AMS / ABB Automotive Manufacturing Outlook Survey 2022

Executive Summary

The automotive manufacturing sector faces a continuing set of external headwinds and internal challenges. Like all industries, the impact of the Covid pandemic still has lingering effects. For automotive in particular it exposed many of the automotive industry's vulnerabilities to such disruptions, due to the strong reliance upon just in time / just in sequence supply chains and lean manufacturing principles.

And the automotive industry is still experiencing production impacts due to the chronic shortage of semiconductors, and wider shortages of components, and raw materials, in part due to the strict zero-Covid policy taken by China, and which has now been compounded by the ongoing Ukraine / Russian war. In light of these events, leading carmakers have been forced to revise their annual production forecasts.

Furthermore, from an economic perspective, the inflationary effects of that war have driven up the prices of critical raw materials and components, squeezing margins and ultimately pushing up the cost of vehicles, in particular batteries for EVs. And from a consumer perspective, the inflationary effects and uncertainties created by the ongoing war in Ukraine are deeply affecting consumer confidence, which is now likely to be compounded by a period of recession across most advanced economies. Those inflationary pressures are also leading to labour shortages, recruitment and a higher incidence of strike threats and industrial action in different parts of the value chain compounding already disrupted supply chains.

For the automotive industry itself, there are a raft of internal challenges – first and foremost is the wholesale transition to electrification over the 2030-2040 window, with key difference in pace by region. But the industry transformation must go beyond tailpipes emissions. Now the industry is being given tough targets to become entirely sustainable and zero emission over the next few decades which creates an unprecedented era of transformation across all parts of the industry supply chain.

Automotive manufacturing has to evolve and adapt to this plethora of challenges whilst also becoming more efficient, flexible, and adaptable in response to this new 'never normal'. Despite these challenges, the outlook for the automotive industry remains bright. The opportunity to reinvent itself over the next decade to become zero emission, sustainable, to embrace new technologies such as connectivity, artificial intelligence and autonomy creates huge new opportunities that stakeholders must capture to thrive in this new world order.

To accurately measure the extent of the challenge in the automotive manufacturing sector and supply chain, Automotive Manufacturing Solutions (AMS) has teamed up with automation and robotics expert ABB to gauge industry views and provide definitive data with the **AMS/ABB Automotive Manufacturing Outlook Survey 2022**, which is based upon a comprehensive survey of manufacturing industry experts providing a total of 590 responses.

Key findings -

Challenges in automotive manufacturing When asked about the main challenges in manufacturing, the largest single dominant response was unsurprisingly 62% 'Supply chain disruption, parts shortages and unpredictability'. However, beyond that there was quite a spread of other concerns with 41% citing 'Rising material costs', 31% 'Growing labour costs / skills shortages', 28% 'Rising energy costs', and 22% 'Digitalisation / data management'.

Challenges in supply chains In response to a more focused question around the specific challenges in supply chains, the single dominant response was 67% for 'Supply chain disruption, parts shortages and unpredictability'. This was followed distantly by 30% 'Increasing supply chain complexity', 27% 'Rising logistics costs', 25% 'Rising energy costs', 24% 'Growing labour costs / skills shortages', and 18% 'Challenges moving from single sourcing to dual & multi-sourcing'.

Cost concerns When queried about cost concerns 62% said 'Raw material costs', 59% 'Energy', 35% 'Labour costs', 32% 'Logistics', and 31% 'Components'. Relatively minor concerns were 19% 'Fuel', 18% 'Equipment', 14% 'Financing and debt', 12% 'Plant facilities'.

Labour and skills challenges Questioned about labour and skills, responses led with 56% 'Specific skills shortages', but with a spread of other challenges such as 48% 'New skillsets required', 38% 'General labour shortages', 35% 'Lack of education, training & qualifications', 33% 'Competition from other industries', and 29% 'Uncompetitive pay and conditions'.

Manufacturing complexity The question on manufacturing complexity yielded a lead response of 53% 'Supply chain disruption, parts shortages and unpredictability'. In a distant 2nd place, were 31% 'Faster product lifecycles', 30% 'The shift to flexible manufacturing', 29% 'Greater digitalisation & data management', 26% 'Increased use of automation / robotics', 25% 'Increase in customer vehicle personalisation', 23% 'Difficulty in hitting sustainability targets', 19% 'Complexity of powertrain variants', 19% 'Increase In build to order', and 16% 'Production line stoppage'.

Future of the industry When asked which technologies will change automotive manufacturing, 50% of respondents indicated 'Digitalisation & data management' would be 'extremely significant' with another 37% stating 'significant'. 43% of respondents stated that 'Automation & robotics' would be 'extremely significant' with 41% stating 'significant'. 41% of respondents believed that 'Sustainability targets' would be 'extremely significant' with 40% stating 'significant'. 39% of respondents thought 'Modular & flexible manufacturing 'would be 'extremely significant' with 46% stating 'significant'. 38% of respondents thought that 'Industry 4.0' would be 'extremely significant' with another 39% stating 'significant'.

Sustainability Respondents were positive about achieving sustainability targets with 16% 'yes definitely', 51% 'yes but it won't be easy', 29% 'possibly but with great difficulty', 4% 'No, I don't see this happening', and 1% 'I'm not sure'. Overall, 96% of respondents believed it's possible to meet sustainability targets, albeit with varying degrees of difficulty.

Barriers to sustainable manufacturing Questioned about the barriers to sustainable manufacturing, the responses were led by 24% 'High levels of capital investment required', 15% 'Sourcing renewable energy', 12%' 'Recycling challenges', 11% 'Implementing new manufacturing processes', 10% 'Reducing energy consumption', and 8% 'Difficulty conducting a carbon impact assessment'.

Electrification Asked how realistic it is to shift to 100% electric vehicle production by the target dates of 2030-2040, respondents were pessimistic with more than half believing it is not realistic. The only positive views were 11% 'Yes, definitely', followed by 28% 'Yes, but it won't be easy'. Those that thought the target dates would not be met included 41% 'Possibly, but not by the target dates', 18% 'I don't see this happening, ever', and 2% 'Not sure'. Therefore, a total of 39% believe that targets dates will be met with a varying degree of difficulty. In contrast a total of 59% believe that targets will not be met by the target date.

Barriers to electrification When probed about the specific barriers to achieving 100% electrification by the target dates, the major responses were 19% 'Adapting to the new battery supply chain', 19% 'Other', 16% 'High levels of capital investment required', 14% 'Too rapid a pace of change', 8% 'Refitting & adapting existing production lines & plants'.

Constraints to electric vehicle industry growth When asked about constraints to electric vehicle growth, respondents cited 26% 'Lack of charging infrastructure', 17% 'High battery & electric vehicle prices', 12% 'Slow technological advances in EV range & charging performance', 8% 'Constrained upstream battery supply chain', 7% 'Consumer resistance to EVs', and 7% 'Lack of battery cell gigafactory capacity'.

Alternative fuels Looking beyond EVs, respondents were asked which technology is likely to make a major contribution and 26% cited 'Hydrogen fuel cell vehicles', 25% 'Advanced batteries: solid state, lithium sulphur, lithium air etc'., 20% 'Battery electric / hydrogen fuel cell hybrids', 12% 'Hydrogen combustion engines', 7% 'Advanced synthetic e-fuels', 4% 'Smart aftermarket technology for hard to electrify vehicles', 3% 'Other'.

New Economy Questioned about which new CASE (connected , autonomous, shared, and electric) and other technologies would advance the most over the next year, unsurprisingly the dominant response was 42% 'Electric vehicles', followed by 17% 'Connected vehicles', 16% 'Autonomous vehicles', 15% 'Shared mobility', and just 9% 'Software defined vehicles'.

State of the industry: production vs demand constraints Respondents indicated that vehicles volumes will be constrained by production, with 24% 'Strongly constrained by production', 33% 'Moderately constrained by production', 13% 'Neither: production will meet demand'. In contrast only 18% said 'Moderately constrained by demand', and 8% 'Strongly constrained by demand'. Overall, 57% believed volumes would be constrained by production, 13% neither: production will meet demand, and 26% constrained by demand.

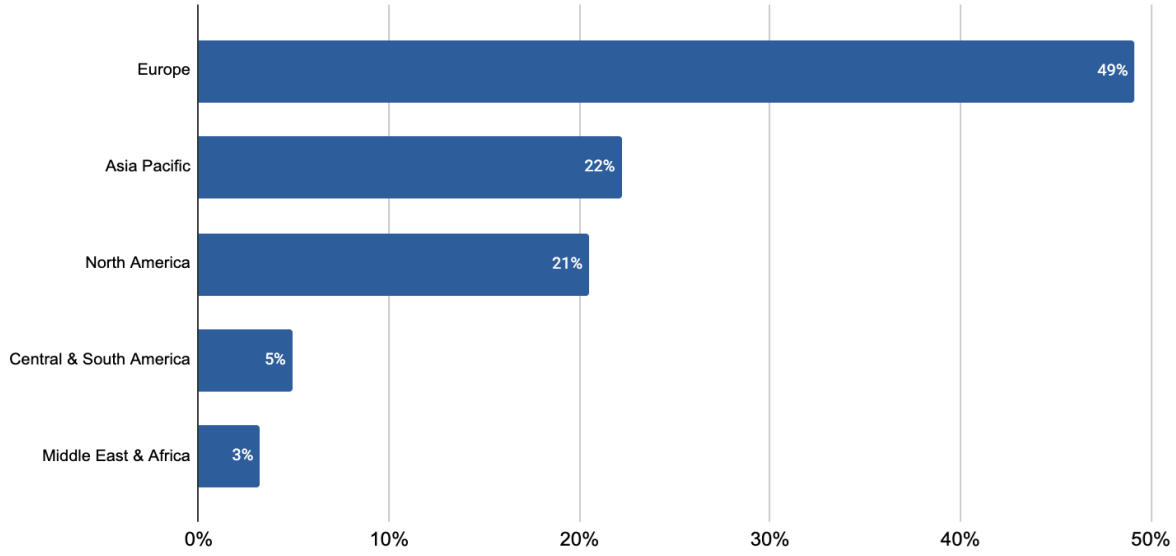
Production & sales volumes Questioned on global vehicle production and sales outlook in the next 12 months, responses for production were evenly balanced with 43% stating it will be 'Increasing', 13% 'Stay the same', and 44% 'Decreasing'. For sales, the outlook was evenly balanced: 41% stating it will be 'Increasing', 14% 'Stay the same', 44% 'Decreasing'.

Survey respondents

Respondents by region

Of the 590 respondents to the survey examining current trends within automotive manufacturing, 49% were from Europe, 22% from Asia Pacific, 21% from North America, 5% from Central & South America and 3% from Middle East & Africa. Whilst Europe is slightly overrepresented amongst the survey respondents, overall there is still a good mix of respondents from the major manufacturing regions.

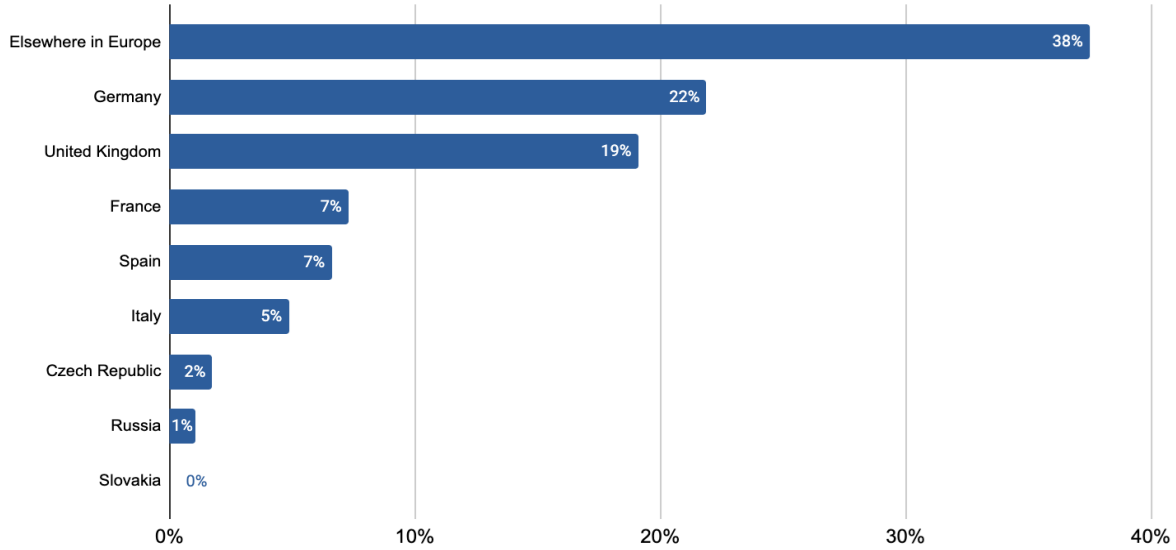
Figure 1: Survey respondents by region



European respondents

Of those in Europe, 22% were from Germany, 19% from the UK, 7% from France, 7% from Spain, 5% from Italy, 2% from Czech Republic, 1% from Russia and 38% elsewhere in Europe. In terms of production bases, France, Spain, and Italy are slightly underrepresented.

