Motor Industry Skills of the Future

Research project to investigate the relevance of occupations and skills for the South African motor industry

FINAL REPORT

Prepared by:

David Ansara, BA, BSocSci (Hons), MSocSci [UCT]

Benchmarking and Manufacturing Analysts SA (Pty) Ltd

&

Marwaan Davids, TQ.Diesel Mech (MITB), HDipEd [UNISA], ETDPCert [EDPTSETA], AdvCertLO (UNISA), AdvCertRes [Wits]

The Motor Industry Bargaining Council (MIBCO)

For

The merSETA Motor Chamber

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B&M Analysts
POWERING COMPETITIVENESS

MOTOR INDUSTRY BARGAINING COUNCIL
MIBCO
Good to Great Together

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ACRONYMS

APDP	Automotive Production Development Programme
ASCCI	Automotive Supply Chain Competitiveness Initiative
AI	Artificial Intelligence
AVs	Autonomous Vehicles
BBBEE	Broad Based Black Economic Empowerment
BEV	Battery Electric Vehicle
BMA	Benchmarking and Manufacturing Analysts SA (Pty) Ltd
CBU	Completely Built Unit
CKD	Completely Knocked Down
DHET	Department of Higher Education and Training
dti	Department of Trade and Industry
EEV	Energy Efficient Vehicle
EU	European Union
EV	Electric vehicle
GDP	Gross Domestic Product
ICE	Internal Combustion Engine
LCV	Light Commercial Vehicle
LV	Light Vehicle
M&HCV	Medium and Heavy Commercial Vehicle
MIBCO	Motor Industry Bargaining Council
ML	Machine Learning
NAACAM	National Association of Automotive Component and Allied Manufacturers
NAAMSA	National Association of Automobile Manufacturers of South Africa
OEM	Original Equipment Manufacturer

ORP	Occupational Research Project
PHEV	Plug-in Hybrid Electric Vehicle
PV	Passenger Vehicle
R&D	Research and development
SA	South Africa
SAAM	South African Automotive Masterplan
SKD	Semi Knocked Down
SSA	Sub-Saharan Africa
TaaS	Transport-as-a-Service
UK	United Kingdom
US	United States

1. Joint Introduction

The global automotive industry can be broadly divided into automotive manufacturing and automotive retail functions. These two sub-sectors are responsible for the manufacturing, marketing, and selling of motor vehicles, while the vehicle design function is principally conducted by Original Equipment Manufacturers (OEMs), working in conjunction with third-party design partners. The OEMs are all headquartered off-shore but maintain a local presence in order to enforce strict quality standards for South African-based vehicle manufacturers, as well as branding, sales, and aftermarket service providers.

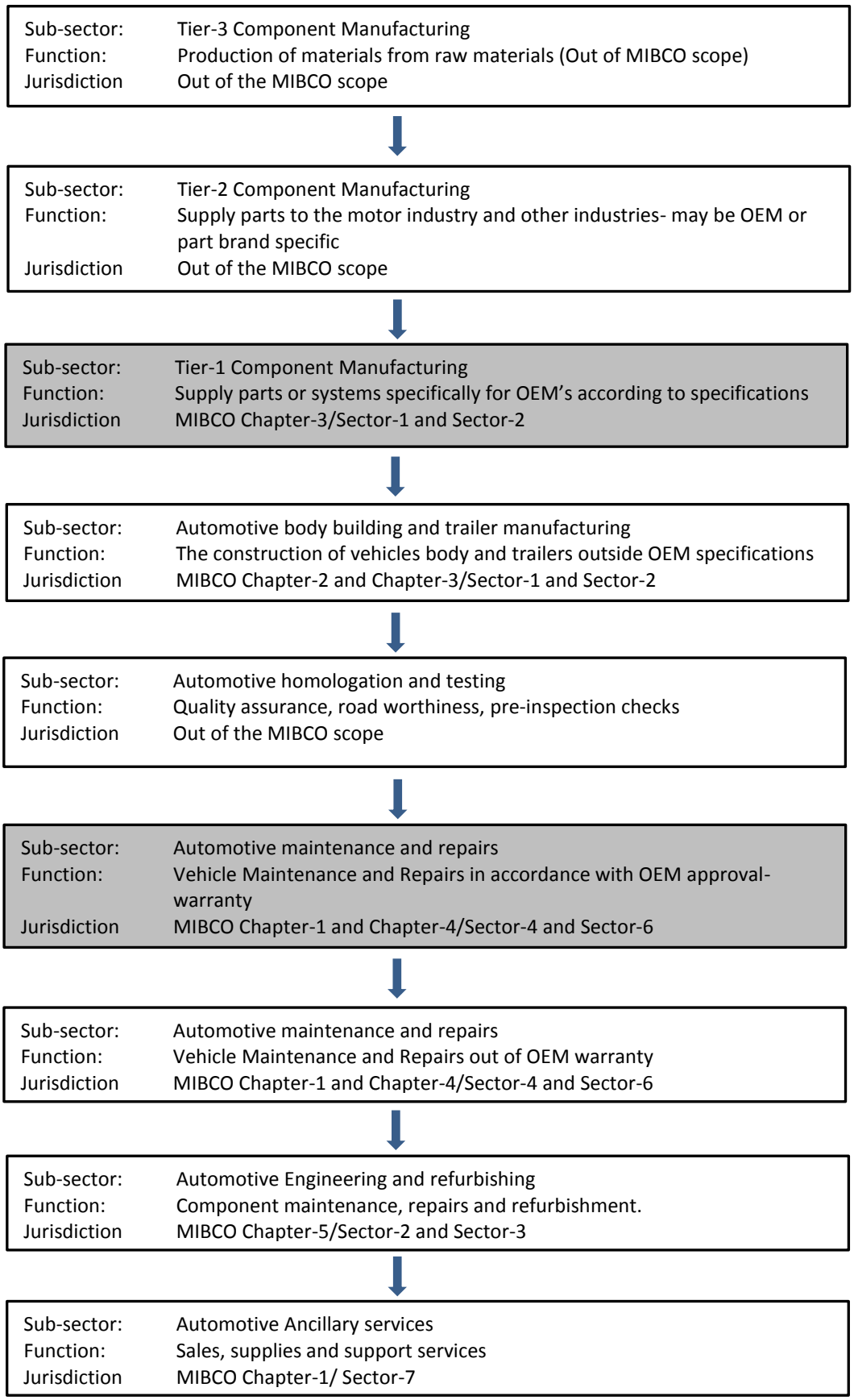
This research project will focus on two units of the South African automotive value chain:

- Tier-1 automotive component manufacturers; including:
    - Electronics; Foundry/forge; Glass; Harnesses; Heat transfer; JIT Assembly; Metal fabrication; Metal form/press; Plastic moulding; Precision machining; Trim

- Automotive aftermarket service and support (AAS&S) sectors; including:
    - Dealer networks (retail, maintenance and repairs); Service provider networks; and Support providers (the importing of vehicles, branding and marketing; driver assistance programmes, etc).

Both research categories fall under the jurisdiction of the Motor Industry Bargaining Council (MIBCO) as the labour regulator for the industry. **Figure 1** illustrates MIBCO's categorization of the motor industry value chain, with the greyed-out areas reflecting the position of Tier 1 manufacturers and AAS&S providers respectively. Related skills development and training functions are the responsibility of the merSETA, which has commissioned this research to better understand the skills development requirements of the motor industry.

FIGURE 1: MOTOR INDUSTRY VALUE CHAIN FLOW CHART



Source: Definitions of MIBCO Chapters and Sectors drawn from the MIBCO Main Collective Agreement.

It may be necessary for future research projects on this topic to explore other areas of the motor industry value chain, but for present purposes the research will focus on Tier 1 component manufacturers and the AAS&S sectors only.

1.1 Purpose statement

This research is guided by the need to gain an understanding of the reorganisation changes at workplaces and to determine what skills development people must undergo to adapt, remain relevant and progress within the motor industry.

1.2 Research question

The research project seeks to answer the following primary research question:

"What skills development is needed and available for people to adapt and remain relevant to changes within the Motor Industry?"

The primary research question is supported by several secondary research questions:

- How will South Africa respond to the challenges presented by disruptive technological changes in global automotive value chains?
- What future skills development will be needed and available for people to adapt and remain relevant to these changes?
- What skills are required to achieve the vision of SA's automotive manufacturing policy framework, the South African Automotive Master Plan (SAAM)?

1.3 Research background and objectives

1.3.1 Background

This research is preceded by the Occupational Research Project (ORP), conducted by the MIBCO. The findings and recommendations of the ORP were presented to the merSETA Motor Chamber Committee for its review and input. In addition, two previous merSETA Motor Chamber Committee research reports and related findings were also taken into consideration by the Motor Chamber, namely:

- Employment and Educational and Skills Audit Research of the merSETA Motor Chamber Committee (2012/13 Research Report)
  - This research focused on political and socio-economic issues, and supply and demand factors that affect skills development. Eight priority focus areas were identified, and further research was recommended to understand those priorities.
- Follow-up future skills development research project for the motor chamber for vision 2020 (2013/14 Research Report).
  - This research further developed the findings of the Employment and Educational and Skills Audit and focused on what could be done to address those priorities

1.3.2 Objectives

This research report aims to augment the findings of the previous three research projects listed above. The specific objective of this report is to understand what impact the motor industry megatrends will have on skills and occupations in the workplace. In so doing, the report seeks to determine:

- How the market and consumer trends have changed motor vehicles
- How changes in vehicle specifications have affected the maintenance and repair of vehicles
- How the changes in vehicle specifications have affected the manufacturing components for vehicles
- How operational changes in the manufacturing, maintenance and repair of motor vehicles have affected occupations
- What skills and competencies are required to fulfil occupational roles
- What can be done to develop, reskill and upskill people to become relevant
- What can be done to develop the skills that do not exist
- What implications workplace reorganisation and skills reform will have on skills and labour authorities

2. Research methodology

2.1 Scope of work

As indicated in the introduction, the scope of work has a deliberately narrow focus on two discreet elements of the motor industry value chain, which are covered in two separate "research streams" in the report.

- **Research Stream I**
  - Considers the skills development needs of OEM-approved vehicle component manufacturers (referred to henceforth as "Tier 1 automotive manufacturers");
  - This research was conducted by Benchmarking and Manufacturing Analysts SA (Pty) Ltd (BMA)

- **Research Stream II**
  - This stream deals with the aftermarket services and support provided by automotive dealer and distribution establishments (referred to as "automotive aftermarket services and support").
  - This research was conducted by the MIBCO.

2.2 Approach

The research methodology combines desktop research, qualitative primary research and quantitative primary research, as outlined below.

2.2.1 Desktop research

A variety of internal resources were used, including firm-level data sourced from BMA's benchmarking databases. Extensive insight is drawn from the South African Automotive Master Plan (SAAM) project, a policy framework developed by BMA for the national Department of Trade and Industry (the dti), in close consultation with industry, labour and government stakeholders. Resources provided by the Durban Automotive Cluster and the Automotive Supply Chain Competitiveness Initiative (ASCCI) – both industry clusters facilitated by BMA - were also consulted. Historical research reports produced by both MIBCO and BMA relating to the automotive sector and the associated skills development needs of the industry were also consulted. A wide range of external resources, such as third-party industry reports and periodicals, were used to analyze the key technological drivers, as well as to understand the current skills environment in South Arica.

2.2.2 Qualitative primary research

Desktop research findings were supplemented by two parallel industry consultation processes (Tier 1 automotive manufacturers; as well as automotive aftermarket service providers, including dealers and distribution establishments). Workshops and interviews were held in Johannesburg/Pretoria, Port Elizabeth and Durban in February 2018, where the preliminary desktop research findings were shared with stakeholders and industry participants. These engagements with industry were useful for understanding what skills are available for the existing motor industry occupations and identifying what new skills will be required in the future. Determining the skills development resources required to skill people sufficiently to fulfil these occupations was also discussed with participants. A full list of participants for Tier 1 automotive manufacturers is shown in **APPENDIX A – Qualitative research participants (Tier 1 automotive** manufacturers) while automotive aftermarket services and support research participants are shown in **APPENDIX B – Quantitative research participants (Tier 1 automotive manufacturers)** .

2.2.3 Quantitative primary research

The quantitative primary research process included the preparation of electronic questionnaires, which were guided by desktop research and focus group output. Three versions of the questionnaire were developed to be targeted at two distinct groups:

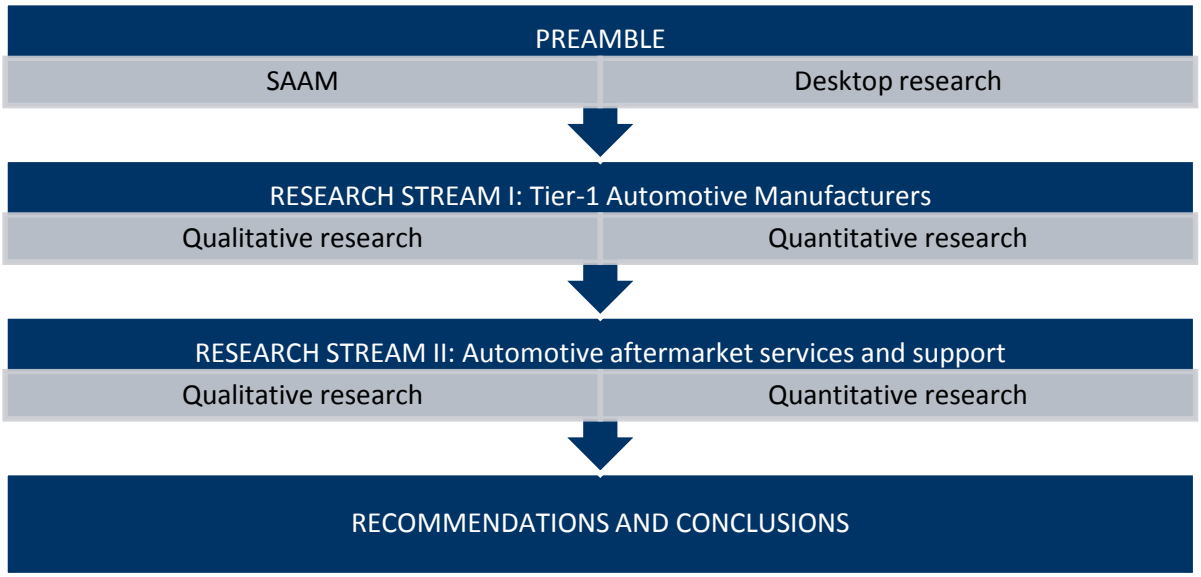
- Tier 1 automotive manufacturers (Stream I)
- Aftermarket support (Stream II)

These questionnaires were circulated widely to industry participants, and consultations with participating organisations were conducted in order to obtain the data. The findings of the quantitative research process are presented in **section 6** for Research Stream I and **section 11** for Research Stream II.

2.3 Report structure

As discussed, the research report is divided into two distinct research themes covering i) Tier 1 automotive manufacturers, and; ii) Automotive aftermarket services and support. To contextualise both research streams the report also includes a "preamble" chapter which provides an explanation of the SAAM and showcases the main desktop research findings. The report is therefore divided into three separate chapters: Preamble, Research Stream I, and Research Stream II, as reflected in **Figure 2**. Each research stream includes both qualitative (interviews and workshops) and quantitative (electronic survey) research findings.

FIGURE 2: REPORT STRUCTURE



The preamble chapter begins in **section 3**, which includes an explanation of the South African Automotive Master Plan (SAAM) project. A high-level summary of the vision, key objectives and strategic pillars of the SAAM is given, as well as the key policy recommendations of the SAAM vis-à-vis the skills development requirements and employment trends of the motor industry. **Section 4** reviews the existing literature on the evolution of motor manufacturing and new technological trends in the sector. These technological forces are set to fundamentally disrupt global automotive value chains, and the report examines seven of the most critical technology drivers in detail. The domestic implications of these changes on occupations and skills requirements are also explored. Stream I commences at **section 5,** where a brief context is provided for Tier 1 automotive manufacturers. The qualitative feedback for Tier 1 auto manufacturers is highlighted in **section 6**, followed by the quantitative findings in **section 7**. An identical format is followed for Stream II, with a brief overview of automotive aftermarket services and support providers in **section 8** and desktop research in **section 9**. This is followed by the qualitative research findings in **section 10** and the quantitative research outcomes in **section 11**. The primary research findings for both streams include recommendations to guide skills development and labour directives for the respective sectors. Finally, a **JOINT CONCLUSION** provides a summary of the principal findings and key policy recommendations.

PREAMBLE

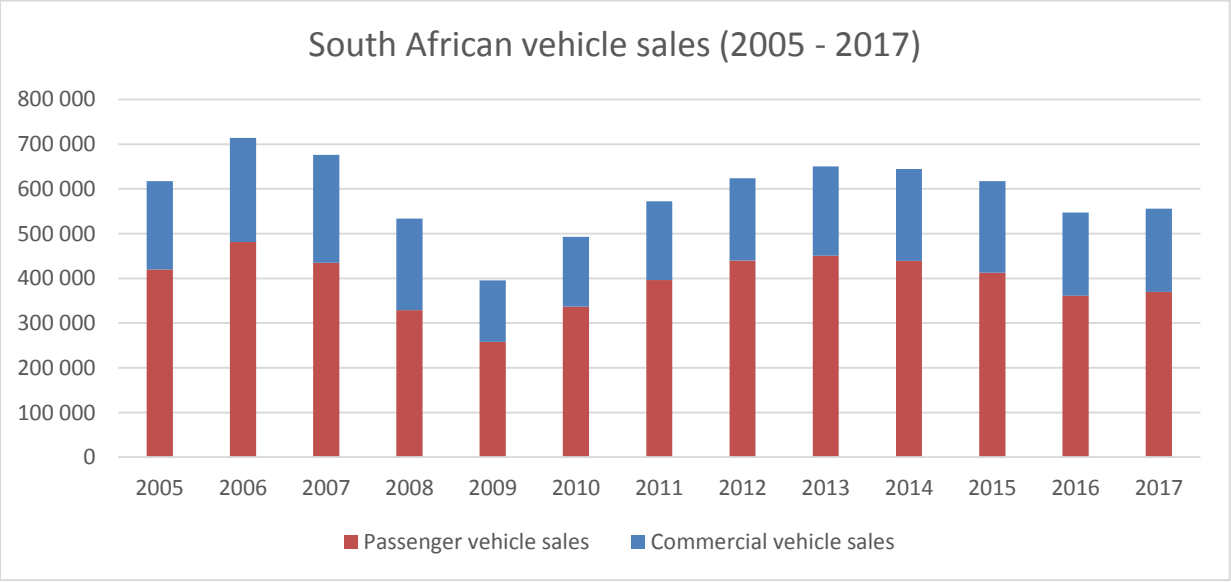
3. The South African Automotive Master Plan (SAAM)

3.1 Background to the SAAM

The local automotive industry is a marginal player globally, contributing only 0.65% of global vehicle output, equating to a production output of 590,000 units in 2017 (OICA production statistics, 2017). Local content levels within South African vehicles have declined from 47% in 2012 to 38% in 2015. This is in the context of an overall decline in manufacturing output from 23.6% in 1990 to only 13.2% of GDP in 2016 (World Development Indicators, as cited in Barnes, et al, 2017). Despite this, the local automotive industry still demonstrates resilience, contributing substantially to direct employment (approximately 112,000 jobs), boosting exports, and creating diverse technology multipliers and downstream economic activity. These contributions have positioned the automotive industry as a core, strategic industrial sector within the South African economy.

South Africa's domestic market is small by comparative standards. As demonstrated in **Figure 3** and **Table 1,** domestic vehicle sales for all categories stood at 555,716 in 2017, comprising 186,117 commercial vehicles and 369,599 passenger cars (OICA vehicle sales statistics, 2005 - 2017).

