributed teams	Security testing takes too much time	Other
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	33%	13%	4%	25%	21%		4%
ECU/ECM	37%	7%	10%	24%	15%	0%	7%
Powertrain (non-EV)	26%	12%	9%	24%	24%	0%	5%
AD/Autonomous Drive	26%	29%	9%	21%	15%	0%	0%
Access Control and Comfort Systems	34%	9%	12%	27%	15%	0%	3%
ADAS/Driver Assistance	31%	25%	10%	17%	17%	0%	0%
Infotainment Systems	26%	17%	6%	26%	20%	0%	5%
LIDAR	17%	17%	28%	17%	21%	0%	0%
Connected Car and V2X	29%	23%	10%	19%	13%	0%	6%
Instrument Clusters/HVAC/Lighting	26%	17%	10%	17%	26%	0%	4%
Dealer Management	16%	26%	16%	11%	21%	0%	10%
Diagnostic	27%	9%	9%	21%	25%	0%	9%
Manufacturing	41%	6%	6%	18%	24%	0%	5%
Supply Chain	27%	9%	9%	9%	37%	0%	9%
3D Visualization/Digital Twins/Immersive Design	26%	21%	5%	21%	16%	0%	11%
N/A	13%	25%	13%	38%	11%	0%	0%

Legend:
- It is difficult (and time-consuming) to fulfill security requirements (i.e., IEC/ISO 21434).
- We are concerned with unauthorized access to on-board/off-board systems.
- It is difficult to enforce secure coding practices.
- Our development team lacks the skills needed to combat security threats.
- We need to enable secure, efficient collaboration across globally distributed teams.
- Security testing takes too much time — it slows down development.
- Other

Automotive Development Focus (EV)

For respondents focusing on electric vehicle components, those working in all areas cited "[fulfilling] security requirements" as their leading concern. However, Energy Management and Powertrain listed a similar amount of concern about teams "[lacking] the skills needed to combat security threats."

Powertrain	28%	15%	15%	27%	15%	0%	0%
EV Charging	29%	24%	10%	24%	12%	0%	1%
Hybrid Electric Control Systems (HEV/EV)	25%	18%	9%	27%	18%	0%	3%
Energy Management	29%	13%	16%	29%	10%	0%	3%

- It is difficult (and time-consuming) to fulfill security requirements (i.e., IEC/ISO 21434).
- We are concerned with unauthorized access to on-board/off-board systems.
- It is difficult to enforce secure coding practices.
- Our development team lacks the skills needed to combat security threats.
- We need to enable secure, efficient collaboration across globally distributed teams.
- Security testing takes too much time — it slows down development.
- Other

Team Productivity

General

10% of those surveyed cited team productivity as their top concern in automotive software development, which was the same percentage as last year's report.

"[Managing] design/development/IP assets to ensure alignment across hardware and software teams in parallel development" (32%) aligns with a similar response level of the top answers last year as a leading productivity concern.

If they have not done so already, automotive software development professionals should consider creating a Software Bill of Materials (SBoM), which is a detailed inventory that lists all software components, modules, libraries, and tools used in the build of a software project. Creating and delivering an SBoM with the product improves alignment between hardware and software teams, allowing both teams to see when a change is made, understand its dependencies, and make their own changes as needed — as well as make changes earlier in the development process, avoid breaks in the hardware or software process, and reduce rework. Many automotive semiconductor design teams already using tools like Perforce IPLM to manage the lifecycle of their IP and provide traceability into IP usage, for example, are now adopting the same tool for their software projects, especially as the Perforce IPLM solution includes the automatic creation and management of the SBoM for these software projects.

The second leading productivity concern, "We are struggling to meet the performance and scalability demands of distributed developers and remote teams working with large, complex assets" (25%), speaks to ever-increasing file sizes and project complexity as well as the shift in market conditions this year —including growing concerns around "outsourcing talent and resources globally" (34%), "shift to remote/hybrid workforce" (25%), and "opening new locations and expanding offices" (20%).

In addition, the concern about "QA cycles [being] long" returned to being more of a concern again, hitting closer to the 2023 percentage point (22% in 2023, 18% in 2025) after a 14% drop last year.

Key areas of concern in regards to team productivity: Managing design, development, and IP assets and ensuring alignment across hardware and software teams; and maintaining productivity among distributed teams with large assets across the globe.

WHICH BEST DESCRIBES YOUR TEAM PRODUCTIVITY CONCERNS?
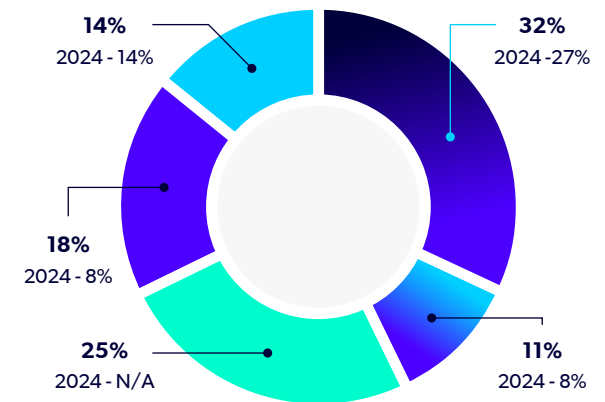
14%
2024 - 14%

32%
2024 - 27%

18%
2024 - 8%

11%
2024 - 8%

25%
2024 - N/A

- We need to manage design/development/IP assets to ensure alignment across hardware and software teams in parallel development.
- Inconsistent, overly complex branching is causing merge conflicts and broken builds, extending release cycles.
- We are struggling to meet the performance and scalability demands of distributed developers and remote teams working with large, complex assets.
- QA cycles are long, so we are often waiting for testing to be complete.
- Other (please specify).

Team Size

While "[managing] design/development/IP assets to ensure alignment across hardware and software teams in parallel development" led overall, when breaking down the top concerns by team size, smaller teams with 1-5 people were most concerned with "[meeting] the performance and scalability demands of distributed developers and remote teams working with large, complex assets," which may mean that they do not have the right tool in place to allow rapid access to assets around the world.

Those respondents working on larger teams of 101-250 cited these scalability demands as just as significant as keeping hardware/software teams aligned, so it may be that, as teams grow, the scalability issues caused by distributed workforces and larger file sizes are compounded by having a larger number of cross-functional team members working simultaneously on the same massive files or assets. To solve this problem, automotive development teams should use a data management tool like Perforce P4 that can scale across all of these dimensions.

Team Size Chart

Team Size					
1-5	10%	36%	18%	36%	
6-20	38%	15%	9%	23%	15%
21-100	32%	8%	24%	32%	4%
101-250	45%	10%	45%	0%	0%
251+	33%	20%	20%	7%	20%

- We need to manage design/development/IP assets to ensure alignment across hardware and software teams in parallel development.

- Inconsistent, overly complex branching is causing merge conflicts and broken builds, extending release cycles.

- We are struggling to meet the performance and scalability demands of distributed developers and remote teams working with large, complex assets.

- QA cycles are long, so we are often waiting for testing to be complete.

- Other

Testing

General

Testing was the leading concern in automotive software development for 8% of those surveyed, similar to last year.

Struggling to test efficiently remained the top testing concern at 31%, a slight increase over last year. An interesting change this year is that while difficulty in "[documenting our automated and manual testing efforts for compliance" remained at a similar percentage (19%) compared to last year, respondents are now just as concerned about "coordinating testing efforts…across global teams" — a 4% increase over last year.

17% of respondents are also concerned about "not testing early enough in development," a decrease of 7% since last year. This is an encouraging sign that more developers are now taking a shift-left approach and testing early, improving code quality from the start and contributing to more efficient testing.

WHICH BEST DESCRIBES YOUR TESTING CONCERNS?

14% 2024 - 14%

31% 2024 - 26%
- We are struggling to test efficiently—testing and software validation are time-consuming.

19% 2024 - 20%
- It is difficult to document our automated and manual testing efforts for compliance.

17% 2024 - 24%
- We are not testing early enough in development, so we find bugs too late.

19% 2024 - 16%
- Coordinating testing efforts is difficult across global teams.

- Other

Organization Size

Medium to Enterprise-sized organizations had difficulty testing efficiently as their top concern. Small-sized organizations had much more difficulty coordinating testing efforts across global teams.

Small (Less than 100 employees)
21% | 11% | 14% | 36% | 18%

Medium (101-999 employees)
32% | 30% | 25% | 11% | 2% | 0%

Large (1000+ employees)
45% | 18% | 10% | 27%

Enterprise (10,000+ employees)
32% | 10% | 10% | 24% | 24%

- ● We are struggling to test efficiently—testing and software validation are time-consuming.
- ● It is difficult to document our automated and manual testing efforts for compliance.
- ● We are not testing early enough in development, so we find bugs too late.
- ● Coordinating testing efforts is difficult across global teams.
- ● Other

Areas of Automotive Software Development

The automotive software industry continues to evolve and adapt to growing market demands. As we can see from the respondents to this survey, today's vehicles are made up of many different software components and development focuses. There were respondents from most of these areas, allowing us to establish some noteworthy trends that emerged in our survey results.

Automotive Development Focus (Non-Electric Vehicle Components)

Automotive software development covers many areas of design and development, from chassis and safety (electric power steering, brakes, airbags) software to ADAS/driver assistance, and software for the supply chain.

The automotive software industry covers all aspects of what makes a vehicle today, from electric components to instruments, and software for the supply chain.

WHAT DOES YOUR DEVELOPMENT TEAM DESIGN (NON-EV)? SELECT ALL THAT APPLY.

Category	Percentage
Chassis and Safety (Electric Power Steering (EPS), Brakes, and Airbags)	25%
ECU/ECM	28%
Powertrain (non-EV)	21%
AD/Autonomous Drive	26%
Access Control and Comfort Systems	16%
ADAS/Driver Assistance	25%
Infotainment Systems	17%
LIDAR	8%
Connected Car and V2X	16%
Instrument Clusters/HVAC/Lighting	15%
Dealer Management	8%
Diagnostic	16%
Manufacturing	13%
Supply Chain	7%
3D Visualization/Digital Twins/Immersive Design	8%
N/A	6%
Other	8%

Adoption & Implementation of Shift-Left

Shift-left strategy refers to processes and tooling to automate testing and security scanning earlier — ideally, as soon as the code is written — within the software development lifecycle (SDLC). Although there is still progress to be made in the automotive software industry, the majority of respondents are at least in the process of implementing it, increasing from 26% to 38% year over year. Considering the increase in testing concerns this year about being able to test more efficiently, more teams implementing a shift-left strategy should help make testing and software development more efficient earlier in the development process.

Those respondents with no plans to implement a shift-left strategy decreased slightly since last year.

The majority of the automotive software industry has adopted or is actively implementing shift-left practices.

SHIFT-LEFT TESTING MOVES TESTING EARLIER IN THE SOFTWARE DEVELOPMENT LIFECYCLE. DOES YOUR ORGANIZATION HAVE A SHIFT-LEFT STRATEGY IN PLACE?

31% 2024 - 33%
38% 2024 - 26%
17% 2024 - 26%
14% 2024 - 16%

- Yes, we have implemented it.
- Yes, we are in the process of implementing it.
- No, we do not but know that it is important.
- No, we do not have a plan to implement it.
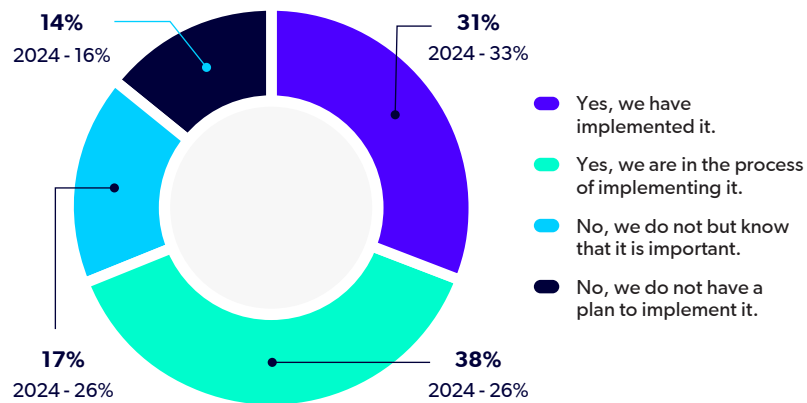
Region

When looking at the respondents who are shifting testing to the left by region, those in North America and the Middle East said that they were in the process of implementing it. Slightly more respondents in Europe/UK have already implemented shift-left into their SDLC. Those in the Asia-Pacific and Latin America regions do not currently have a shift-left strategy in place, but they know that it is important.
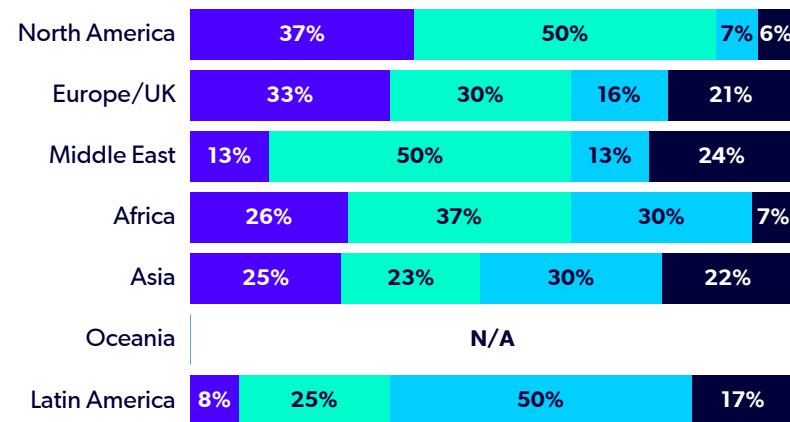
Region	Yes, we have implemented it.	Yes, we are in the process of implementing it.	No, we do not but know that it is important.	No, we do not have a plan to implement it.
North America	37%	50%	7%	6%
Europe/UK	33%	30%	16%	21%
Middle East	13%	50%	13%	24%
Africa	26%	37%	30%	7%
Asia	25%	23%	30%	22%
Oceania	N/A			
Latin America	8%	25%	50%	17%

- Yes, we have implemented it.
- Yes, we are in the process of implementing it.
- No, we do not but know that it is important.
- No, we do not have a plan to implement it.

Organization Size

Organizations of all sizes have already shifted left or are at least in the process of implementing it.

Organization	Yes, implemented	Yes, in process	No, but important	No plan
Small (Less than 100 employees)	36%	26%	21%	17%
Medium (101-999 employees)	24%	53%	13%	10%
Large (1000+ employees)	27%	34%	23%	16%
Enterprise (10,000+ employees)	40%	27%	15%	18%

- Yes, we have implemented it.
- Yes, we are in the process of implementing it.
- No, we do not but know that it is important.
- No, we do not have a plan to implement it.
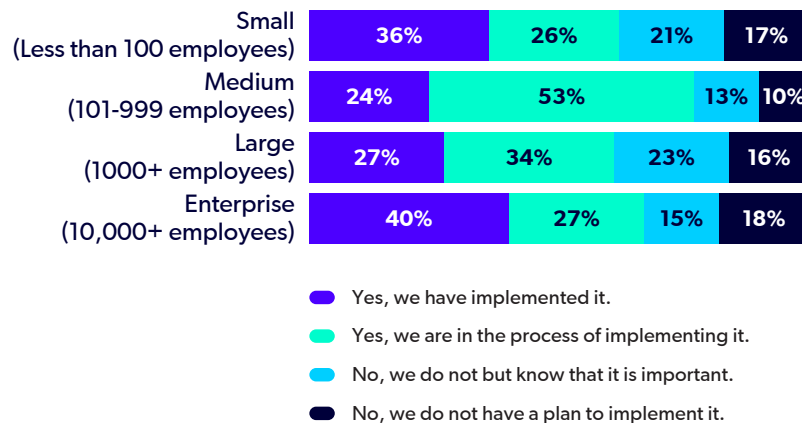
Automotive Development Focus (NON-EV)

Most areas of non-EV automotive development have either already adopted or are in the process of adopting a shift-left strategy.

Area	Yes, implemented	Yes, in process	No, but important	No plan
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	41%	41%	10%	8%
ECU/ECM	30%	39%	17%	14%
Powertrain (non-EV)	34%	46%	11%	9%
AD/Autonomous Drive	36%	45%	13%	6%
Access Control and Comfort Systems	28%	46%	18%	8%
ADAS/Driver Assistance	39%	35%	16%	10%
Infotainment Systems	44%	29%	16%	11%
LIDAR	33%	40%	15%	12%
Connected Car and V2X	35%	33%	16%	17%
Instrument Clusters/HVAC/Lighting	39%	36%	15%	10%
Dealer Management	37%	37%	20%	6%
Diagnostic	37%	31%	21%	11%
Manufacturing	29%	32%	21%	18%
Supply Chain	33%	29%	19%	19%
3D Visualization/Digital Twins/Immersive Design	37%	31%	21%	11%
N/A	25%	22%	13%	40%

- Yes, we have implemented it.
- Yes, we are in the process of implementing it.
- No, we do not but know that it is important.
- No, we do not have a plan to implement it.