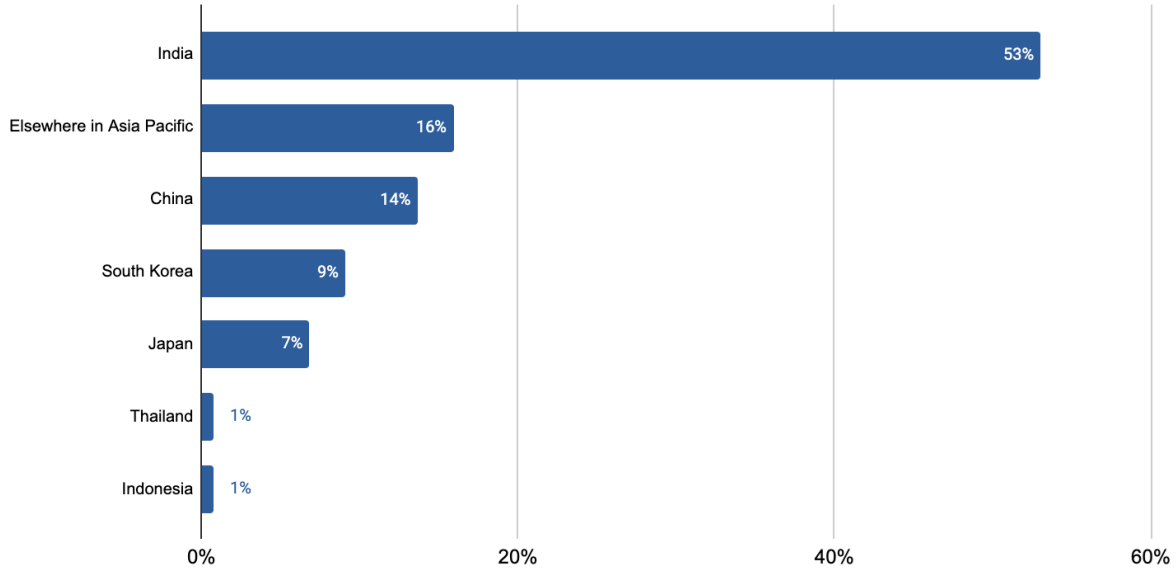
Figure 2: Survey respondents from European countries



Asia Pacific respondents

For those located in Asia Pacific, respondents were 53% from India, 14% from China, 9% from South Korea, 7% from Japan, 1% from Thailand, 1% from Indonesia and 16% from elsewhere in Asia Pacific. The Indian respondents are overrepresented and Chinese, South Korean and Japanese respondents underrepresented.

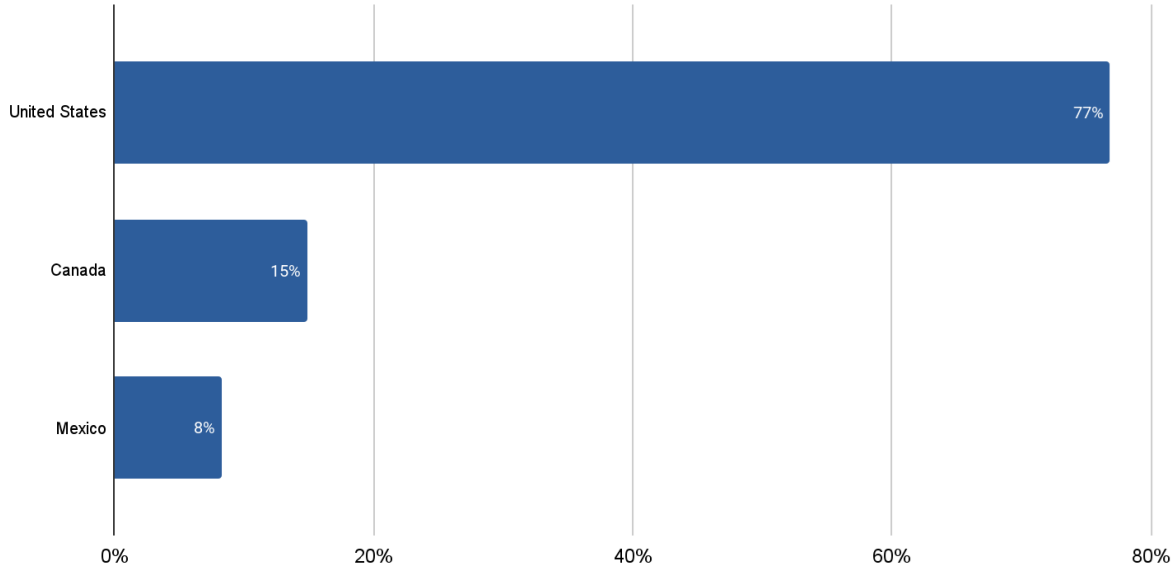
Figure 3: Survey respondents from Asia Pacific countries



North America respondents

For those from North America, 77% were from the US, 15% from Canada and 8% from Mexico, which broadly reflects the differing regional production bases in those regions, although slightly underrepresenting Mexico.

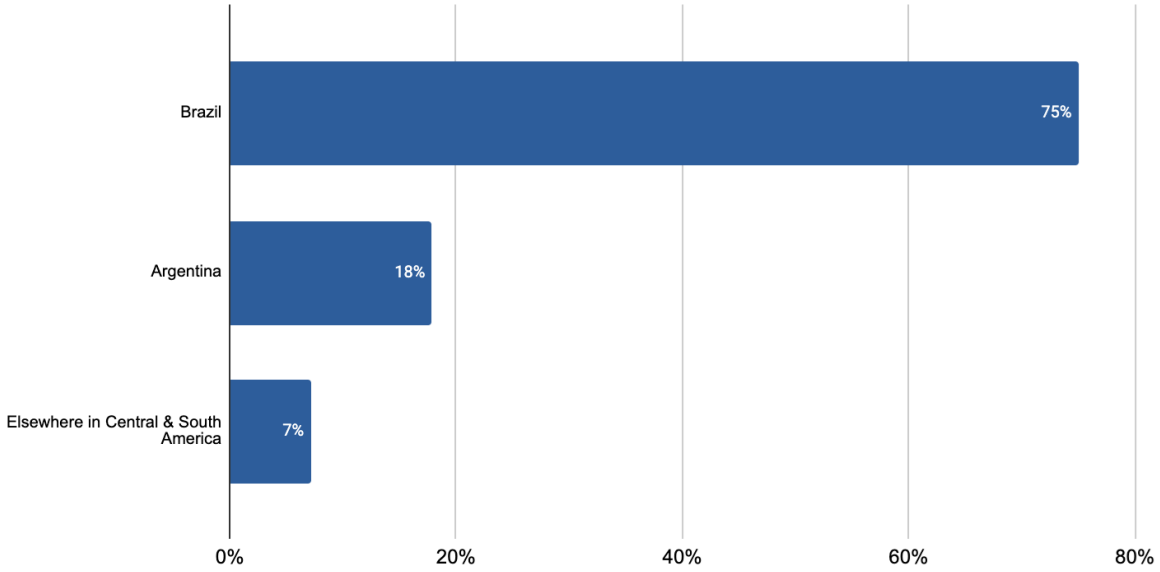
Figure 4: Survey respondents from North American countries



South & Central America respondents

For those from South & Central America, 75% of respondents were from Brazil, 18% from Argentina and 7% from elsewhere in South & Central America which broadly represents the automotive production bases in those respective regions.

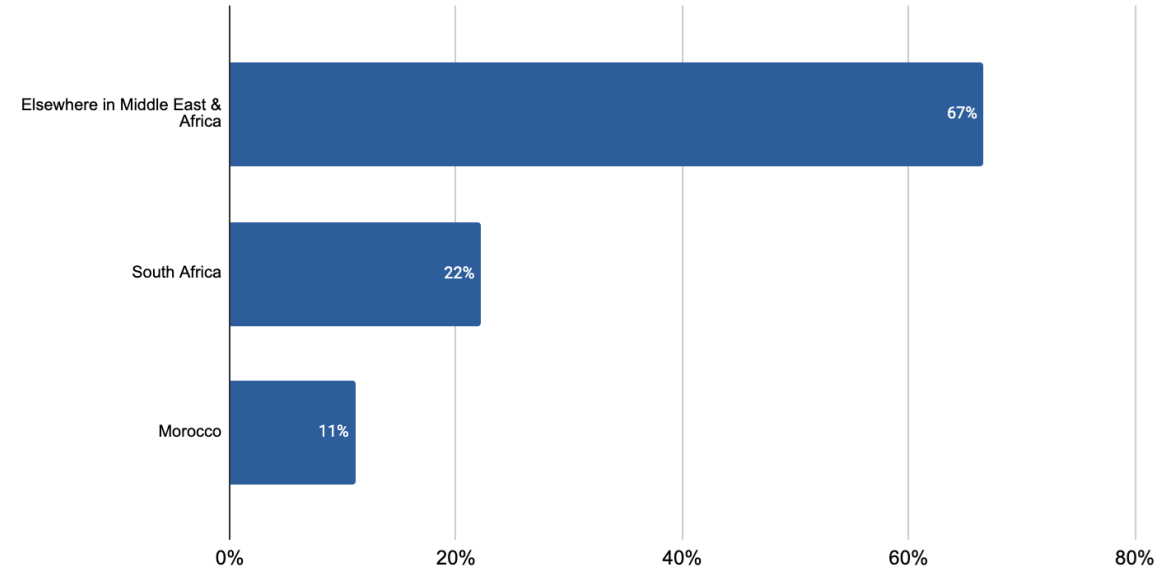
Figure 5: Survey respondents from South & Central American countries



Middle East & Africa respondents

For those from Middle East & Africa, 22% were from South America, 11% from Morocco and 67% were from elsewhere in Middle East & Africa. As Morocco and South Africa are the major automotive production bases in the MEA, these countries are therefore underrepresented.

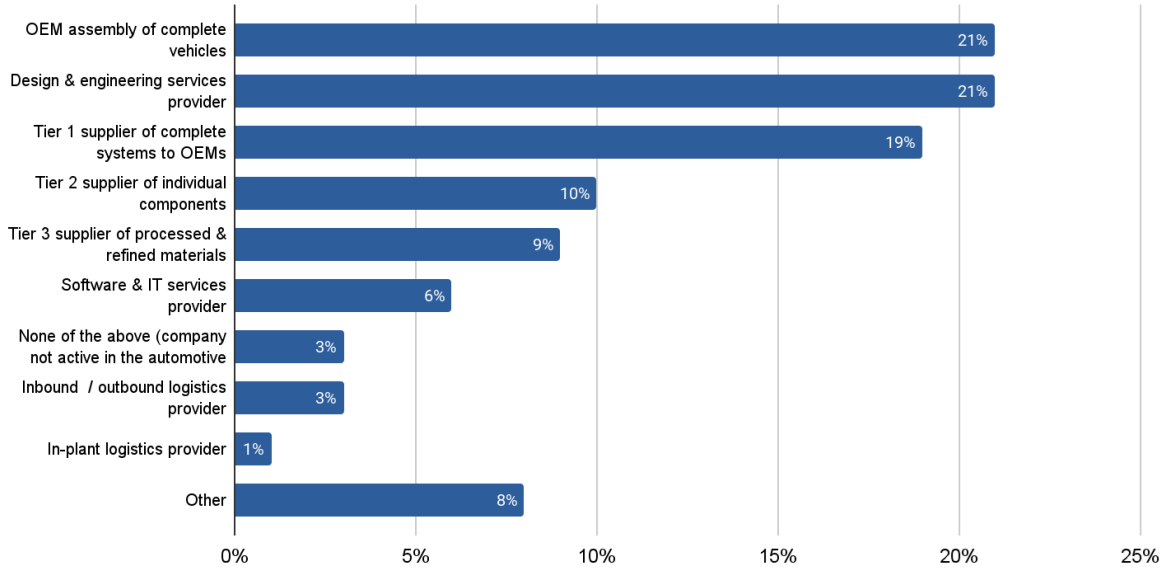
Figure 6: Survey respondents from Middle East & African countries



Company Type

Regarding company type, 21% of the respondents were 'OEMs', 21% offered 'Design & engineering services', 19% were 'Tier 1 suppliers', 10% were 'Tier 2 suppliers', and 9% were 'Tier 3 suppliers'. This wide spread of respondents provides an excellent representative picture of the entire automotive manufacturing industry value chain.