FIGURE 3: SOUTH AFRICAN VEHICLE SALES (2005 - 2017)



Source: OICA vehicle sales statistics, 2005 - 2017

TABLE 1: SOUTH AFRICAN VEHICLE SALES (2017)

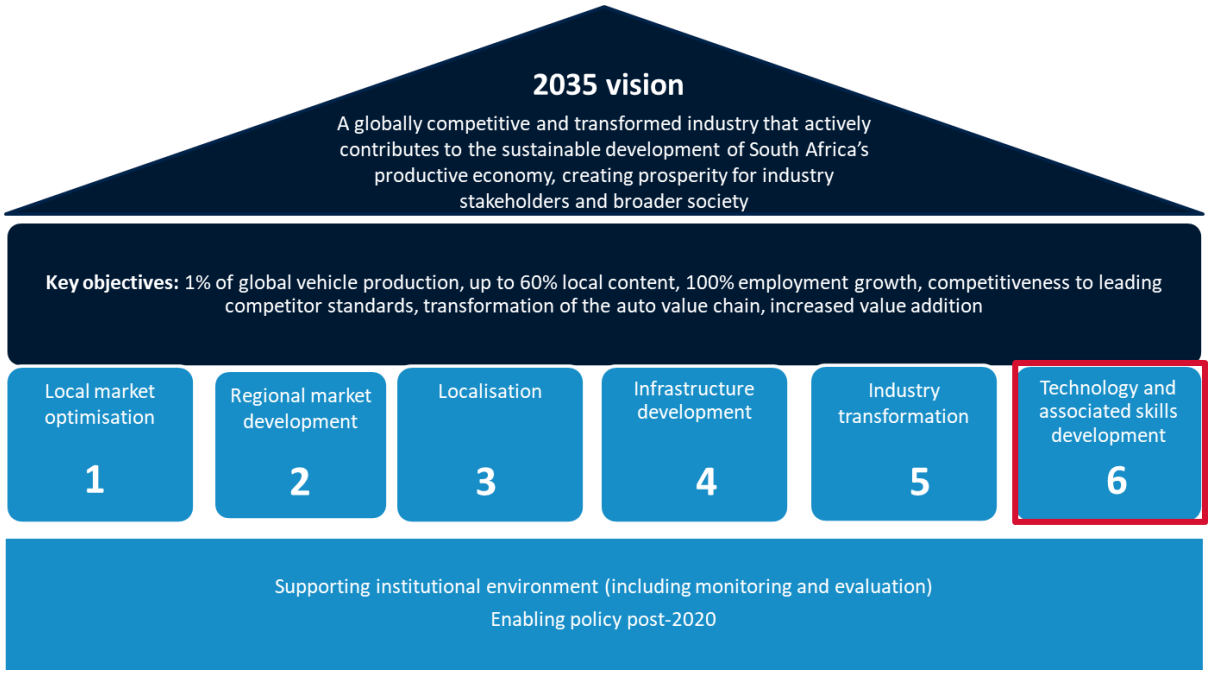
Category	Units sold (2017)
Commercial vehicle sales	186,117
Passenger car sales	369,599

Source: OICA vehicle sales statistics, 2005 - 2017

It is against this backdrop that the South African Automotive Master Plan (SAAM) policy development process took place. Once formally adopted, the SAAM will replace the Automotive Production Development Programme (APDP), which was introduced in 2013 and is set to run until 2020. The SAAM is intended to guide South Africa's automotive manufacturing policy development process for the period 2020 – 2035.

The realization of the SAAM's vision and key objectives would enable the local automotive industry to substantially increase its contribution to the SA economy to 2035, with production, local content and employment growing significantly. The vision, objectives and strategic implementation pillars of the SAAM are summarised in **Figure 4**, and are further elaborated in the following sub-sections.

FIGURE 4: THE SAAM'S 2035 VISION, OBJECTIVES, AND STRATEGIC IMPLEMENTATION PILLARS



Source: SAAM Report 4 of 4 (Barnes, et al, 2017)

3.2 2020-2035 vision

Following extensive consultation with industry stakeholders, government, and labour, the SAAM vision is articulated as follows:

> *A globally competitive and transformed industry that actively contributes to the sustainable development of South Africa's productive economy, creating prosperity for industry stakeholders and broader society*

This vision encompasses the four key themes of global competitiveness, transformation, sustainability and shared stakeholder prosperity, and serves as a guide to the automotive policy development process for the period 2020 – 2035.

3.3 SAAM objectives

The SAAM vision is underpinned by a set of realizable objectives. These objectives are to:

1. Grow South African vehicle production to 1% of global output
2. Increase local content in South African assembled vehicles from 38% to up to 60%
3. Double total employment in the automotive value chain
4. Improve automotive industry competitiveness levels to that of leading international competitors
5. Transformation of the South African automotive industry
6. Deepen value addition within South African automotive value chains

These objectives are intended to produce specific outcomes across various economic indicators for the local automotive industry. The estimated impact of each objective is summarised in **Table 2**.

TABLE 2: SUMMARY OF SAAM OBJECTIVES AND ESTIMATED IMPACT ON SOUTH AFRICAN AUTOMOTIVE INDUSTRY[1]

Objective	Estimated impact on SA auto industry
1. Grow SA vehicle production to 1% of global output	• Grow CBU production to 1.39 million units annually (129% higher than 2015 levels) • Increase of value of vehicle production to R314 billion
2. Increase local content in SA assembled vehicles to up to 60%	• Increase of R135.4 billion on 2015 local content levels • Local content increase of 21.3% per vehicle produced (55% increase) • Increase automotive component aftermarket and export production by at the same pace as local content growth
3. Double employment in the auto value chain	• Employment growth of 112,000 • Aggregate employment from 112,000 to 224,000

[1] SAAM projections through to 2035 are based on the following calculations (all constant 2015 Rands), as outlined in the SAAM report 4 of 4 "Geared for Growth South African automotive industry masterplan to 2035 (Barnes, et al, 2017):

1. Base 2015 figures derived from actual data (mainly NAAMSA)
2. Annual production extrapolated forward to achieve 1.392 million units in 2035, as follows:
    a. 4.5% for passenger vehicles
    b. 3.5% for LCVS
    c. 3.0% for M&HCVs13
3. Local content projected to increase 2.2167% annually (taking local content from 38.7% in 2015 to 60% in 2035)
4. Vehicle production values calculated at R225,804 per unit, which is the figure for NAAMSA OEMs for the first quarter of 2016
5. Employment growth subjected to 60.7496% productivity deflator, leading to employment doubling from 2015 to 2035
6. Local production and export spread for passenger vehicles and LCVs based on NAAMSA's projection for 2018 (hence no change in proportionate breakdown from 2020 to 2035)

4. Improve auto industry competitive levels to that of leading international competitors	• Sustainable automotive industry based on comparative price and non-price competitiveness versus leading international competitiveness • Sustained export competitiveness
5. Transformation of the South African automotive value chain	• 25% Black-owned involvement at Tier 2 and Tier 3 component manufacturer levels, as well as in dealership networks and authorised repair facilities • Amplified skills development of Black South Africans • Enhanced employment equity at senior management, artisan and professional employment levels across automotive value chain
6. Deepen value addition within SA auto value chains	• Growth in R&D and other innovation metrics within the South African automotive value chain

Source: SAAM Report 4 of 4 (Barnes, et al, 2017)

These objectives are interdependent and cannot be pursued in isolation. As outlined in report 4 of 4 of the SAAM:

> *It is important to present the objectives in a summarised form as they need to be viewed as a mutually supportive package of objectives, as opposed to being individually exclusive. Whether the objectives are realised or not is entirely dependent on substantial progress being made across each of the six key areas identified. "Cherry picking" selected objectives over others will undermine the realisation of the industry's vision to 2035.* (Barnes, et al, 2017, p.22)

3.4 Summary of strategic implementation pillars and impact on industry

In order to give effect to the 2035 vision, and in pursuit of the key objectives, the SAAM sets out six strategic implementation pillars.

1. Local market optimization
2. Regional market development
3. Localisation
4. Automotive infrastructure development
5. Industry transformation
6. Technology and associated skills development

These pillars are underpinned by the need for a supportive institutional environment for the SAAM and a clear policy implementation process. Each of the strategic implementation pillars are important, and cannot be pursued in isolation, so the general implications of these proposals are considered below.

3.5 Skills development considerations from SAAM objectives and strategic implementation pillars

As highlighted in the first strategic implementation pillar, "Local market optimization", the domestic vehicle market is relatively small by global standards, at approximately 555,000 units sold in 2016 (Barnes, et al, 2017, p.24). Drawing on data provided by NAAMSA, the SAAM suggests that the local

market will need to grow at a compounded average growth rate (CAGR) of at least 4.5% for passenger vehicles, 3.5% for LCVs and 3% for M&HCVs from 2017 to 2035 to absorb vehicle production of 1.4 million units per annum and meet the objective of 1% of global vehicle production (Barnes, et al, 2017, p.24).

The SAAM also notes in Pillar 2, "Regional market development" that there is presently no Sub-Saharan African (SSA) economy with a new vehicle market exceeding 30,000 units of annual new vehicle demand (Barnes, et al, 2017, p.25). This has resulted in a small, fragmented regional market, and a heavy reliance on pre-owned vehicle imports, with most imports coming from Japan (primarily into East Africa) and North America (primarily into West Africa).

As new process and product technologies emerge, the impact on skills development needs in South Africa will also have to evolve to align domestic production with local and regional market requirements. Increasing demand for high-tech features (such as advanced safety, alternative engine technologies, or infotainment) will likely track those of developed markets, at least in the upper income segments of the market. Managers and technical workers of both Tier 1 firms and aftermarket services providers will need to be familiar with these new trends and able to align their local production processes with these new technologies.

The localisation objectives highlighted in the SAAM require an increase in the supply of local content by R135.4 billion on 2015 local content levels, equating to an increase of 21.3% local content per vehicle produced (55% increase). In order to capture a greater share of local and regional markets, SA manufacturers will need to retrain and upskill their personnel to meet new production requirements. The result of not upgrading skills would be a greater vulnerability to import penetration, as more advanced components will not be able to be produced locally. South Africa's labor cost profile and productivity will also have to improve, notes the SAAM.

Achieving the transformation targets of the SAAM, including 25% "Black-owned" involvement at Tier 2 and Tier 3 component manufacturer levels, and in dealership networks and authorized repair facilities, will require a significant investment in skills development for designated firms to meet the stringent operating requirements of the automotive industry. This is particularly necessary at the senior management, artisan and professional employment levels. The SAAM notes the importance of equity equivalence schemes as a way of addressing transformation objectives through the automotive aftermarket and support segment of the value chain:

> *South African OEMs (including importers) have the potential to support the transformation of the country's dealership network and authorised vehicle repair facilities through to 2035. While this portion of the value chain has not been included in the scope of the SAAM, the transformation of dealerships and authorised vehicle repair facilities would appear to represent ideal opportunities for OEMs to secure equity-equivalent scores on their BBBEE scorecards, hence the inclusion of this focus area.* (Barnes, et al, 2017, p.28)

The need for the "automotive infrastructure development" (Pillar 5) is primarily concerned with the provision of hard infrastructure such as roads and ports, and reliable electricity, to create a conducive operating environment for industry. However, equally important for producers to operate effectively is the "soft" infrastructure and complimentary services that support the motor industry, including a capable semi-skilled pool of production workers, as well as a readily available cohort of advanced administration, artisan, and professionally skilled staff (Barnes, et al, 2017, p.28).

Pillar 6 specifically asserts the necessity for the South African automotive industry to develop a technology and associated skills development roadmap to support the evolution of the automotive industry in alignment with each of the key SAAM elements identified above.

South African policy makers and producers will need to take into account new technological changes and the related regulatory requirements emerging in key international markets. As the authors argue:

> *New types of industrial infrastructure will need to be understood and responded to, to ensure SA does not fall too far behind the automotive technology frontier, and that domestic production continues to qualify for supply into developed economy markets.* (Barnes, et al, 2017, p.29).

By way of example, the SAAM notes that green manufacturing and energy efficiency requirements could form an indirect barrier to trade with European markets in future. As product development and production processes within the global automotive industry seek to adhere to new environmental regulations, there will also be clear requirements for the deployment of new production technologies in South Africa. As technology advances, so too will the industry's skills requirements. For this reason, the SAAM also highlights the importance of including a linked skills development plan as part of the broader technology roadmap for the automotive industry to 2035. This will necessitate a major shift in both the number and the level of skilled personnel being recruited into the domestic automotive industry (Barnes, et al, 2017).

The SAAM recommends the following for technology and associated skills development for the industry:

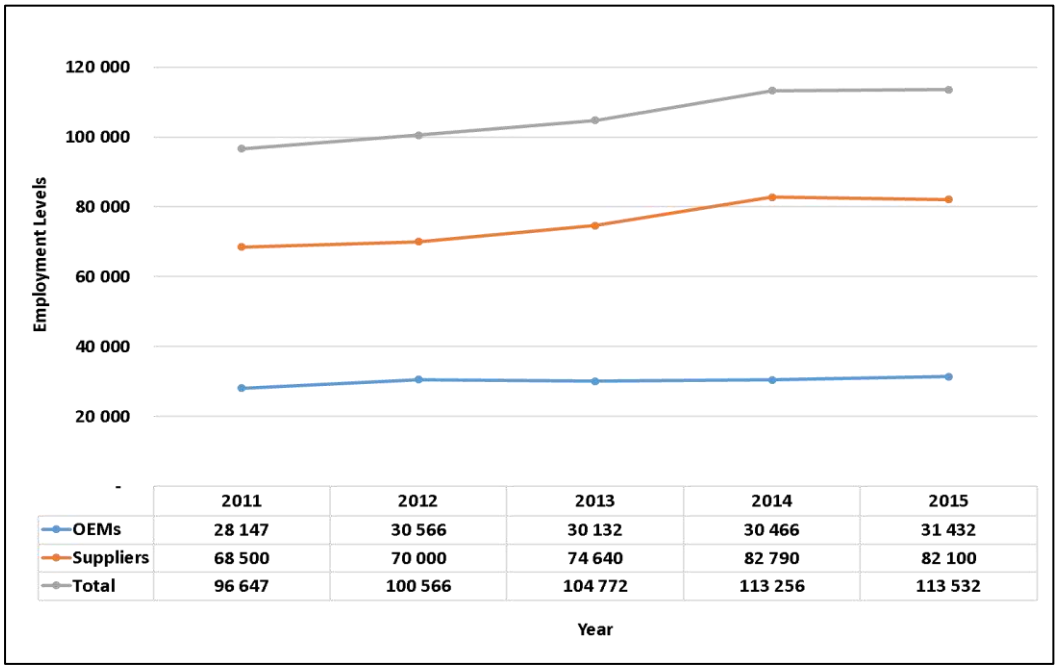
> *SA's global automotive competitors are developing skills in advance of industry requirements to ensure that skills bottlenecks do not stunt the growth and development of their industries. The domestic automotive industry, working in partnership with government and other social partners, should follow a similar model.* (Barnes, et al, 2017, pp. 29 - 30)

Accordingly, technical colleges, on-the-job training programmes, and government supported skills initiatives will have to forecast the technological changes of the future.

3.6 Employment trends in SA automotive manufacturing as identified in the SAAM

According to data provided by NAAMSA (2013 – 2016) and AIEC (2012 – 2016) (as represented in **Figure 5**) the motor industry employs approximately 113,000 people across the seven light vehicle OEMs, a number of SKD-based Medium and Heavy Commercial Vehicle (M&HCV) OEMs, and over 400 automotive component firms. In 2015, the average monthly employment split was 31,000 employed at OEMs, with 82,000 at auto component firms. **Figure 5** also reveals that employment in the automotive component industry has increased by 13,600 since 2012, with small increases recorded on a year-on-year basis to 2015 (SAAM report 1 of 4, Barnes et al, 2016).

FIGURE 5: EMPLOYMENT TRENDS IN THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY

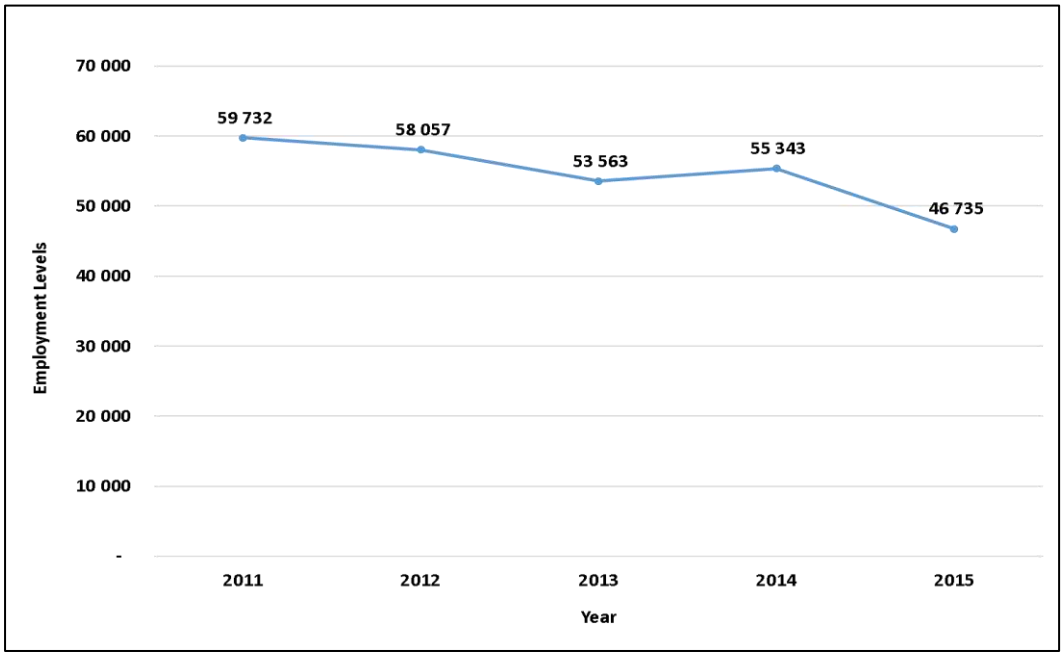


	2011	2012	2013	2014	2015
OEMs	28 147	30 566	30 132	30 466	31 432
Suppliers	68 500	70 000	74 640	82 790	82 100
Total	96 647	100 566	104 772	113 256	113 532

Source: NAAMSA (2013-2016); AIEC (2012-2016) cited in (SAAM report 1 of 4, Barnes et al, 2016).

Figure 5 is contradicted by **Figure 6**, which illustrates parts and accessories manufacturing employment in South Africa, as recorded by StatsSA (2016). According to this data, employment in the components industry has declined from 59,372 in 2011 to 46,735 in 2015 (as cited in SAAM report 1 of 4, Barnes et al, 2016). This employment figure is much lower than the AIEC figure (and likely to substantially under-represent employment levels in the industry). The statistics are nevertheless important to represent here for comparative purposes (Barnes et al, 2016).

FIGURE 6: PARTS AND ACCESSORIES EMPLOYMENT, 2011 TO 2015 (STATSSA)



Source: StatsSA (2016) cited in (SAAM report 1 of 4, Barnes et al, 2016).

4. Desktop research

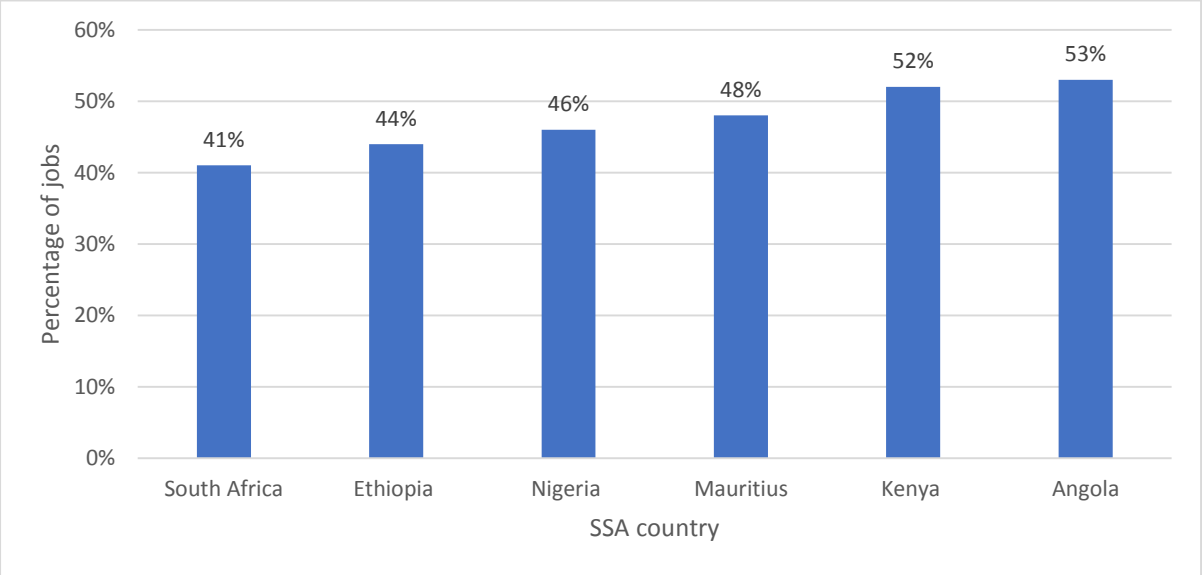
An extensive desktop research process was undertaken to identify the most pressing technological changes that are likely to affect Tier 1 automotive manufacturers and automotive aftermarket service and support providers. The following trends therefore apply equally to both research streams in this report.