Automotive Development Focus (EV)

Similarly, those working in electric vehicle areas have either already shifted left or are in the process of shifting left. As electric vehicle development projects are more recent due to newer technologies, more respondents may have implemented shift-left testing from the start compared to non-EV component projects, but compared to last year it appears that the non-EV components are now catching up and testing earlier in development at similar percentages to the EV components.

	Yes, implemented	Yes, in process	No, but important	No, no plan
Powertrain	43%	37%	12%	8%
EV Charging	32%	40%	17%	11%
Hybrid Electric Control Systems (HEV/EV)	32%	50%	13%	5%
Energy Management	39%	32%	18%	11%

- Yes, we have implemented it.
- Yes, we are in the process of implementing it.
- No, we do not but know that it is important.
- No, we do not have a plan to implement it.
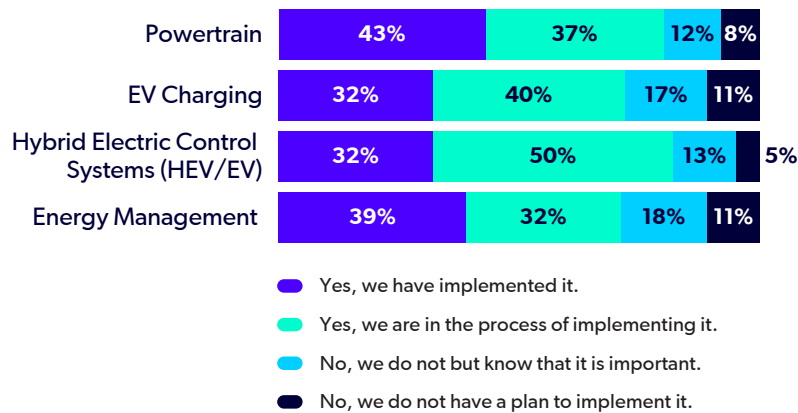
Code Vulnerabilities

Code Vulnerability

Similar to last year's report, most automotive software professionals were not impacted by a code vulnerability. However, there was a slight increase in those who have been impacted several and many times, and a 4% increase in those who have been impacted once.

There are many common software vulnerabilities such as injection, broken access control, and server-side request forgery that malicious actors can exploit to their advantage. Even one code vulnerability can cause significant security issues, sometimes enough to compromise a whole system. The most efficient way to prevent code vulnerabilities is to use static analysis tools that keep code quality high, detect vulnerabilities early in the development lifecycle, and enforce security standards.

HAS YOUR ORGANIZATION BEEN IMPACTED BY A CODE VULNERABILITY?

11% 2024 - 19%
10% 2024 - 9%
20% 2024 - 19%
43% 2024 - 42%
16% 2024 - 12%

- Yes, we have been impacted many times.
- Yes, we have been impacted several times.
- Yes, we have been impacted once.
- No, we have not been impacted.
- I don't know.

ORGANIZATION TYPE

OEM	23%	14%	11%	41%	11%
Tier 1	6%	22%	17%	43%	12%
Tier 2	12%	30%	22%	29%	7%
Tier 3	5%	15%	23%	46%	11%

- Yes, we have been impacted many times.
- Yes, we have been impacted several times.
- Yes, we have been impacted once.
- No, we have not been impacted.
- I don't know.

Preventing Vulnerabilities with Secure Coding Standards

Secure coding standards help developers detect vulnerabilities in their code. Many respondents use CERT, CWE, and OWASP to identify bugs and assess risks during automotive software development. CERT had the highest percentage (66%) of use among respondents. This is probably due to CERT being an easy-to-use coding standard, which helps with the general prevention of vulnerabilities. CWE and OWASP help detect known vulnerabilities.

HOW DO YOU DETECT SOFTWARE VULNERABILITIES? SELECT ALL THAT APPLY.

CERT	CWE	OWASP	Other
66% 2024 - 63%	37% 2024 - 34%	37% 2024 - 29%	8% 2024 - 10%
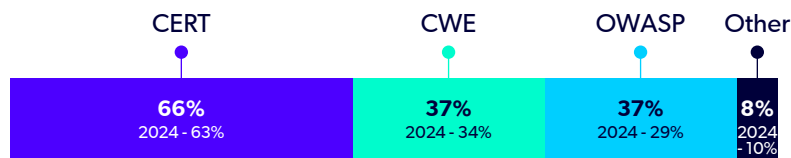
Automotive Software Security

As more software is added to vehicles, enforcing software security is more important than ever before.

The Leading Automotive Software Security Challenges

Like last year, "meeting regulations requiring cybersecurity approval" was the leading software security challenge (39%) and "enforcing secure coding practices" was the second most cited security challenge (30%). This is not surprising, as security for automotive software is a newer requirement compared to safety. Static analysis tools are essential for meeting today's security requirements.

Meeting software security requirements and enforcing secure coding practices are the leading challenges for automotive software security.

WHAT IS YOUR BIGGEST AUTOMOTIVE SOFTWARE SECURITY CHALLENGE?

Enforcing secure coding practices.	Meeting regulations requiring cybersecurity approval.	Delivering software security updates.	Investing in a DevSecOps culture.
30% 2024 - 28%	39% 2024 - 41%	19% 2024 - 14%	10% 2024 - 13%

Other 2% (2024 - 4%)

A Culture of Software Security Is Growing

To meet software security requirements and enforce secure coding practices, the majority of those we surveyed stated that they are provided with tools and/or are given software security training — a 12% increase over last year, which makes up for the 11% decrease from 2023 to 2024. The trend of security training and general employee education this year is likely putting development teams back on track.

DOES YOUR ORGANIZATION OFFER SECURITY TRAINING FOR DEVELOPERS?

8%
2024 - 12%

16%
2024 - 24%

76%
2024 - 64%

- ● Yes, we provide tools and/or training.
- ● No, we do not.
- ● I don't know.
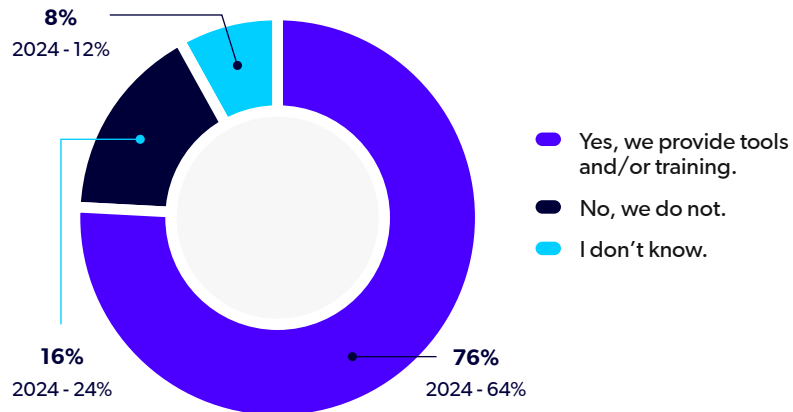
How Are Changes in Electric, Autonomous, and Connected Vehicles Affecting Developers?

In recent years, the automotive industry has been expanding and evolving to include electric, autonomous, semi-autonomous, and connected vehicles. With changes to electric vehicle adoption, market volatility, new legislation, and new technologies such as artificial intelligence and machine learning being introduced to the design and development process for autonomous and connected vehicles, development teams will face unfamiliar challenges and new opportunities for innovation in 2025 and beyond.

Electric Vehicle Development Cools in Some Areas, Ramps Up in Others

The EV market is constantly changing. Some countries, such as the US, are reversing EV directives and loosening environmental restrictions, halting funds and slowing EV infrastructure. At the same time, S&P reports that many automotive companies are considering scaling back their EV goals as early adopters are now exhausted and demand is slowing.

Despite this volatility of the market, electric vehicle sales continue to rise globally. In 2024, over 17 million electric and plug-in hybrid vehicles were sold, growing by 25% from 2023 to 2024. If this trend continues, more than 20 million EV cars will be sold in 2025.

China seems to be ramping up EV development and production. China led EV growth in 2024, accounting for nearly 80% of global EV growth sales and exceeding 1 million monthly EV unit sales for the first time in August 2024.

Maintaining industry competitiveness will be key for global companies producing electric vehicles and EV components as Chinese carmakers begin to export at scale. Already, European and US auto manufacturers are trying to bring development costs down and lower prices for consumers to remain competitive with China, Reuters reports.

While most automotive professionals who responded to our survey are still extensively working on electric vehicles, there was a slight decrease of 4% compared to last year. More respondents are now working on some electric components than last year, a 6% increase, and those who are not at all working on EVs decreased by 2%.

More automotive software developers are working somewhat on EVs because there is more legislation being developed around the world and new entrants to the global market; however, just like the market, legislation is frequently changing and varies from country to country.

Larger impact of electric vehicles in product development and design. 39% of automotive development teams are now working on some electronic vehicle components.

TO WHAT DEGREE HAVE ELECTRIC VEHICLES IMPACTED YOUR PRODUCT DESIGN?

14%
2024 - 16%

39%
2024 - 33%

47%
2024 - 51%

- Extensively — Electric vehicles are driving our design.
- Somewhat — We are working on some electric components.
- Not at all — We are not working on electric vehicles today.
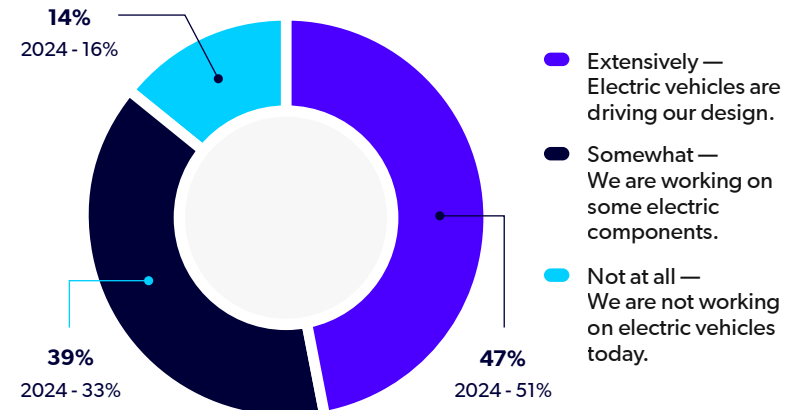
Region

A majority of the responses by region indicated that they are at least somewhat, if not extensively, impacted by electric vehicle and EV components design.

Region	Extensively	Somewhat	Not at all
North America	56%	38%	6%
Europe/UK	42%	39%	19%
Middle East	25%	54%	21%
Africa	38%	43%	19%
Asia	42%	39%	19%
Oceania	100%		0%
Latin America	50%	17%	33%

- Extensively — Electric vehicles are driving our design.
- Somewhat — We are working on some electric components.
- Not at all — We are not working on electric vehicles today.
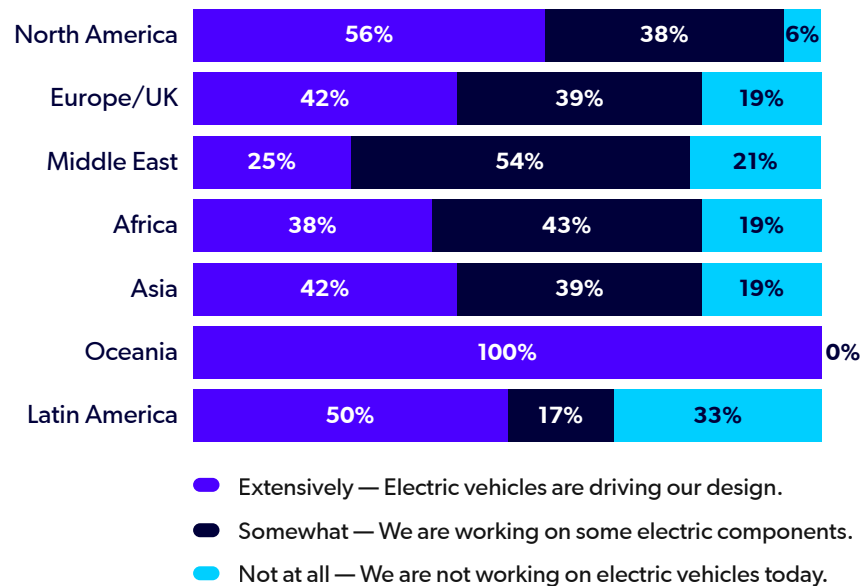
Organization Size

When breaking down EV development by organization size, respondents from all-sized organizations said that they are now actively working on electric vehicles, in a similar trend from last year.

Organization Size	Extensively	Somewhat	Not at all
Small (<100 employees)	43%	40%	17%
Medium (101-999 employees)	49%	41%	10%
Large (1000+ employees)	46%	39%	15%
Enterprise (10,000+ employees)	51%	32%	17%

- Extensively — Electric vehicles are driving our design.
- Somewhat — We are working on some electric components.
- Not at all — We are not working on electric vehicles today.
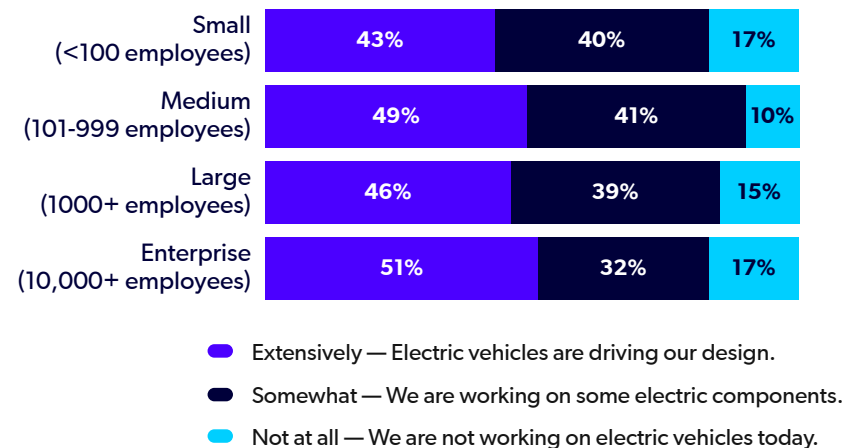
Organization Type

Respondents from OEMs and Tier 3 suppliers are extensively working on electric vehicles, while Tier 1 and Tier 2 suppliers are working on some electric components. Typically, OEMs are the ones designing and assembling vehicles with EVs built in from the design, while Tier 1-3 suppliers provide the parts needed for the OEM design. Overall, the majority of respondents from all organizations are working on some EV/EV component, indicating that EV production is increasing.

	Extensively	Somewhat	Not at all
OEM	69%	23%	8%
Tier 1	40%	46%	14%
Tier 2	41%	48%	11%
Tier 3	47%	38%	15%

● Extensively — Electric vehicles are driving our design.

● Somewhat — We are working on some electric components.

● Not at all — We are not working on electric vehicles today.
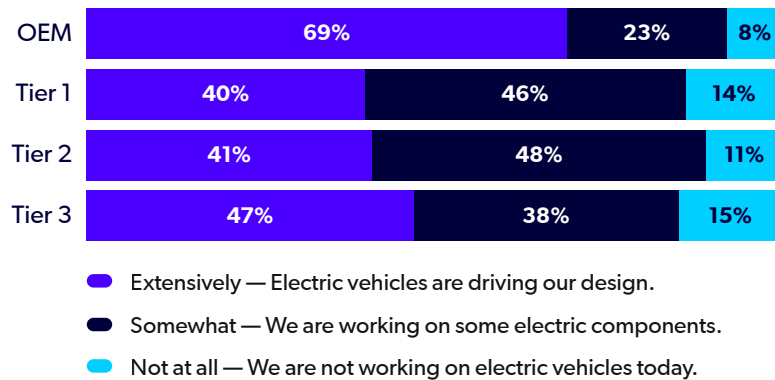
Automotive Development Focus (Electric Vehicle Components)

Automotive software development of electric vehicle components includes Powertrain, EV Charging, Hybrid Electric Control Systems (HEV/EV), and Energy Management. Most respondents who are actively working on electric vehicles are working on all of these areas of automotive development focus.

WHAT DOES YOUR DEVELOPMENT TEAM DESIGN (ELECTRIC VEHICLE COMPONENTS)? SELECT ALL THAT APPLY.