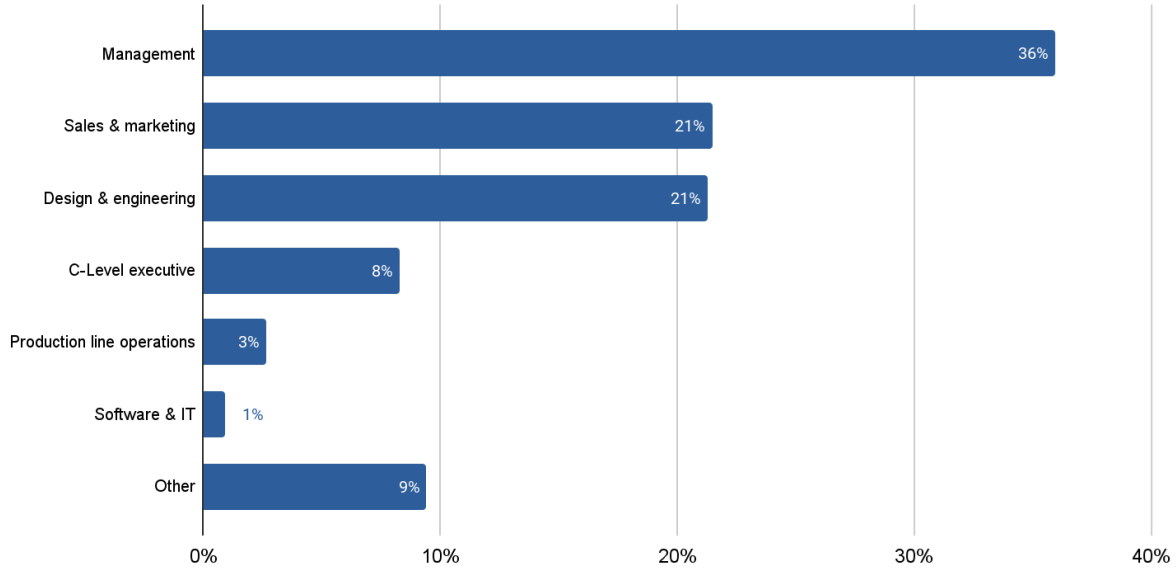
Figure 7: Survey respondents by company type



Job role / function

In terms of job role, 36% were 'Management', 21% 'Design & engineering', 21% 'Sales & marketing', 8% 'C-level executive', 3% 'Production line operations', 1% 'Software and IT', and 9% 'Other', again providing a good spread of expert opinion.

Figure 8: Survey respondents by job role / function



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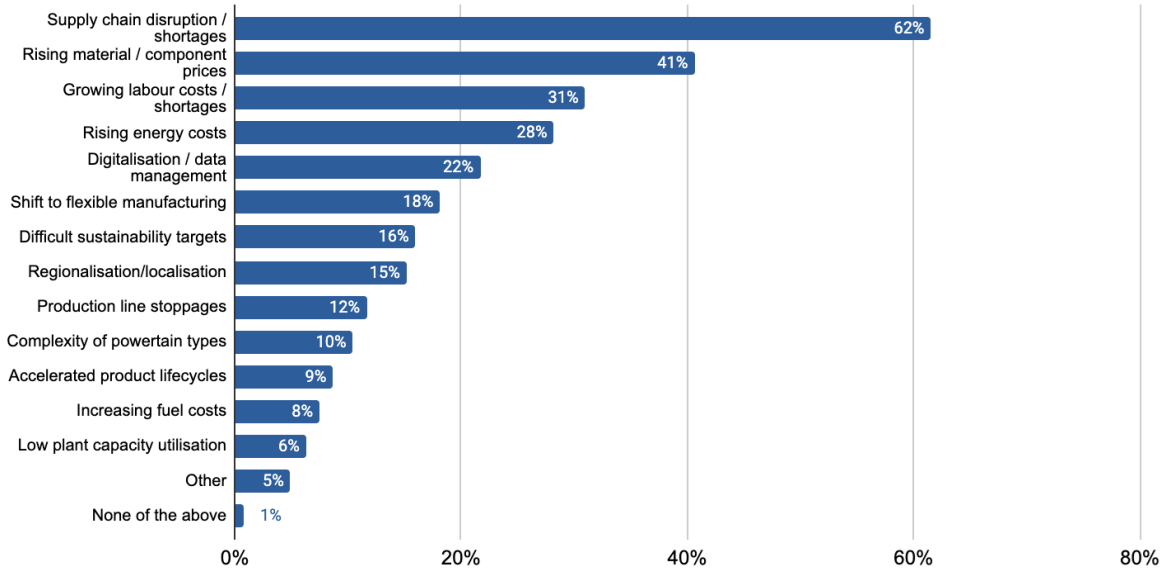
Industry challenges

Challenges in automotive manufacturing

When asked about the main challenges in automotive manufacturing, the largest single dominant response was unsurprisingly 62% 'Supply chain disruption, parts shortages and unpredictability'. However, beyond that there was quite a spread of other concerns with 41% citing 'Rising material costs', 31% 'Growing labour costs / skills shortages', 28% 'Rising energy costs', and 22% 'Digitalisation / data management'.

Figure *9: 'What do you see as the biggest THREE challenges to automotive MANUFACTURING?'*



In terms of regional variances, 'Supply chain disruption' was the number one issue in each region, although scoring higher in North America (70%) than in Europe (64%) ad Asia (52%). 'Rising materials & component prices' was in 2nd place in Asia (42%) and North America (51%), but 3rd place in Europe (36%). 'Rising energy costs' were the 2nd place issue in Europe (46%). 'Labour costs & skills shortages' were the 3rd place issue in Asia (31%) and North America (51%).

Table 1: Top 3 manufacturing challenges by region

Asia	Europe	North America
1 Supply chain disruption 52%	**1 Supply chain disruption 64%**	**1 Supply chain disruption 70%**
2 Rising material & component prices 42%	**2 Rising energy costs 46%**	**2 Rising material & component prices 51%**
3 Labour costs & skills shortages 31%	**3 Rising material & component prices 36%**	**3 Labour costs & skills shortages 51%**

In terms of company type variances, 'Supply chain disruption' was consistently the number one issue for all company types. 'Rising materials costs' were the 2nd placed issue for OEMs, Tier 1's and Tier 2's, but not Tier 3's. 'Rising energy costs' were the 2nd placed issue for Tier 3's, but the 3rd place issue for Tier 1's and Tier 2's. 'Labour costs / shortages' were the 3rd place issue for OEMs and Tier 3's, but not Tier 1's or Tier 2's.

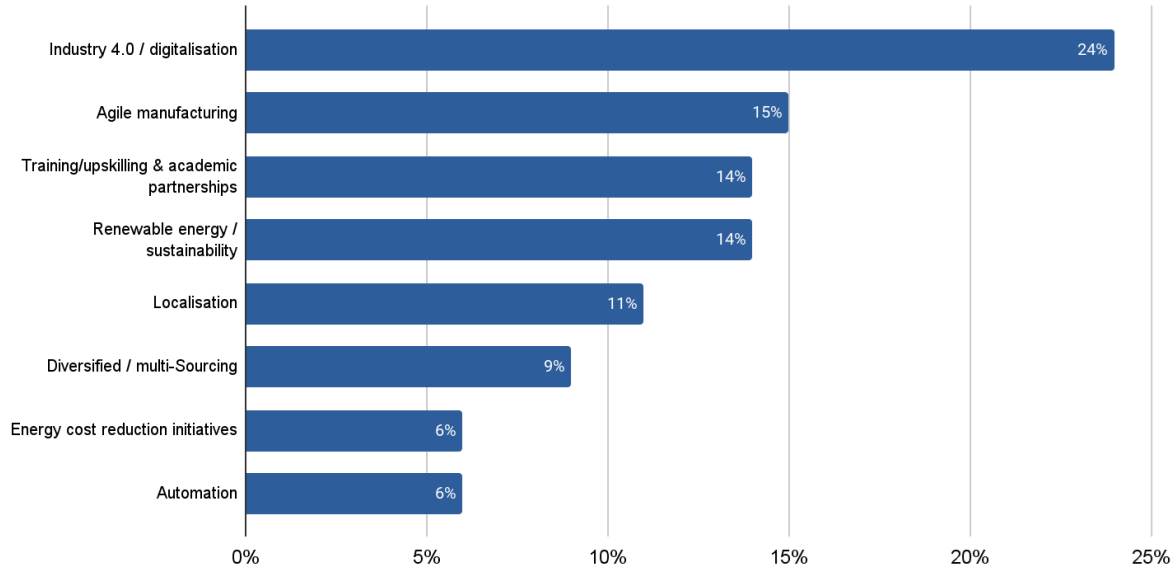
Table 2: Top 3 manufacturing challenges by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Supply chain disruption 64%	1 Supply chain disruption 57%	1 Supply chain disruption 57%	1 Supply chain disruption 61%
2 Rising material costs 48%	2 Rising material costs 54%	2 Rising material costs 53%	2 Rising energy costs 42%
3 Labour costs/shortages 25%	3 Rising energy costs 36%	3 Rising energy costs 43%	3 Labour costs/shortages 42%

Responses to challenges in manufacturing

Respondents were asked an open question and given the opportunity to respond freely in their own words as to how they are adapting to these challenges. 24% of respondents indicated 'Industry 4.0 & digitalisation' will help ease manufacturing challenges, 15% 'Agile manufacturing', 14% 'Training & academic partnerships', and 14% 'Renewable energy / sustainability'.

Figure 10: *'What steps is your business taking to adapt to these MANUFACTURING challenges?'*



Specific examples of how respondents are adapting to manufacturing challenges -

"Working towards Industry 4.0 implementation in a phased manner. Development of alternate fueled vehicles - electric, hydrogen, CNG/LNG. Building stock to mitigate uncertainties and supply disturbances."
OEM assembly of complete vehicles

"Increased focus on flexibility in the manufacturing processes to allow easier transfer / balancing of business between lines and sites."
Supplier of complete systems to OEMs

"Partnerships with academia to reach top level students."
Design & engineering services provider

"We are adding more digital engineering services including newer technologies, automation with IoT/Industry 4.0-5.0 outlook, building skillsets to develop better manufacturing processes, moving horizontally to cover all aspects of customer requirements as a one stop solution provider."
Design & engineering services provider

"Digitalization, AI implementation, automation to replace labour."
Supplier of individual components

"Improvement of carbon-neutral response processes, review of energy-low-cost facilities, establishment of smart factory systems, and increasing the number of people related to big data."
OEM assembly of complete vehicles

"Flexible manufacturing set up. Innovative approach in new product line up. Focus on re-engineering to raise quality standards. Stress on sustainability and digitization."
Supplier of excavators

"Increased automation, digital twin tech and more / better use of cloud-based analytics."
Supplier of individual components

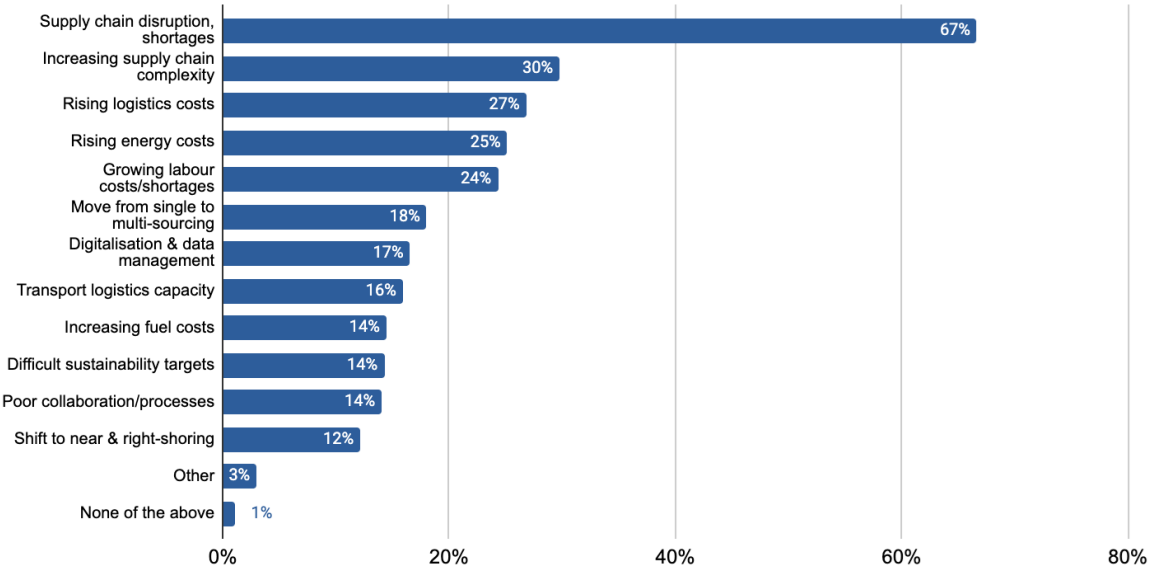
"Training sessions to better understand what digitalization means and how to take advantage of it."
Supplier of complete systems to OEMs

"Flexible manufacturing, reduce no. of stations. High level of automation."
Design & engineering services provider

Challenges in supply chains

In response to a more focused question around the specific challenges in supply chains, the single dominant response was 67% for 'Supply chain disruption, parts shortages and unpredictability'. This was followed distantly by five other main issues including 30% 'Increasing supply chain complexity', 27% 'Rising logistics costs', 25% 'Rising energy costs', 24% 'Growing labour costs / skills shortages', and 18% 'Challenges moving from single sourcing to dual & multi-sourcing'.