4.1 Global and regional skills forecasts

The McKinsey Global Institute (2017) estimates that between 60 million to 375 million individuals around the world may need to transition to new occupational categories by 2030 as a result of technological disruption. More positively, the World Economic Forum (2017) argues that while the Fourth Industrial Revolution (or "Industry 4.0") will disrupt many occupations, new job categories in science, technology, engineering and mathematics (STEM) fields - such as data analysis and computer science - may also emerge.

However, the WEF's Human Capital Index also notes that the Sub-Saharan Africa (SSA) region currently only captures 55% of its human capital potential, compared to a global average of 65%. While many SSA countries are starting to benefit from higher labour participation rates, as well as robust economic growth and a young workforce, many of its current jobs are vulnerable to automation, as shown in **Figure 7**.

FIGURE 7: POTENTIAL JOB CATEGORIES SUSCEPTIBLE TO AUTOMATION (SSA REGION)



Source: World Bank (2016), cited by World Economic Forum (2017)

The South African economy will be similarly affected. Error! Reference source not found. **Table 3** lists the World Economic Forum's (2017) "key drivers of disruptive technological change" for the South African economy and ranks the most likely trends to impact on the future of jobs and skills development.

TABLE 3: TECHNOLOGICAL DRIVERS OF DISRUPTIVE CHANGE

Rank	Drivers of change, 2015–2020
1	Processing power, Big Data
2	Changing nature of work, flexible work
3	Middle class in emerging markets
4	Mobile Internet, cloud technology
5	Geopolitical volatility
6	Climate change, natural resources
7	Sharing economy, crowdsourcing
8	New energy supplies and technologies
9	Young demographics in emerging markets
10	Rapid urbanisation
11	Women's economic power, aspirations
12	Internet of Things
13	Advanced Manufacturing, 3D printing
14	Artificial Intelligence
15	Robotics, autonomous transport
16	Advanced materials, biotechnology

Source: World Economic Forum (2017)

The trends identified by WEF will have a variety of consequences for skills development in South Africa. For example, the ability to analyse large data sets will require greater investment in mathematics and quantitative reasoning skills in the workforce. Similarly, the "changing nature of work" will require firms to be more willing to employ high numbers of staff on a flexible or *ad hoc* basis, thus promoting a more agile workforce. Mobile internet and cloud technology also represents a way to enhance efficiency and productivity in the workplace, but this will mean workers will have to be more adaptable to new technology. Some trends might not be simply disruptive - but rather destructive - to jobs in South Africa. These include 3D printing, robotics and artificial intelligence, although the lower-order ranking may imply that these trends may only occur over the longer term.

4.2 Identifying foreseen changes in the automotive industry over the period 2020-2035

In developed markets such as the US, UK, and the EU, a shortage of high-end skills is currently evident in automotive manufacturing (Centre for Automotive Research, 2013). This is a multi-causal phenomenon. One reason is the retirement of the "Baby Boomer" generation, which is leading to a deficit of skills (Cameron, 2015). A 2016 UK Automotive Council survey of 61 auto companies (OEMs & T1s) showed that +2,500 vacancies were highlighted by employers as being 'difficult to fill' or 'challenging' jobs to fill. A quarter of those jobs were classed as 'critical' - i.e. having been open for a period of 3+ months (UK Automotive Council, 2016). This has resulted in higher wages for scarce

skills but has also threatened the sector's ability to meet customer demands, increase production, and raise productivity (Cameron, 2015).

However, current roles, skills and job titles of today are likely to change fundamentally tomorrow. New technology, such as automation and robotics, threaten to make many existing motor industry occupations and skills redundant (UK Automotive Council, 2016).

A variety of technological changes are set to transform process and product technologies across automotive manufacturing. These can be broadly categorised as digitisation and innovation.

4.2.1 Digitisation

Predictive analytics, cloud computing, and the greater interconnectivity of manufacturing equipment through Internet of Things (IoT) technology (e.g. embedded sensor networks and radio frequency identification tags), will have a fundamental impact on industrial production in the automotive sector. These advancements will have the effect of lowering production costs, reducing downtime, and improving worker productivity (Thyagarajan, 2018).

On the product side, the volume and quality of data produced by modern vehicles has also improved, while customer feedback through information channels such as social media has enabled firms to better understand the customer experience (PWC, 2013).

Digital disruption is effectively transforming auto companies from product manufacturers into digital services providers. Research conducted for Accenture by Gissler, et al (2016) shows that by 2020 for an OEM with US$55 billion in annual net revenues, digitization could create up to US$2.3 billion in new value. Conversely, a failure to digitize could see OEMs lose up to 15% in revenue (Gissler, et al, 2016). This will require a much greater investment in digital and information and communications technology (ICT) skills.

On the regional level, jobs across various sectors are becoming more reliant on digital technology. According to the World Economic Forum, "average ICT intensity of jobs in South Africa increased by 26% over the last decade, while 6.7% of all formal sector employment in Ghana and 18.4% of all formal sector employment in Kenya occurs in occupations with high ICT intensity." (p.11). The WEF argues that greater emphasis should be placed on "digital fluency" and ICT literacy skills. The automotive sector is likely to be similarly affected.

The auto industry in South Africa must confront its low levels of ICT literacy and numeracy skills if it is to adapt to the technological challenges that lie ahead.

4.2.2 Innovation

Firms that aggressively drive innovation will have an edge on their competitors. A PWC (2013) study into innovation in the automotive sector polled 1757 "C-Suite" and executive-level respondents across various sectors (including 72 automotive industry respondents). Respondents were asked how companies are using innovation to drive growth, how approaches to innovation are changing, and what are the best practices and critical success factors that deliver tangible business results.

The survey revealed that the most innovative companies grew at a rate of 16% higher than the least innovative companies in the survey. The PWC report also noted that "not every company will have

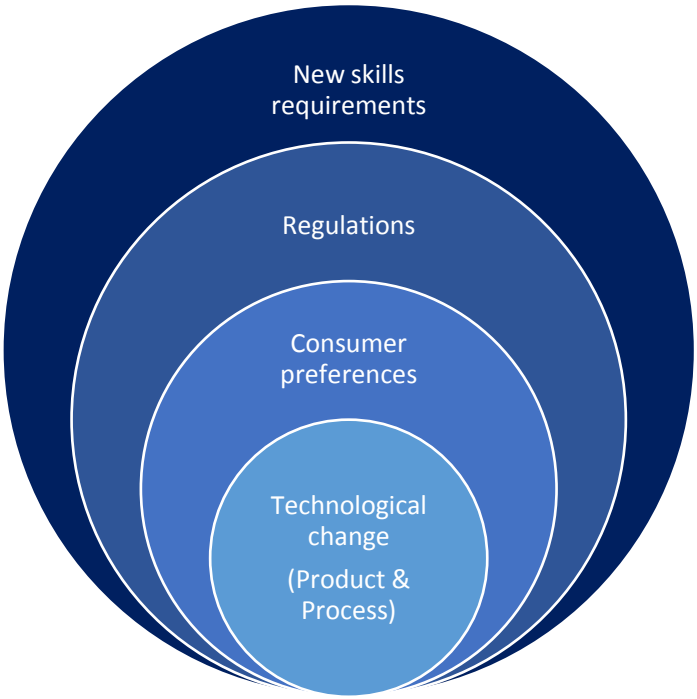
the same innovation agenda. But management at every company needs to define concrete innovation priorities and map out plans to execute them." (PWC, 2013, p.6).

At the management level of key OEMs, new designations are emerging such as "Chief Technology Officer", and "Chief Innovation Officer." This reflects the seriousness with which autos firms are approaching new technological innovations across the value chain (PWC, 2013). PWC also notes that car makers looking to maintain a competitive edge will need to partner more closely with firms that lie outside of the traditional automotive space, especially technology and communications companies.

One conclusion of the PWC study is that auto makers will need to create a "balanced innovation portfolio", which means "finding the right mix of investments in incremental, breakthrough and radical innovation in products, technology and processes." (PWC, 2013, p.10)

Figure 8 visually represents how digital and other forms of technological innovation will alter product and process technologies, which will shape consumer preferences, and in turn create new regulatory responses from policy makers. Finally, motor industry skills along the value chain will have to accommodate these new consumer preferences and regulatory requirements. In some cases, the sequence may be reversed, with new regulatory requirements creating new consumer preferences, which will spur innovation (for example, light-weighting and emissions requirements in developed economies).

FIGURE 8: INNOVATION AND DISRUPTION TO AUTO GVCS



4.3 Technological disruptors to global automotive value chains and the impact on skills development

The South African automotive industry will be impacted by a range of major technological changes which are set to transform manufacturing globally. In the following sections we identify seven emerging Global Value Chain (GVC) disruptors which are most likely to reshape the automotive

industry, and explore how these forces will alter the production requirements of developing markets like South Africa (briefly summarised in **Table 4** and expanded in the sub-sections which follow).

TABLE 4: AUTOMOTIVE GVC DISRUPTORS

	Technological disruptor	Drivers of change, 2020 – 2035	Skills implications
1	**Alternative engine technologies**	The move to Plug-in Hybrid electric vehicles (PHEVs), then battery electric vehicles (BEVs), as battery costs plummet and environmental regulations tighten. Simultaneous move to high technology, smaller displacement internal combustion engines (ICEs).	A higher degree of electrical engineering and mechatronic skills will be required. New maintenance and aftermarket service capabilities will also be needed.
2	**Green manufacturing**	Regulatory and consumer demand for carbon-neutral production processes, recycled material and reduced emissions. What are the compliance cost implications?	Regulatory compliance knowledge and enforcement capabilities.
3	**New materials design**	Development of composites, embedded nano-technology, and durable, light materials to reduce the weight of vehicles (resulting in improved emissions and fuel economy).	Advanced materials engineering knowledge will be required. Research and development capabilities (university-level)
4	**Infotainment and vehicle connectivity developments**	Internet and satellite connectivity leading to improved in-vehicle entertainment and navigation capabilities.	Advanced ICT skills, e.g. network design, programming.
5	**Robotics and artificial intelligence**	Rise of machine learning, big data and robotics will lead to product and process improvements.	Ability to programme, maintain, and work alongside machines (e.g. use of "Cobots"). Data analysis skills. Disruptive effects from automation.
6	**Passive and active vehicle safety advances**	Introduction of new safety features will reduce collisions and road casualties but lead to a bifurcation of consumer markets as costs rise.	Familiarity with safety standards. Greater vehicle maintenance and repair skills.
7	**Mobility services & autonomous vehicles**	Alternative transport solutions (e.g. autonomous fleets of on-demand EVs) have the potential to displace private vehicle ownership.	Potential for mass redundancy and skills migration.

These changes will fundamentally transform product and process technologies through the period 2020 – 2035. In the subsequent sections we explore the implications of these GVC disruptors on SA's existing skills base and future skills requirements.

4.3.1 Alternative engine technologies

In developed countries, more stringent vehicle fleet fuel economy requirements have spurred a move to alternative engine technologies, also referred to as Energy Efficient Vehicles (EEVs). These include Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Battery Electric Vehicles (BEVs), and hydrogen fuel cell-based vehicles. As costs of batteries plummet, driving ranges increase, and regulatory pressures are brought to bear, this trend is likely to intensify (Barnes, 2017).

Widespread adoption of alternative engine technologies is already evident and growing, with many OEMs rapidly introducing EV models, e.g. Nissan expects 20% of its EU sales to be EVs by 2020 (Reuters, 2017). The shift is also being helped along by policymakers and regulators. According to the Economist (2017), China's EV market already exceeds 400,000 units with the government planning quotas requiring 8% of vehicles sold to be BEVs/PHEVs. Bloomberg New Energy Finance (2017) predicts that 54% of new car sales and 33% of the global car fleet will be electric by 2040.

The McKinsey Global Institute (2016) argues that electrified vehicles are becoming more viable and competitive. In addition to lower battery costs (which are predicted to drop to between USD 150 to 200 per kWh over the next decade), the McKinsey Global Institute also believes that more widely available charging stations and increasing consumer acceptance of electric vehicles will lead to deeper market penetration of alternative engine technologies. As a result, McKinsey estimates that by 2030 the share of electrified vehicles could range from 10 to 50 percent of new vehicle sales.

In parallel to the rise of electric vehicles is the associated movement to high technology, smaller displacement, internal combustion engines (ICEs), which is likely to benefit developing economy markets. According to Barnes (2017), this trend is already observable in South Africa, and could increase dramatically as highly fuel efficient, sub-1,000cc engine technologies develop.

What does the shift to alternative engine technologies and smaller displacement ICEs mean for SA, and particularly the skills profile of the existing workforce? What will SA's conversion rate to PHEVs and BEVs look like? Although only 574 PHEVs were sold in 2016 - along with a handful of BEVs - this trend will have a large impact on production requirements for Tier 1 component manufacturers supplying to global automotive value chains (Barnes, 2017). South Africa's ability to sell larger engine vehicles into developed economy markets such as the EU may also come under pressure (Barnes, 2017). SSA markets are still dominated by pre-owned petrol or diesel-powered import sales, so the potential growth of the regional market may present an opportunity for ongoing ICE production in SA.

From a skills perspective, the shift to EEVs will present a challenge for the SA automotive industry. The lower levels of componentry and moving parts in electric vehicles could impact negatively on the type and number of jobs in the South African auto value chain. Given the likely split in the consumer market, local production will be at risk of develop along two parallel tracks (an ICE track and an EEV track) with distinct skills requirements for each track. This may result in diseconomies of scale, diluting the already small production market in SA and frustrating skills development initiatives. It will also necessitate a higher degree of electrical engineering and mechatronic skills among the workforce. New maintenance and aftermarket service capabilities will also be needed to provide e.g. battery repair or replacement services.

4.3.2 Green manufacturing

Although international green production standards such as ISO14000 are now a management requirement within most auto GVCs (Barnes, 2017), the automotive industry in developed economies (as well as in China, India, etc.) is under increasing pressure to secure carbon neutrality. Auto makers are being urged to phase out materials that cannot be recycled. Materials that contain in-use or post-use contaminants are also under increasing scrutiny. Consequently, developing economy production will need to conform to new green requirements, which will have major consequences for "Tier 2" auto economy producers like South Africa.

Local content use by SA-based OEMs is already low for the reasons to be discussed in **section 4.4**, but one difficulty is conforming with developed economy market entry requirements (e.g. homologation). OEMs can only source in the South African market when full legal conformance with its most onerous market supplied is assured. For example, the EU Commission's End of Life Vehicle legislation (directive 2000/53/EC), sets specific targets for the reduction of environmentally hazardous waste in vehicles.

As requirements become more onerous, what are the consequences for developing market auto economies like SA that are looking to continue supplying developed markets? From a skills perspective, South African auto makers will need to develop regulatory compliance capabilities to conform with standards in developed markets or risk being shut out of these markets altogether.

Although engineers will be at the forefront of the technological requirements, other job categories such as supervisors and artisans will also need to be equipped with the necessary knowledge to ensure the correct implementation of environmentally sustainable interventions, e.g. reduced use of solvents, waste minimisation, energy efficiency systems.

Compliance costs may rise, which would potentially impact negatively on component exporters and jeopardize export capabilities. However, as Barnes (2017) argues, if SA firms cannot demonstrate their use of compliant materials, the alternative is imports. In other words, the opportunity cost of lost production could far outweigh the cost of upskilling workers to adhere to new environmental rules.

4.3.3 New materials design

Closely linked to the theme of green manufacturing discussed in the previous sub-section, is the growing use of durable, light materials such as composites and alloys, that could fundamentally change the nature of vehicle production going forward (Barnes, 2017). Light-weighting is principally motivated by fuel economy considerations, as it takes less energy for a lighter vehicle to accelerate, producing lower CO_2 emissions. A 10% reduction in vehicle mass is estimated to translate into a 3% to 7% reduction in fuel consumption (Centre for Automotive Research, 2011). These savings can help to reduce CO_2 emissions by approximately 0.08g of CO_2 for every kilogram of weight saved (McKinsey, 2012).

The advent of high-strength, lighter steels including dual-phase, martinsitic and boron steel, have also enabled manufacturers to produce lighter components (such as chassis and body panels). Boron steel is highly malleable and employs general forming methodologies which are fundamentally

different to traditional forming techniques (e.g. extremely high heat) (Centre for Automotive Research, 2011).

Aluminium is also becoming more prevalent, being particularly useful for cast parts such as engine blocks, transmission casings and wheels. Over 50 percent of all cylinder blocks are made from aluminium, according to the Centre for Automotive Research (2011).

Newly commercialised casting methods such as twin roll casting have also allowed for the development of specialist steel that maintains its strength at lighter densities. Twin roll casting also uses less energy (approximately 80%), which helps to save on production costs (The Economist, 11 March 2017).

South African component manufacturers face the dual challenge of complying with the regulatory requirements for lightweight materials, while simultaneously minimising the additional cost burden associated with producing ever more complex materials. The replacement of steel components with durable, lightweight plastics or other non-steel substances could disrupt metal fabrication and metal pressing firms that characterise the SA value chain. Conversely, these materials could also create new additive manufacturing opportunities for SA suppliers. However, this is contingent on developing the manufacturing skills required to utilise this technology on a competitive basis.

The development of new materials will lead to new products and processes, which in turn will require new skills. Given this trend, a high level of materials engineering capability will need to be cultivated. Research and development programmes will also need to be strengthened and supported in universities and private enterprises to ensure that SA contributes to the development of new materials. Material testing expertise will also have to be improved.

4.3.4 Infotainment and vehicle connectivity developments

Every vehicle model change sees major improvements in the quality and range of in-cabin infotainment services. Internet and broader satellite connectivity has enhanced the levels of intelligence in vehicles, many of which are now equipped with sophisticated on-board computing systems that integrate a range of safety, navigation and entertainment functions, rendered on a large dashboard display. According to Stratistics MRC (2017), the global automotive infotainment systems market accounted for US$14.92 billion in 2016, and is expected to reach US$36.68 billion by 2023, at a compound annual growth rate (CAGR) of 13.7%.

The Blackrock Investment Institute (2017) sees semiconductor and software providers as the primary beneficiaries of the growing digitalisation of vehicles, but also notes that automakers and suppliers are working aggressively to catch up.[2]

While infotainment systems have improved driving experiences, the associated costs have placed upward pressure on vehicle pricing. Combined with the increasing cost of active and passive safety systems, and the potential for further revolutionary developments in respect of in-cabin infotainment (e.g. autonomous vehicles, specialized mobility services), what are the consequences

[2] By way of example, Korean technology giant, Samsung's acquisition of Harman International is intended to boost its autonomous driving and infotainment offering - a sign of technology companies' growing interest in automotive markets. Together with Harman, Samsung has developed a "digital cockpit" which enables drivers to personalize cars by pulling users' profiles from their mobile devices and the cloud (Reuters, 2018). Harman's advanced camera technology includes features such as anti-collision and lane-departure warnings, and adaptive cruise control.

for developing market auto economies? Barnes & Black (2017) maintain that infotainment production has largely been confined to developed auto economies. If infotainment systems were manufactured in SA, production would compensate for the value addition loss in "commodity production areas," they say. Barnes & Black further argue that SA's primary areas of value addition are in metal pressing and fabrication, plastic moulding, and sub-assembly and assembly processes. As argued elsewhere, cost pressures and increasing technical specifications could displace these firms from the industry, reducing value addition and impacting negatively on jobs in the sector, they argue.

The nature of in-vehicle infotainment systems will require advanced levels of ICT skills (such as network design, software programming), as well as electronics. While South African firms may not be at the forefront of developing new infotainment solutions (this will be done by OEMs and other technology partners), SA production workers and aftermarket service providers will still need the skills to install, maintain and repair these systems.

4.3.5 Robotics and artificial intelligence

The emergence of artificial intelligence (AI) and robot technology will profoundly influence the future of manufacturing, and the consequences for the automotive sector will be no less significant.

Robots have already been in use in automotive manufacturing in the form of production line machines performing routine, repetitive tasks. However, AI is far more than simply robotics, with other applications including the use of "Big Data" to improve process efficiencies, predictive maintenance of equipment, and Machine Learning (ML).

McKinsey (2018) differentiates between three forms of AI:

1. **Narrow AI** – automation of a traditionally human activity but outperforming in efficiency and endurance.
2. **General AI/human-level AI** - the capacity of machines to understand their environment and reason and act accordingly
3. **Super AI** - the highest level of AI. When AI becomes more capable than the best human brains in every field.