Component	2025	2024
Powertrain	33%	41%
EV Charging	38%	41%
Hybrid Electric Control Systems (HEV/EV)	51%	44%
Energy Management	25%	N/A
Other	9%	15%
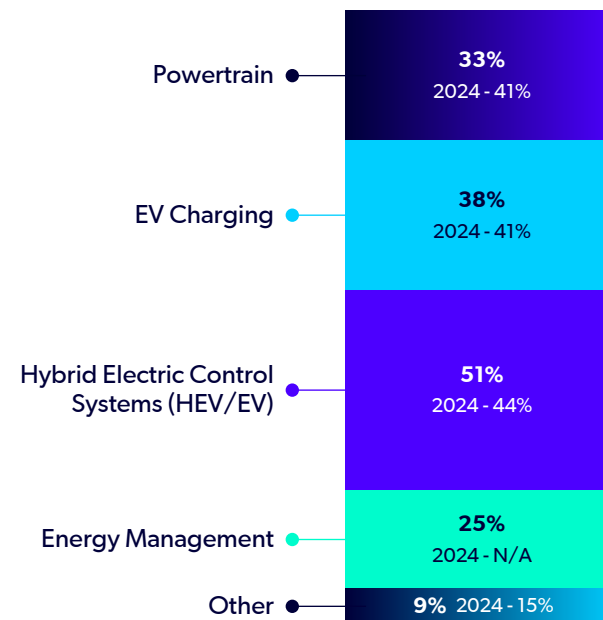
Leading Concerns About Electric Vehicle Development

For electric vehicles, where many hardware components have been replaced by software electronic devices, it is essential that the software is compliant with key functional safety and security standards.

That may be why complying with regulations to ensure safety remained the top concern with the same percentage as last year (40%) citing it as "very concerning." Security and avoiding cyberattacks was the second leading concern for 25% of respondents, also similar to the 2024 report. These results correlate with the trend that embedded safety and security continue to be important as developers focus on education and compliance training in these areas.

The leading concerns of electric vehicle development are ensuring safety and security.

Category	Very Concerning	Concerning	Somewhat Concerning	Not Concerning
Safety — Complying with Regulations	40%	34%	17%	9%
Security — Avoiding Cyberattacks	25%	28%	28%	19%
Time-to-Market — Delivering Innovative Software on Time	17%	19%	31%	33%
Development Costs — Keeping Them Under Control	18%	19%	24%	39%

● Very Concerning ● Concerning ● Somewhat Concerning ● Not Concerning
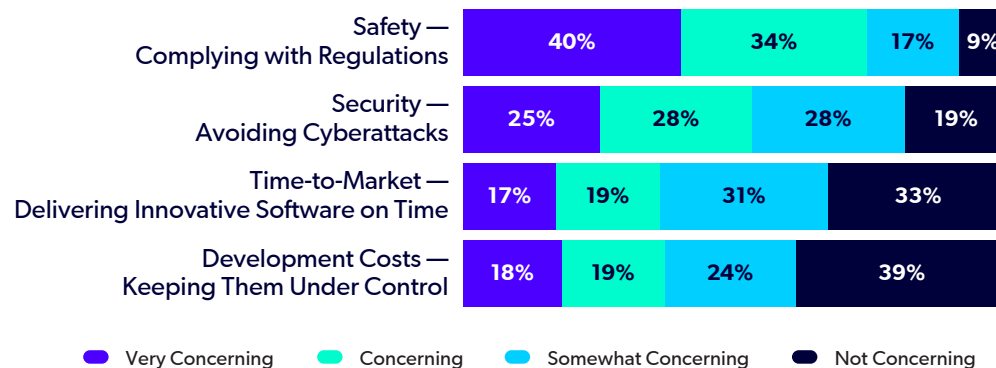
AI for Autonomous Vehicles Is Here

The automotive industry has continued to make steady progress on the development of fully autonomous vehicles, but they are still not quite ready. However, the introduction of AI is changing the autonomous vehicle landscape. For this year's report, the autonomous vehicle question has been rephrased to reflect AI/ML impact on autonomous vehicle design.

This year, the majority of respondents (42%) are actively using AI to design a fully autonomous vehicle. AI is affecting some autonomous components for 38% of respondents. Comparing year over year, 5% more people are working on autonomous vehicles/implementing AI in autonomous vehicles today. It is unknown whether developing semi-autonomous and fully autonomous vehicles will continue to be a work in progress with AI/ML now assisting in the design and development process, or if the focus will shift elsewhere.

TO WHAT DEGREE HAS AI AND/OR ML IMPACTED YOUR AUTONOMOUS VEHICLE PRODUCT DESIGN?

20%
2024 - 25%

38%
2024 - 42%

42%
2024 - 33%

- Extensively — We are focused on using AI to design a fully autonomous vehicle.
- Somewhat — AI is affecting some autonomous components.
- Not at all — We are not implementing AI in autonomous vehicles today
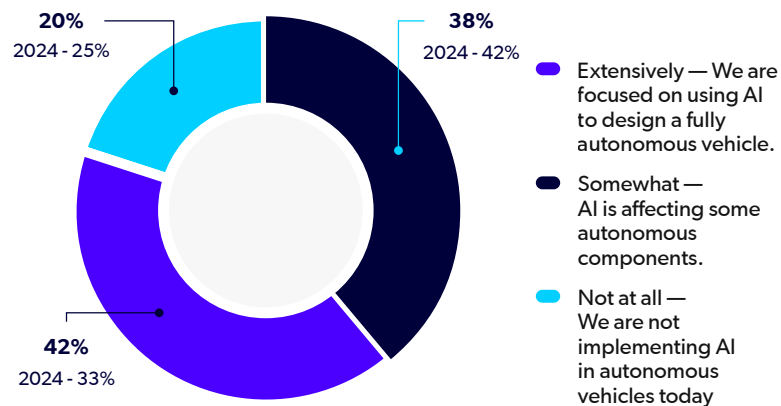
Region

When looking at the collected responses by region, respondents in North America, the Middle East, Africa, and Oceania are extensively using AI in autonomous vehicle design. Respondents in Europe/UK, Asia, and Latin America said that AI is affecting some autonomous components.
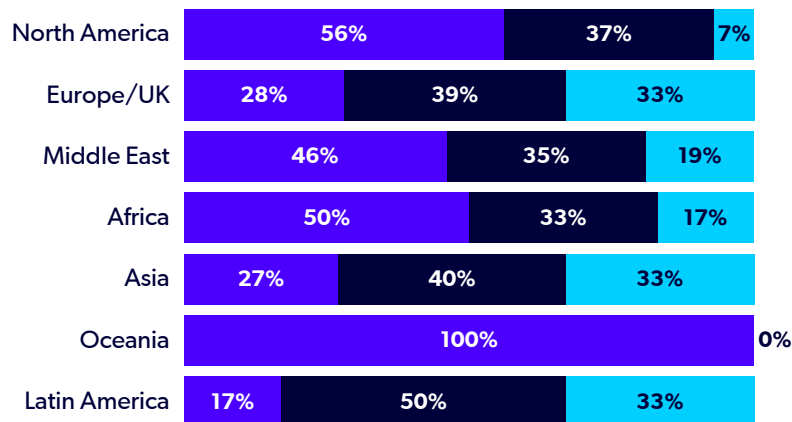
Region	Extensively	Somewhat	Not at all
North America	56%	37%	7%
Europe/UK	28%	39%	33%
Middle East	46%	35%	19%
Africa	50%	33%	17%
Asia	27%	40%	33%
Oceania	100%		0%
Latin America	17%	50%	33%

- Extensively — We are focused on using AI to design a fully autonomous vehicle.
- Somewhat — AI is affecting some autonomous components.
- Not at all — We are not implementing AI in autonomous vehicles today.

AI in Connected Vehicles

Connected vehicles have become the norm, as most vehicles now feature built-in connectivity. Last year, many of our respondents were working on connected vehicles, but as most connected vehicles are now on the market, there is less of a developmental need for them. This could be why the introduction of AI in connected vehicle design/development drew similar results from our respondents as last year, when we asked more generally about connected vehicles impacting product design.

TO WHAT DEGREE HAS AI AND/OR ML IMPACTED YOUR CONNECTED VEHICLE PRODUCT DESIGN?

20%
2024 - 21%

39%
2024 - 39%

41%
2024 - 40%

● Extensively — AI is driving our connected vehicle design.

● Somewhat — AI is affecting some connectivity components.

● Not at all — We are not implementing AI in connected vehicles today.
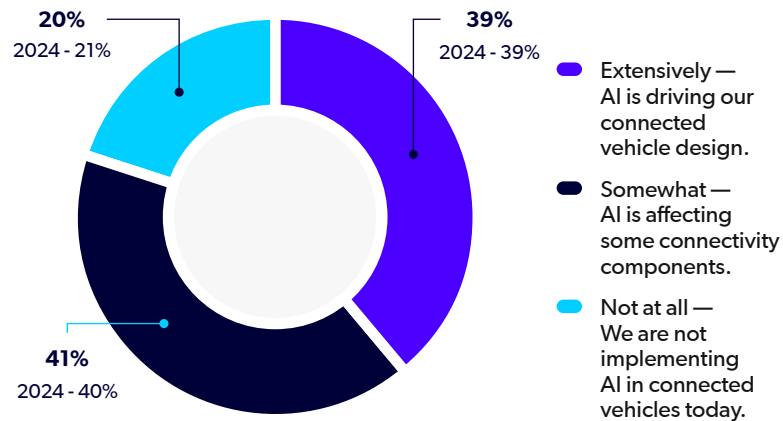
Region

When looking at the collected responses by region, a majority of respondents indicated that AI is affecting some connectivity components. North America appears to be ahead in this sense in AI driving connected vehicle design (53%).

	Extensively	Somewhat	Not at all
North America	53%	40%	7%
Europe/UK	29%	40%	31%
Middle East	19%	54%	27%
Africa	42%	50%	8%
Asia	27%	36%	37%
Oceania	100%		0%
Latin America	17%	58%	25%

● Extensively — AI is driving our connected vehicle design.

● Somewhat — AI is affecting some connectivity components.

● Not at all — We are not implementing AI in connected vehicles today.
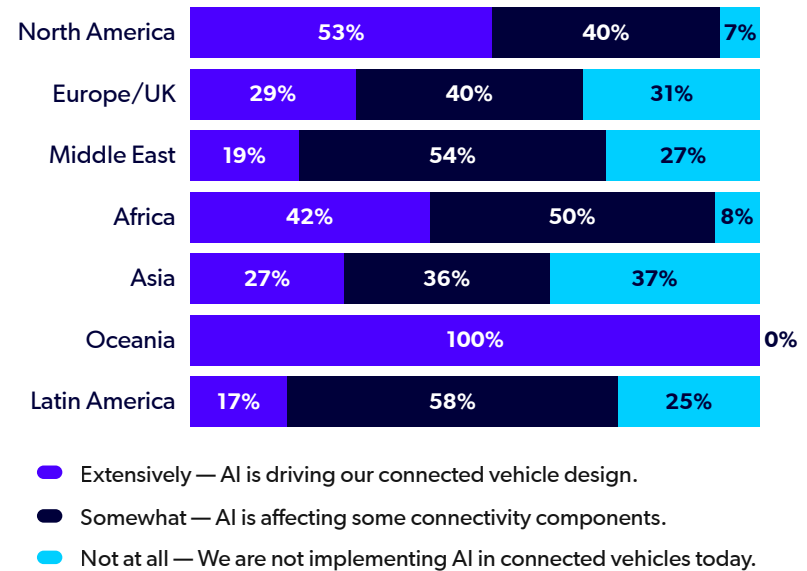
Automotive Development Focus (NON-EV)

Breaking down the responses by automotive development focus, respondents are extensively using AI in many of the non-EV areas. AI is affecting some connectivity components in ECU/ECM, Powertrain, Dealer Management, and Manufacturing.
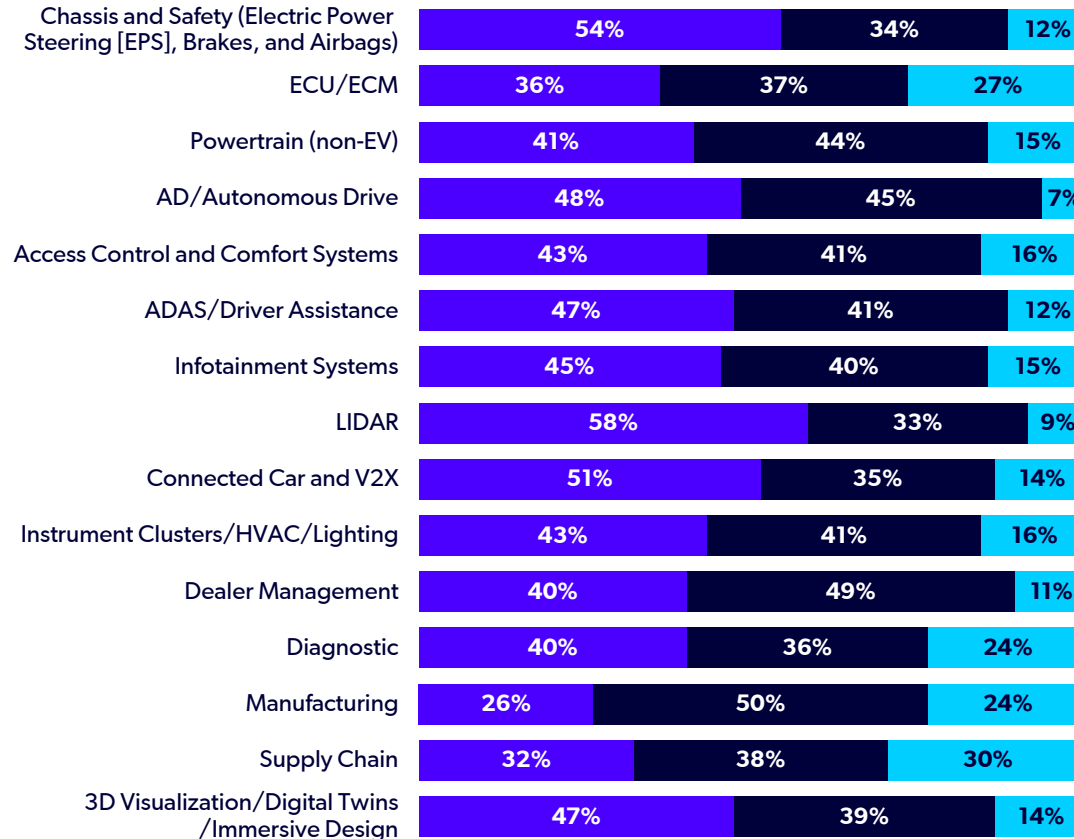
Category	Extensively	Somewhat	Not at all
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	54%	34%	12%
ECU/ECM	36%	37%	27%
Powertrain (non-EV)	41%	44%	15%
AD/Autonomous Drive	48%	45%	7%
Access Control and Comfort Systems	43%	41%	16%
ADAS/Driver Assistance	47%	41%	12%
Infotainment Systems	45%	40%	15%
LIDAR	58%	33%	9%
Connected Car and V2X	51%	35%	14%
Instrument Clusters/HVAC/Lighting	43%	41%	16%
Dealer Management	40%	49%	11%
Diagnostic	40%	36%	24%
Manufacturing	26%	50%	24%
Supply Chain	32%	38%	30%
3D Visualization/Digital Twins /Immersive Design	47%	39%	14%

- **Extensively** — AI is driving our connected vehicle design.
- **Somewhat** — AI is affecting some connectivity components.
- **Not at all** — We are not implementing AI in connected vehicles today.

Automotive Development Focus (EV)

Breaking down the responses by automotive development focus for electric vehicle components, there is extensive AI use in connected vehicle design for Powertrain and EV charging; and AI is affecting some connectivity components for HEV/EV and Energy Management.

Powertrain	51%	32%	17%
EV Charging	46%	41%	13%
Hybrid Electric Control Systems (HEV/EV)	44%	45%	11%
Energy Management	41%	45%	14%

● Extensively — AI is driving our connected vehicle design.

● Somewhat — AI is affecting some connectivity components.

● Not at all — We are not implementing AI in connected vehicles today.
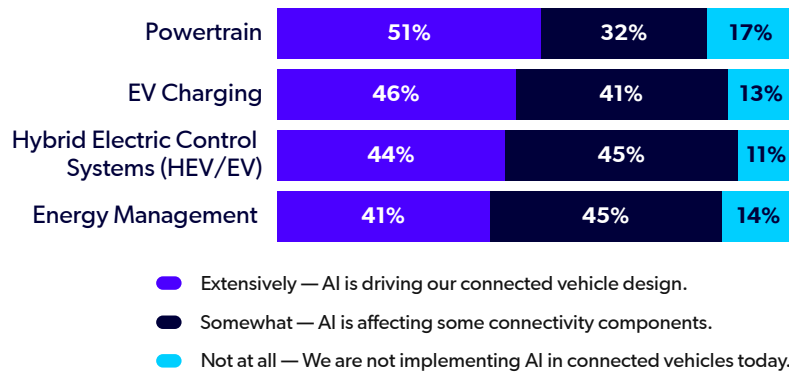
Leading Concerns in AI Vehicle Development

As AI use increases in the design and development of automotive software, various concerns arise, especially as regulations and guidance around AI are still being developed. Automotive software teams are under pressure to compete in the shifting market and therefore must deliver a quality product on time — while keeping costs down and ensuring safety and security.