Figure 11: *'What are the biggest challenges specific to automotive SUPPLY CHAINS?'*



In terms of regional variances, 'Supply chain disruption' was the number one issue in each region, although scoring higher in North America (72%) than in Europe (68%) ad Asia (63%). 'Supply chain complexity' was the 2nd biggest issue in Asia (29%), but 3rd place in Europe (29%) and North America (31%). 'Rising energy costs' were the 2nd place issue in Europe (40%). 'Labour costs & skills shortages' were the 2nd place issue in North America (39%), but the 3rd place issue in Asia (25%).

Table 3: Top 3 supply chain challenges by region

Asia	Europe	North America
1 Supply chain disruption 63%	**1 Supply chain disruption 68%**	**1 Supply chain disruption 72%**
2 Supply chain complexity & Rising logistics costs (both) 29%	**2 Rising energy costs 40%**	**2 Labour costs/skills shortages 39%**
3 Labour costs/skills shortages 25%	**3 Supply chain complexity 29%**	**3 Supply chain complexity 31%**

In terms of company type variances, 'Supply chain disruption' was consistently the number one issue for all company types. However, beyond this dominant issue, the results were more varied and fragmented. 'Rising energy costs' were the 2nd placed issue for Tier 3's (42%), and the 3rd place issue for Tier 1's. (32%). 'Labour costs / shortages' were the 2nd place issue for Tier 2's only. 'Rising logistics costs' was the 2nd major issues for Tier 1's (41%) and the 3rd place issue for Tier 2's (30%). 'Digitalisation' was the 3rd place issue for OEMs (22%) only. 'Hitting sustainability targets' was the 3rd place issue for Tier 3's only (29%).

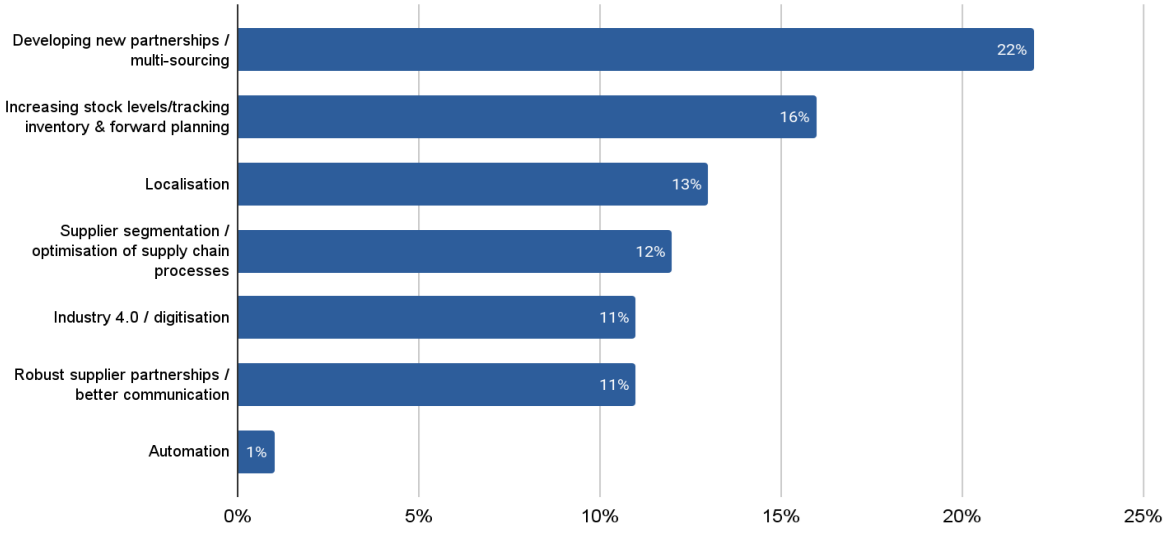
Table 4: Top 3 supply chain challenges by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Supply chain disruption 71%	**1 Supply chain disruption 69%**	**1 Supply chain disruption 70%**	**1 Supply chain disruption 58%**
2 Supply chain complexity 42%	**2 Rising logistics costs 41%**	**2 Labour costs & shortages 30%**	**2 Rising energy costs 42%**
3 Digitalisation 22%	**3 Rising energy costs 33%**	**3 Rising logistic costs 30%**	**3 Hitting sustainability targets 29%**

Responses to challenges in supply chains

Respondents were asked an open question to respond freely in their own words as to how they are adapting to these supply chain challenges. 22% of respondents indicated 'Developing new partnerships / multi-sourcing', 16% 'Increase stock levels/tracking inventory and forward planning', and 13% 'Localisation'.

Figure 12 *'What steps is your business taking to mitigate against automotive SUPPLY CHAIN DISRUPTION?'*



Specific examples of how respondents are adapting to supply chain challenges -

"Develop more capable suppliers into the supplier pool. Put more management on supplier improvement. Grow with small & less 'famous' suppliers."
OEM assembly of complete vehicles

"Expanding our supplier base, reducing # of SKUs offered to focus on higher volume products, increasing inventory and securing long term supply agreements for hard to find components."
Supplier of robotic end effectors & accessories

"Forward planning of material purchases, stock investment to buffer supply / demand requirements, innovation in component design to reduce cost, process time and impact on expected delivery time."
Quality inspection equipment supplier

"Build up new suppliers. No more single sourcing. buy more locally & create more supplier loyalty."
Software & IT services provider

"Actively pursuing alternative sources for critical components."
OEM over-the-road car haulers

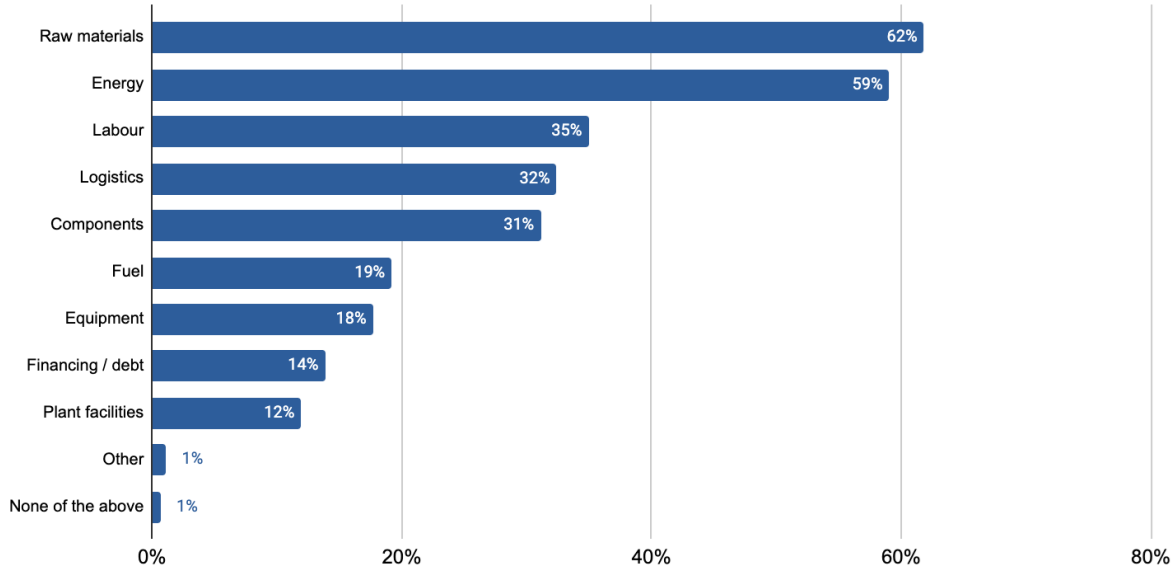
"More and more the trend will be 'production on demand' instead of mass production. Reduction of cycle time on production processes to reduce energy and resource consumption."
Design & engineering services provider

"Aggressively looking for multiple suppliers of material."
Supplier of individual components

Rising costs

When queried about rising costs, the main concerns respondents gave were 62% 'Raw material costs', 59% 'Energy', 35% 'Labour costs', 32% 'Logistics', and 31% 'Components'. Relatively minor concerns were 19% 'Fuel', 18% 'Equipment', 14% 'Financing and debt', and 12% 'Plant facilities'.

Figure 13: *'In which areas are you most concerned about RISING COSTS?'*



In terms of regional variances, 'Raw materials' was the leading issue in Asia (66%), and North America (65%), and the 2nd largest issue in Europe (60%). 'Labour' was the 2nd largest issue in Europe (38%), and North America (41%), but the 3rd largest issue in Europe (33%), in joint third place with 'Components'. 'Energy' was the leading issue in Europe (80%), but only the 3rd largest issue in Asia (33%), and North America (39%) which was also in joint third place with 'Logistics' (39%).

Table 5: Top 3 cost challenges by region

Asia	Europe	North America
1 Raw materials 66%	**1 Energy 80%**	**1 Raw materials 65%**
2 Labour 38%	**2 Raw Materials 60%**	**2 Labour 41%**
3 Energy 33%	**3 Labour 33% & Components 33%**	**3 Energy 39% & Logistics 39%**

In terms of company type variances, all company types responded with a remarkably similar set of concerns. 'Raw materials' was consistently the number one issue for all company types. 'Energy' was the 2nd largest issue for all company types. 'Labour' and / or 'logistics' all took the 3rd place for all company types.

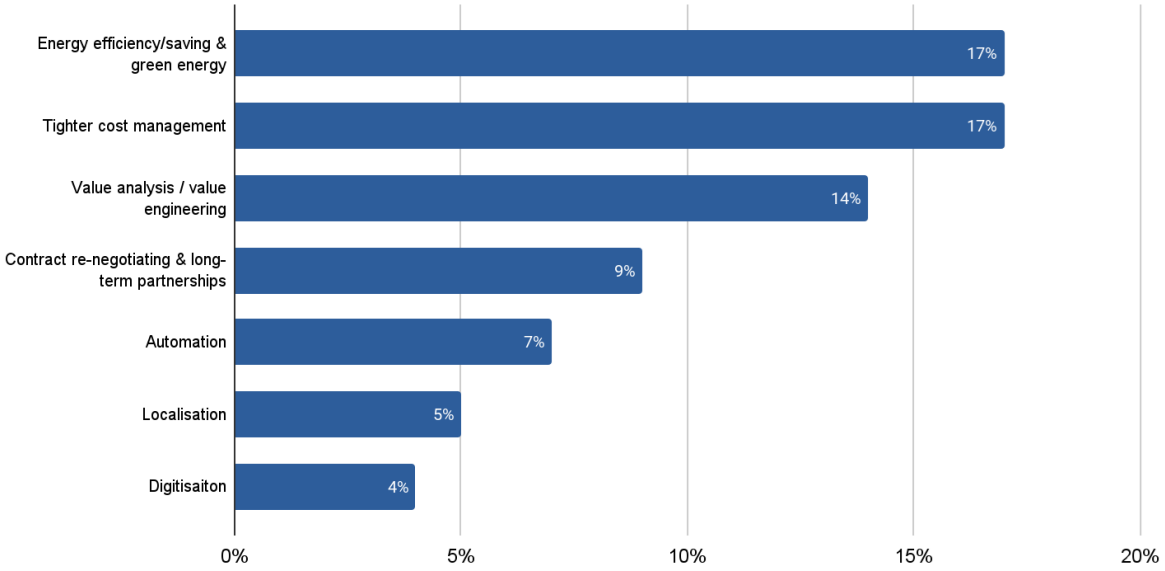
Table 6: Top 3 cost challenges by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Raw materials 59%	1 Raw materials 71%	1 Raw materials 71%	1 Raw materials 68%
2 Energy 55%	2 Energy 56%	2 Energy 64%	2 Energy 65%
3 Labour 39% & Logistics 39%	3 Labour 39% & Logistics 39%	3 Labour 42%	3 Logistics 35%

Responses to rising costs

Respondents were asked an open question to respond freely in their own words as to how they are adapting to rising costs. 17% of respondents indicated 'Energy efficiency/saving & green energy',17% 'Tighter cost management, and 14% 'Value analysis / value engineering'

Figure 14: *'What measures is your business taking in response to rising COSTS?'*



Specific examples of how respondents are responding to rising costs -

”Focusing on waste reduction - through war rooms, green energy utilisation, carbon footprint reduction and circular economy adoption from initial planning stage itself.”