McKinsey defines ML as an approach to creating AI: "[ML] describes automated learning of implicit properties of, or underlying rules for data. It is a major component for implementing AI since its output is used as the basis for recommendations, decisions, and feedback mechanisms with regards to a previously unknown situation." (2018, p.13)

Robots that interact and collaborate with humans - known as "cobots" - are already available in the market. Auto manufacturers have found applications for cobots in injection moulding, welding, painting, polishing and machine inspection (BMW has used a cobot named "Miss Charlotte" in its Spartanburg plant since 2013). Another example is Rethink Robotics' "Baxter" model, a relatively inexpensive, re-programmable "machine assistant" aimed at small and medium sized manufacturers. Baxter can assist human operators with functions such as line loading and machine tending, as well as packaging and material handling, at a fraction of the cost and with more flexibility than large conventional robots. If cobots are to find traction in SA Tier-1 manufacturers, then SA workers must be sufficiently skilled to be able to "instruct" these devices correctly, and to collaborate effectively.

AI and ML advances are likely to contribute to changing factory conditions and work arrangements as "smart factories" emerge in the future. As the inevitable restructuring and re-tooling of operations occurs the effect on human capital requirements will become more pronounced. The relationship between capital and labour is likely to change too. Although the added costs of robot and AI technology will become higher, South African auto makers should consider the cost implications of implementing AI versus *not* implementing AI in their production processes (Barnes, 2017).

Low-skilled workers may also be threatened by the disruptive effects of mechanisation of routine tasks, which could lead to higher levels of industrial action or other conflicts. Ultimately the structure of a factory floor could be radically different in the not-too-distant future, with one predicted outcome being small numbers of highly-trained personnel and a handful of operators overseeing a sprawling fleet of semi-autonomous robots. South African Tier-1 producers' heavy reliance on large groups of production workers could make it be susceptible to this outcome.

4.3.6 Passive and active vehicle safety advances

The introduction of advanced safety features into modern vehicles is becoming more important for consumers and a key differentiator for OEMs seeking competitive advantage. New features include:

- Multiple traction devices;
- Potential accident detection systems;
- Multiple airbags;
- Driver fatigue monitors;
- Advanced Noise, Vibration, and Handling (NVH) specifications; etc

As Barnes & Black (2017) point out, while these developments are positive for the global automotive industry in terms of reducing road casualties, in the short-term the benefits accrue exclusively to those consumers that can afford the cost of these features. As a result, Barnes & Black note that SA has a bifurcated vehicle market, with a roughly 50:50 split between affluent and value-driven consumers. The domestic light vehicle market is already small at 520,177 units in 2016, so for local OEMs selling to the SA market this bifurcation represents a challenge as it dilutes the economies of scale needed to justify investing in new models. For SA producers to take advantage of this trend, there will need to be a greater emphasis on formal training around new vehicle safety standards. Managers of local firms should ensure that new technologies are identified in advance, that adequate funding is set aside, and that the appropriate process improvements are implemented. In terms of aftermarket support, an investment in vehicle maintenance and repair skills will also be needed.

4.3.7 Mobility services and autonomous vehicles

Mass mobility services such as e-hailing and ride-sharing offer a glimpse into the future of transportation. Existing on-demand mobility services such as Uber, Lyft and Taxify will have a major impact on private vehicle ownership levels across developed and developing economies.

One extreme forecast by Arbib and Seba (2017) anticipates that by 2030 transport-as-a-service (TaaS) providers will supply 95% of US passenger miles using fleets of autonomous electric vehicles.

Arbib and Seba predict that TaaS will be four to ten times cheaper per mile than buying a new car, and two to four times cheaper than operating an existing vehicle in 2021. Accordingly, car ownership will decline dramatically with far fewer vehicles on the road doing much higher mileages.

The World Economic Forum (2018) supports this view: "Although personal-use vehicles will likely remain a significant portion of the vehicle stock for many years, they are on the road less than 5% of the time, representing a low volume of overall miles driven" (p.5). The WEF also argues that high-use vehicles are likely to amplify the benefits of electrification, as fleets, taxis, TaaS vehicles and public transport vehicles are more likely to be run on electric engines.

Arbib and Seba (2017) estimate that by 2030, individually owned ICE vehicles will still represent 40% of the vehicles in the U.S. vehicle fleet, but the growth of TaaS will mean that ICEs will only provide 5% of passenger miles. Under this scenario the effect on ICE production (particularly in developing markets like SA) would be catastrophic, but significant benefits would accrue in terms of vehicle safety and reduced congestion and emissions. Although the wholesale adoption of these mobility platforms is likely to take longer in SA, the effect on local production capabilities will be dramatic as global ICE demand shrinks.

The trend towards mass mobility solutions will be amplified by the advent of autonomous vehicles (AVs). Forecasts differ, as the adoption of AV technology in different markets will vary according to the pace of technological change and the flexibility of policy makers to these changes. However, according to the Blackrock Investment Institute (2017), full AVs will only begin to take off rapidly from 2025 with a 75% adoption by 2035. Although this is on the optimistic side, even a 20-30% adoption rate will dramatically affect production and consumption in developing market auto economies (Barnes, 2017). The realization of AVs will also require substantial structural change in both market and production infrastructure.

Although on-demand mobility services and autonomous vehicles constitute two parallel trends, the convergence of these technologies will amplify their effects. Bloomberg New Energy Finance (2017) predicts that the impact of autonomous driving will be limited for the next 10 years, but that ride hailing and car sharing services will have a more immediate impact over the short term. Under this forecast autonomous shared-use vehicles will begin to replace existing human-driven shared and hailed cars starting in 2030. This is likely to impact negatively on vehicle sales and increase the average distance travelled per vehicle. Bloomberg NEF also expects 80% of all autonomous vehicles in shared applications to be electric by 2040 due to lower operating costs.

How this trend will affect motor industry skills in South African Tier-1 suppliers and aftermarket service providers is uncertain at this stage. However, one implication already explored in the earlier infotainment and vehicle connectivity section would be the increased use of high-technology electrical systems in vehicles, which will require advanced skills in electronics, ICT, and software development. For example, rooftop sensors used for autonomous navigation will need to be installed, repaired or replaced. While the interior linings and basic parts (e.g. seats, bumpers) are likely to remain the same, autonomous vehicles will contain fewer moving parts (e.g. no steering column or rear-view mirrors). This will likely reduce the overall production value-addition that South African auto suppliers currently perform.

Although beyond the scope of this study, the main disruptive effect of autonomous vehicles will be the impact on jobs in the transport and logistics sector, with many low-skilled driver jobs at risk of being phased out altogether.

4.4 Identifying the domestic implications on occupations and skills requirements for sub-sectors of interest

As discussed in the sections above, global automotive value chains will experience significant disruption owing to a variety of combined forces, such as new EEVs, highly efficient ICEs, lightweight materials, green manufacturing, passive and active safety features, infotainment, automation and mass mobility solutions. As Barnes, et al, (2017), point out, these forces:

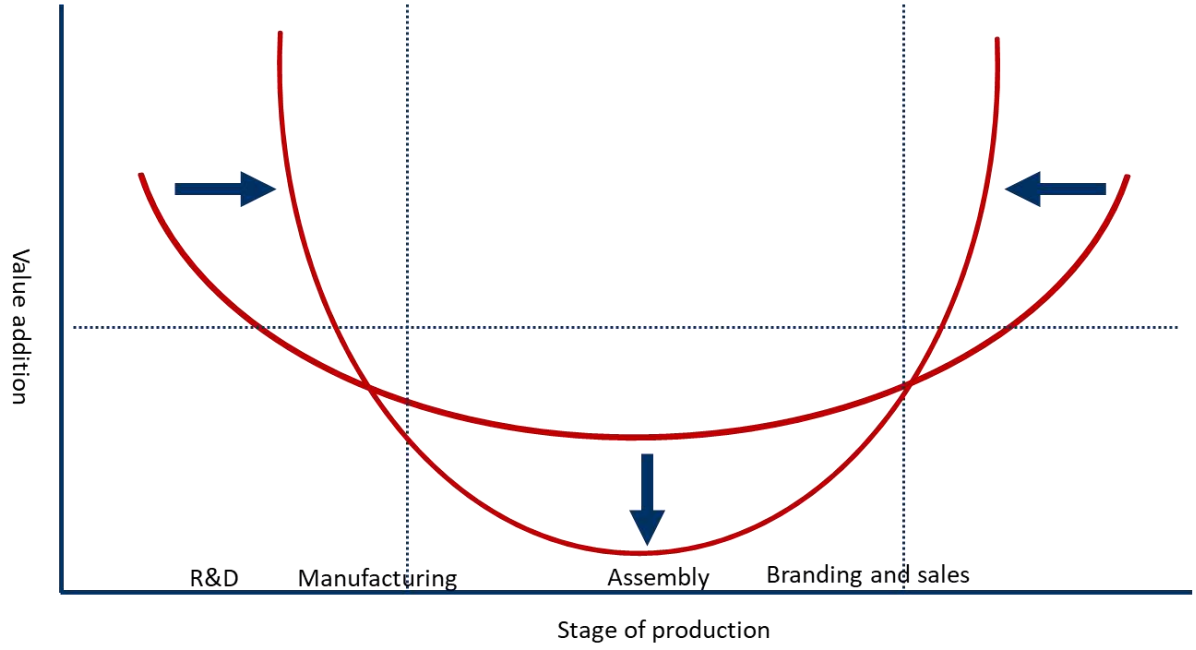
> *…point to a future where the South African automotive industry either plays a narrow assembly/light manufacturing role within automotive GVCs, or establishes itself as a part of an emerging product development ecosystem, and demonstrates its ability to increase its value addition within particular product niches. Identifying and deepening South African involvement in these niches is clearly a critical development challenge for the South African automotive industry.* (p.22)

It is important to explore the implications of these changes on the existing skills profile of the SA workforce and the new skills that will have to be developed by automotive manufacturers.

4.4.1 The "Smiling Curve" of value addition

South Africa's precarious position in Global Automotive Value chains is illustrated by the "Smiling Curve" of value addition, shown in **Figure 9**. In this conceptual framework, value-adding activities are seen to be primarily located in research and development (R&D) and after sales service (represented by the left and right ends of the curve). These activities rest primarily in the hands of OEMs and international technology companies.

FIGURE 9: THE "SMILING CURVE" OF VALUE ADDITION



The influence of the "GVC disruptors" discussed previously will result in a "squeezing" of the curve, as value is increasingly concentrated in the hands of OEMs and services sectors. SA currently occupies the space at bottom of the curve, performing basic assembly and component manufacturing functions. This position will be further challenged as the GVC pressures drive down value addition opportunities in basic manufacturing and assembly.

4.4.2 What is the existing employment profile across various sub-sectors?

The profile of South African Tier 1 component manufacturers is clearly demonstrated in **Table 5**, which is sourced from the BMA benchmarking database of 82 supplier firms across various product categories/firm types. This gives a useful, although by no means comprehensive, cross section of job categories across automotive suppliers.

TABLE 5: EMPLOYMENT PROFILE BY JOB CATEGORY

Firm type	Management	Professional / Engineer	Supervisor	Artisan	Operator/ Production	Other
Components	7%	3%	6%	3%	74%	7%
Electronics	3%	5%	8%	2%	71%	11%
Foundry/forge	3%	2%	9%	10%	61%	14%
Glass	2%	3%	12%	4%	71%	8%
Harnesses	3%	4%	9%	1%	73%	11%
Heat transfer	5%	9%	7%	6%	53%	21%
JIT Assembly	3%	16%	6%	5%	62%	8%
Metal fabrication	7%	3%	7%	6%	69%	8%
Metal form/press	7%	8%	8%	4%	64%	9%
Other (paint/rubber)	5%	6%	7%	4%	71%	8%
Plastic Moulding	8%	5%	5%	6%	73%	3%
Precision Machining	0%	1%	11%	27%	57%	3%
Trim	4%	2%	6%	3%	81%	4%
Average	**4%**	**5%**	**8%**	**6%**	**68%**	**9%**

Source: BMA benchmark database (sample of 82 automotive supplier firms), 2016

The distribution of job types illustrated above shows the heavy weighting of South African auto manufacturers towards operators / production workers (68%). Since this grouping occupies the lowest skill level of all the five job categories, it is likely that the GVC disruptors will affect this grouping the most. As many of the associated tasks are routine, and could easily be mechanised, the risk of redundancies in this category is therefore high. It is also worth noting the ratios of other employment categories per sub-sector. Are these categories prepared for GVC disruption or at risk of disappearing altogether?

Other job categories will also be affected in different ways. For example, the management category, while being the smallest of the categories listed above, will likely be impacted by the more onerous regulatory requirements emerging out of green manufacturing and new materials design. Managers of the future will have to have a deep familiarity with occupational standards and be able to identify and drive new skills development and training amongst workers. Similarly, engineers will be required to develop more advanced electrical and mechatronic capabilities in order to harness the power of robotics at a process level. Another cross-cutting theme is the digitisation of the factory floor, and the ability of technical and production workers to collect and analyse data. Developing better numeracy and ICT skills will therefore be an essential feature of all employment categories.

RESEARCH STREAM I: TIER-1 AUTOMOTIVE MANUFACTURERS

5. Overview

Research Stream I focuses on the skills development needs of Tier 1 Automotive Manufacturers, comprised of the following firm categories: Electronics; Foundry/forge; Glass; Harnesses; Heat transfer; JIT assembly; Metal fabrication; Metal form/press; Plastic moulding; Precision machining; and Trim, among others.

This Stream considers the following questions in light of the "GVC disruptors" highlighted in the preceding literature review, and situates this analysis within the context of the South African Master Plan policy framework:

- How will South African Tier-1 automotive manufacturers respond to the challenges presented by disruptive technological changes in global automotive value chains?
- What skills development is needed and available for people to adapt and remain relevant to these changes?

Research Stream I has been prepared by Benchmarking and Manufacturing Analysts SA (Pty) Ltd.

6. Primary research findings (Qualitative)

6.1 Qualitative research methodology and scope

As discussed in **section 2.2.2**, the qualitative research process involved a series of workshops and interviews held with industry participants and stakeholders in Johannesburg/Pretoria, Port Elizabeth and Durban. A full list of research participants is shown in **APPENDIX A – Qualitative research participants (Tier 1 automotive** manufacturers)**.** Participants were questioned about the impact of the foreseen technological changes to global automotive value chains (as detailed in the literature review in **section 4**), and the implications on occupations and skills requirements for South African Tier 1 automotive component manufacturers.

Participants were specifically asked to consider the following research questions:

- What skills are needed for these existing occupations and what new skills will be required?
- What skills development resources are required to skill people sufficiently to fulfil these occupations?
- What will be the new occupations for the future (i.e. occupations that bear little or no resemblance to existing occupations)?
- What will be the skills requirements for future occupations?
- What skills development resources will be required to skill people sufficiently to fulfil these occupations?
- What occupations and skills will become redundant as processes / technologies change?

6.2 Availability of current skills, new skill requirements and required changes:

Participants were asked to reflect on the availability of current skills in Tier 1 automotive component manufacturers, and also to anticipate new skills needs for the period 2020 – 2035. Focus groups were prompted to reflect on the required changes that will need to be implemented in order to develop the skills that will be required. Participants were asked to reflect on these questions as they apply to five job categories: Management; Professionals / Engineers; Supervisors; Artisans; and Production Workers / Operators.

6.2.1 Management

Management capabilities of South African Tier 1 automotive component manufacturers require specific skills. The current management skills listed in the first column of **Table 6** were drawn primarily from analysis conducted by White & Ellis (2017) in their "ASCCI Supplier skills needs assessment and leadership needs analysis project." Participants were asked to reflect on these proposed skills and to anticipate new skills requirements and associated changes for managers. Feedback from these sessions is listed in the "Required changes" and "Future skills" columns**.**

TABLE 6: CURRENT MANAGEMENT SKILLS, NEW SKILL REQUIREMENTS AND REQUIRED CHANGES

Current skills	Required changes	Future skills
• Lean manufacturing capabilities • Computer literacy / ICT • Global thinking / strategic insight • Financial management • Operations / Production management • Leadership and team-building • Conflict management & negotiation	• Greater sophistication of machine testing technology. • Adaptability to technological, market and production changes. • Use of Big Data and Machine Learning to seek process efficiencies. • Develop cell leaders and management groups • Understanding of technical requirements only is insufficient. Effective managers must also have a high Emotional Quotient • Adoption of Industrial Internet of Things (IIoT) platforms to improve manufacturing processes. E.g. remote monitoring devices, wearable tech • Good engineer ≠ good manager. Coaching of engineers for future management responsibilities needed.	• Production line robotics and automation. • Advanced design capabilities • Data analytics (e.g. Big Data and Machine Learning). • Advanced computer skills (e.g. programming/system design) • Green production techniques (understanding and adherence to international quality standards, e.g. ISO14000) • Regulatory compliance • Advanced process monitoring techniques • Succession management • Risk management

6.2.2 Professionals / Engineers

Professional / engineering capabilities of South African Tier 1 automotive component manufacturers require a unique set of technical competencies. The current professional and engineering skills listed in the first column of **Table 7** were drawn primarily from desktop research and qualitative interviews.

TABLE 7: CURRENT PROFESSIONAL / ENGINEERING SKILLS, NEW SKILL REQUIREMENTS AND REQUIRED CHANGES

Current skills	Required changes	Future skills

• Creative Thinking
• Computer Modelling
• Attention to Detail
• Advanced Mathematics
• Communication Skills
• Leadership and management
• Teamwork
	• Implement digital monitoring tools
	• Explore greater integration of ICT with process technology (e.g. connected factories)
	• Awareness campaigns regarding existing ISO standards
	• PHEV and EV tech requires more specialised training, R&D.
	• Shift to new materials requires:
	  • Capital investment
	  • Awareness training
	  • Process control
		• Robotics and automation
		• Advanced computer programming
		• Data analytics
		• Artificial intelligence
		• Mechatronics
		• Infotainment and vehicle connectivity (IoT)
		• Compliance with international quality standards
		• Process control techniques

6.2.3 Supervisors

Supervisors are often described as the "heart and soul" of a manufacturing firm, occupying a unique intermediary position between managers and technical experts on the one hand, and artisans and production workers on the other. The current supervisor skills listed in the first column of **Table 8** were drawn from the Automotive Supply Chain Competitiveness Initiative (ASCCI) High Level Skills Framework (2017). The "Required changes" and "Future skills" columns reflect the recommendations of industry stakeholders solicited during the workshops and interviews.

TABLE 8: CURRENT SUPERVISOR SKILLS, NEW SKILL REQUIREMENTS AND REQUIRED CHANGES

Current skills	Required changes	Future skills
• IR & Code of Conduct • Health, Safety & Environment • Financial Basics (Individual & business) • Communication & Team-work • Time Management • Leadership • Lean manufacturing • Manufacturing Techniques	• Improve knowledge of advanced machinery and fault-finding techniques. • Position supervisors as the "heart and soul" of a firm.. • Artisan-level production issues to be fed to management • Develop continuous improvement and visual process management techniques (e.g. ILUO Charts) • Move away from being "policemen" of the shop floor • Enable Mission-Directed Work Teams (small work units with own strategy, goals and activities) • Explore downtime reduction strategies • Exposure to international work placements & global best practice.	• Robotics and automation • Green manufacturing • Adherence to passive and active safety specifications • Conflict management • Regulatory compliance • Adequate waste disposal • Intermediate management skills

6.2.4 Artisans

The current artisan skills listed in the first column of **Table 9** were drawn from the Automotive Supply Chain Competitiveness Initiative (ASCCI) High Level Skills Framework (2017). The "Required changes" and "Future skills" columns reflect the recommendations of industry stakeholders solicited during the workshops and interviews.

TABLE 9: CURRENT ARTISAN SKILLS, NEW SKILL REQUIREMENTS AND REQUIRED CHANGES

Current skills	Required changes	Future skills
• IR and Code of Conduct • Health, Safety & Environment • Financial Basics • (Individual & business) • Communication & Team-work • Time Management • Leadership • Lean • Manufacturing Techniques	• Greater investment in equipment for enhanced fault detection (quality control) is needed. • An awareness of the cost implications of green manufacturing • Training on ISO and other regulatory compliance needs • Implement advanced CNC training and best practice	• New materials knowledge • Advanced tool maintenance and repair • Knowledge of alternative engine technologies (e.g. electric vehicles) • Green manufacturing • Passive and active safety specifications • Flexibility and adaptability

6.2.5 Production workers / operators

Production workers and operators make up the largest job category in Tier 1 auto component manufacturers (roughly 68% according to BMA databases, as detailed in **section 4.4.2**). As already discussed, this group of workers occupies a vulnerable position in the value chain, given its exposure to potential mass redundancies that may result from automation of repetitive manual tasks. The current production worker / operator skills listed in the first column of **Table 10** were drawn from the Automotive Supply Chain Competitiveness Initiative (ASCCI) High Level Skills Framework (2017). The "Required changes" and "New skills" columns reflect the recommendations of industry stakeholders solicited during the workshops and interviews.