Safety and "Safe decision-making for AI algorithms in autonomous/semi-autonomous vehicles" was the leading concern in AI vehicle development (49%). Development teams who are guided by functional safety standards need

to employ additional considerations when using AI as the algorithms tend to be non-deterministic. Fortunately, existing standards are already being adapted and new standards like ISO/DPAS 8800, "Road vehicles—safety and artificial intelligence" are being introduced. In addition, techniques are already available that can be applied to AI algorithms, but there is still much work to be done to ensure and enforce autonomous vehicle safety with AI technology.

Security, specifically "avoiding vulnerabilities and cyberattacks with the introduction of advanced AI," was the second most-concerning issue for the survey respondents. Connected systems with increasingly complex technologies like those used for AI create many more attack vectors, which bad actors could then exploit. As for safety, there are numerous security standards and regulations that can and are being adapted for the inclusion of AI.

Time-to-market and development costs fell somewhere in the middle as concerns about AI in vehicle development. Once safety and security issues are addressed, organizations developing automotive software with AI may be able to focus more on this side of industry competitiveness.

It is interesting that the use of generative AI and "keeping code quality high when written by AI tools" is the least concerning for respondents, when quality was the overall leading automotive development concern in this report. It is possible that respondents are assuming that AI contributes to better quality code.

AI VEHICLE DEVELOPMENT CONCERNS, RANKED

Safety — Safe Decision-Making for AI Algorithms in Autonomous/Semi-Autonomous Vehicles: 49% | 27% | 10% | 8% | 5%

Security — Avoiding Vulnerabilities and Cyberattacks with the Introduction of Advanced AI Technologies: 1% | 26% | 37% | 20% | 10% | 4%

Time-to-Market — Delivering Innovative Software on Time and Avoiding Recalls/Delays: 3% | 11% | 19% | 33% | 16% | 12% | 9%

Development Costs — Balancing AI/ML Costs with the Efficiency These Tools Provide: 10% | 10% | 22% | 37% | 15% | 6%

Predictive Maintenance and Vehicle Diagnostics — Getting Accurate Results: 1% | 9% | 20% | 46% | 21% | 3%

Generative AI — Keeping Code Quality High When Written by AI Tools: 3% | 6% | 10% | 17% | 60% | 4%

Legend:
- Extremely Concerning
- Very Concerning
- Concerning
- Somewhat Concerning
- Mildly Concerning
- Not Concerning

Additionally, the "Other" responses give an interesting overview of the specific functional areas where AI/ML are used, rather than just the components (e.g., image recognition and tracking reports). They are also used for data management in the cloud and resource optimization within the components.

Notable "Other" responses included:

- ECU and BMS
- Java development
- Code migration
- Sensing data fusion
- Cluster
- PLM and ALM infrastructure building
- TARA
- HARA
- Test coverage
- Security/Cybersecurity
- Energy cost reduction
- Mobile telematics
- IPG CarMaker-based end-to-end simulation-based L4 and L5 systems OEDR module
- 4D Imaging Radar
- Battery management systems.

A Closer Look at AI/ML Use in Automotive Software Development

Respondents who are using AI/ML in automotive software development were asked specifically between certain areas of automotive development focus. Most of those surveyed were focusing on AI/ML in ADAS, a decrease of 16% since last year. Those focusing on AI/ML in In-Vehicle Infotainment (IVI) systems increased by 8% over last year. AI/ML use also increased in LiDAR by 3%.

HOW ARE YOU USING AI/ML IN AUTOMOTIVE SOFTWARE DEVELOPMENT? SELECT ALL THAT APPLY.

ADAS	LIDAR	In-Vehicle Infotainment (IVI) systems
52% 2024 - 68%	**36%** 2024 - 33%	**48%** 2024 - 40%

Other **6%** 2024 - 10%
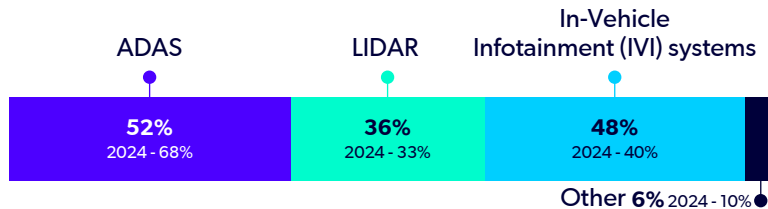
New Automotive AI Standard Accounts for Safety

The recently published ISO/DPAS 8800 standard addresses AI-specific challenges for the functional safety for all road vehicles.

ISO/DPAS 8800, "ROAD VEHICLES — SAFETY AND ARTIFICIAL INTELLIGENCE" IS A NEW STANDARD CURRENTLY IN DEVELOPMENT. WILL THIS STANDARD BE IMPORTANT TO YOUR TEAM IN THE FUTURE?

Yes	No	I don't know
71%	**6%**	**23%**

Why Standards Compliance Remains Vital for Automotive Development

The Automotive Industry Remains Highly Regulated

All vehicle components — regardless of whether they are for autonomous/ semi-autonomous, electric, connected, or traditional vehicles — have safety and security requirements, but the level of coverage varies depending on the functionality of the component. However, for all levels, ensuring that software is compliant with key industry coding standards and guidelines is an essential part of the automotive software development process for all types of vehicles.

ISO 26262 Is Still Key

ISO 26262 is a key functional safety standard for the automotive industry. A majority of those we surveyed are required to comply with ISO 26262, increasing from 77% to 83% over last year.

17% 2024 - 23%

83% 2024 - 77%

- Yes
- No
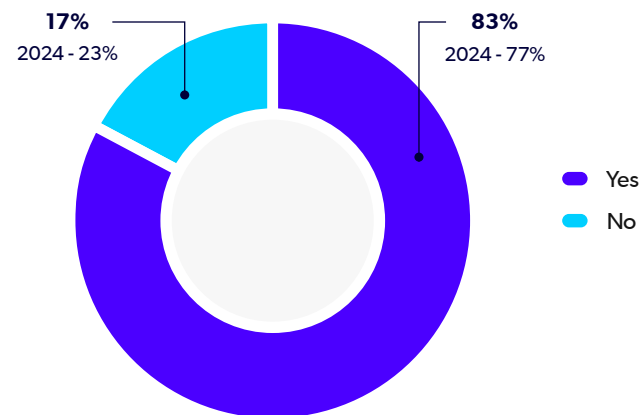
Why Developers Need to Comply With ISO 26262

For those who need to comply with ISO 26262:

- 45% need to comply due to a market requirement, an increase of 10% over last year.

- 40% need to comply due to a customer requirement, a decrease of 8% over last year.

- 14% have an internal requirement, a decrease of 3% over last year.

WHY DO YOU NEED TO COMPLY WITH ISO 26262?

14%
2024 -17%

1%
2024 - 0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

40%
2024 - 48%

45%
2024 - 35%
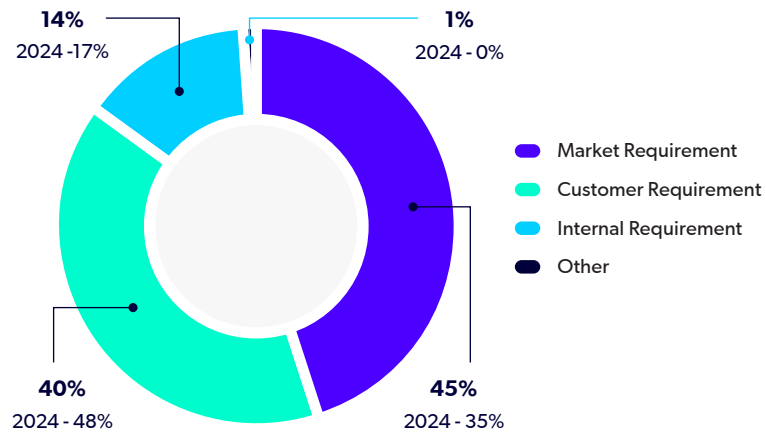
Organization Type

The type of organization matters for ISO 26262 compliance. Suppliers (Tiers 1-3) had a higher customer requirement to ensure components compliance with ISO 26262 because OEMs are their customers, while OEMs had a higher market requirement to comply with the standard.

	Market	Customer	Internal	Other
OEM	66%	16%	18%	0%
Tier 1	43%	44%	12%	1%
Tier 2	37%	45%	18%	0%
Tier 3	32%	60%	8%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other
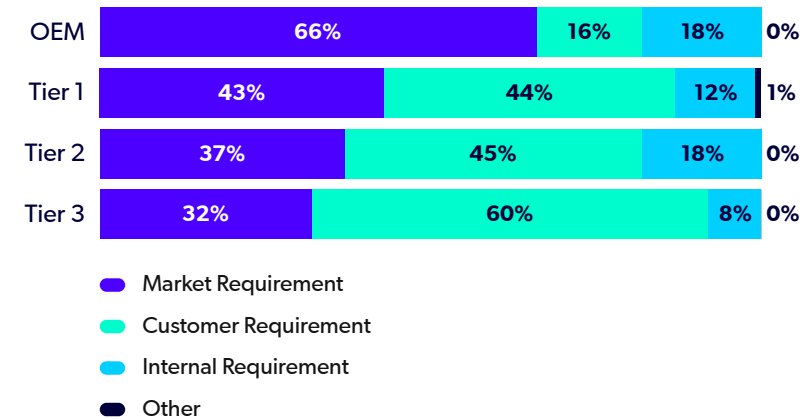
Region

ISO 26262 compliance is a nearly universal expectation, yet the reasoning for its compliance differs. For example, most regions' respondents cited that ISO 26262 is a customer requirement, whereas the majority of respondents from North America (53%) were from OEMs who said that it was a market requirement.
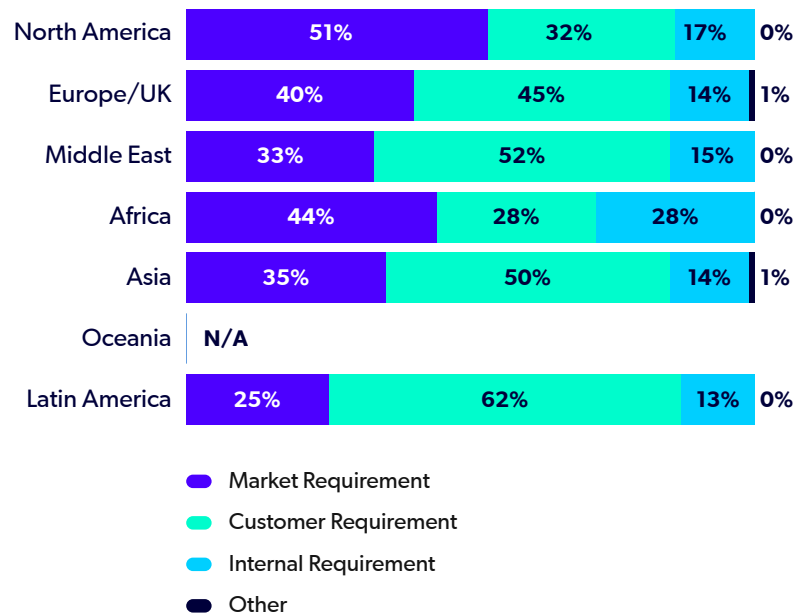
Region	Market Requirement	Customer Requirement	Internal Requirement	Other
North America	51%	32%	17%	0%
Europe/UK	40%	45%	14%	1%
Middle East	33%	52%	15%	0%
Africa	44%	28%	28%	0%
Asia	35%	50%	14%	1%
Oceania	N/A			
Latin America	25%	62%	13%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

Automotive Development Focus (NON-EV)

When looking at the collected responses by automotive development focus, the leading reason for ISO 26262 compliance was that it was a customer requirement for most non-EV components. The market requirement included Chassis and Safety, ECU/ECM, Powertrain, AD/Autonomous Drive, and LiDAR.

Focus	Market Requirement	Customer Requirement	Internal Requirement	Other
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	55%	33%	12%	0%
ECU/ECM	46%	43%	9%	2%
Powertrain (non-EV)	42%	41%	17%	0%
AD/Autonomous Drive	50%	32%	18%	0%
Access Control and Comfort Systems	40%	41%	19%	0%
ADAS/Driver Assistance	37%	46%	16%	1%
Infotainment Systems	33%	51%	15%	1%
LIDAR	48%	41%	10%	1%
Connected Car and V2X	38%	50%	11%	1%
Instrument Clusters/HVAC/Lighting	36%	45%	18%	1%
Dealer Management	28%	50%	19%	3%
Diagnostic	39%	49%	11%	1%
Manufacturing	36%	48%	14%	2%
Supply Chain	40%	44%	16%	0%
3D Visualization/Digital Twins /Immersive Design	37%	46%	17%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

Automotive Development Focus (EV)

For EV components, Powertrain and HEV/EV components cited the leading reason for ISO 26262 compliance as a market requirement. Energy Management cited a customer requirement as the leading reason for compliance. EV charging was split evenly between a market requirement and a customer requirement as the leading reason for ISO 26262 compliance.

	Market Requirement	Customer Requirement	Internal Requirement	Other
Powertrain	57%	33%	9%	1%
EV Charging	43%	43%	14%	0%
Hybrid Electric Control Systems (HEV/EV)	51%	37%	12%	0%
Energy Management	35%	49%	16%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other
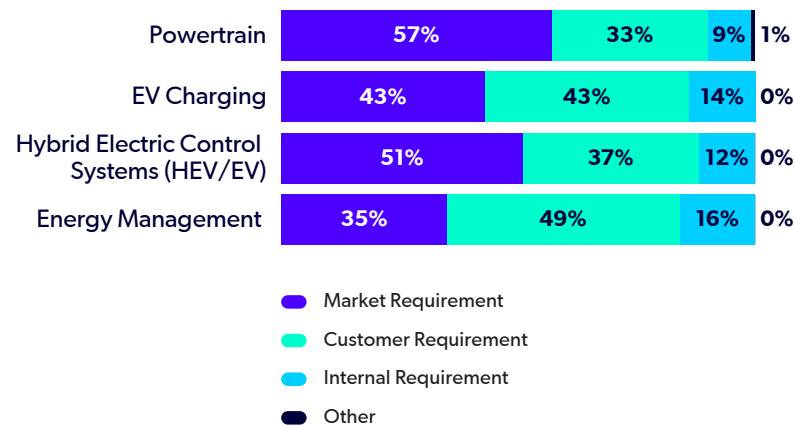
ASIL Levels

Automotive Safety Integrity Level (ASIL) is a key component of ISO 26262. ASIL A is the minimum level of risk and ASIL D is the maximum level of risk. Going from A to D, the compliance requirements get stricter. As 38% of survey respondents said that they are required to achieve ASIL D, most respondents are working on higher-risk automotive systems/components. Even for organizations designing individual components as opposed to whole vehicle systems, customers want these to be at ASIL D so they can be used anywhere. It is interesting to note that there was a 5% increase in needing to achieve the least-risk level, ASIL A, year over year.

WHICH ISO 26262 ASIL LEVEL DO YOU NEED TO ACHIEVE?

ASIL D
38%
2024 - 40%

ASIL C
30%
2024 - 33%

ASIL B
23%
2024 - 23%

ASIL A
9% 2024 - 4%
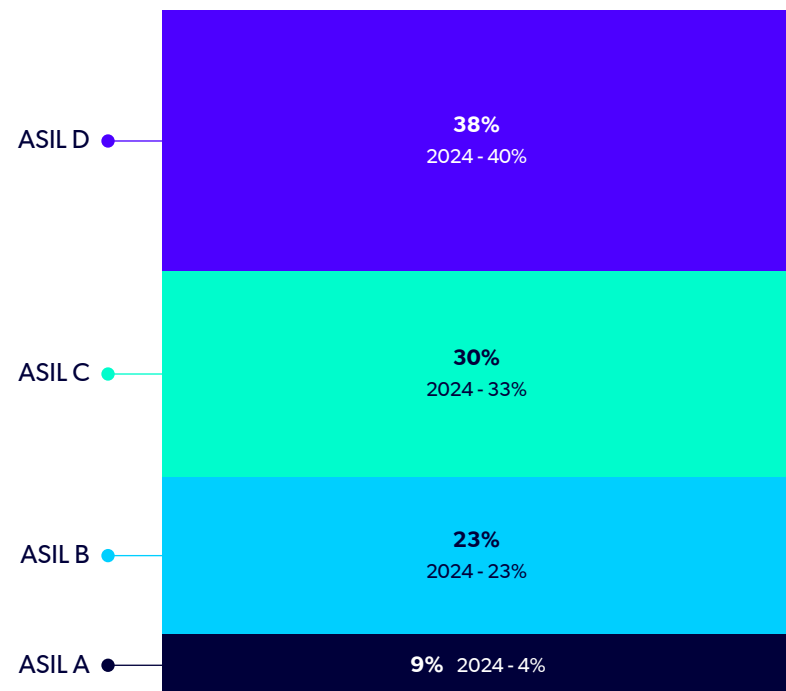
Region

Respondents in most regions need to achieve ASIL D.