”Aggressive management of costs across the board, coupled with transparent review of the specific challenges with our OEM customers.”
Supplier of complete systems to OEMs

”Advance purchase of bulk material to achieve efficiency in deliverables and discount strategies for cost effective purchase strategy, based on heightened forecasting of deliverables to end user based on contractual and volume requirements.”
Quality Inspection equipment supplier

”Active search for possible energy savings, balancing of overall energy and resource consumption of process chains.”
R&D in automotive production

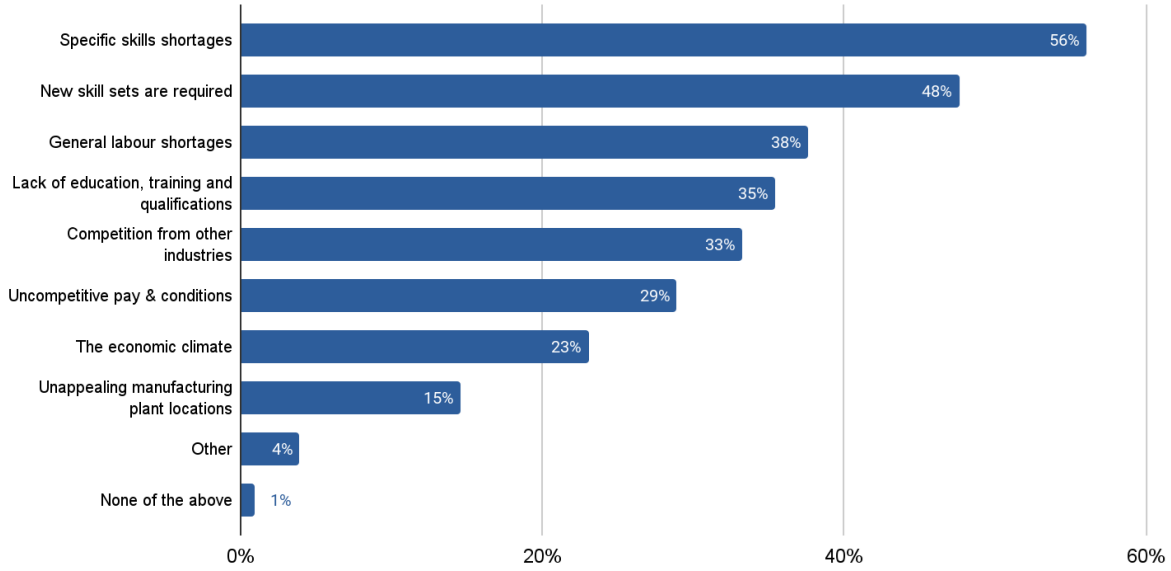
”Driving various cost saving initiatives, cutting unnecessary expenditures. Efficiency of operation improvement, Development of cost effective alternate sourcing, alternate fuel, reverse logistics.”
OEM assembly of complete vehicles

”Shopping around for better pricing, working relationships with suppliers to cut every cost possible as well as improving efficiency with value add labour.”
Welding robotics systems supplier

Labour and skills challenges

Questioned about labour and skills, the responses led with 56% 'Specific skills shortages', but followed by quite a wide spread of other challenges such as 48% 'New skillsets required', 38% 'General labour shortages', 35% 'Lack of education, training & qualifications', 33% 'Competition from other industries', and 29% 'Uncompetitive pay and conditions'.

Figure 15: '*What are the LABOUR and SKILLS challenges impacting manufacturing?*'



In terms of regional variances, the top 3 issues in each region were very similar, albeit in a slightly different order of importance. 'New skillsets required' was the leading issue in Asia (57%), the 2nd largest issue in Europe (48%) and the third largest issue in North America (37%). 'Specific skills shortages' were the leading issue in Europe (58%), and the 2nd largest issue in Asia (53%), and North America (53%). 'Labour shortages' was the leading issue in North America (56%) and the 3rd largest issue in Asia (37%). 'Lack of education/training' was the 3rd largest issue in Europe (35%).

Table 7: Top 3 labour & skills challenges by region

Asia	Europe	North America
1 New skillsets required 57%	**1 Specific skills shortages 58%**	**1 Labour shortages 56%**
2 Specific skills shortages 53%	**2 New skillsets required 48%**	**2 Specific skills shortages 53%**
3 Labour shortages 37%	**3 Lack of education/training 35%**	**3 New skillsets required 37%**

In terms of company type variances, 'Specific skills shortages' was the leading issue for OEM's (57%), Tier 1's (55%), and Tier 2's (53%), but not for Tier 3's. 'New skillsets required' were the 2nd largest issue for OEM's (51%), for Tier 2's (51%) and the 3rd largest issue and Tier 3's (43%). 'Competition from other industries' was the 2nd largest issue for Tier 1's (42%), Tier 3's (47%), and the 3rd largest issue for Tier 2's (51%). 'Labour shortages' were the 3rd largest issue for OEM's (38%) and Tier 1's (37%).

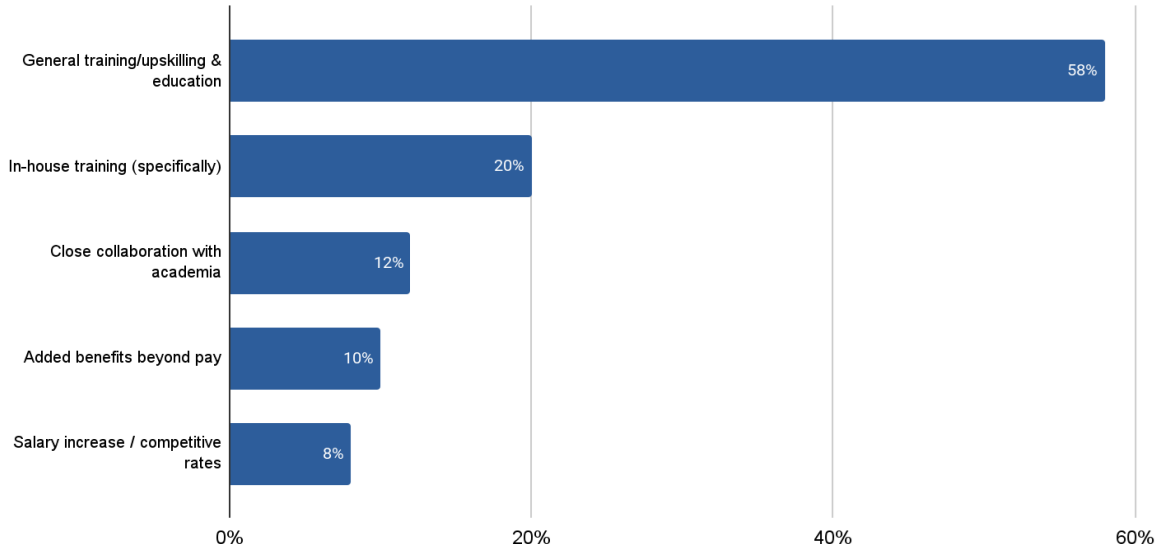
Table 8: Top 3 labour & skills challenges by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Specific skills shortages 57%	1 Specific skills shortages 55%	1 Specific skills shortages 53%	1 Labour shortages 47%
2 New skillsets required 51%	2 Competition from other industries 42%	2 New skillsets required 51%	2 Competition from other industries 47%
3 Labour shortages 38%	3 Labour shortages 37%	3 Competition from other industries 51%	3 New skillsets required 43%

Responses to labour and skills challenges

Respondents were asked an open question to respond freely in their own words as to how they are adapting to these labour and skills challenges. 58% of respondents indicated 'General training/upskilling & education', 20% 'In-house training', and 12% 'Close collaboration with academia'.

Figure 16: *What steps is your business taking in response to LABOUR and SKILLS challenges?'*



Specific examples of how respondents are responding to labour and skills challenges -

”Huge investment in training.”
Supplier of complete systems to OEMs

”Serious commitment to internal training and development - create the needed skills organically.”
Supplier of complete systems to OEMs

”Developing our own talent in house via apprenticeship programs.”
Supplier of complete systems to OEMs

”Apprenticeship programs in connection with local high schools and technical colleges to build the workforce. A large focus on obtaining technology to adapt to the new workforce and to upskill current employees.”
Supplier of complete systems to OEMs

”Increased collaboration with colleges. Creating internal training programs. Increased mentorship. Increased internships.”
Supplier of complete systems to OEMs

”We cannot compete on salaries, so we try to focus on work / life balance that sets us apart from Chinese companies.”
Supplier of complete systems to OEMs

”Focus on an attractive package of benefits beyond pay.”
Supplier of processed & refined materials

”Taking care of employees. Collaboration with local technical institutions for skill training (e.g. welding). Own training institute for excavator operation. ”**Excavator supplier**

”Upskilling and cross skilling of older manpower.”
Design & engineering services provider

”Adopting technical training centres under CSR. Incubating student trainees.”
OEM assembly of complete vehicles

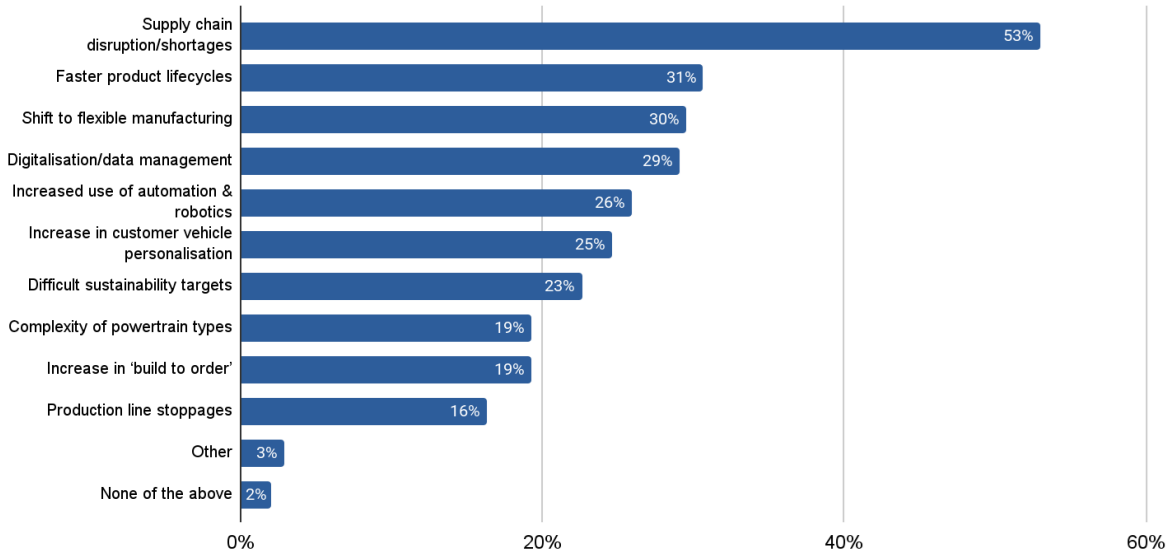
”Adjusting compensation and benefits at par in the industry standard and a little bit more.”
Supplier of complete systems to OEMs

”Competitive rates of pay, training and development, career progression & rotation.”
Inbound / outbound logistics provider

Manufacturing complexity

The question on manufacturing complexity yielded a lead response of 53% 'Supply chain disruption, parts shortages and unpredictability'. In a distant 2nd place, were 31% 'Faster product lifecycles', 30% 'The shift to flexible manufacturing', 29% 'Greater digitalisation & data management', 26% 'Increased use of automation / robotics', 25% 'Increase in customer vehicle personalisation', 23% 'Difficulty in hitting sustainability targets', 19% 'Complexity of powertrain variants', 19% 'Increase in build to order', and 16% 'Production line stoppage'.