TABLE 10: CURRENT PRODUCTION WORKER / OPERATOR SKILLS, NEW SKILL REQUIREMENTS AND REQUIRED CHANGES

Current skills	Required changes	Future skills
• IR & Code of Conduct • Health, Safety & Environment • Financial Basics (Individual and business) • Communication & Team-work • Time Management • Leadership • Lean manufacturing • Manufacturing Techniques	• Greater emphasis on primary and secondary education system needed. Quality of school-leavers must improve to meet skill needs. Introduce qualification for school-leavers to fast-track into production work. • Bolster internal training & learnership programmes. • Literacy development • Numeracy development • Basic computer training • Productivity measurement and improvement (mindset change needed for long-tenure workers) • Shop floor workers to be properly informed of issue escalation policy: Act quickly, report, prevent reoccurrence and escalate if necessary	• Self-management • Tool maintenance and repair • Conflict management • Intermediate mathematics • Computer literacy • Flexibility and adaptability • Electronics

The qualitative research process set out above served as the foundation for the quantitative research process. Specifically, the current and future skills identified by research participants for each job category were included in the electronic survey, which was subsequently circulated widely to industry. The results of the quantitative research process are set out in the following section (**section 7)**.

7. Primary research findings (Quantitative)

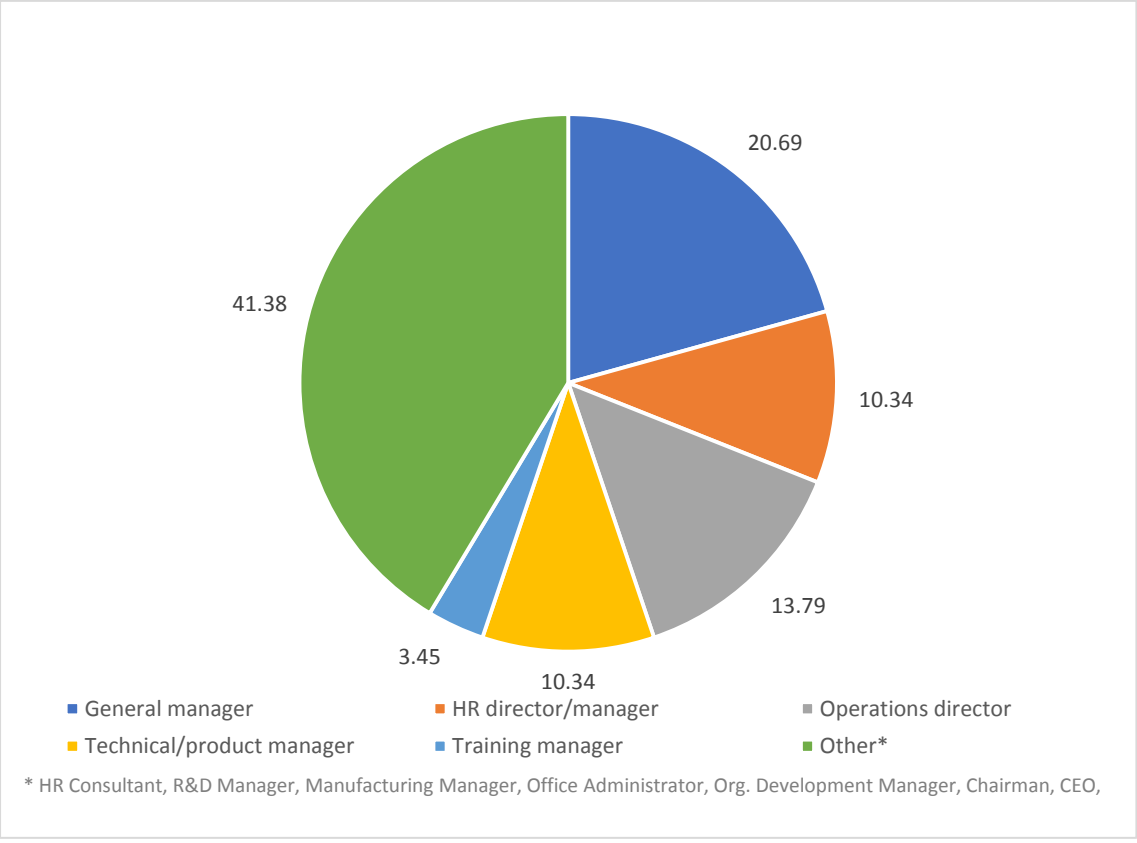
7.1 Quantitative research methodology and scope

In March 2018, an electronic questionnaire was emailed to relevant contacts on the B&M Analysts' benchmarking database of automotive supplier firms with a request for feedback. Respondents were asked to evaluate the existing skills profile of Tier 1 automotive manufacturers across the five designated job categories (management; professionals/engineers; supervisors; artisans, and; production workers / operators). Respondents were then presented with a shortlist of future skills for the period 2020 - 2035 (as discussed during the qualitative research process) and asked to identify the most cogent future skills needs for the auto industry. Respondents were also given the opportunity to suggest the most likely skills to become redundant in future.

An additional objective of the survey was to ascertain the degree to which firms in the industry are planning to invest in the critical auto industry skills that were deemed important for the industry, as well as the extent to which resources were sufficiently available to invest in these skills development and training initiatives.

A total of 29 submissions were received from industry representatives. A breakdown of the various current roles and functions of the respondents is represented in Figure 10: Current role/function within organisation **Figure 10**.

FIGURE 10: CURRENT ROLE/FUNCTION WITHIN ORGANISATION



The largest category of respondents was general managers with 6 responses (20%), followed by 4 operations directors (13%), 3 HR directors/training managers, and 3 technical/product managers (10%). The "Other" category consisted of a variety of roles making up 41% or 12 out of 29 total number of responses. This miscellaneous category included an HR consultant, research & development manager, manufacturing manager, administrator, organisational development manager, and a CEO.

A breakdown of the companies represented in the survey is depicted in **Figure 11** and Table 11.

As evidenced, there is a diffusion of companies across Tier 1 and other automotive manufacturers, with the largest category being metal fabrication (9 respondents, 18%) and 6 component (engine/powertrain) manufacturers, followed by 5 metal form/press and 5 interior trim firms (10% each). Note that surveyed respondents were permitted to apply up to three sub-sector identifiers, so the total number of categories checked was 49 across the 29 firms that responded.

FIGURE 11: SUB-SECTOR BREAKDOWN OF COMPANIES REPRESENTED

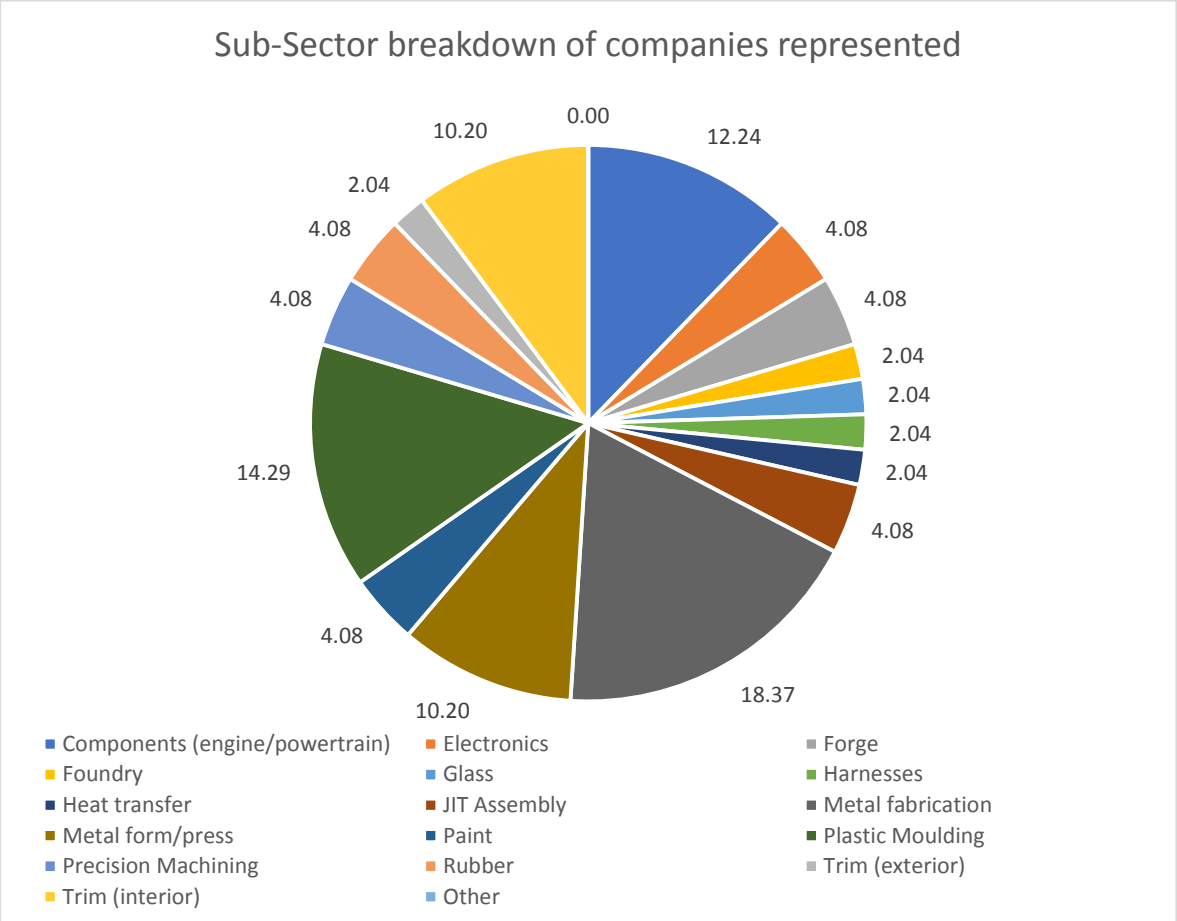
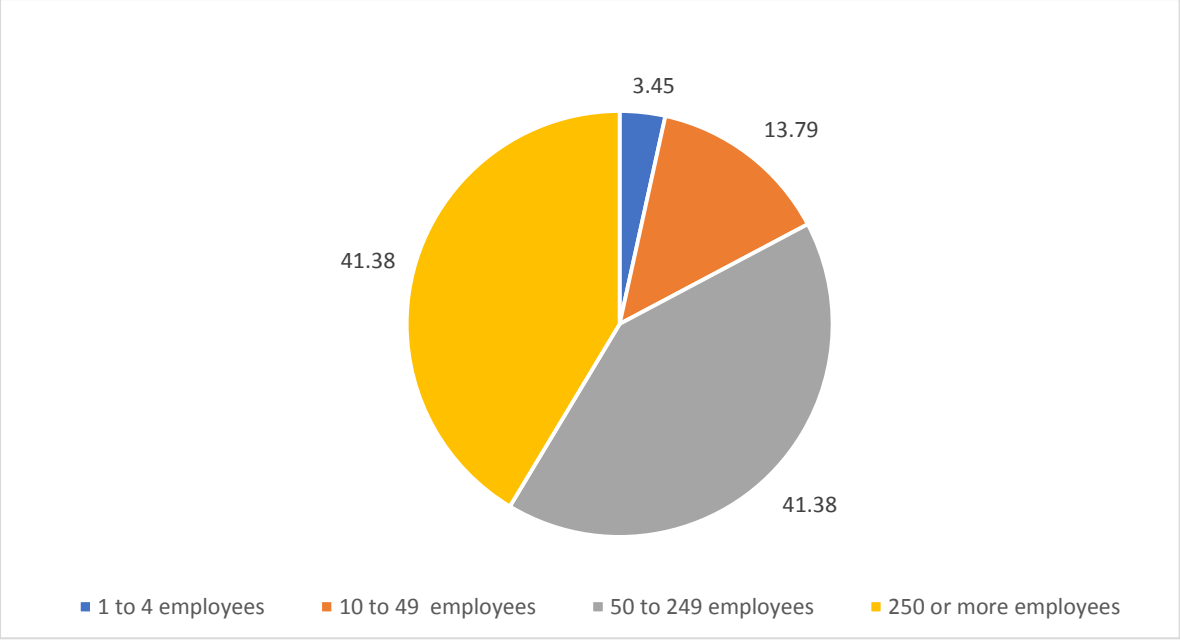


TABLE 11: SUB-SECTOR BREAKDOWN OF COMPANIES REPRESENTED

Sub-Sector breakdown of companies represented		
	Count	%
Components (engine/powertrain)	6	12,24
Electronics	2	4,08
Forge	2	4,08
Foundry	1	2,04
Glass	1	2,04
Harnesses	1	2,04
Heat transfer	1	2,04
JIT Assembly	2	4,08
Metal fabrication	9	18,37
Metal form/press	5	10,20
Paint	2	4,08
Plastic Moulding	7	14,29
Precision Machining	2	4,08
Rubber	2	4,08
Trim (exterior)	1	2,04
Trim (interior)	5	10,20
Other	0	0,00
	49	100,00

Firms were also asked to reflect their total employee count across all operations in South Africa. The breakdown of responses is shown in **Figure 12.**

FIGURE 12: TOTAL EMPLOYEE COUNT (ACROSS ALL OPERATIONS IN SOUTH AFRICA)



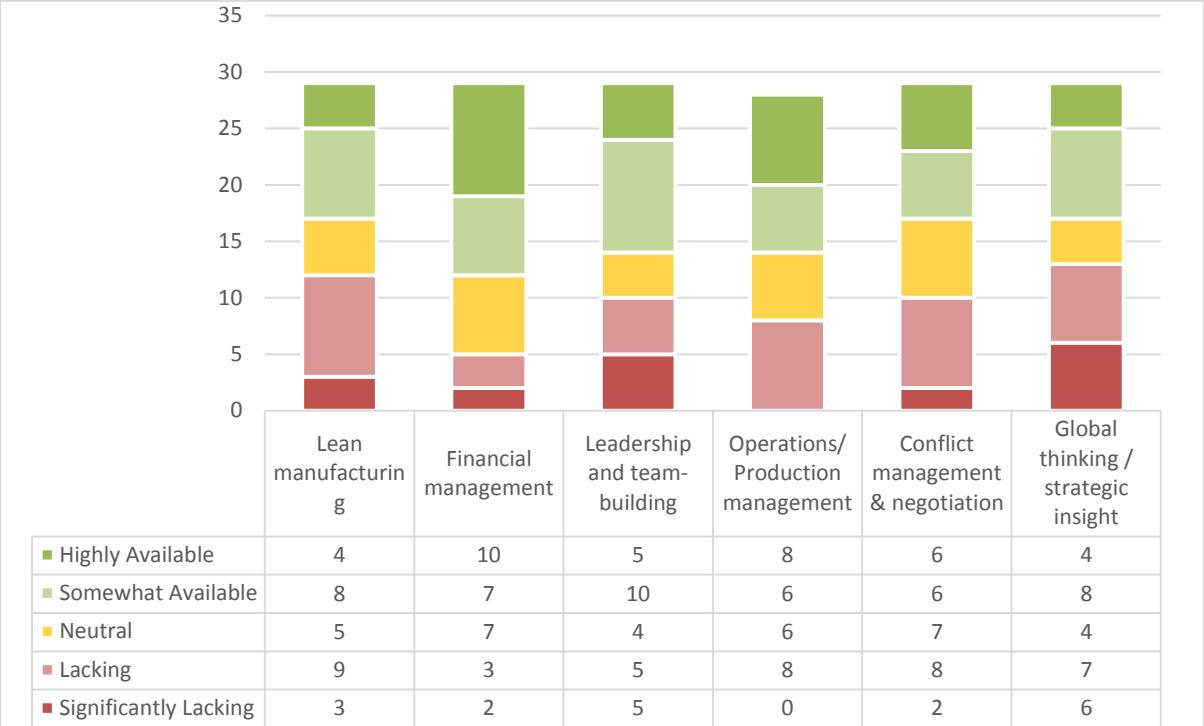
The two largest categories were 50 – 249 employees and 250 or more employees (12 responses each). A single firm had 1 to 4 employees, while 4 respondents were from a firm with between 10 and 49 employees. This reflects the labour-intensive nature of the industry.

7.2 Management

7.2.1 Current management skills proficiency

Respondents were asked to rate their management team's current skills proficiencies, with responses listed in **Figure 13**. The most highly available skills were *financial management* and *operations/production* management skills. This indicates that managers of Tier 1 manufacturing firms have been able to successfully develop core technical functions and have a high level of financial literacy and commercial acumen. However, there is room for improvement in terms of *lean manufacturing* capabilities. This capability will need to be developed to raise the competitiveness of SA component manufacturers and to enhance productivity and efficiency.

FIGURE 13: MANAGEMENT TEAM'S CURRENT SKILLS PROFICIENCIES



	Lean manufacturing	Financial management	Leadership and team-building	Operations/ Production management	Conflict management & negotiation	Global thinking / strategic insight
Highly Available	4	10	5	8	6	4
Somewhat Available	8	7	10	6	6	8
Neutral	5	7	4	6	7	4
Lacking	9	3	5	8	8	7
Significantly Lacking	3	2	5	0	2	6

The most significantly lacking skills were identified as *global thinking and strategic insight*. This is a potential threat to managers of Tier 1 firms, who may be too preoccupied with day-to-day operational requirements and not focused enough on long-term macro trends that may affect their business. *Leadership and teambuilding* skills, were predominantly viewed as being only "somewhat available", although respondents rated managers ability to deal with conflict fairly well.

7.2.2 Redundant management skills

Respondents were also asked about which management skills they saw as being at risk of becoming obsolete during the period 2020 – 2035 and were given the opportunity to provide written responses. One individual noted that there would need to be "much more emphasis on process control, productivity improvements and cost reduction." Another noted that the top management structures of firms will be minimised in order to reduce overhead costs. A general observation was

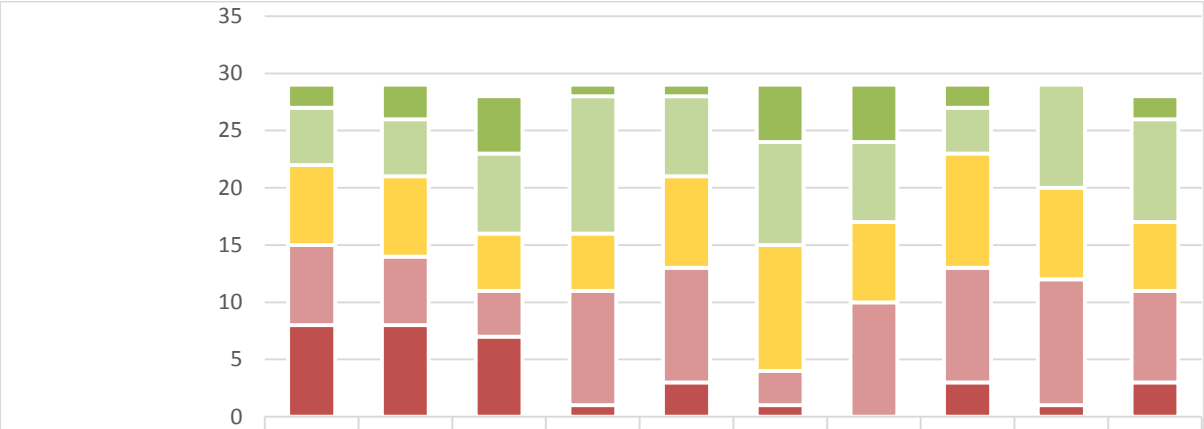
made that there was a high degree of resistance to change among managers with "rigid formal controls limiting change."

Quality management was seen as a skill that would likely become less relevant in future. As one respondent noted: "the increase in automation and AI will make human verification obsolete as more and more intelligent automated processes will check and diagnose itself. The ability for self-repair will follow." Another view was that the rise of robotics and intelligent systems would make *conflict management & negotiation* and *leadership & teambuilding* less relevant skills for the average factory owner, owing to smaller workforces and a lower likelihood of industrial action. Another noted that none of the skills listed above would become obsolete but added that new skills would be needed to fill the gaps created by new technological developments.

7.2.3 Future skills

Managers' future skills capabilities were also assessed, as shown in **Figure 14.** Managers' knowledge of *robotics* was significantly lacking, which points to the relatively low levels of automation and the high reliance of SA Tier-1 manufacturers on a large workforce of production workers / operators. Managers' advanced *design capabilities (both product and process)*, were also seen as being lower than the expected standard.