Region	ASIL D	ASIL C	ASIL B	ASIL A
North America	45%	30%	19%	6%
Europe/UK	39%	23%	29%	9%
Middle East	19%	48%	33%	0%
Africa	22%	33%	28%	17%
		0%		
Asia	32%	32%	24%	12%
Oceania	N/A			
		0%		
Latin America	25%	25%	50%	

- ASIL D
- ASIL C
- ASIL B
- ASIL A
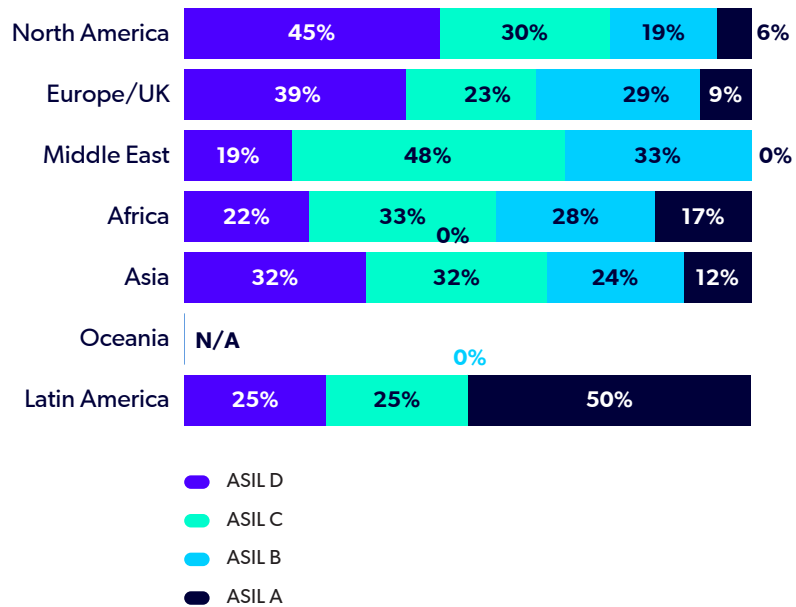
ISO/SAE 21434 Highlights the Growing Need for Software Security

ISO/SAE 21434 is a relatively recent automotive standard that focuses on cybersecurity risk in road vehicle electronic systems. Already, a majority of those surveyed will be required to comply with ISO/SAE 21434 (79%), an increase of 14% since last year.

## Why Developers Need to Comply with ISO/SAE 21434

For those who need to comply with ISO/SAE 21434:

- 45% need to comply due to a market requirement, an increase of 6% over last year.

- 37% need to comply due to a customer requirement, a decrease of 9% over last year.

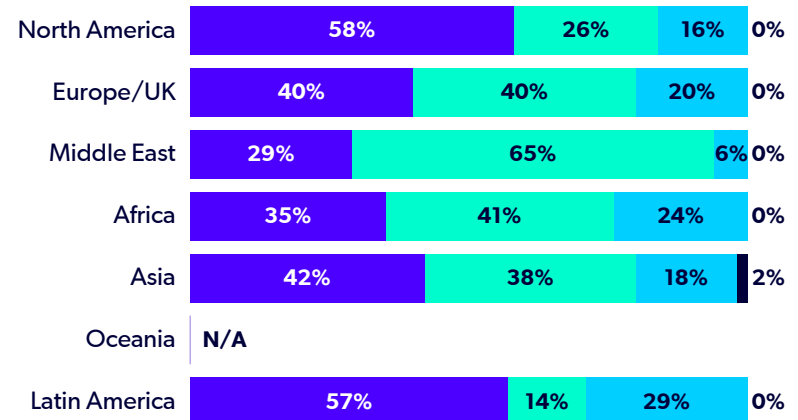- 18% have an internal requirement, an increase of 3% over last year.

21%   79%

- Yes
- No

WHY DO YOU NEED TO COMPLY WITH ISO/SAE 21434?

Market Requirement	Customer Requirement	Internal Requirement
45% 2024 - 38%	**37%** 2024 - 46%	**18%** 2024 - 15%

Other **0%** 2024 - 1%
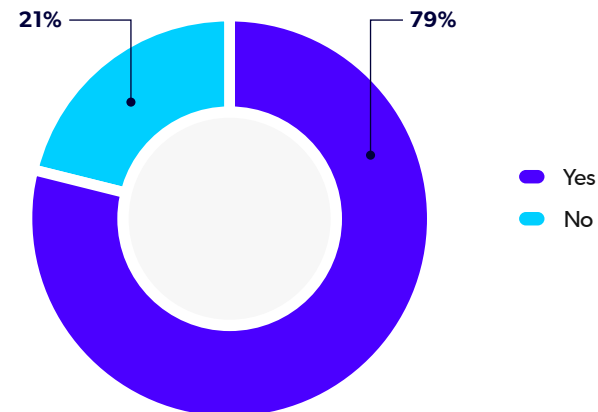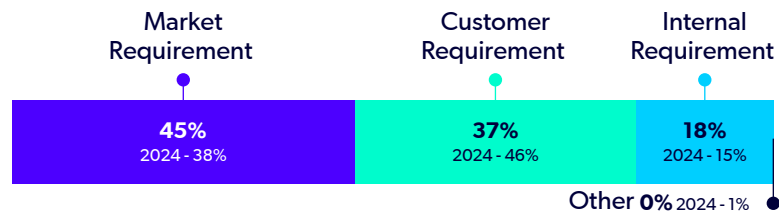
Region

ISO/SAE 21434 compliance was more of a market requirement for North America, Europe/UK, and Asia. As predicted, market requirements became the top concern over customer requirements since last year's report, likely due to recent international requirements for regulatory cybersecurity compliance for vehicles, such as UNECE WP.29 R155.

Respondents from the Middle East, Africa, and Latin America said that compliance was mostly because of a customer requirement.
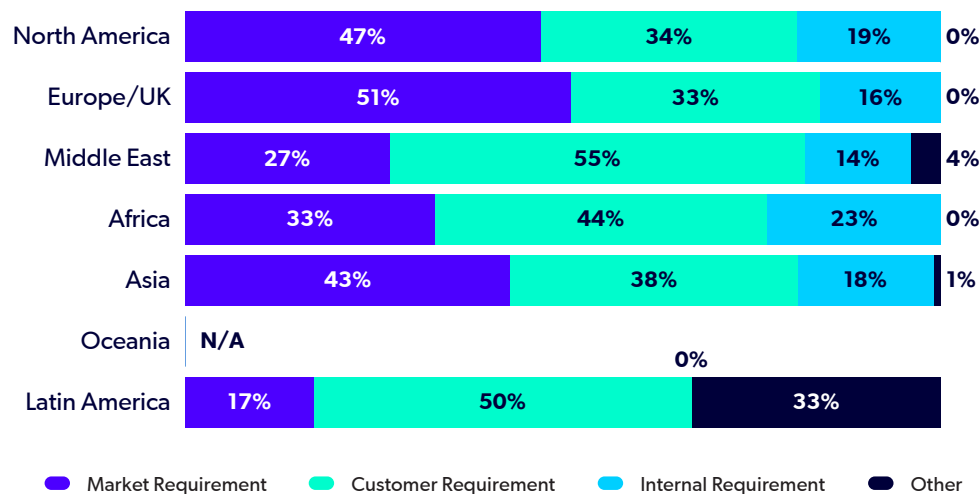
Region	Market Requirement	Customer Requirement	Internal Requirement	Other
North America	47%	34%	19%	0%
Europe/UK	51%	33%	16%	0%
Middle East	27%	55%	14%	4%
Africa	33%	44%	23%	0%
Asia	43%	38%	18%	1%
Oceania	N/A			0%
Latin America	17%	50%		33%

● Market Requirement ● Customer Requirement ● Internal Requirement ● Other

Automotive Development Focus (NON-EV)

When looking at the collected responses by automotive development focus, compliance with ISO/SAE 21434 is becoming more of a market requirement for areas like ECU/ECM and Powertrain compared to last year when they needed to comply more as a customer requirement. Many other components are still needing to comply primarily as a customer requirement. This makes sense as it is not yet an industry requirement, but will become mandatory in the future. In addition, customers have to conform with regulatory guidance regarding security.

Focus	Market Requirement	Customer Requirement	Internal Requirement	Other
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	58%	29%	13%	0%
ECU/ECM	43%	39%	16%	2%
Powertrain (non-EV)	40%	39%	18%	3%
AD/Autonomous Drive	47%	30%	22%	1%
Access Control and Comfort Systems	36%	51%	13%	0%
ADAS/Driver Assistance	43%	38%	16%	3%
Infotainment Systems	33%	49%	15%	3%
LIDAR	48%	38%	14%	0%
Connected Car and V2X	40%	48%	10%	3%
Instrument Clusters/HVAC/Lighting	36%	49%	14%	1%
Dealer Management	34%	47%	16%	3%
Diagnostic	32%	47%	17%	4%
Manufacturing	46%	42%	10%	2%
Supply Chain	35%	45%	14%	6%
3D Visualization/Digital Twins /Immersive Design	29%	43%	20%	8%

● Market Requirement

● Customer Requirement

● Internal Requirement

● Other

Automotive Development Focus (EV)

For electric vehicles, compliance with ISO/SAE 21434 saw a marked shift from customer requirement to primarily a market requirement year over year for all areas of automotive development focus.

Powertrain	59%	27%	14%	0%
EV Charging	48%	36%	15%	1%
Hybrid Electric Control Systems (HEV/EV)	48%	34%	18%	0%
Energy Management	40%	38%	22%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other
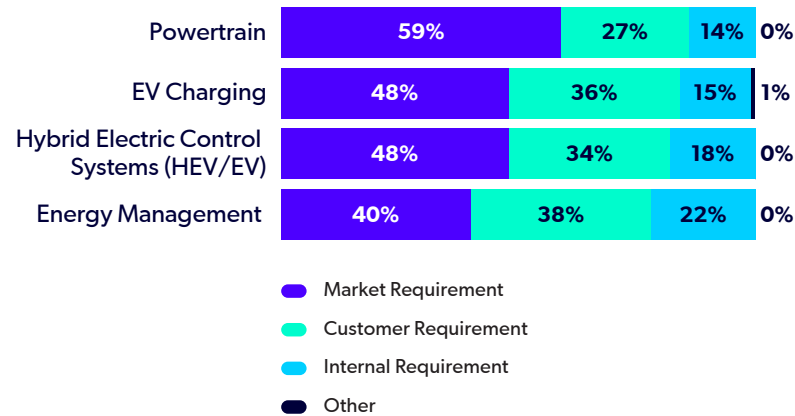
SOTIF (ISO/PAS 21448) Continues to Be Important

SOTIF (ISO/PAS 21448) was developed to address the additional safety challenges for autonomous and semi-autonomous vehicles. A majority of those we surveyed stated that SOTIF (ISO/PAS 21448) was part of their software development process — a reassuring return from last year's anomaly. The 2025 report respondents who do have SOTIF as part of their process increased from 49% to 63% year over year. This increase was expected, because this standard, which is applicable to AI, has become more important with the increased use of AI.

- Yes
- No

37%   63%
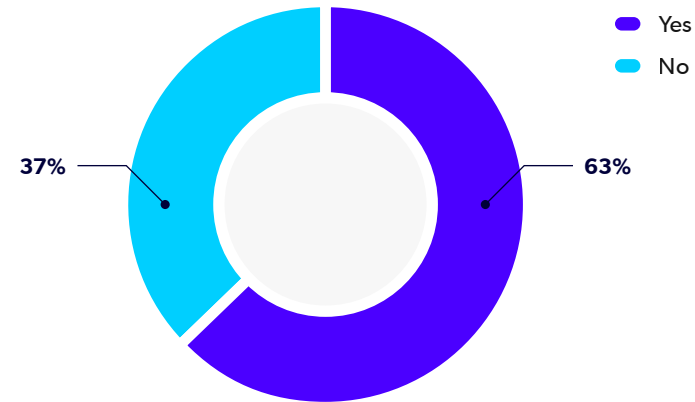
Why Developers Need to Comply with SOTIF (ISO/PAS 21448)

For those who need to comply with SOTIF (ISO/PAS 21448):

- 50% need to comply due to a market requirement, an increase of 12% over last year.

- 32% need to comply due to a customer requirement, a decrease of 12% over last year.

- 18% have an internal requirement, an increase of 1% over last year.

WHY DO YOU NEED TO COMPLY WITH SOTIF (ISO/PAS 21448)?

18%
2024 -17%

0%
2024 - 1%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

32%
2024 - 44%

50%
2024 - 38%
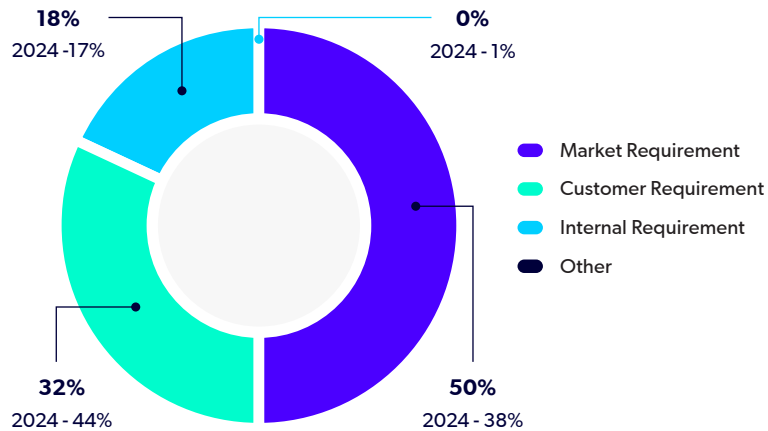
Region

Market requirements for compliance with SOTIF (ISO/PAS 21448) were the leading reason among respondents from most regions.

Region	Market Requirement	Customer Requirement	Internal Requirement	Other
North America	58%	26%	16%	0%
Europe/UK	40%	40%	20%	0%
Middle East	29%	65%	6%	0%
Africa	35%	41%	24%	0%
Asia	42%	38%	18%	2%
Oceania	N/A			
Latin America	57%	14%	29%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

Automotive Development Focus (NON-EV)

While the market requirement was the leading reason for compliance, some areas of automotive software development have a higher customer demand for SOTIF (ISO/PAS 21448). For example, Access Control and Comfort Systems, Connected Car, Dealer Management, Diagnostic, and Manufacturing.

	Market Requirement	Customer Requirement	Internal Requirement	Other
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	55%	29%	17%	0%
ECU/ECM	55%	32%	12%	1%
Powertrain (non-EV)	51%	38%	11%	0%
AD/Autonomous Drive	50%	25%	25%	0%
Access Control and Comfort Systems	38%	49%	13%	0%
ADAS/Driver Assistance	46%	35%	18%	1%
Infotainment Systems	46%	40%	14%	0%
LIDAR	55%	32%	13%	0%
Connected Car and V2X	36%	44%	19%	1%
Instrument Clusters/HVAC/Lighting	43%	41%	14%	2%
Dealer Management	26%	55%	19%	0%
Diagnostic	38%	53%	9%	0%
Manufacturing	30%	40%	30%	0%
Supply Chain	39%	39%	22%	0%
3D Visualization/Digital Twins /Immersive Design	48%	39%	13%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other

Automotive Development Focus (EV)

Electric vehicle areas of automotive development focus had a greater percentage of respondents with market requirements.