Figure 17: *'Which of the following are most contributing to increasing manufacturing COMPLEXITY?'*



In terms of regional variances, 'Supply chain issues' was the leading response in all regions for North America (61%), Europe (56%), but less important in Asia (41%). 'Flexible/modular manufacturing' was the 2nd largest issue in Asia (36%), and 3rd largest issue in Europe (32%). 'Digitisation' was the 2nd largest issue in Europe (34%). 'Faster product lifecycles' was the 2nd largest issue in North America (34%). 'Automation/robotics' was the 3rd largest issue in Asia (35%). 'Hitting sustainability target' was the 3rd largest issue in North America.

Table 9: Top 3 manufacturing complexity challenges by region

Asia	Europe	North America
1 Supply chain issues 41%	**1 Supply chain issues 56%**	**1 Supply chain issues 61%**
2 Flexible/modular manufacturing 36%	**2 Digitalisation 34%**	**2 Faster product life cycles 34%**
3 Automation/robotics 35%	**3 Flexible/modular manufacturing 32%**	**3 Hitting sustainability target 26%**

In terms of company type variances, 'Supply chain issues' was the leading issue reported by all company types. 'Customer personalisation' was the 2nd major issue for OEM's (36%). 'Powertrain variants' were the 2nd largest issue for Tier 1's (30%) and Tier 2's (30%). 'Sustainability targets' were the 2nd largest issue for Tier 3's (47%) and joint 3rd largest issue for Tier 2's (33%). 'Flexible manufacturing' was the 3rd largest issue for OEM's (35%). 'Automation/robotics' was the 3rd largest issue for Tier 1's and jointly 3rd for Tier 2's (33%). 'Faster product lifecycles' was the 3rd largest issue for Tier 3's (33%).

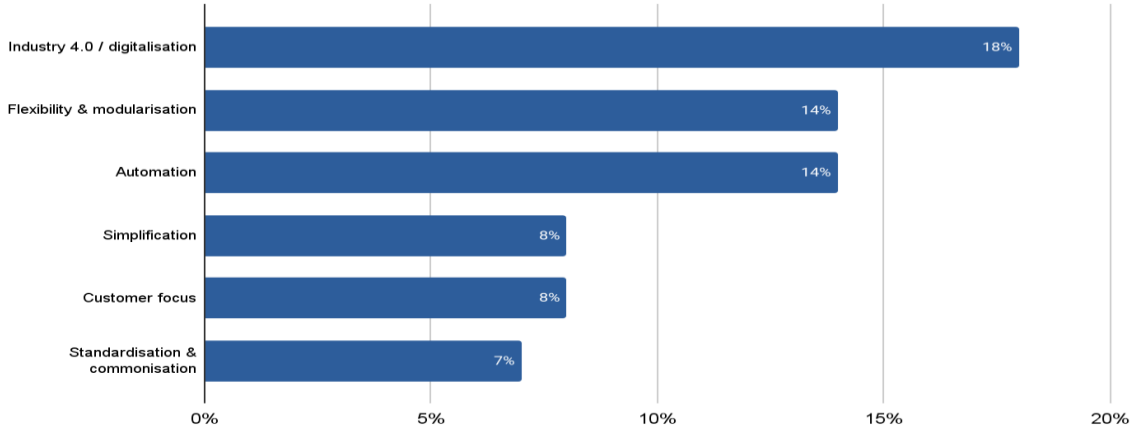
Table 10: Top 3 manufacturing complexity challenges by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Supply chain issues 46%	**1 Supply chain issues 61%**	**1 Supply chain issues 58%**	**1 Supply chain issues 63%**
2 Customer personalisation 36%	**2 Powertrain variants 30%**	**2 Powertrain variants 30%**	**2 Sustainability targets 47%**
3 Flexible manufacturing 35%	**3 Automation / robotics 24%**	**3 Automation / robotics & Sustainability targets (both) 33%**	**3 Faster product lifecycles 33%**

Responses to manufacturing complexity

Respondents were asked an open question to respond freely in their own words how they are adapting to manufacturing complexity. 18% of respondents cited 'Industry 4.0 / digitalisation', 14% cited 'Flexibility & modularisation', 14% referred to 'Automation, 8% mentioned 'simplification', 8% 'Customer focus' and 7% 'Standardisation & commonisation'.

Figure 18: *'In response to this increased manufacturing COMPLEXITY, what measures is your company introducing?'*



Specific examples of how respondents are responding to manufacturing complexity –

”We’re a small dynamic company trying to overcome these issues for ourselves and our customers. Automation is key to this and where our focus is.”
Prototypes and laser processing equipment supplier

”Installed flexible manufacturing systems. Develop multiple fuel options in engines. Build cars on common platform. e.g. hatchback and notchback sharing 70% design shape, size, and aesthetics.”
OEM assembly of complete vehicles

”Use more advanced digital & AI solutions.”
OEM assembly of complete vehicles

”Complexity management and digitalisation through industry 4.0.”
OEM assembly of complete vehicles

”Lessons learned from previous projects, increased internal training for automation and robotics (e.g. E-learning).”
Supplier of complete systems to OEMs.

”We are working on digitisation and creating IoT based infrastructure to have real time meaningful insights for prompt actions/decisions.”
Supplier of individual components

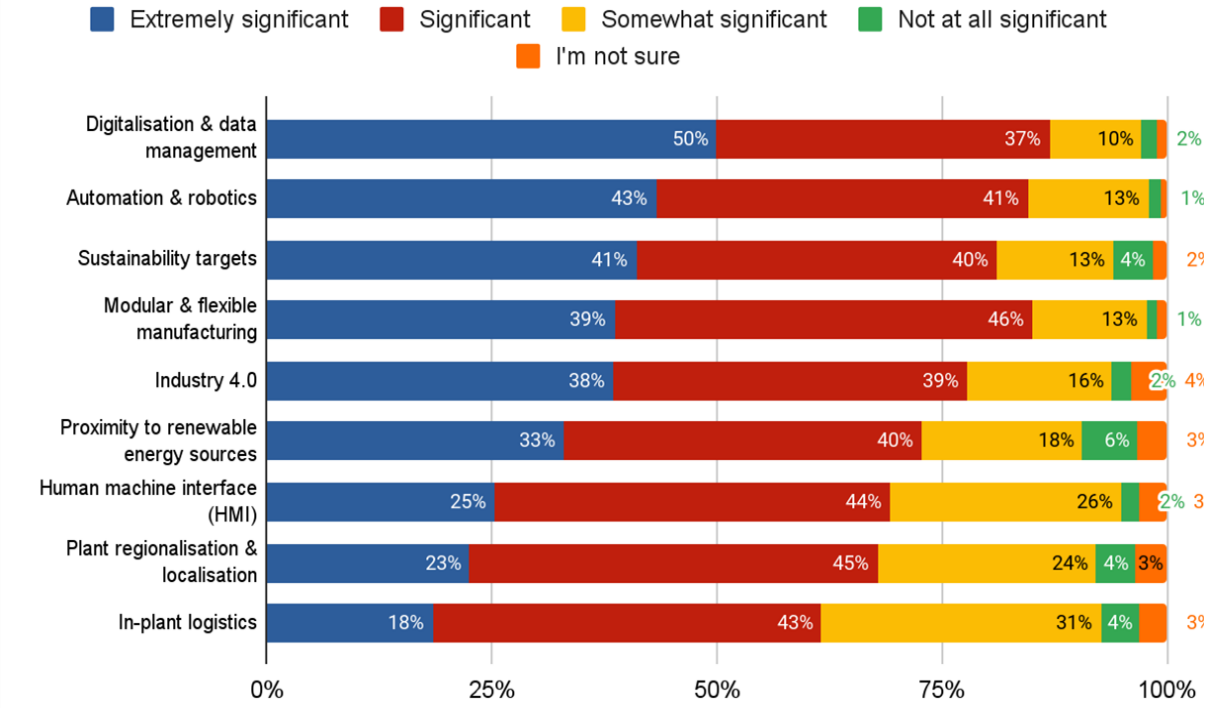
”We are increasing our robotisation and automation every year. We are also working on more of lean manufacturing concepts.”
Supplier of complete systems to OEMs.

”Keeping employees at the same level of knowledge by giving importance to digitalization.”
Supplier of complete systems to OEMs.

Future of automotive manufacturing

When asked how significant technologies will be in changing automotive manufacturing, 50% of respondents indicated that 'Digitalisation & data management' would be 'extremely significant' with another 37% stating 'significant'. 43% of respondents stated that 'Automation & robotics' would be 'extremely significant' with another 41% stating 'significant'. 41% of respondents believed that 'Sustainability targets' would be 'extremely significant' with another 40% stating 'significant'. 39% of respondents thought that 'Modular & flexible manufacturing 'would be 'extremely significant' with another 46% stating 'significant'. 38% of respondents took the view that 'Industry 4.0' would be 'extremely significant' with another 39% stating 'significant'.

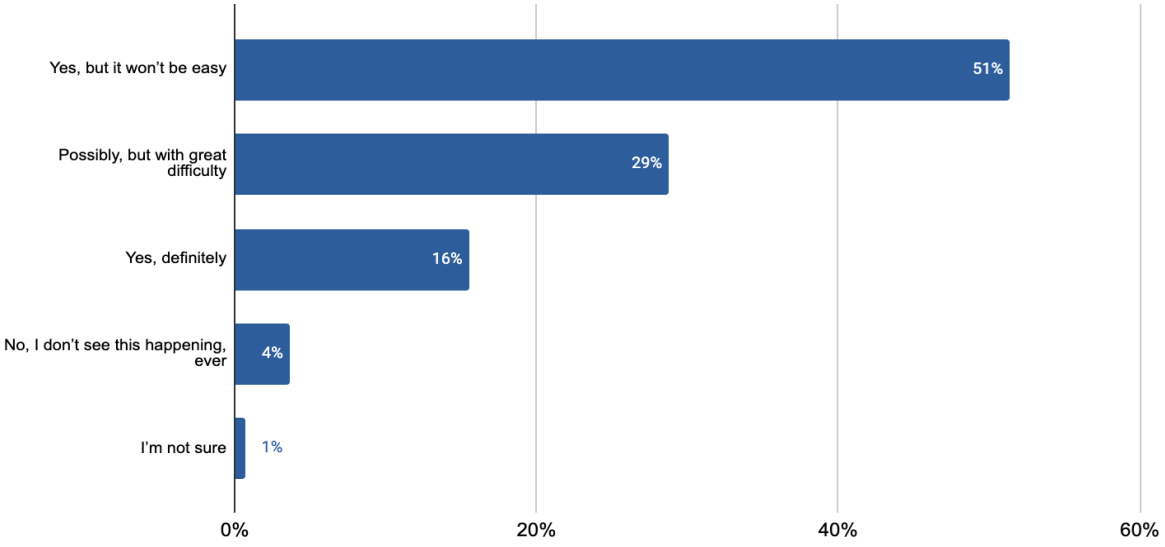
Figure 19: *'How significant do you think the following will be in changing automotive manufacturing in the next three years?'*



Sustainable manufacturing

Respondents were broadly positive about the prospects of achieving sustainability targets with 16% 'yes definitely', 51% 'yes but it won't be easy', 29% 'possibly but with great difficulty', 4% 'No I don't see this happening', and 1% 'I'm not sure'. Overall, therefore 96% of respondents believed it's possible to meet sustainability targets, albeit with varying degrees of difficulty.