FIGURE 14: RELEVANCE OF FUTURE MANAGEMENT SKILLS - 2020-2035



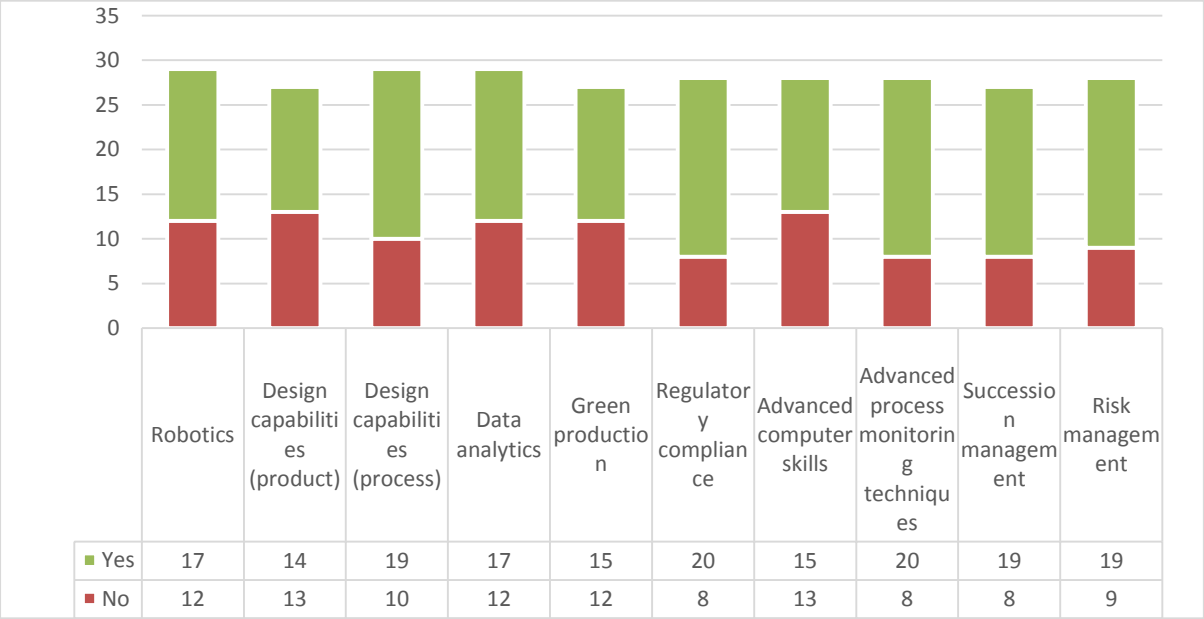
	Robotics	Design capabilities (product)	Design capabilities (process)	Data analytics	Green production	Regulatory compliance	Advanced computer skills	Advanced process monitoring techniques	Succession management	Risk management
Highly Available	2	3	5	1	1	5	5	2	0	2
Somewhat Available	5	5	7	12	7	9	7	4	9	9
Neutral	7	7	5	5	8	11	7	10	8	6
Lacking	7	6	4	10	10	3	10	10	11	8
Significantly Lacking	8	8	7	1	3	1	0	3	1	3

The lack of *advanced computer skills* was highlighted as a deficiency, which echoed many of the sentiments gleaned from the qualitative research, where managers were seen as being somewhat removed from the ICT functions of the business (e.g. relying on secretarial support for basic ICT tasks). Given the increasing digitisation of the auto industry, ICT skills should be seen as necessary investments for future managers and therefore a surprising outcome of the survey. Related to this, *data analytics* was mostly viewed as being lacking or only somewhat available, but this area will need to be further developed if Tier-1 firms are to capture data generated by their plants and utilise this knowledge to improve production processes. The most available future skill identified was *regulatory compliance*. Skills not listed, but which were highlighted by respondents, include: *stamping, transformation management*, and "utilisation of manpower while waiting for a machine to complete a cycle", all of which were noted as currently lacking.

7.2.4 Firms' plans to invest in important management skills and resource availability

In response to the question, "Is your firm planning to invest in the following new management skills identified as important by industry?" individuals surveyed revealed that their firms are most likely to invest in *regulatory compliance* skills and *advanced process monitoring techniques*. This reflects the growing prominence of onerous regulatory requirements of OEMs in developed markets, which in turn pass on these requirements to suppliers further down the value chain. *Green production*, while scoring relatively low on this survey, may form part of the *regulatory compliance* requirements of industry in the future.

FIGURE 15: FIRMS' PLANS TO INVEST IN IMPORTANT MANAGEMENT SKILLS AS IDENTIFIED BY INDUSTRY

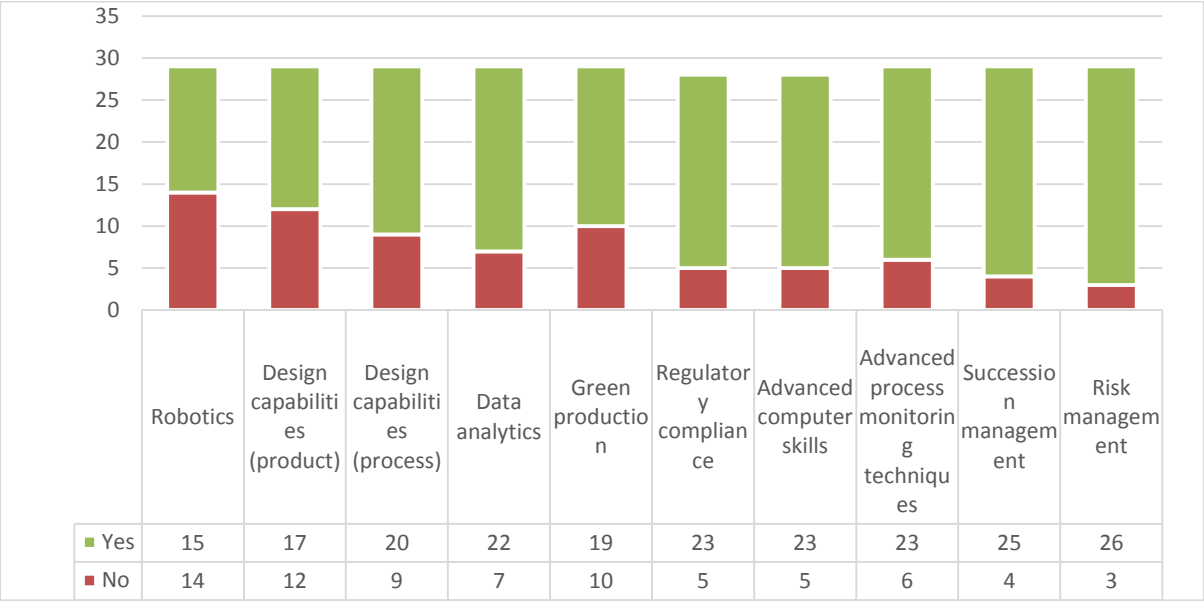


	Robotics	Design capabilities (product)	Design capabilities (process)	Data analytics	Green production	Regulatory compliance	Advanced computer skills	Advanced process monitoring techniques	Succession management	Risk management
Yes	17	14	19	17	15	20	15	20	19	19
No	12	13	10	12	12	8	13	8	8	9

The most neglected investment outcomes were *advanced computer skills*, and *design capabilities (product)*. The lack of investment in ICT stands out, as respondents earlier regarded these skills as being particularly deficient in the current skills profile and an important skill to develop in future. Further investment will therefore be required to fill this knowledge gap, but the source of this funding does not appear available from firms' own budgets. Alternative funding sources, such as development finance institutions, may help to close this gap.

In response to the question: "Do you believe resources are available to adequately develop the new management skills identified as important by industry?", a large selection of respondents (see **Figure 16**) believe that a significant amount of resources has been devoted to *risk management* and *succession management skills*. These are largely soft, non-technical skills, but reflect the concern of an aging management cohort and the risk of retiring "baby-boomer" generation. Once again, robotics features low on the resource allocation scale. This could reflect the high fixed capital costs and the advanced training requirements associated with robotics.

FIGURE 16: RESOURCE AVAILABILITY TO ADEQUATELY DEVELOP IMPORTANT MANAGEMENT SKILLS AS IDENTIFIED BY INDUSTRY



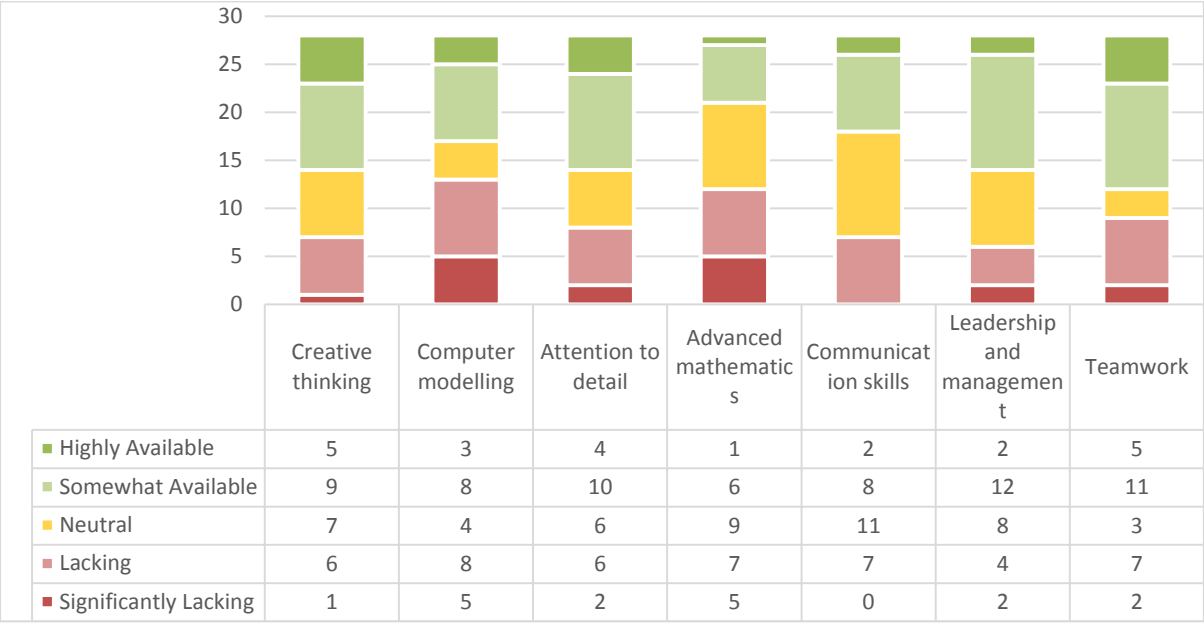
	Robotics	Design capabilities (product)	Design capabilities (process)	Data analytics	Green production	Regulatory compliance	Advanced computer skills	Advanced process monitoring techniques	Succession management	Risk management
Yes	15	17	20	22	19	23	23	23	25	26
No	14	12	9	7	10	5	5	6	4	3

7.3 Professionals / Engineers

7.3.1 Current professional / engineering skills proficiencies

Respondents were asked to rate their firm's current professional/engineering skills proficiencies (see **Figure 17**). The results of this survey question were evenly spread, with few responses in the "highly available" and "significantly lacking" categories. However, *attention to detail*, was seen as somewhat available, and this is reflective of the highly technical responsibilities of professionals in this category. Surprisingly, many respondents did not rank engineers' current *advanced mathematics* capabilities particularly highly, with 9 "neutrals" and 7 indicating that these skills were "lacking".

FIGURE 17: PROFESSIONAL/ENGINEERING TEAM'S CURRENT SKILLS PROFICIENCIES



	Creative thinking	Computer modelling	Attention to detail	Advanced mathematics	Communication skills	Leadership and management	Teamwork
Highly Available	5	3	4	1	2	2	5
Somewhat Available	9	8	10	6	8	12	11
Neutral	7	4	6	9	11	8	3
Lacking	6	8	6	7	7	4	7
Significantly Lacking	1	5	2	5	0	2	2

The related concepts of *leadership and management*, and *teamwork* were also identified as being somewhat available, reflecting the perception of engineers as performing discreet functions within a firm and operating somewhat independently of others. However, *teamwork and management* competencies will need to be further developed to prepare engineers for future management roles. *Communication skills* were met with a lukewarm response, with the majority of those surveyed indicating that this quality was either "neutral" (11) or "lacking" (7).

When prompted to consider other skills not listed above, respondents noted that *logistics*, *maintenance* (particularly of electrical systems) and *business etiquette*, were seen to be lacking amongst engineers / professionals, while *big data management* was "somewhat available" in this category.

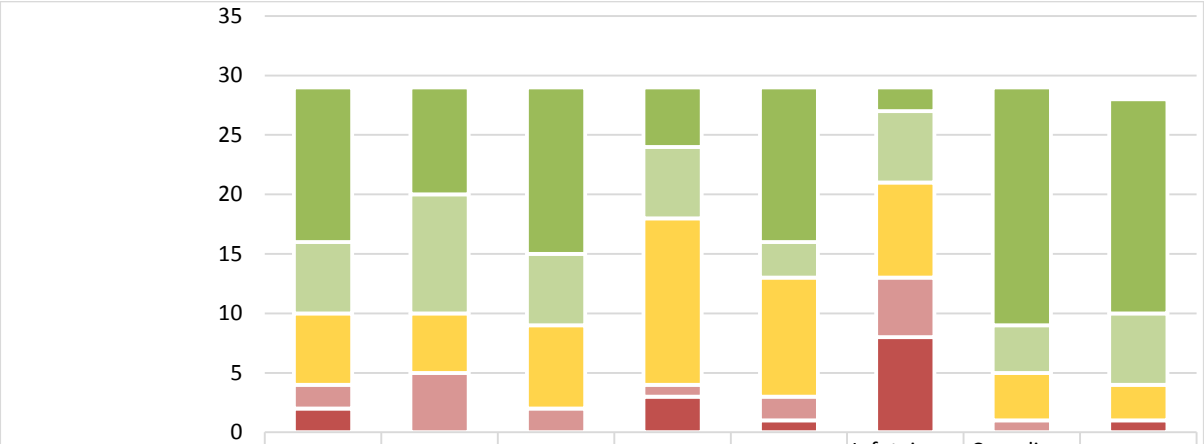
7.3.2 Redundant professional / engineering skills

Skills identified as no longer being relevant, or likely to become redundant, for professionals/engineers in the period 2020 - 2035 included *process management*; *teamwork*, *leadership and management*; and *component building*. The disregard of team-related and leadership functions may reflect a perception of "soft" skills becoming less important for professionals/engineers as their functions become increasingly technically focused. One reading of this result could be that as workforces diminish in size, the people-management aspect of production may become less of a concern for engineers and other professionals.

7.3.3 Future professional / engineering skills

As shown in **Figure 18**, respondents appeared to have acknowledged that South African component manufacturers' continued participation in global automotive value chains was dependent on ongoing compliance with *international quality standards* and the *process control techniques* expected by international OEMs. Other "highly relevant" future skills identified for the period 2020 – 2035 were *data analytics,* indicating an acceptance of the importance of Big Data and digitisation of automotive production in the coming years. In this regard, greater training and development will be required on STEM and other quantitative disciplines.

FIGURE 18: RELEVANCE OF FUTURE PROFESSIONAL/ENGINEERING SKILLS - 2020-2035



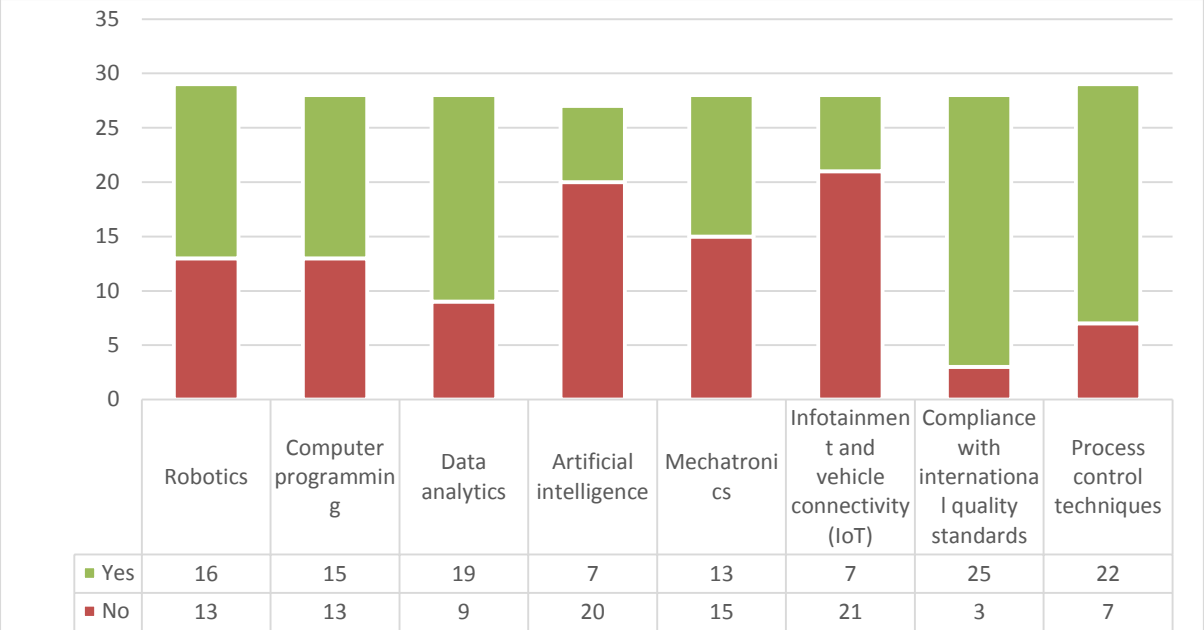
	Robotics and automation	Computer programming	Data analytics	Artificial intelligence	Mechatronics	Infotainment and vehicle connectivity (IoT)	Compliance with international quality standards	Process control techniques
Highly Relevant	13	9	14	5	13	2	20	18
Somewhat Available	6	10	6	6	3	6	4	6
Neutral	6	5	7	14	10	8	4	3
Somewhat	2	5	2	1	2	5	1	0
Irrelevant	2	0	0	3	1	8	0	1

The least relevant skills for the future included *infotainment and vehicle connectivity*, which received 8 "irrelevant" and 8 "neutral" responses. This may reflect a lack of appreciation for how this new technology will affect the skills profile of engineers, or how it might differ from existing requirements. While not dismissed out of hand, respondents reflected a mostly neutral attitude towards *artificial intelligence*, which echoes the sentiments of workshop participants who saw this trend as only emerging over the longer term, and with uncertain consequences for suppliers in SA.

7.3.4 Firms' plans to invest in important professional / engineering skills and resource availability

As shown in **Figure 19**, respondents were consistent in their support for developing *compliance with international quality standards,* with 25 out of 29 respondents indicating their plans to invest in this skill. As identified in the previous section, process control techniques have been prioritized as a key skill for the future, and this was reflected in the allocation of resources, with 22 respondents indicating that they had planned to invest in this skill. *Data analytics* had also received some attention in terms of planned investment (19 "yes" answers), again echoing the prioritisation of this skill in the previous section on future relevant skills. Similarly, the absence of resources being allocated to *artificial intelligence* and *infotainment and vehicle connectivity* could be explained by the low value-addition position of domestic Tier-1 suppliers in global automotive value chains. The intensive R&D investment requirements for these activities is typically beyond the capability of local suppliers, which tend to focus on low-technology activities like plastic injection moulding or metal fabrication.