	Market Requirement	Customer Requirement	Internal Requirement	Other
Powertrain	59%	29%	12%	0%
EV Charging	50%	34%	16%	0%
Hybrid Electric Control Systems (HEV/EV)	55%	26%	19%	0%
Energy Management	36%	34%	30%	0%

- Market Requirement
- Customer Requirement
- Internal Requirement
- Other
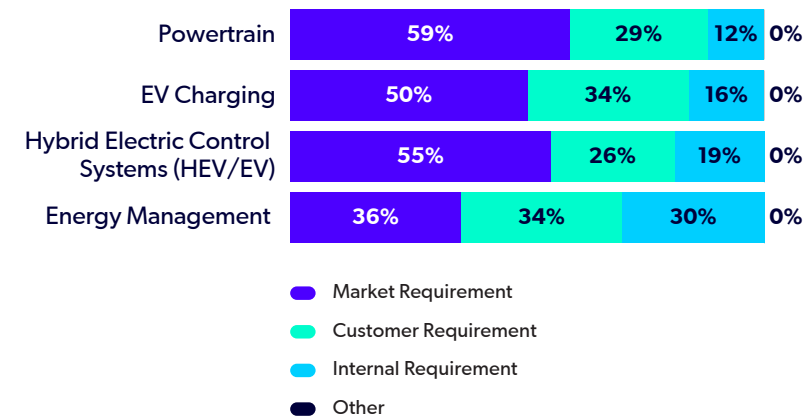
Leading Challenges in Proving Compliance

Proving compliance with key automotive functional safety and security standards can be a challenging and time-consuming process, but we continue to see increased demand from customers for meeting these standards.

Consistent with the 2024 report, most of those we surveyed struggled to fulfill safety requirements and prove that those requirements have been filled, an increase of 3% over last year. Development teams can easily fulfill safety requirements (and prove it) by using a qualified tool for use in safety-critical applications.

19% of respondents struggled with "enforcing coding standards," also increasing by 3% over last year. There was a continuing decrease in those who had difficulties with documenting versions of files and assets (-3%).

WHAT IS YOUR BIGGEST CHALLENGE IN PROVING COMPLIANCE?

2% 2024 - 4%

12% 2024 - 14%

7% 2024 - 10%

13% 2024 - 12%

19% 2024 - 16%

47% 2024 - 44%

- Enforcing Coding Standards
- Fulfilling Safety Requirements (and Proving It)
- Qualifying Tools
- Documenting Versions of Files and Assets
- Analyzing Risk
- Other
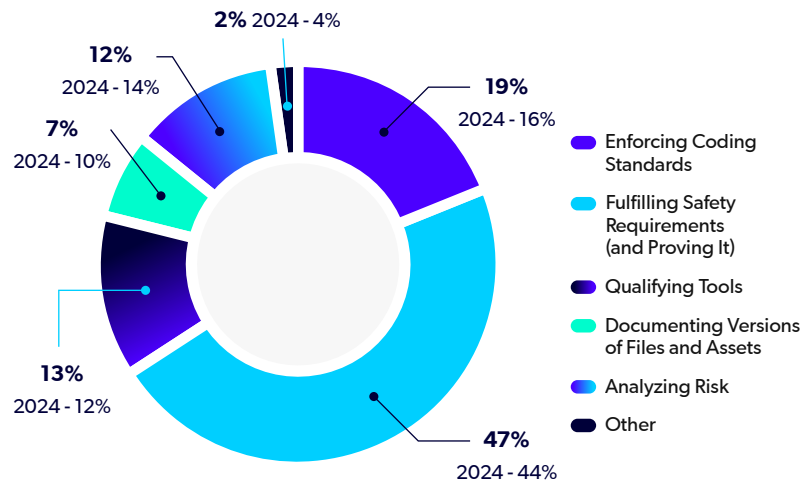
Fulfilling safety requirements and providing documentation proving that the criteria have been met is the leading challenge with automotive software compliance.

Organization Size

When looking at the collected responses by organization size, Small organizations struggled slightly more with "enforcing coding standards" than "fulfilling safety requirements (and proving it," over Medium to Enterprise organizations that were most concerned with the latter.

	Enforcing coding standards	Fulfilling safety requirements	Qualifying Tools	Documenting versions	Analyzing Risk	Other
Small (<100 employees)	34%	31%	14%	5%	11%	5%
Medium (101-999 employees)	17%	48%	16%	9%	10%	0%
Large (1000+ employees)	12%	65%	10%	5%	7%	1%
Enterprise (10,000+ employees)	11%	47%	11%	7%	23%	1%

- Enforcing coding standards
- Fulfilling safety requirements (and proving it)
- Qualifying Tools
- Documenting versions of files and assets
- Analyzing Risk
- Other

Respondent Experience Level

Industry professionals with less than 1 year of experience were much less concerned about "fulfilling safety requirements [and proving it]" (19%), compared to all other experience levels who expressed this as their top concern (45-55%).

	Enforcing coding standards	Fulfilling safety requirements	Qualifying Tools	Documenting versions	Analyzing Risk	Other
Less than 1 year	37%	19%	21%	6%	11%	6%
1-3 years	24%	50%	10%	9%	7%	0%
3-5 years	26%	45%	13%	8%	8%	0%
5-10 years	13%	55%	13%	6%	13%	0%
More than 10 years	11%	47%	14%	7%	17%	4%

- ● Enforcing coding standards
- ● Fulfilling safety requirements (and proving it)
- ● Qualifying Tools
- ● Documenting versions of files and assets
- ● Analyzing Risk
- ● Other

Key Coding Standards for Automotive Software Development

86% of those surveyed are using at least one coding standard, an increase of 4%. The use of a coding standard is important for code quality, which helps to ensure that it is safe, secure, and compliant.

DOES YOUR TEAM USE A CODING STANDARD TODAY?

14%
2024 - 18%

86%
2024 - 82%

- ● Yes
- ● No
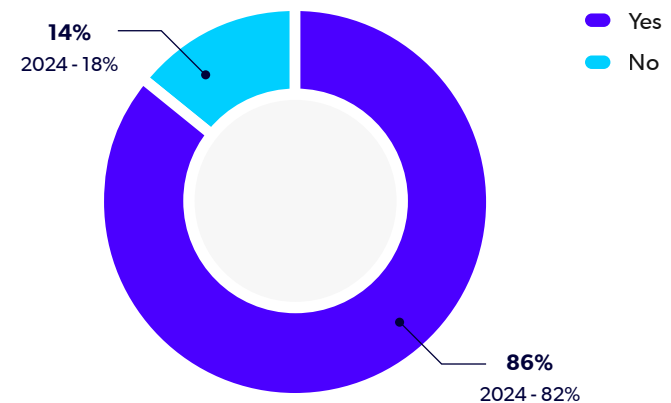
Coding standards are used by 86% of organizations in the automotive software development industry.

WHICH CODING STANDARDS DO YOU CURRENTLY USE? SELECT ALL THAT APPLY.

MISRA
53%
2024 - 62%

C++ Core Guidelines
39%
2024 - 36%

AUTOSAR C++14
36%
2024 - 32%

Embedded C (Barr Group)
24%
2024 - 21%

High Integrity C++
22%
2024 - 16%

CERT
21%
2024 - 25%

Google C++ Style Guide
12%
2024 - 14%

Other
2%   2024 - 3%
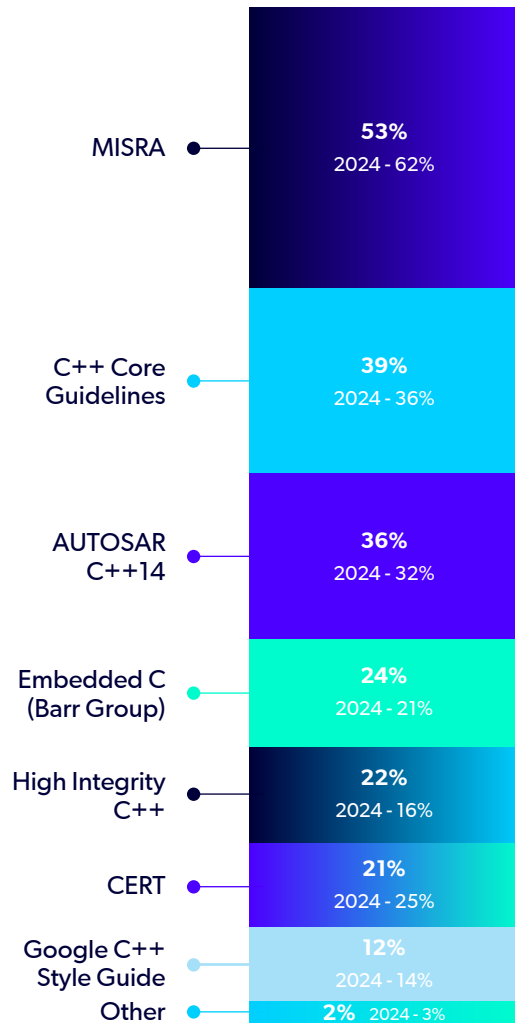
Which Coding Standards Developers Use Most For Automotive Software

Many of those we surveyed are using multiple coding standards. While there was a decrease from 62% to 53% of those using MISRA, MISRA is still the leading coding standard for the majority of respondents. The sharp 20% increase from 2023 to 2024 and steadier decline in 2025 likely accounts for the timing of the MISRA C:2023 and MISRA C++:2023 publication updates that aligned with the release of the 2024 automotive survey and report.

With MISRA C:2025 expected to be released this year, respondents using MISRA in automotive software development is expected to again increase between 2025 and 2026.

It is important to use a static analysis tool that enforces all the new MISRA guidelines.

The second most-used coding standard is C++ Core Guidelines, which saw an increase of 3% over last year for a total of 39%.

Some of those surveyed use the following standards:

- 36% use AUTOSAR C++14, an increase of 4%.

- 24% use Embedded C (Barr Group), an increase of 3%.

- 22% use High Integrity C++, an increase of 6%.

- 21% use CERT, a decrease of 4%.

- 12% use Google C++ Style Guide, a decrease of 2%.

MISRA is used across all automotive software development areas globally. Perforce Static Analysis provides 100% rule enforcement coverage for all the new MISRA guidelines.

Are You Required to Track Code Quality Metrics?

Of those surveyed, the majority of respondents are required to track code quality metrics, an increase of 12%.

11%
2024 -23%

89%
2024 -77%

- Yes
- No
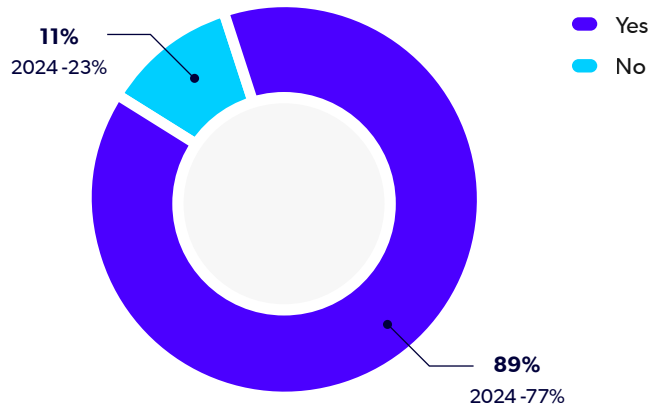
Most respondents who need to track code quality metrics are required to track cyclomatic complexity (59%) and the number of lines of code (57%). The metrics most likely to be tracked are part of the HIS metric set and are particularly applicable to the C language.

Cyclomatic complexity is useful, as it gives an indication of the number of test cases required—but it should be considered as a comparative measure and not to always be below a pre-specified threshold. The number of lines of code is particularly difficult to evaluate for more modern languages and requires a definition of "line of code" to be useful.

WHICH CODE QUALITY METRICS ARE YOU REQUIRED TO TRACK? SELECT ALL THAT APPLY.

Metric	Percentage
Cyclomatic Complexity	59%
Coupling	46%
Number of Lines of Code	57%
Churn	21%
Other	2%
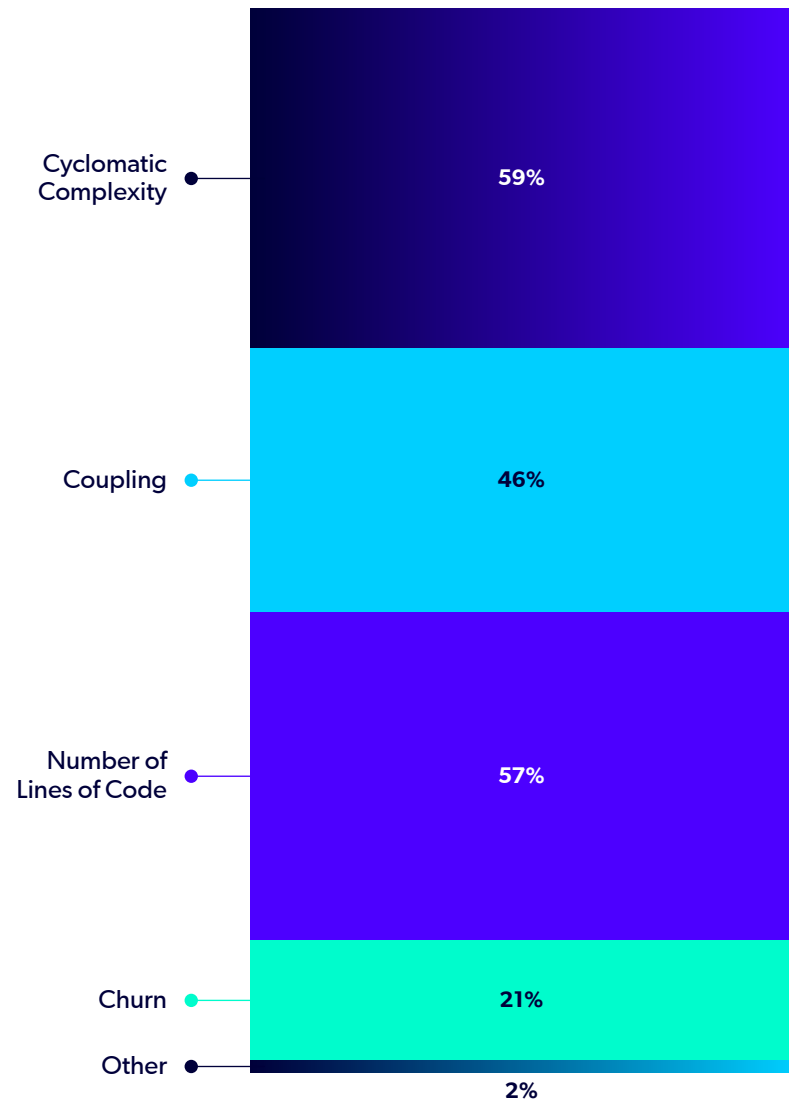
How Development Teams Manage Their Work

C and C++ Are Still the Most Commonly Used Programming Languages

Based on our survey results, C++ is still the leading programming language for automotive software development (54%), followed by C (44%). Interestingly, the use of C++ increased by 3% over last year, while the use of C decreased by 6% over last year.

When compared to last year's report, the use of Python, which is the preferred language for AI and ML applications, decreased by 11%; and the use of Rust decreased by 3%. The use of all other languages increased year over year.