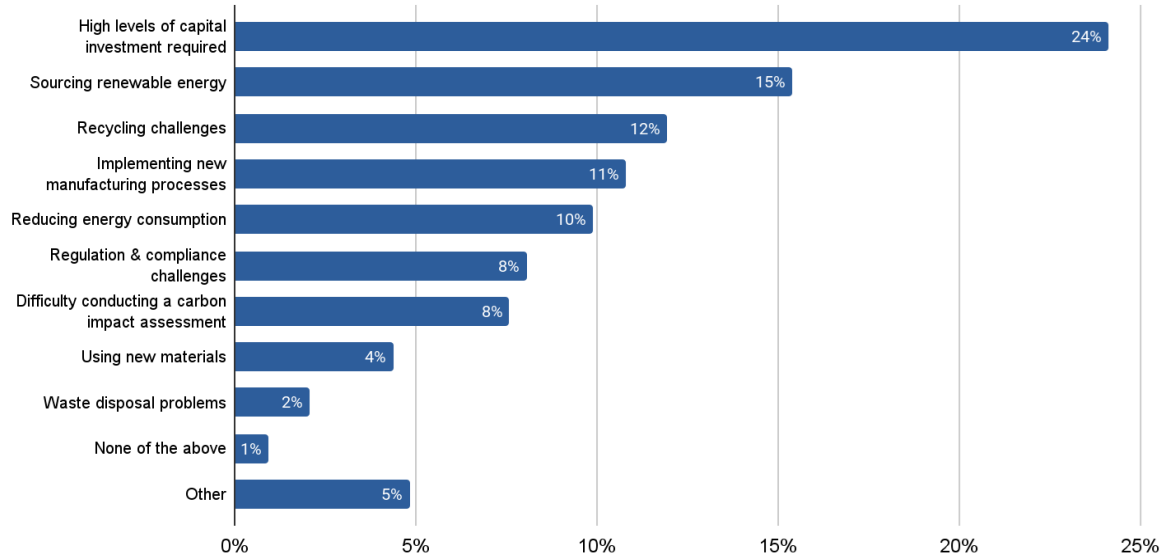
Figure 20: *'Do you think genuinely sustainable manufacturing is possible to achieve?'*



Barriers to sustainable manufacturing

Questioned about the barriers to achieving sustainable manufacturing, the responses were led by 24% 'High levels of capital investment required', 15% 'Sourcing renewable energy', 12%' 'Recycling challenges', 11% 'Implementing new manufacturing processes', 10% 'Reducing energy consumption', and 8% 'Difficulty conducting a carbon impact assessment'.

Figure 21: *'If you had to pick just one, what do you see as the biggest barrier to sustainable manufacturing?'*



In terms of regional variances, 'High capital investment' was the main barrier to sustainable manufacturing in Europe (25%), North America (24%) and Asia (20%). 'Sourcing renewable energy' was the 2nd largest barrier in Asia (19%) and Europe (16%), although in North America, 'Regulation & compliance' was the 2nd largest issue (16%). However, the 3rd place barrier differed in each region with both 'Reducing energy consumption' & 'Conducting carbon impact assessments' in Asia (11%), 'Recycling challenges' in Europe (14%), and 'New manufacturing processes' in North America (14%).

Table 9: Top 3 barriers to sustainable manufacturing by region

Asia	Europe	North America
1 High capital investment 20%	**1 High capital investment 25%**	**1 High capital investment 24%**
2 Sourcing renewable energy 19%	**2 Sourcing renewable energy 16%**	**2 Regulation & compliance 16%**
3 Reducing energy consumption & Conducting carbon impact assessments (both) 11%	**3 Recycling challenges 14%**	**3 New manufacturing processes 14%**

In terms of company type variances, 'High capital investment' was the leading barrier for OEMs (30%), Tier 1's (27%), and Tier 2's (28%), but the 3rd place barrier for Tier 3's (17%). 'Sourcing renewable energy' was the 2nd largest barrier for OEM's (16%) and Tier 1's (14%). However, 'Recycling challenges' were the 2nd largest barrier for Tier 2's (21%) and Tier 3's (24%). However, the 3rd place barrier was 'New manufacturing processes' for OEM's (14%), Tier 1's (11%). However, for Tier 2's, the 3rd place barrier was jointly 'Reducing energy consumption', 'Sourcing renewable energy', and 'Conducting carbon impacts assessments'.

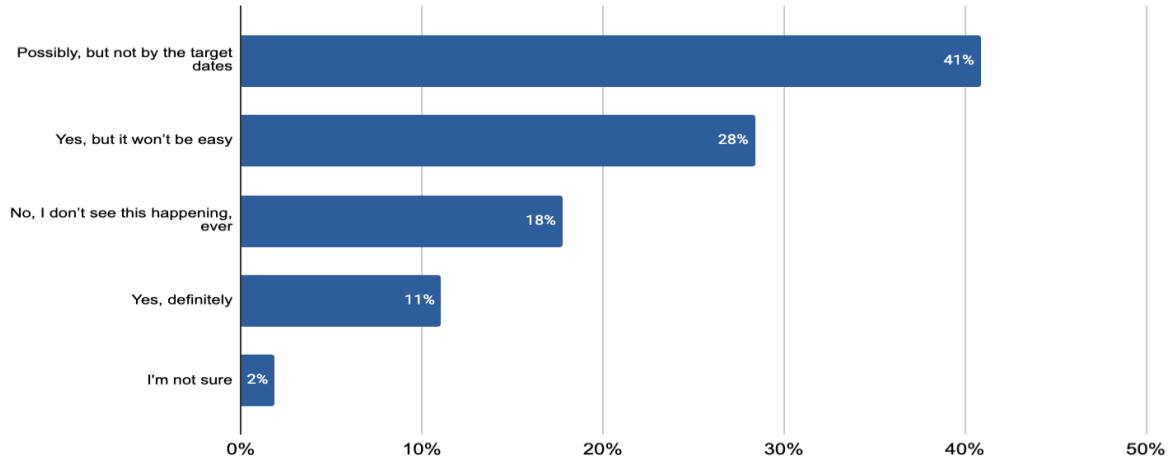
Table 10: Top 3 barriers to sustainable manufacturing by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 High capital investment 30%	**1 High capital investment 27%**	**1 High capital investment 28%**	**1 Sourcing renewable energy 24%**
2 Sourcing renewable energy 16%	**2 Sourcing renewable energy 14%**	**2 Recycling challenges 21%**	**2 Recycling challenges 24%**
3 New manufacturing processes 14%	**3 New manufacturing processes 11%**	**3= Reducing energy consumption / sourcing renewable energy / conducting carbon impact assessments 13%**	**3 High capital investment 17%**

Electrification

Asked about how realistic it is for industry to shift to 100% electric vehicle production by the target dates, ranging from 2030-2040, respondents were pessimistic with more than half believing that 100% electrification is not realistic by the target dates. Of the responses, the only positive views were 11% 'Yes definitely', followed by 28% 'Yes, but it won't be easy'. Those that thought the target dates would not be met included 41% 'Possibly, but not by the target dates', 18% 'I don't see this happening, ever', and 2% 'Not sure'. Therefore, when those results are grouped together, a total of 39% believe that targets dates will be met with a varying degree of difficulty. In contrast a total of 59% believe that targets will not be met by the target date, or don't see it ever happening.

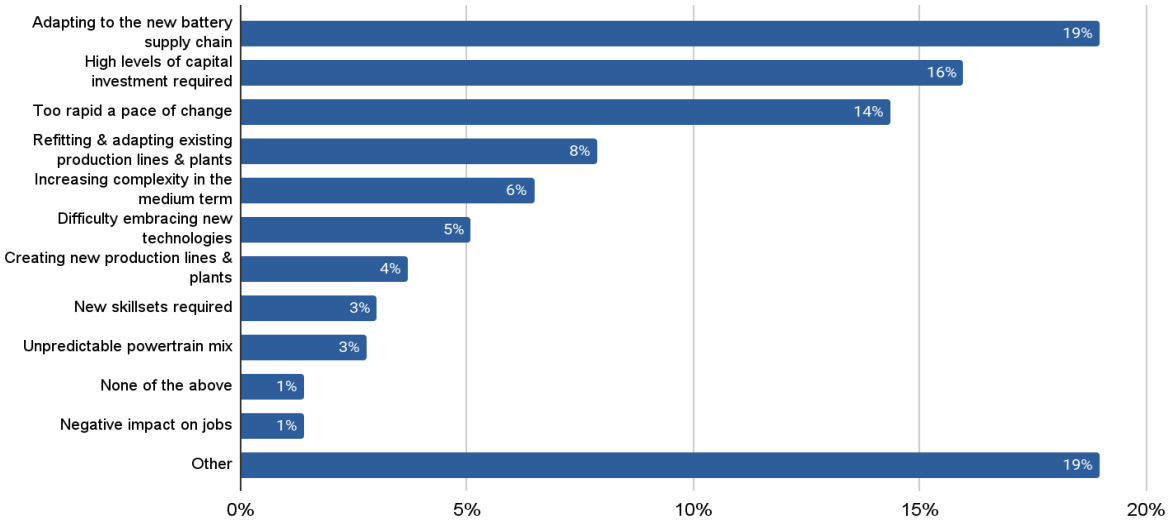
Figure 22: "*When it comes to electrification, do you think it's realistic to shift to 100% electric vehicle production to meet the different regional targets from 2030 to 2040?*"



Barriers to electrification

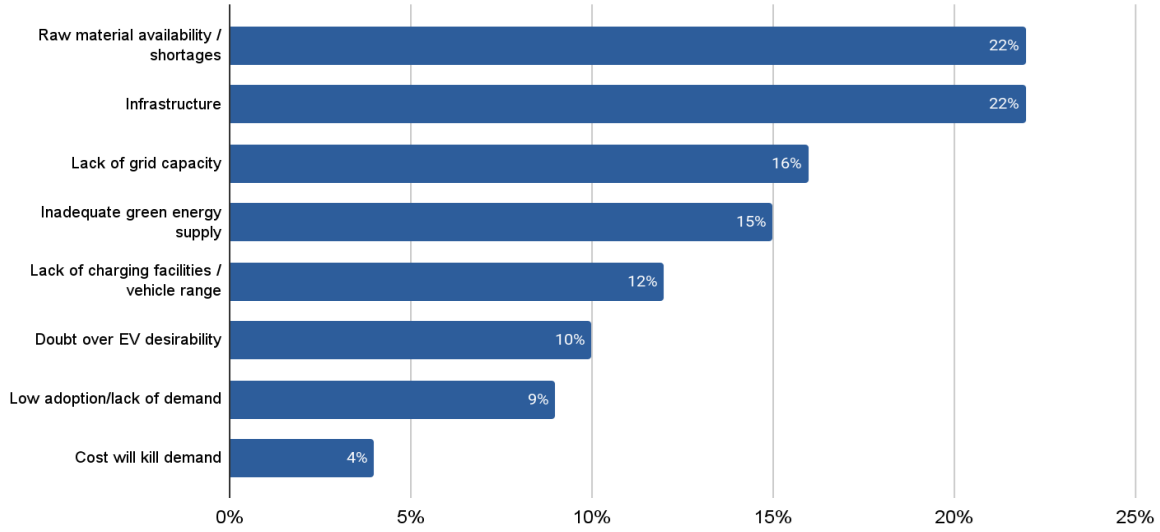
When probed further about what are the specific barriers are to achieving 100% electrification by the target dates, the major responses were 19% 'Adapting to the new battery supply chain', 19% 'other', 16% 'High levels of capital investment required', 14% 'Too rapid a pace of change', 8% 'Refitting & adapting existing production lines & plants'.

Figure 23: *'If you had to pick just one, what do you see as the biggest barrier to achieving 100% electric vehicle production by the target dates, which range from 2030 to 2040?'*



Notably the 'Other' responses were quite significant at 19%, and these other responses are analysed further in **Figure 24.**

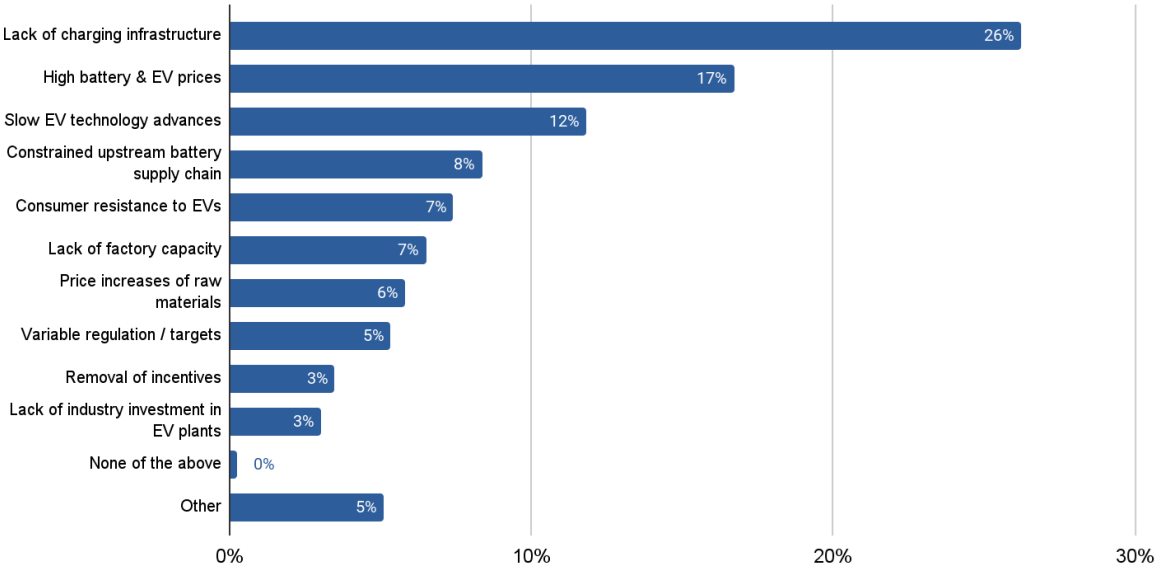
Figure 24: *'If you had to pick just one, what do you see as the biggest barrier to achieving 100% electric vehicle production by the target dates, which range from 2030 to 2040? 'Other' responses from previous chart*



Constraints to electric vehicle industry growth

When the audience was surveyed more broadly about the constraints to electric vehicle growth, respondents cited 26% 'Lack of charging infrastructure', 17% 'High battery & electric vehicle prices', 12% 'Slow technological advances in EV range & charging performance', 8% 'Constrained upstream battery supply chain', 7% 'Consumer resistance to EVs', and 7% 'Lack of battery cell gigafactory capacity'.