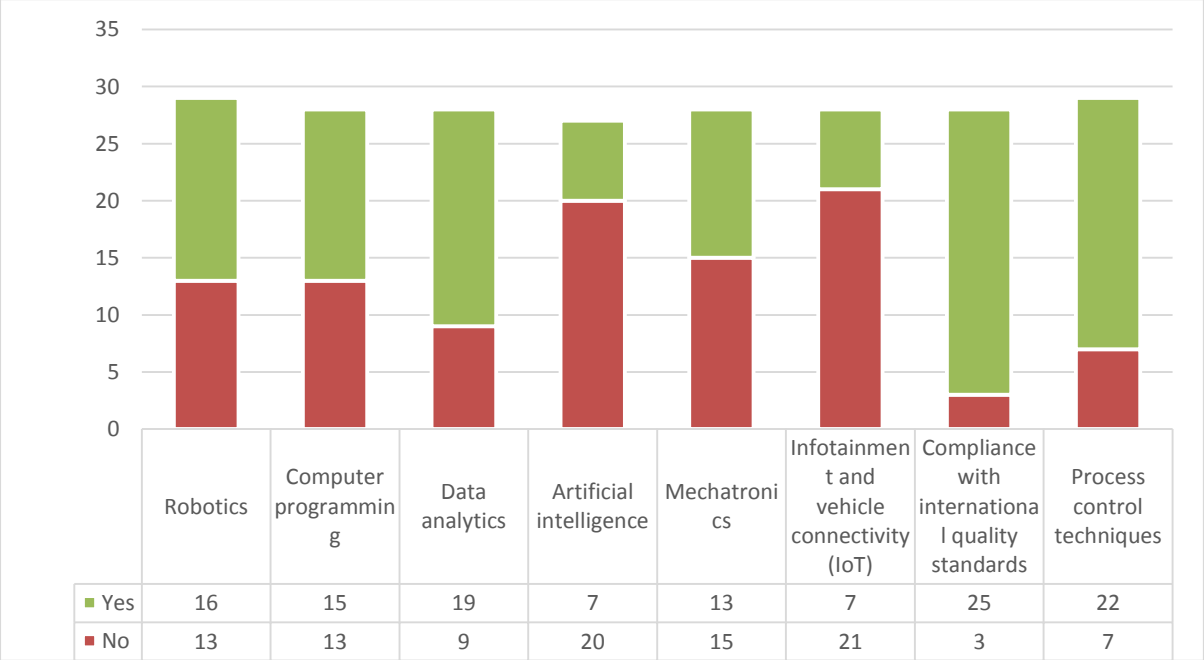
FIGURE 19: FIRMS' PLANS TO INVEST IN IMPORTANT PROFESSIONAL/ENGINEERING SKILLS AS IDENTIFIED BY INDUSTRY



	Robotics	Computer programming	Data analytics	Artificial intelligence	Mechatronics	Infotainment and vehicle connectivity (IoT)	Compliance with international quality standards	Process control techniques
Yes	16	15	19	7	13	7	25	22
No	13	13	9	20	15	21	3	7

Firms plan to invest in *compliance with international quality standards* as well as process control techniques is supported by a high availability of resources in these areas, as shown by Error! Not a valid bookmark self-reference.. There is a discrepancy between the high level of resources available for *computer programming*, with 24 out of 29 respondents indicating resource availability, but with only 15 respondents planning to invest in this skill. *Artificial intelligence* and *infotainment and vehicle connectivity* lacked resource availability, which correlated with the absence of planned investments, as indicated earlier.

FIGURE 20: RESOURCE AVAILABILITY TO ADEQUATELY DEVELOP IMPORTANT PROFESSIONAL/ENGINEERING SKILLS AS IDENTIFIED BY INDUSTRY



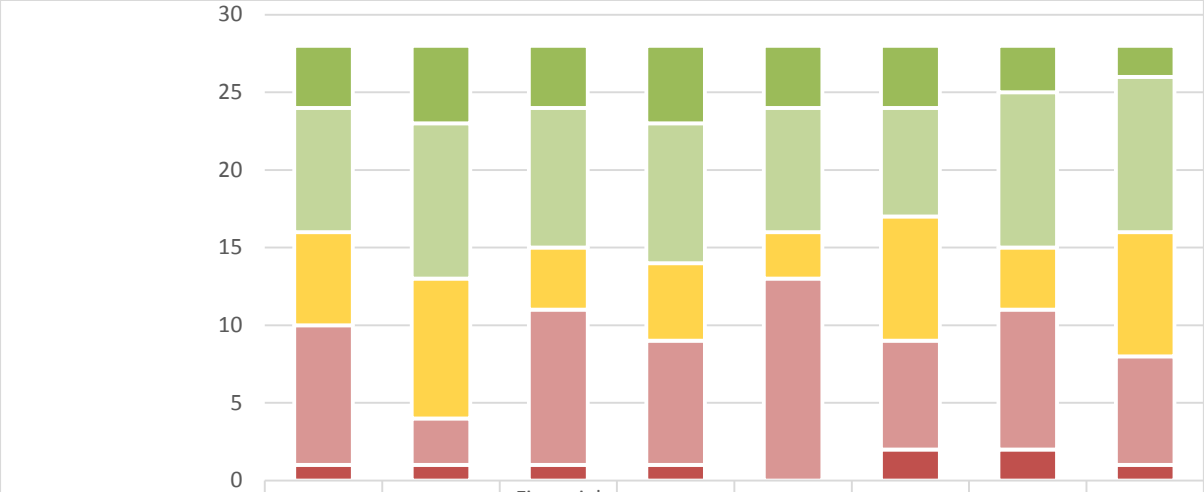
	Robotics	Computer programming	Data analytics	Artificial intelligence	Mechatronics	Infotainment and vehicle connectivity (IoT)	Compliance with international quality standards	Process control techniques
Yes	16	15	19	7	13	7	25	22
No	13	13	9	20	15	21	3	7

7.4 Supervisors

7.4.1 Current supervisor skills proficiency

The current list of supervisor skills proficiencies identified by industry participants is shown in **Figure 21**. *Health, safety and environment* scores the highest, with 5 survey respondents classifying the skill as "highly available", and 10 considering it as only "somewhat available". The ability of supervisors to maintain a safe and clean environment for workers is essential for the successful functioning of the plant. Curiously, however, *health safety and environment* also received the greatest number of "neutral" responses (9) out of the various skills showcased.

FIGURE 21: SUPERVISOR'S CURRENT SKILLS PROFICIENCIES



	IR & Code of Conduct	Health, Safety & Environment	Financial Basics (Individual & business)	Communication & Team-work	Time Management	Leadership	Lean manufacturing	Manufacturing Techniques
Highly Available	4	5	4	5	4	4	3	2
Somewhat Available	8	10	9	9	8	7	10	10
Neutral	6	9	4	5	3	8	4	8
Lacking	9	3	10	8	13	7	9	7
Significantly Lacking	1	1	1	1	0	2	2	1

As discussed in the qualitative research sections, supervisors are often considered to be the "heart and soul" of a manufacturing firm, performing a critical intermediary function between managers and technical experts on the one hand, and artisans and production workers on the other hand. This view is supported by supervisors' high scoring on the *communication and team-work* metric, with 5 respondents indicating this skill as "highly available" and 9 reporting the skill as "somewhat available." The ability to communicate instructions to production workers and artisans while feeding information back up to management requires a unique set of communication abilities.

Results suggest that more work needs to be done on improving *time management* capabilities of supervisors, with 13 respondents reporting this skill as "lacking" in this category. This is a striking result given the need for supervisors to oversee multiple, complex tasks of various groups. *Time management* should be actively developed. The *leadership* score was lower than expected, with 7 respondents for each of the "somewhat available" and "lacking" measures.

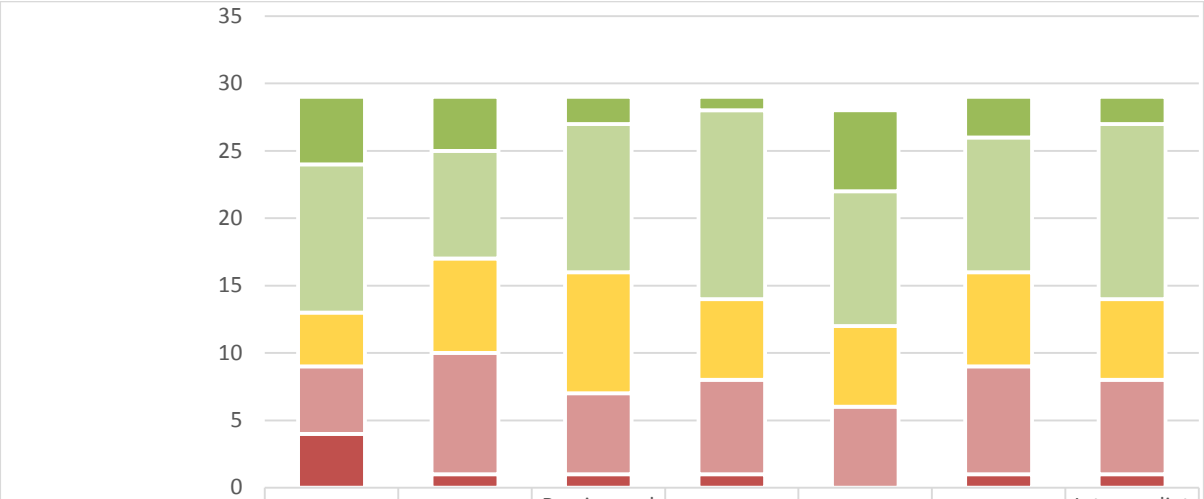
7.4.2 Redundant supervisor skills

When asked to report on redundant supervisor skills, respondents predicted that *IR and code of conduct* will become less relevant as robotics and automation begin to replace human workers. Interestingly, 9 respondents observed that *IR and code of conduct* is lacking among supervisors (compared to 8 who saw it as "somewhat available" and 4 who viewed it as "highly available").

7.4.3 Future supervisor skills

The supervisor skills developed in consultation with stakeholders during the qualitative research process were presented to industry participants in the electronic survey, the results of which are presented in **Figure 22**.

FIGURE 22: RELEVANCE OF FUTURE SUPERVISOR SKILLS - 2020-2035



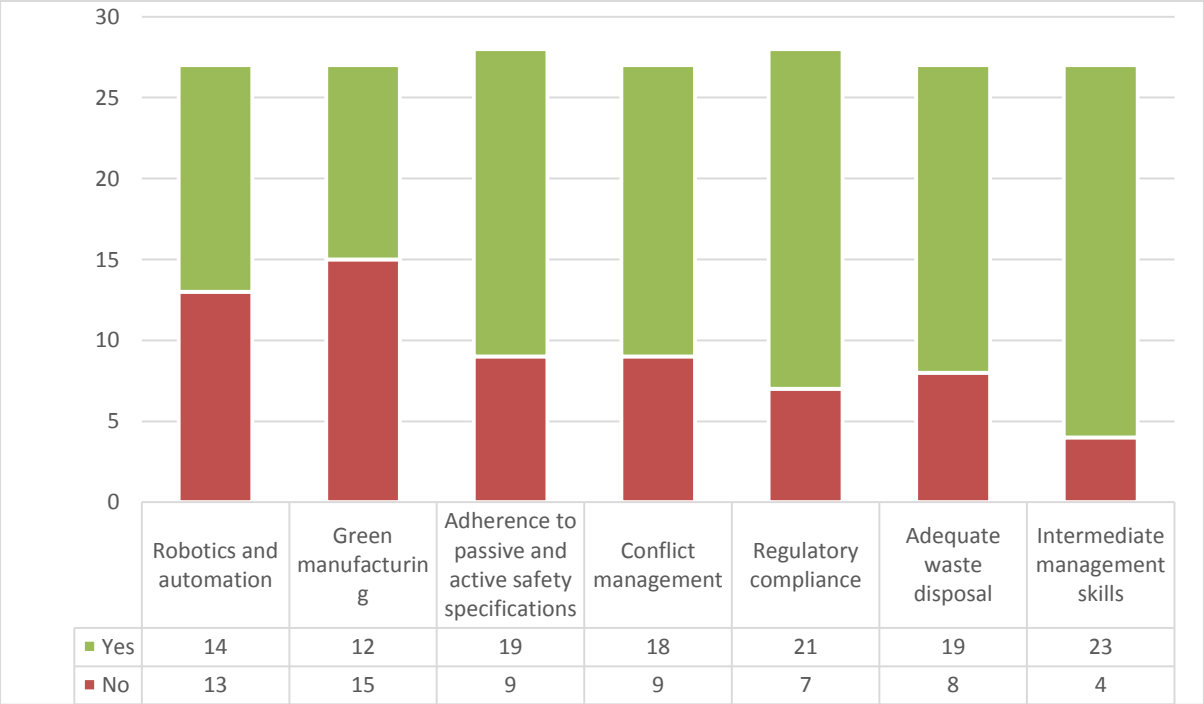
	Robotics and automation	Green manufacturing	Passive and active safety specifications	Conflict management	Regulatory compliance	Adequate waste disposal	Intermediate management skills
Highly Available	5	4	2	1	6	3	2
Somewhat Available	11	8	11	14	10	10	13
Neutral	4	7	9	6	6	7	6
Lacking	5	9	6	7	6	8	7
Significantly Lacking	4	1	1	1	0	1	1

Regulatory compliance was seen as the most important skill for the future, with 6 industry participants selecting this skill as "highly available" and 10 selecting it as only "somewhat available". This reflects the growing complexity of regulatory standards which supervisors will have to monitor and enforce with greater discipline. *Conflict management* is also seen as a skill that is "somewhat available" (14 mentions) as a future skill. *Robotics and automation* was given a lukewarm response, with 11 saying it was merely "somewhat available" and 4 indicating this skill is "significantly lacking".

7.4.4 Firms' plans to invest in important supervisor skills and resource availability

The most significant target of investment in supervisor skills, as illustrated in **Figure 23**, is *intermediate management skills*, with 23 respondents indicating a positive score on this measure. *Regulatory compliance* also scored highly, with 21 positive indications of planned investments in this skill category. *Green manufacturing* has the lowest recorded investment level, with 15 respondents saying that no planned investments were being considered for this capability in supervisors. This is potentially a strategic mistake by firms, as a lack of green manufacturing compliance could shut them out of supplier networks in future.

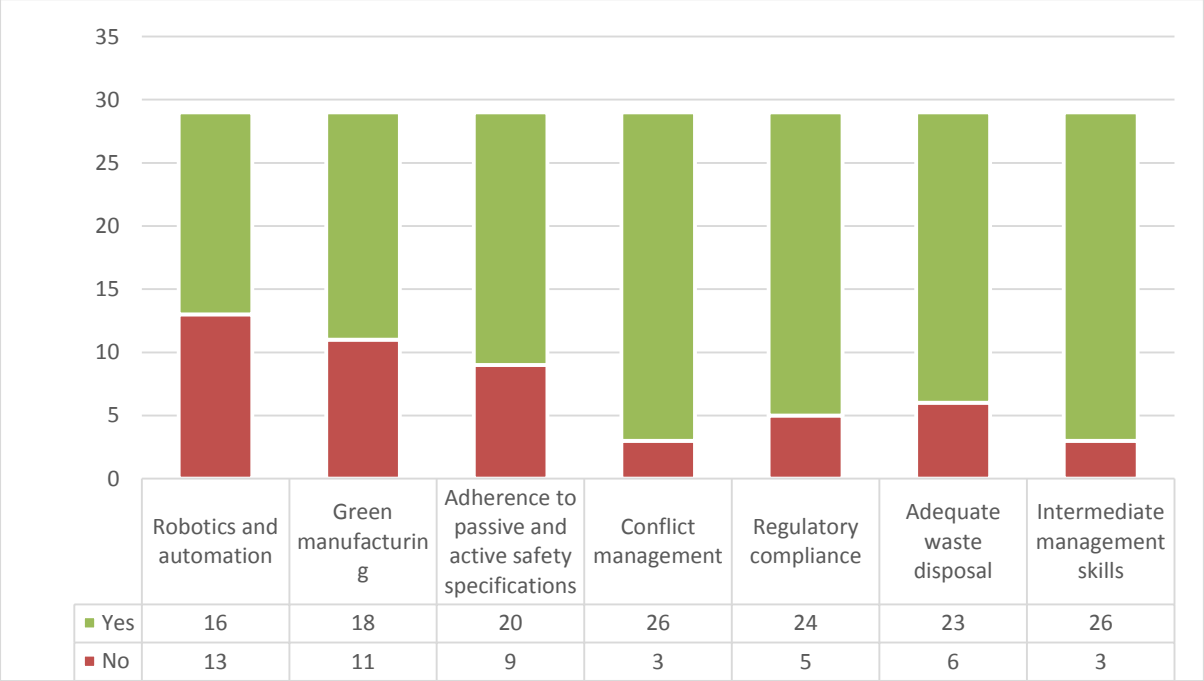
FIGURE 23: FIRMS' PLANS TO INVEST IN IMPORTANT SUPERVISOR SKILLS AS IDENTIFIED BY INDUSTRY



	Robotics and automation	Green manufacturing	Adherence to passive and active safety specifications	Conflict management	Regulatory compliance	Adequate waste disposal	Intermediate management skills
Yes	14	12	19	18	21	19	23
No	13	15	9	9	7	8	4

In terms of the availability of resources, the two categories of *conflict management* and *intermediate management skills* were the most likely to benefit from skills investment, with 26 positive responses each (see **Figure 24**). *Intermediate management* skills were also showcased as a target for planned investment, so the high availability of funds is an encouraging correlation. The same can be said for *regulatory compliance* (24 positives), which will be necessary for supervisors looking to adhere to new manufacturing standards emerging out of developed markets. *Green manufacturing* suffers from a low level of available funding, which correlates with the smaller number of planned investments discussed earlier.

FIGURE 24: RESOURCE AVAILABILITY TO ADEQUATELY DEVELOP IMPORTANT SUPERVISOR SKILLS AS IDENTIFIED BY INDUSTRY



	Robotics and automation	Green manufacturing	Adherence to passive and active safety specifications	Conflict management	Regulatory compliance	Adequate waste disposal	Intermediate management skills
Yes	16	18	20	26	24	23	26
No	13	11	9	3	5	6	3

7.5 Artisans

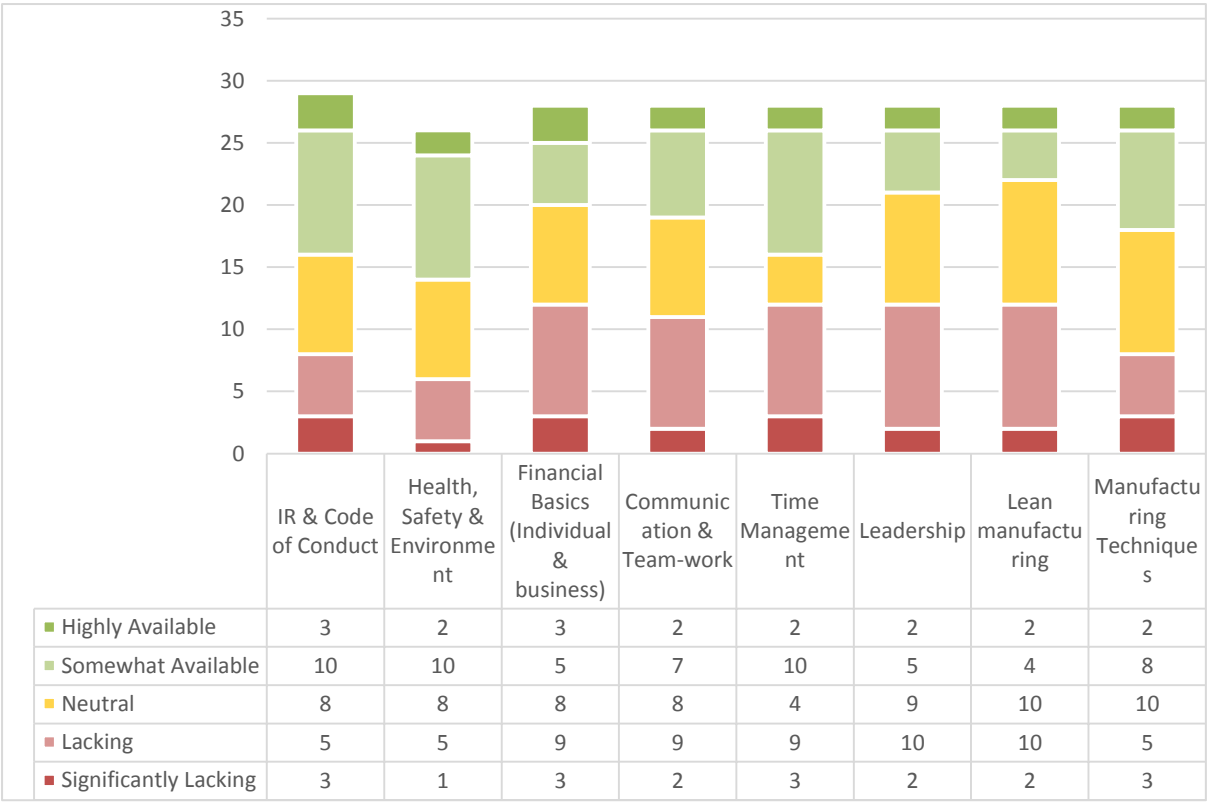
7.5.1 Current artisan skills proficiencies

The current skills proficiencies of artisans identified by industry are listed in **Figure 25**. Respondents did not have strong opinions on these skills, with few responses on the high and low ends of the evaluation spectrum. For example, there was an average scoring of 2.3 responses for both "significantly lacking" skills and "highly available" skills, compared with an average of 8.1 for "neutral" responses.

That being the case, *IR & code of conduct*, *health safety & environment*, and *time management* each received 10 responses under the "somewhat available" evaluation category, suggesting that these skills are core to the functioning of a successful artisan, but not as readily available as industry requires (it should be noted that *time management* also received 9 "lacking" responses, indicating that this skill is weaker than its "somewhat available" score suggests).