WHICH PROGRAMMING LANGUAGE(S) DOES YOUR TEAM CURRENTLY USE? SELECT ALL THAT APPLY.
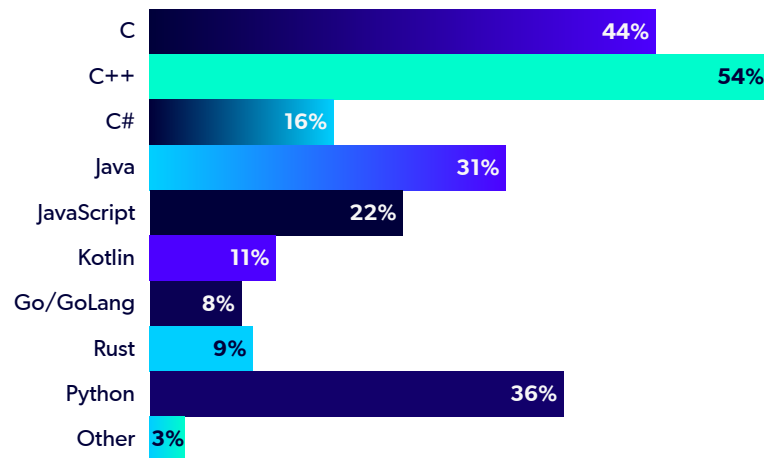
Language	Percentage
C	44%
C++	54%
C#	16%
Java	31%
JavaScript	22%
Kotlin	11%
Go/GoLang	8%
Rust	9%
Python	36%
Other	3%

Automotive Development Focus (NON-EV)
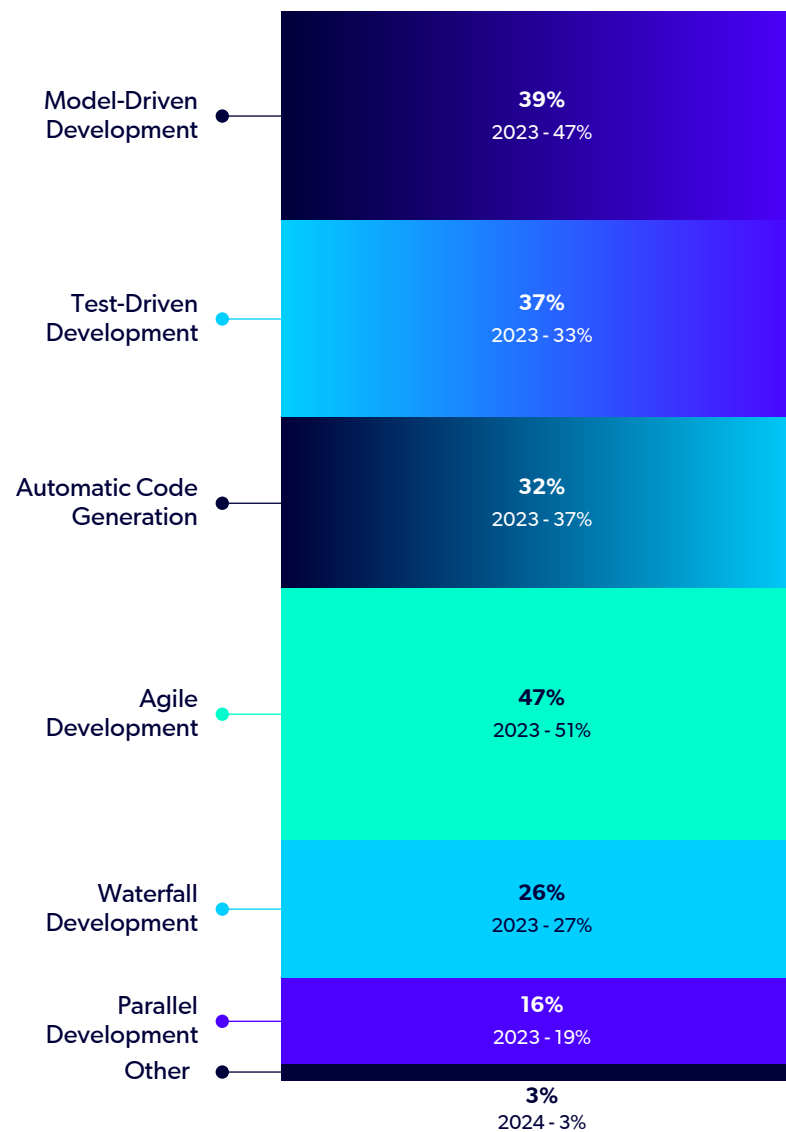
When looking at the collected responses by automotive development focus, we found the following, with the most-used automotive components for each programming language highlighted:

	C	C++	C#	Java	JavaScript	Kotlin	Go/GoLang	Rust	Python
Chassis and Safety (Electric Power Steering [EPS], Brakes, and Airbags)	20%	23%	6%	15%	10%	4%	4%	4%	14%
ECU/ECM	26%	24%	6%	10%	7%	2%	3%	4%	14%
Powertrain (non-EV)	16%	18%	8%	15%	11%	5%	4%	4%	16%
AD/Autonomous Drive	16%	21%	8%	14%	11%	6%	4%	4%	16%
Access Control and Comfort Systems	13%	21%	7%	14%	10%	7%	5%	5%	17%
ADAS/Driver Assistance	21%	23%	6%	11%	0%	4%	3%	5%	18%
Infotainment Systems	19%	22%	5%	13%	8%	5%	6%	5%	17%
LIDAR	19%	20%	5%	13%	8%	7%	4%	7%	17%
Connected Car and V2X	18%	21%	8%	12%	8%	6%	2%	6%	17%
Instrument Clusters/HVAC/Lighting	19%	19%	9%	11%	10%	5%	5%	7%	15%
Dealer Management	10%	15%	9%	14%	14%	8%	6%	10%	12%
Diagnostic	21%	19%	6%	11%	10%	5%	4%	6%	17%
Manufacturing	16%	19%	8%	12%	12%	4%	4%	5%	19%
Supply Chain	10%	16%	6%	15%	13%	8%	7%	6%	15%
3D Visualization/Digital Twins/Immersive Design	11%	15%	8%	11%	12%	9%	7%	7%	17%

Automotive Development Focus (EV)

When looking at the collected responses by electric vehicle development focus, we found the following, with the most-used automotive components for each programming language highlighted.

	C	C++	C#	Java	JavaScript	Kotlin	Go/ GoLang	Rust	Python
Powertrain	22%	23%	6%	11%	10%	4%	3%	4%	15%
EV Charging	18%	21%	7%	14%	12%	7%	3%	4%	14%
Hybrid Electric Control Systems (HEV/EV)	16%	21%	7%	16%	11%	5%	5%	4%	15%
Energy Management	16%	19%	6%	14%	11%	4%	5%	4%	19%

Teams Are Leveraging Faster Methods and Processes

Many automotive development teams have adopted methods and processes that help them to quickly adapt and develop quality software faster. In comparison to last year's results, it appears that respondents are decreasing the number of methods they are using, closer to the 2023 report numbers. Test-driven development was the only method that saw an increase (4%) over last year.

WHICH DEVELOPMENT METHODS AND PROCESSES ARE YOU USING TODAY? SELECT ALL THAT APPLY.

Model-Driven Development
39%
2023 - 47%

Test-Driven Development
37%
2023 - 33%

Automatic Code Generation
32%
2023 - 37%

Agile Development
47%
2023 - 51%

Waterfall Development
26%
2023 - 27%

Parallel Development
16%
2023 - 19%

Other
3%
2024 - 3%

Leading Challenges for Teams Short on Time

Teams adopting faster methods and processes are still running into activities that take too much time.

The most time-consuming activity this year continued to be "verifying and validating software," with 42% of respondents citing this activity as a pain point. "Reviewing code for errors/coding rule violations" was also particularly time-consuming for respondents.

The sharpest increases over last year included "establishing risk control measures (+12%) and "organizing and prioritizing work" (+11%).

Combining faster methods with tool — such as static code analyzers — that help automate these top time-consuming tasks can go a long way in helping teams accelerate automotive software development.

WHICH OF THE ACTIVITIES BELOW DO YOU FIND PARTICULARLY TIME-CONSUMING FOR YOUR TEAM TODAY? SELECT ALL THAT APPLY.

Establishing Risk Control Measures
32%
2024 - 20%

Organizing and Prioritizing Work
30%
2024 - 19%

Reviewing Code for Errors /Coding Rule Violations
41%
2024 - 34%

Documenting Work and Reviewing Documentation
34%
2024 - 41%

Verifying and Validating Software
42%
2024 - 47%

Communicating with Other Team Members
18%
2024 - 20%

Managing Multiple Variant Configurations
26%
2024 - 24%

Managing Continuous Integration /Build Pipeline
20%
2024 - 17%

Other
2%
2024 - 3%

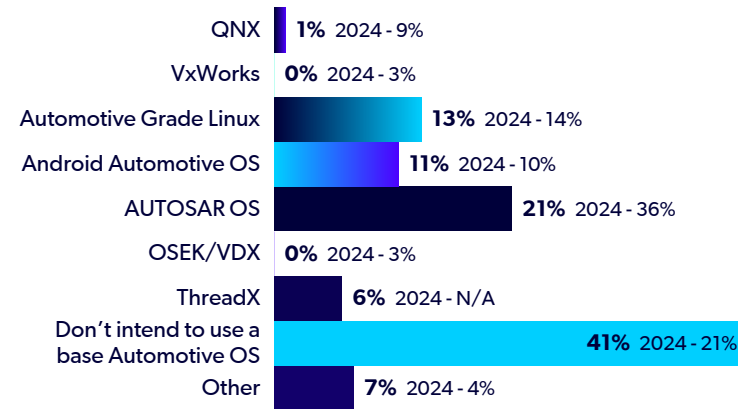## The Automotive OS That Development Teams Are Using

As more software is added to vehicles, it is important to look at the operating system (OS) that development teams are using in the embedded software. According to our results, the leading operating system was AUTOSAR OS (28%), followed by Automotive Grade Linux (18%).

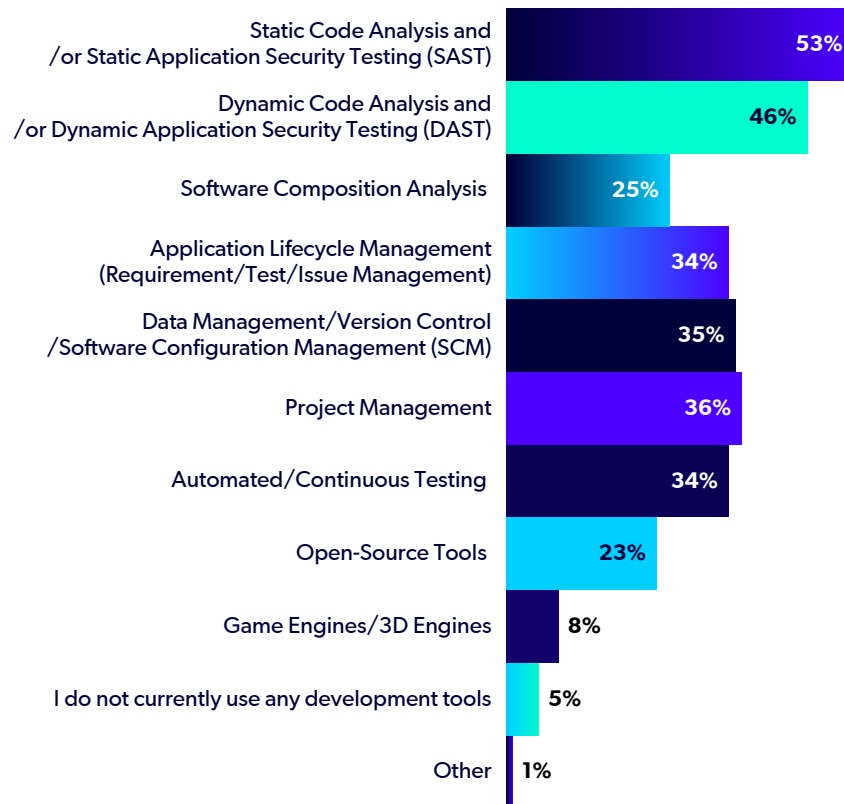**WHAT IS THE BASE AUTOMOTIVE OS THAT YOUR DEVELOPMENT TEAM IS BUILDING FROM?**

OS	2025	2024
QNX	11%	9%
VxWorks	6%	7%
Automotive Grade Linux	18%	13%
AUTOSAR OS	28%	34%
OSEK/VDX	4%	5%
ThreadX	2%	N/A
Android Automotive OS	12%	8%
N/A	14%	18%
Other	5%	6%
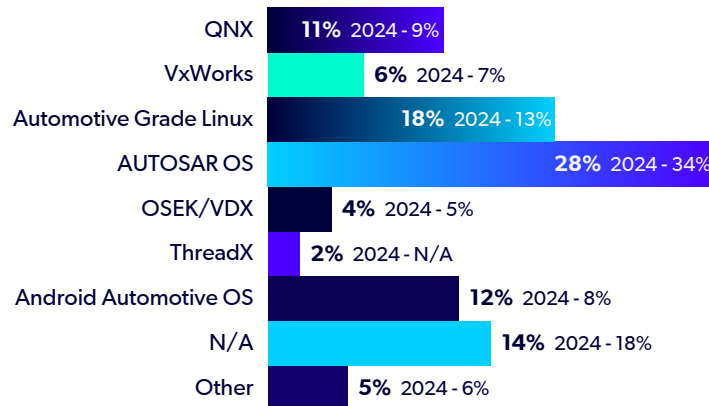
While 41% of respondents said that they have no intention of using a base Automotive OS, those who did intend to use one said they are most likely to use AUTOSAR OS (21%), Automotive Grade Linux (13%), and Android Automotive OS (11%).

IF YOU ARE NOT USING A BASE AUTOMOTIVE OS NOW, WHICH ONE WOULD YOU MOST LIKELY USE IN THE FUTURE?

OS	2025	2024
QNX	1%	9%
VxWorks	0%	3%
Automotive Grade Linux	13%	14%
Android Automotive OS	11%	10%
AUTOSAR OS	21%	36%
OSEK/VDX	0%	3%
ThreadX	6%	N/A
Don't intend to use a base Automotive OS	41%	21%
Other	7%	4%

Which Software Tools Development Teams Are Using

Using the right software development tools is essential for ensuring that your software is safe, secure, and reliable. Some of the top tools for those we surveyed included:
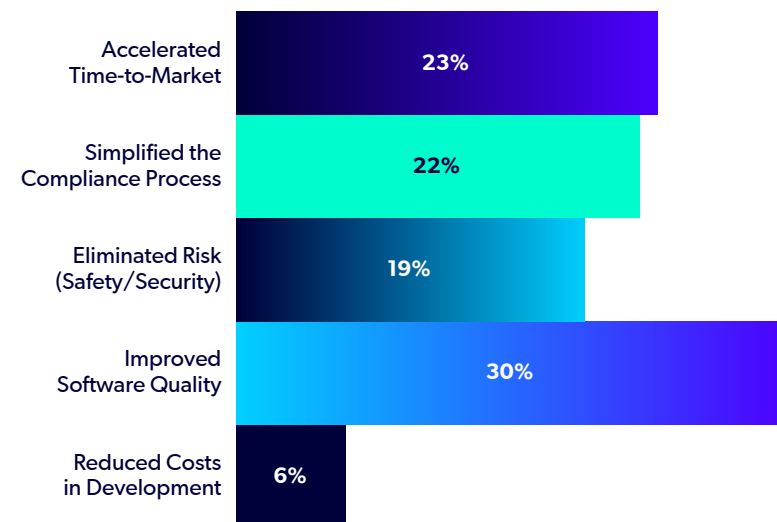
Tool	Percentage
Static Code Analysis and /or Static Application Security Testing (SAST)	53%
Dynamic Code Analysis and /or Dynamic Application Security Testing (DAST)	46%
Software Composition Analysis	25%
Application Lifecycle Management (Requirement/Test/Issue Management)	34%
Data Management/Version Control /Software Configuration Management (SCM)	35%
Project Management	36%
Automated/Continuous Testing	34%
Open-Source Tools	23%
Game Engines/3D Engines	8%
I do not currently use any development tools	5%
Other	1%

Static Analysis/SAST (53%) continued to be the leading tool for software development teams in automotive. This year, the use of Dynamic Code Analysis/DAST took the lead over Data Management/Version Control/SCM and Project Management, but there is still strong interest in these tools.

Leading Benefit of Development Tools

A majority (30%) of those surveyed said that improving software quality was their primary reason for using development tools. As software quality was the leading automotive software and technology development concern in this report overall, respondents seem to be aware that development tools play a big part in improving quality.

WHAT IS YOUR PRIMARY REASON FOR USING DEVELOPMENT TOOLS?

Reason	Percentage
Accelerated Time-to-Market	23%
Simplified the Compliance Process	22%
Eliminated Risk (Safety/Security)	19%
Improved Software Quality	30%
Reduced Costs in Development	6%

Open-Source Automotive Software

A majority of those we surveyed said they were using open-source tools and in-vehicle software for automotive development, which is increasing overall in the automotive industry. Some respondents using these tools were also contributing to open-source projects (39%), a 4% increase over last year; while those automotive professionals using the tools but not actively contributing to open-source projects (29%) decreased by 6%. These shifts could indicate that more developers now have the time or resources to contribute to open-source projects in addition to using the tools, or are allocating those resources differently this year to maximize existing resources/talent to remain competitive.

For those who are not adopting open-source software or contributing to open-source projects, the most common barriers year over year remained time and development resources (39%) and safety/security concerns (30%). Notably, safety/security concerns did decrease by 7% since last year, so developers may be feeling more confident in the safety and security of open-source software and peer rigor in checking for safety/security vulnerabilities. Both automotive professionals and open-source developers/contributors are more aware now than ever before of the importance of functional safety and security in vehicle software development and the best practices, tools, standards and guidelines that keep the software safe and secure — so concerns about using open-source software are lessening.
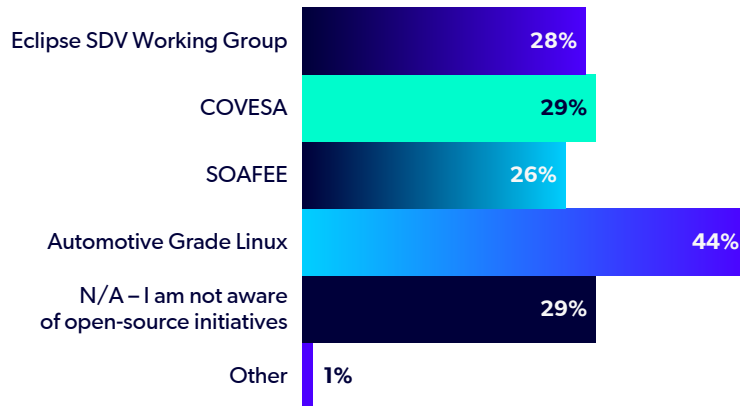
Many respondents also cited the unclear value proposition (28%) and the lack of collaboration frameworks for open-source software in the automotive space (28%), both of which increased as concerns this year. Since more organizations are investing in employee training in 2025, open-source tools may be an area in which to experiment and measure the value.