Figure 25 *'And what do you see as the single biggest constraint to electric vehicle industry growth?'*



In terms of regional variances, 'Lack of charging infrastructure' was the leading constraint in Asia (23%), Europe (28%) and North America (27%). 'High EV prices' was the 2nd largest constraint in Asia (18%), Europe (17%), but the 3rd largest constraint in North America (12%). 'Customer resistance' was the 2nd largest issue in North America (14%). The 3rd place constraint was 'Upstream battery supply chain' in Asia (16%) but 'Slow advances in EV range/charging was the 3rd place constraint in Europe (10%).

Table 11: Top 3 constraints to electric vehicle growth by region

Asia	Europe	North America
1 Lack of charging infrastructure 23%	**1 Lack of charging infrastructure 28%**	**1 Lack of charging infrastructure 27%**
2 High EV prices 18%	**2 High EV prices 17%**	**2 Customer resistance 14%**
3 Upstream battery supply chain 16%	**3 Slow advances in EV range/charging 10%**	**3 High EV prices 12%**

In terms of company type variances, 'Lack of charging infrastructure' was the leading constraint for all company types. 'High EV prices' was the 2nd largest constraint for all company types. 'Slow advances in EV range / charging' was the 3rd largest constraint for OEM's and Tier 1's. However, 'Consumer resistance' was the 3rd largest constraint for Tier 2's and Tier 3's.

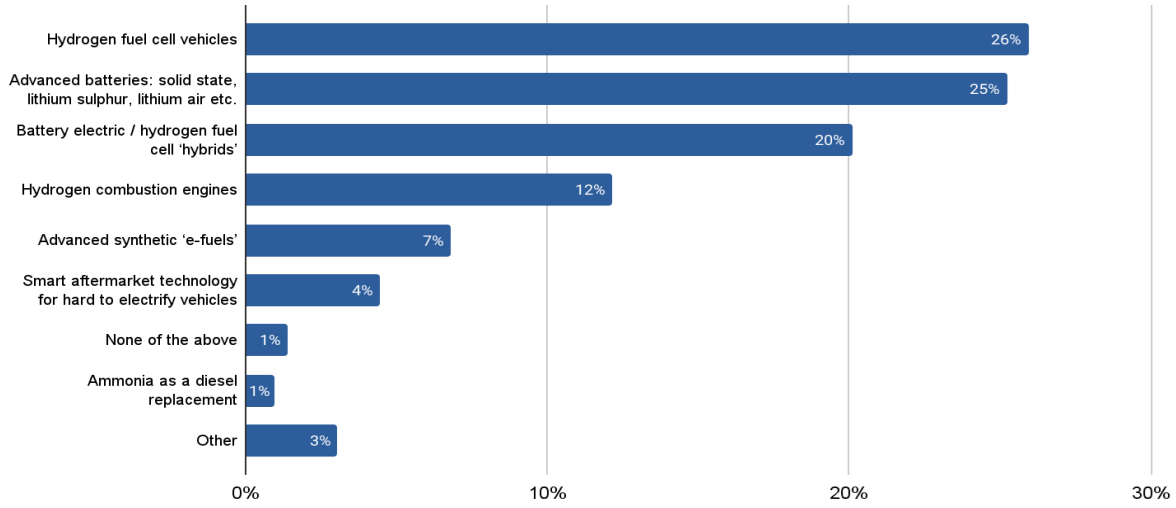
Table 12: Top 3 constraints to electric vehicle growth by company type

OEMs	Tier 1: Suppliers of Complete Systems	Tier 2: Suppliers of Individual Components	Tier 3: Suppliers of Processed & Refined Materials
1 Lack of charging infrastructure 28%	**1 Lack of charging infrastructure 19%**	**1 Lack of charging infrastructure 32%**	**1 Lack of charging infrastructure 31%**
2 High EV prices 16%	**2 High EV prices 15%**	**2 High EV prices 21%**	**2 High EV prices 14%**
3 Slow advances in EV range / charging 12%	**3 Slow advances in EV range / charging 12%**	**3 Consumer resistance 13%**	**3 Consumer resistance 14%**

Alternative fuels

Looking beyond electric vehicles, when respondents were asked which technology is likely to make a major contribution 26% cited 'Hydrogen fuel cell vehicles', 25% 'Advanced batteries: solid state, lithium sulphur, lithium air etc'., 20% 'Battery electric / hydrogen fuel cell hybrids', 12% 'Hydrogen combustion engines', 7% 'Advanced synthetic e-fuels', 4% 'Smart aftermarket technology for hard to electrify vehicles', 3% 'Other', and 1% 'Ammonia as a diesel replacement'.

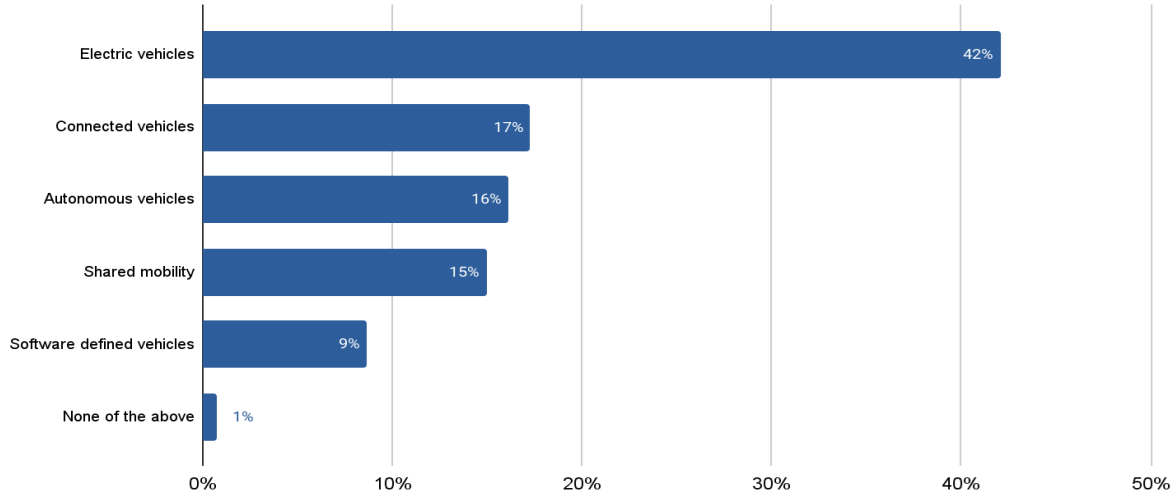
Figure 26: '*Looking further into the future and beyond current EVs, which single technology has the most potential to make a major contribution?*'



New Economy & CASE technologies

When questioned about which new CASE (connected , autonomous, shared, and electric) and other technologies would advance the most over the next year, unsurprisingly the dominant responses was 42% 'Electric vehicles', followed by 17% 'Connected vehicles', 16% 'Autonomous vehicles', 15% 'Shared mobility', and just 9% 'Software defined vehicles'.

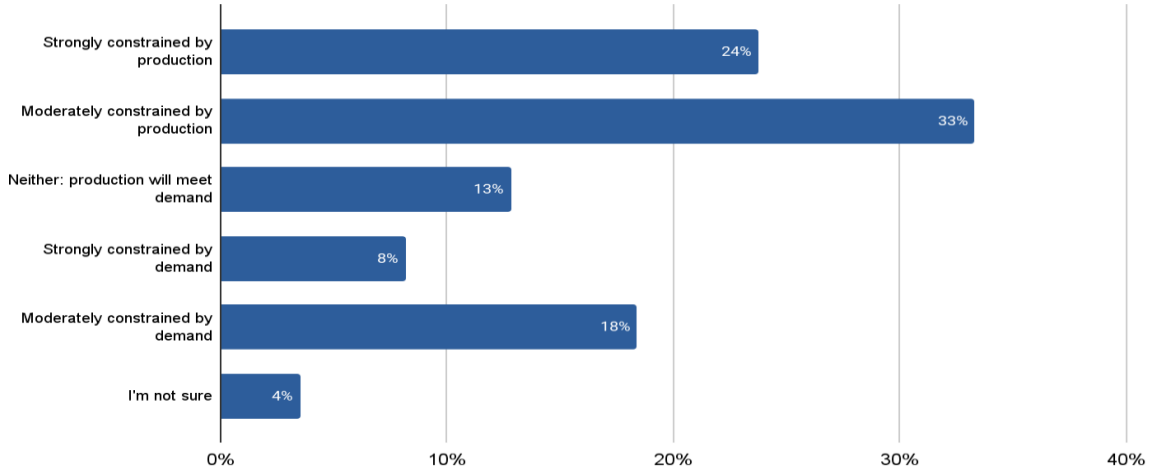
Figure 27: '*In terms of the 'New Economy' for connected, autonomous, shared & electric vehicles (CASE) and other trends, which technology do you see advancing the most in the next year?*'



State of the industry: production vs demand constraints

When asked about vehicle volumes respondents indicated a strong ratio of 2:1 believing that volumes will be constrained more by production rather than by demand. Responses were 24% **'**Strongly constrained by production', 33% 'Moderately constrained by production', 13% 'Neither: production will meet demand'. In contrast 18% selected 'Moderately constrained by demand', and 8% 'Strongly constrained by demand'. Overall, 57% believed volumes would be constrained by production, 13% neither: production will meet demand, and only 26% constrained by demand.

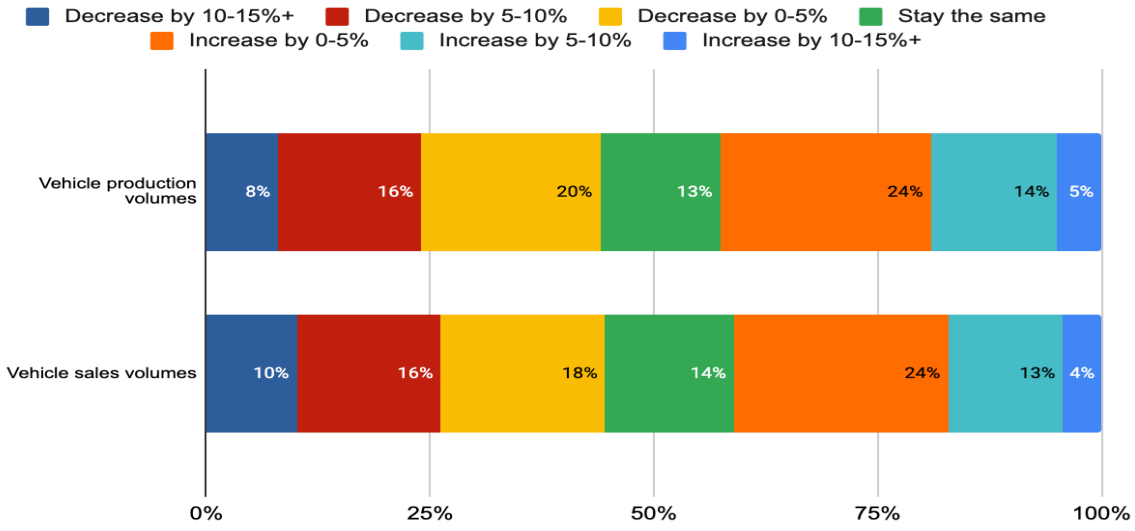
Figure 28: *'Over the next 12 months, do you expect global vehicle volumes to be constrained by production, by demand, or neither?'*



Production & sales volumes

Questioned on the global vehicle production and sales outlook over the next 12 months, the responses for production were very evenly balanced with 43% stating it will be 'increasing', 13% 'stay the same', and 44% 'decreasing'. For sales, again the outlook was very evenly balanced with 41% stating it will be 'increasing', 14% 'stay the same', and 44% 'decreasing'.

Figure 29: *'And finally, to what extent do you expect global vehicle production and sales volumes to increase or decrease in the next 12 months?'*



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