WHAT BEST DESCRIBES YOUR ENGAGEMENT WITH OPEN-SOURCE AUTOMOTIVE SOFTWARE?

6% 2024 - 14%
15% 2024 - 16%
11% 2024 - N/A
29% 2024 - 35%
39% 2024 - 35%

- We use open-source tools and/or open-source in-vehicle software and contribute to open-source projects.
- We use open-source tools and/or open-source in-vehicle software but do not contribute to open-source projects.
- We use open-source software in-vehicle and contribute to open-source projects.
- We do not use or contribute to open-source projects but are interested.
- We do not use or contribute to open-source projects and are not currently interested.

WHAT ARE THE BARRIERS TO YOUR TEAM ADOPTING AND/OR CONTRIBUTING TO OPEN-SOURCE SOFTWARE? SELECT ALL THAT APPLY.

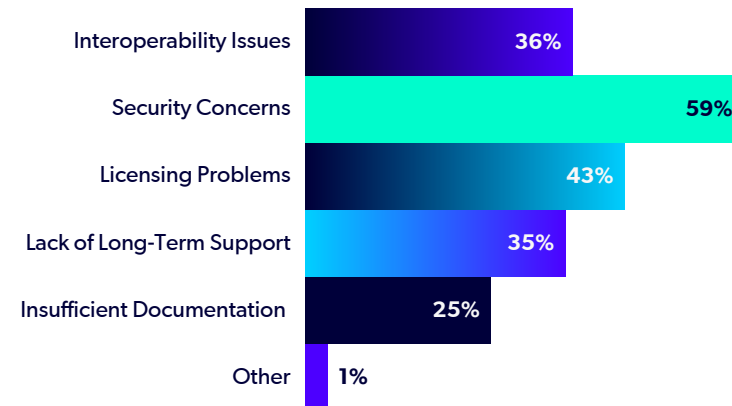| Barrier	2025	2024
Organizational support/buy-in	22%	28%
Time and development resources	39%	42%
Unclear value proposition	28%	23%
Vendor lock-in	16%	14%
IP concerns	27%	30%
Lacking collaboration frameworks to work across the industry	28%	15%
Safety/security concerns	30%	37%
Other	3%	3%
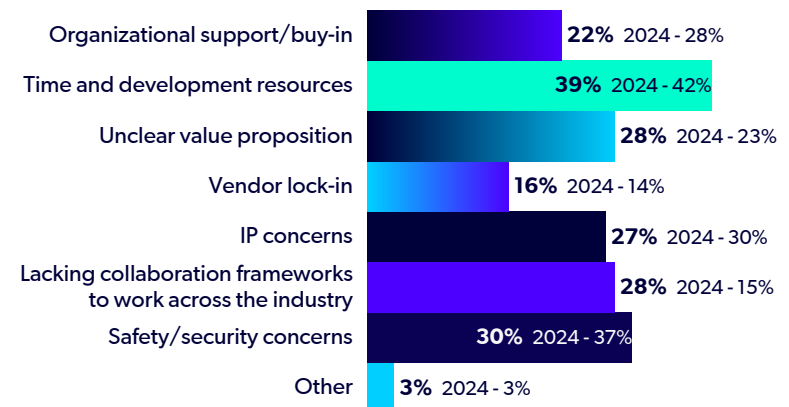
The majority of respondents are aware of Automotive Grade Linux (44%) open-source domain initiatives in 2025.

WHAT INITIATIVES IN THE OPEN-SOURCE DOMAIN ARE YOU AWARE OF? SELECT ALL THAT APPLY.

Initiative	%
Eclipse SDV Working Group	28%
COVESA	29%
SOAFEE	26%
Automotive Grade Linux	44%
N/A – I am not aware of open-source initiatives	29%
Other	1%

The leading challenge for automotive development teams integrating open-source software with their proprietary automotive systems was security concerns (59%). While general safety/security open-source automotive software concerns decreased somewhat over last year, it appears that integration could be a sticking point.

Licensing problems were the second-most top challenge (43%), followed by interoperability issues (36%), lack of long-term support (35%), and insufficient documentation (25%).

WHAT CHALLENGES DO YOU FACE WHEN INTEGRATING OPEN-SOURCE SOFTWARE WITH PROPRIETARY AUTOMOTIVE SYSTEMS? SELECT ALL THAT APPLY.

Challenge	%
Interoperability Issues	36%
Security Concerns	59%
Licensing Problems	43%
Lack of Long-Term Support	35%
Insufficient Documentation	25%
Other	1%

Why Static Analysis Remains Essential for Automotive Software Development

Based on survey responses, the leading concerns across multiple areas of automotive development are quality, safety, and security. One of the most effective methods to mitigate potential functional code quality and safety issues is to use a static analysis tool.

An industry standardized static analysis tool — such as Perforce QAC and Perforce Klocwork — enables teams to effectively identify software vulnerabilities and weaknesses as well as enforce recommended coding standards and guidelines.

Both Perforce Static Analysis tools verify compliance with the coding standards and guidelines, as well as provide evidence of that compliance. This will provide overall consistency, correctness, and completeness with respect to functional safety and cybersecurity requirements.

By using a static analysis tool, you can accelerate compliance by:

- Enforcing coding standards and detecting rule violations.
- Detecting compliance issues earlier in development.
- Accelerating code reviews and manual testing efforts.
- Reporting on compliance over time and across product versions.

In addition, Perforce Static Analysis tools provide compliance to MISRA guidelines. They are also certified for use for safety-critical systems by TÜV-SÜD, including ISO 26262 up to ASIL level D.

See for yourself how Perforce Static Analysis can help you ensure the functional safety and security of your automotive software. Request your free trial today.

Static Analysis Free Trial ▶

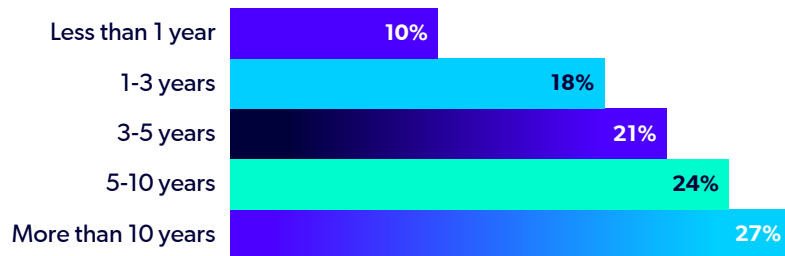www.perforce.com/products/sca/free-static-code-analyzer-trial

About the Survey — Appendix

The *2025 State of Automotive Software Development Report* is based on an anonymous survey conducted between October 8 and December 6, 2024. It targeted automotive professionals from across the globe and received 656 responses.

To help segment and analyze the survey results, we asked respondents basic demographic questions.
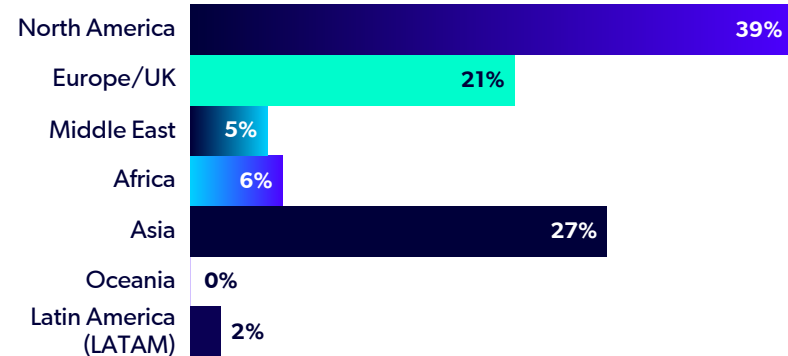
Experience

Those that participated in the survey presented a range of professional experience from less than a year to more than 10. We received a balanced sample of respondents in this category.
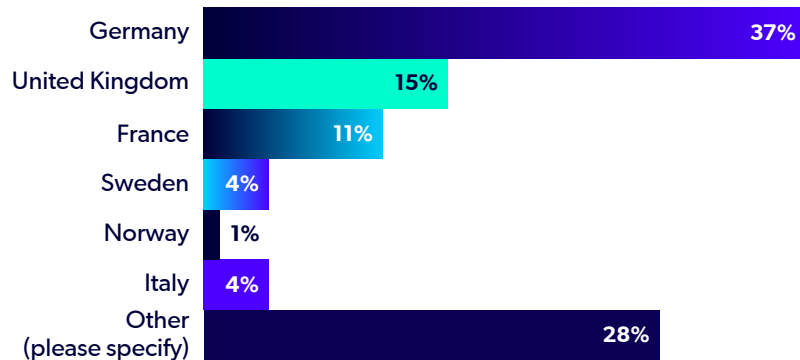
Experience	Percentage
Less than 1 year	10%
1-3 years	18%
3-5 years	21%
5-10 years	24%
More than 10 years	27%

Region

Those that participated in the survey are from seven geographical regions, with North America, Asia, and Europe/UK representing the majority of the responses.

Region	Percentage
North America	39%
Europe/UK	21%
Middle East	5%
Africa	6%
Asia	27%
Oceania	0%
Latin America (LATAM)	2%

Country (Europe/UK)

Among those respondents who are from the Europe/UK region, the majority of respondents are from Germany (37%) and various "Other" countries (28%).

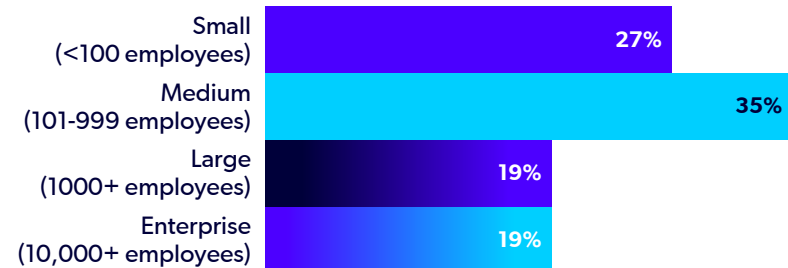|	
Germany	37%
United Kingdom	15%
France	11%
Sweden	4%
Norway	1%
Italy	4%
Other (please specify)	28%

Country (Asia-Pacific)

Among those respondents who are from the Asia-Pacific region, the majority of respondents are from China (33%), India (30%), and Japan (24%).

|	
China	33%
Japan	24%
India	30%
South Korea	5%
Vietnam	1%
Other (please specify)	7%
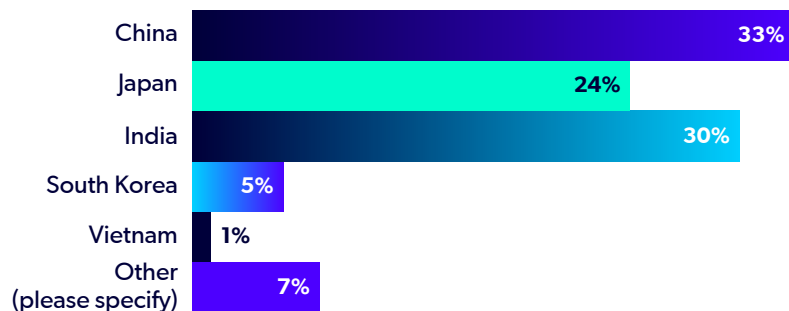
Company Size

Those that participated in the survey work for companies of all sizes, with a good distribution between enterprise, large, medium, and small organizations being represented in the survey.

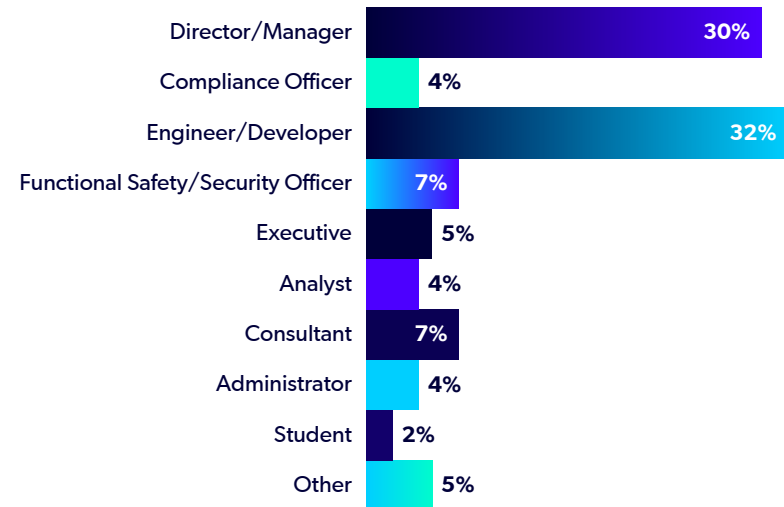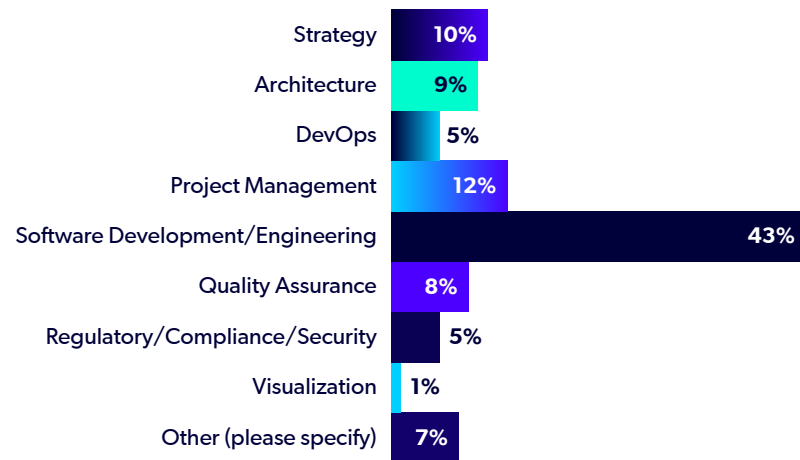|	
Small (<100 employees)	27%
Medium (101-999 employees)	35%
Large (1000+ employees)	19%
Enterprise (10,000+ employees)	19%

Organization Type

Those that participated in the survey work primarily for Tier 1 suppliers and OEMs, but there were also respondents from Tier 2 and Tier 3 suppliers.

OEM	22%
Tier 1 Supplier	34%
Tier 2 Supplier	20%
Tier 3 Supplier	10%
Other	14%
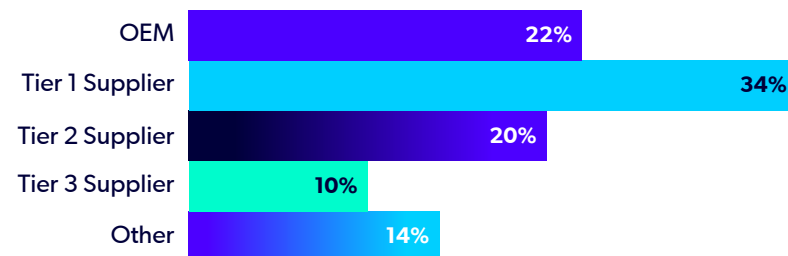
Role and Area in the Organization

To help readers of this report better understand who participated in the survey, we asked the respondents about their area of automotive development, as well as their current roles. It was not surprising to see that "software development/ engineering" was the top selection, but there are a large variety of roles, including testing and research and development under the "other" category.

Area in the Organization

Area	Percentage
Strategy	10%
Architecture	9%
DevOps	5%
Project Management	12%
Software Development/Engineering	43%
Quality Assurance	8%
Regulatory/Compliance/Security	5%
Visualization	1%
Other (please specify)	7%

Role in the Organization

Role	Percentage
Director/Manager	30%
Compliance Officer	4%
Engineer/Developer	32%
Functional Safety/Security Officer	7%
Executive	5%
Analyst	4%
Consultant	7%
Administrator	4%
Student	2%
Other	5%

Have comments or suggestions for next year's report?

Share them with us by emailing info@perforce.com with the subject line "Automotive Software Development 2025."

About Perforce

The best run DevOps teams in the world choose Perforce. Perforce's suite of products is purpose-built to develop, build and maintain high-stakes applications. Companies can finally manage complexity, achieve speed without compromise, and run their DevOps toolchains with full integrity. With a global footprint spanning more than 80 countries and including over 75% of the Fortune 100, Perforce is trusted by the world's leading brands to deliver solutions to even the toughest challenges. Accelerate technology delivery, with no shortcuts. Power Innovation with Perforce.