This lack of adherence to basic time management principles is a consistent theme running throughout the technical job categories and should be a concern for Tier 1 manufacturers. In lieu of formal training around *time management*, managers and supervisors should take the lead in enforcing stricter adherence to timely delivery among technical staff.

FIGURE 25: ARTISAN CURRENT SKILLS PROFICIENCIES



	IR & Code of Conduct	Health, Safety & Environment	Financial Basics (Individual & business)	Communication & Team-work	Time Management	Leadership	Lean manufacturing	Manufacturing Techniques
Highly Available	3	2	3	2	2	2	2	2
Somewhat Available	10	10	5	7	10	5	4	8
Neutral	8	8	8	8	4	9	10	10
Lacking	5	5	9	9	9	10	10	5
Significantly Lacking	3	1	3	2	3	2	2	3

The worst performing skills for artisans were *leadership* and *lean manufacturing*, each receiving 10 responses on the "lacking" Likert scale. While the low scoring on leadership is perhaps understandable given the role that artisans play (not everyone is a leader), for artisans to lack *lean manufacturing* knowledge is a serious deficiency given their position at the coalface of the

production. In this regard, artisans should be specifically targeted for training on 5S, Continuous Flow, JIT, and Kaizen techniques, to name a few lean manufacturing interventions. Given SA's low levels of value addition, it is essential that lean process improvement techniques are properly applied to ensure maximum productivity and efficiency for the functions we do perform.

Artisan skills that were not listed, but which were singled out as "lacking", included certain technical skills, like robotics, Programmable Logic Controllers (PLCs), and Modbus (an open-use serial communication protocol for PLCs).

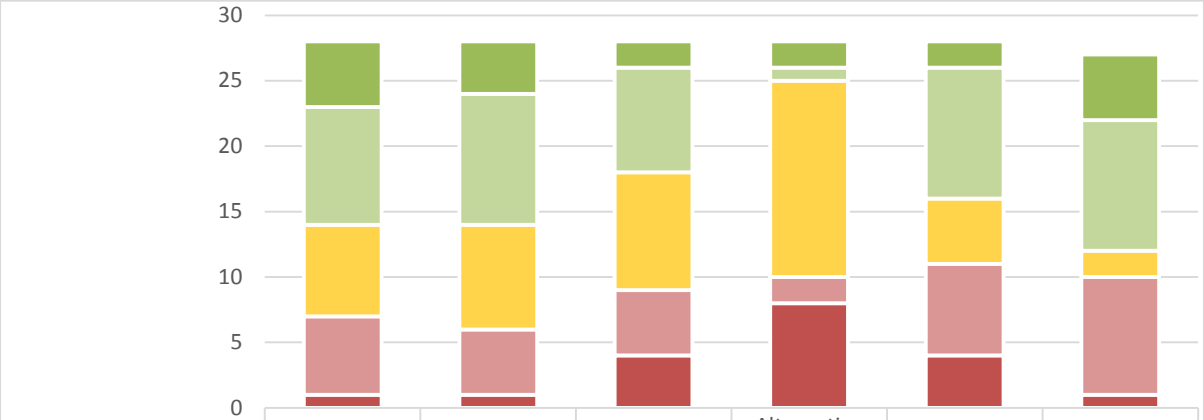
7.5.2 Redundant skills

None of the artisan skills that were presented in the survey were considered by industry participants to be at risk of becoming redundant in 2020 – 2035.

7.5.3 Future skills

The relevance of future artisan skills for the period 2020 – 2035 is shown in **Figure 26**. Knowledge of *new materials* was considered the most important skill, with 5 indications of "highly available" and 9 instances of "somewhat available". This reflects the growing importance of durable, lightweight materials such as composites and alloys in component manufacturing, as identified in the literature review. As suggested earlier, the replacement of steel components with hardwearing, lightweight plastics or other non-steel substances could also disrupt metal fabrication and metal pressing firms that characterise the SA value chain. Industry participants recognise the need for skilled artisans who are capable of implementing advanced material designs and producing quality materials for the future.

FIGURE 26: RELEVANCE OF FUTURE ARTISAN SKILLS - 2020-2035



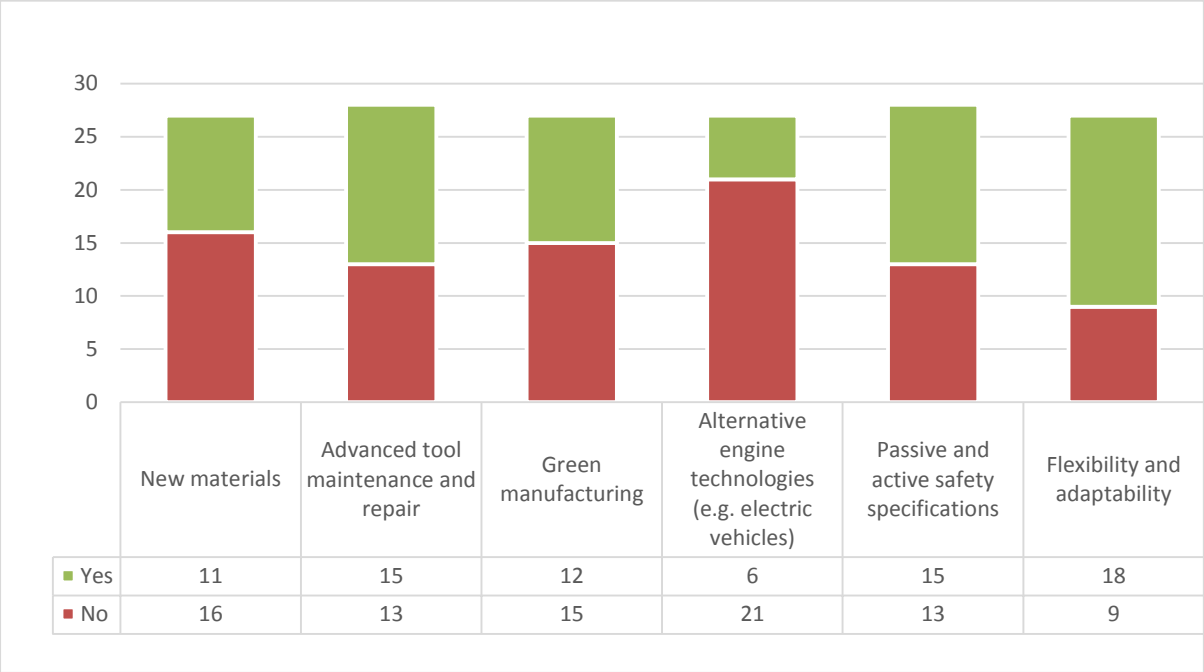
	New materials	Advanced tool maintenance and repair	Green manufacturing	Alternative engine technologies (e.g. electric vehicles)	Passive and active safety specifications	Flexibility and adaptability
Highly Available	5	4	2	2	2	5
Somewhat Available	9	10	8	1	10	10
Neutral	7	8	9	15	5	2
Lacking	6	5	5	2	7	9
Significantly Lacking	1	1	4	8	4	1

Knowledge of *alternative engine technologies* was considered "significantly lacking" as a future artisan skill by 8 respondents, and a large number of "neutrals" (15) also received. This could reflect the lack of EEV production in developing markets such as South Africa's and the novelty of this technology. However, artisans will need to adapt as EEV technology begins to enter the mainstream in the period under consideration. One artisan skill not mentioned in the above list was *budgeting*, which a single respondent viewed as "lacking".

7.5.4 Firms' plans to invest in important artisan skills and resource availability

Firms' plans to invest in artisan skills for the future and the current resource availability to develop these skills are showcased in **Figure 27** and **Figure 28** respectively. As can be seen in both visualisations, the current investment in *alternative engine technologies* is low, with 21 respondents indicating no plans to invest in the artisan skills required for this new technology, and 18 citing a lack of available funds to support such investments. However, respondents were positive on current levels of investment and resource availability for *flexibility and adaptability,* which was identified as an important quality for artisans to develop, although the current perception of this skill capability was mixed, as it was in the previous sub-section.

FIGURE 27: FIRMS' PLANS TO INVEST IN IMPORTANT ARTISAN SKILLS AS IDENTIFIED BY INDUSTRY

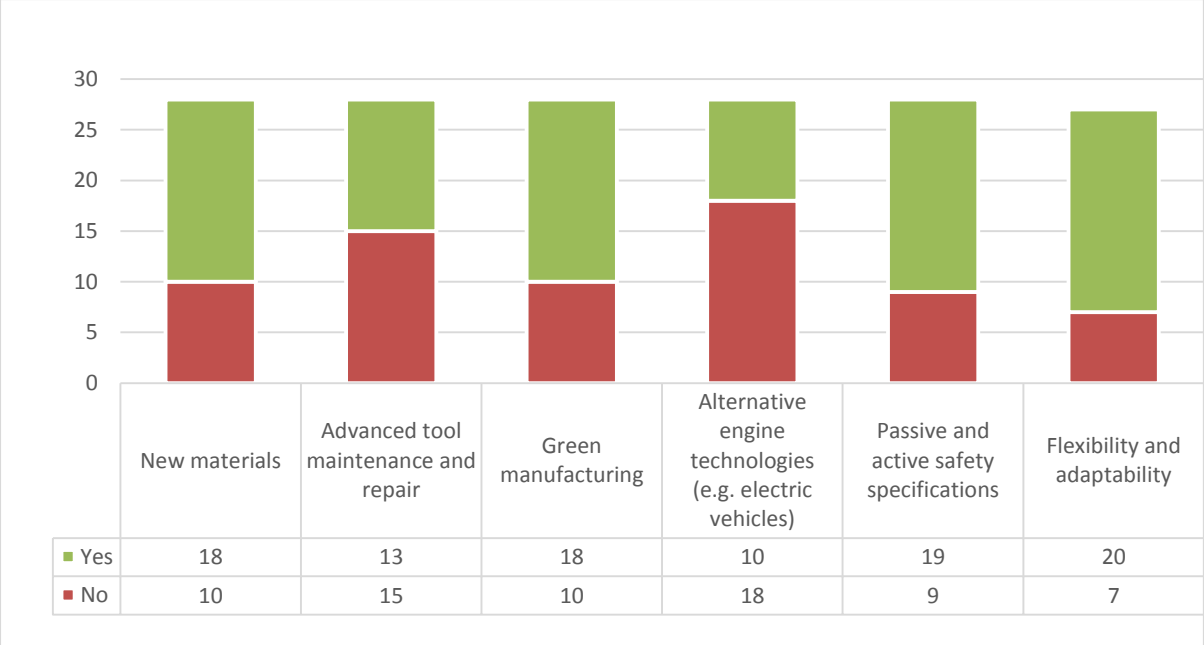


	New materials	Advanced tool maintenance and repair	Green manufacturing	Alternative engine technologies (e.g. electric vehicles)	Passive and active safety specifications	Flexibility and adaptability
Yes	11	15	12	6	15	18
No	16	13	15	21	13	9

There is a discrepancy between the low level of current investment in *green manufacturing*, and a relatively favourable view of resource availability for this skill. This represents a potential opportunity to fill the gap by redirecting resources towards training on new green process methodologies, such as waste reduction, degradable materials and "circular economy" initiatives.

Advanced tool maintenance and repair was identified as a new skill in the qualitative research process, and current levels of investment and available resources appear to be moderate, with respondents roughly split on both measures (13 no / 15 yes; and 15 no / 13 yes). Given the high perception of resource availability for *passive and active safety specifications*, it appears that current levels of investment are too low, and that there is room to better utilize these available resources.

FIGURE 28: RESOURCE AVAILABILITY TO ADEQUATELY DEVELOP IMPORTANT ARTISAN SKILLS AS IDENTIFIED BY INDUSTRY



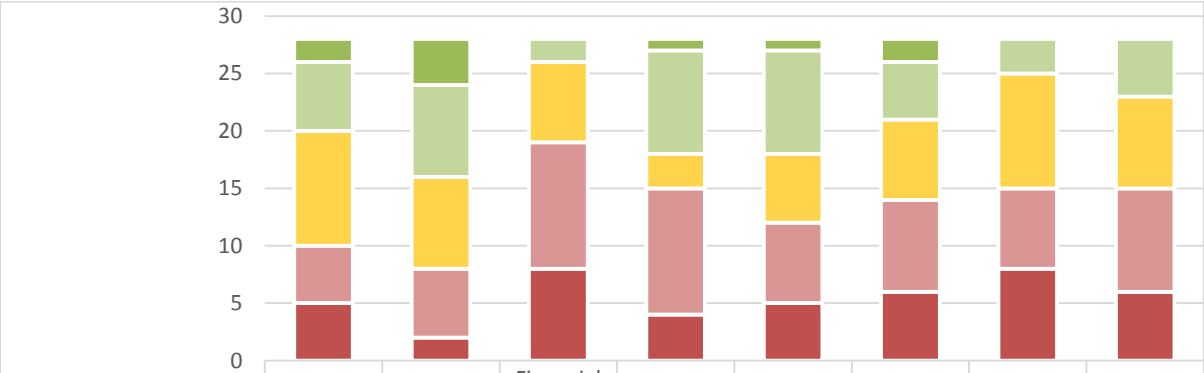
	New materials	Advanced tool maintenance and repair	Green manufacturing	Alternative engine technologies (e.g. electric vehicles)	Passive and active safety specifications	Flexibility and adaptability
Yes	18	13	18	10	19	20
No	10	15	10	18	9	7

7.6 Production workers / operators

7.6.1 Current production worker / operator skill proficiencies

The primary existing operator / production worker skills are presented in **Figure 29**. *Health, safety and environment* scores the highest Likert rating in this job category, with 8 "somewhat available" and 4 "highly available" ratings. This reflects a key concern that production workers ensure a clean and safe operating environment on the factory floor, while reducing waste and/or scrap.

FIGURE 29: PRODUCTION WORKER / OPERATOR CURRENT SKILLS PROFICIENCIES



	IR & Code of Conduct	Health, Safety & Environment	Financial Basics (Individual & business)	Communication & Team-work	Time Management	Leadership	Lean manufacturing	Manufacturing Techniques
Highly Available	2	4	0	1	1	2	0	0
Somewhat Available	6	8	2	9	9	5	3	5
Neutral	10	8	7	3	6	7	10	8
Lacking	5	6	11	11	7	8	7	9
Significantly Lacking	5	2	8	4	5	6	8	6

Financial basics (individual and business) and *lean manufacturing* score poorly, with 8 "significantly lacking" rankings each, and 11 and 7 "lacking" rankings respectively. Given the low levels of financial literacy among entry-level workers in South Africa the poor *financial basics* feedback is perhaps to be expected. However, the absence of *lean manufacturing* knowledge (note the 10 "neutral" responses) demonstrates that lean thinking has not permeated the operational tier of the workforce – no doubt to the detriment of the Tier 1 manufacturing operations. Communication and team work received a decidedly mixed Likert ranking, with respondents divided on whether this skill set was "somewhat available" (9) or "lacking" (11). Skills not listed in the Likert ratings above, but identified by respondents, include *following work instructions* (ranked as "available") and *work readiness* ("lacking").

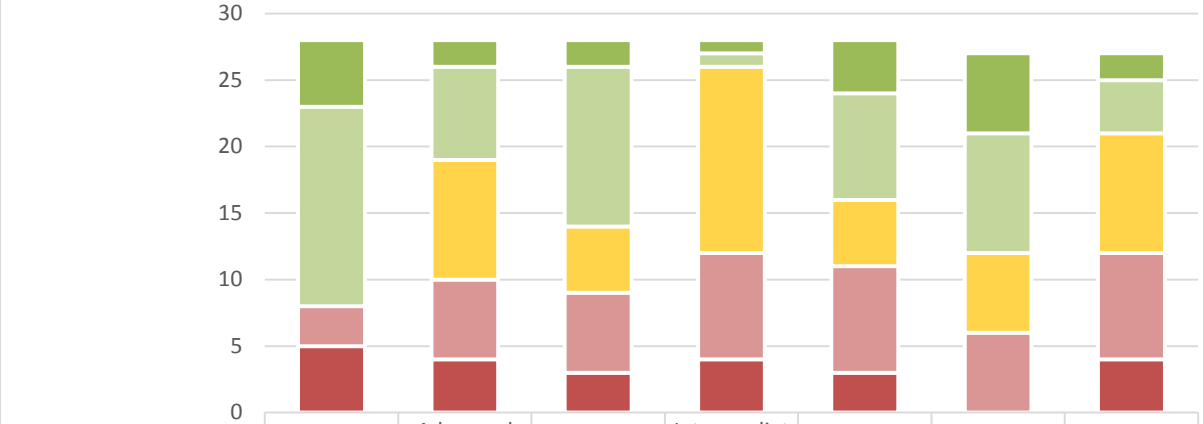
7.6.2 Redundant skills

"Manual intervention" was included as a redundant skill, although it should be noted that this skill was not originally included in the list of available skills that was presented to respondents. Presumably, this refers to the growing incidence of automation of the physical tasks performed by operators.

7.6.3 Future production worker / operator skills

The relevance of future production worker / operator skills, as identified by industry, is presented in **Figure 30**. In terms of future skills, *flexibility and adaptability* ranks highly on the Likert scale, and production workers / operators will need to cultivate this skill in order to respond to the potentially negative disruption effects of new technology and the rapid changes that are likely to come. *Self-management* received a high volume of "somewhat available" (15) and "highly available" (5) rankings, a sign of how production workers will need to act with greater autonomy and less direct instruction from supervisors or technicians / engineers in the years to come. One interpretation of this assessment is that as automation and robotics replaces certain functions of operators / production workers there will be fewer workers who will be required to be more skilled and versatile than is expected today.

FIGURE 30: RELEVANCE OF FUTURE PRODUCTION WORKER/OPERATOR SKILLS - 2020-2035



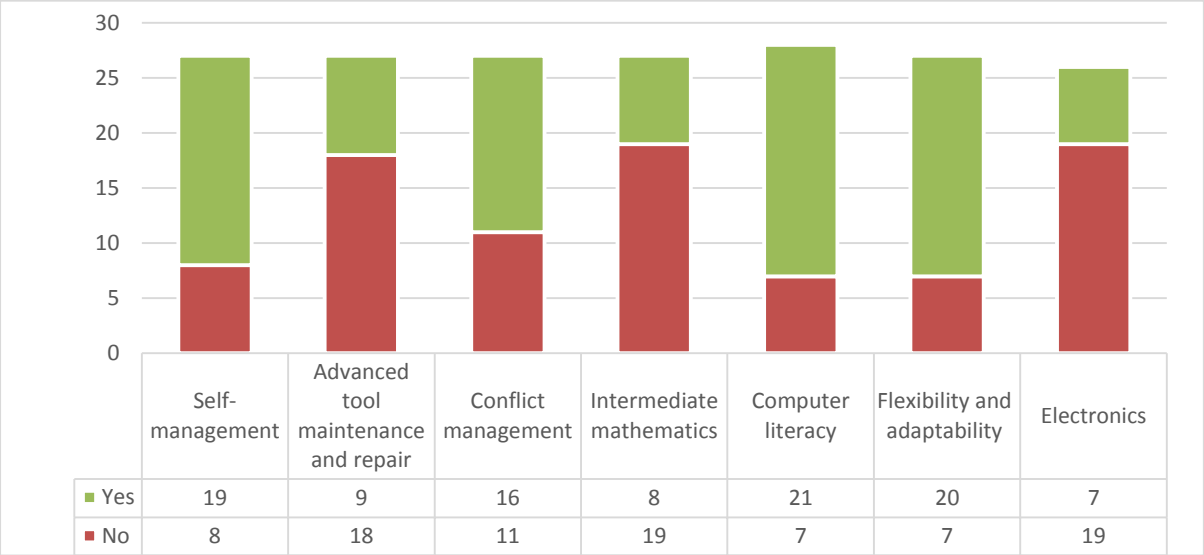
	Self-management	Advanced tool maintenance and repair	Conflict management	Intermediate mathematics	Computer literacy	Flexibility and adaptability	Electronics
Highly Available	5	2	2	1	4	6	2
Somewhat Available	15	7	12	1	8	9	4
Neutral	0	9	5	14	5	6	9
Lacking	3	6	6	8	8	6	8
Significantly Lacking	5	4	3	4	3	0	4

Intermediate mathematics received an unusually high number of "neutral" responses (14), together with 8 "lacking" ratings, indicating that respondents viewed this skill as lacking relevance for this job category.

7.6.4 Firms' plans to invest in important production worker / operator skills and resource availability

Firms' plans to invest in important production worker / operator skills are illustrated in **Figure 31**, while current resource availability to develop these skills is shown in **Figure 32**. Encouragingly, 21 respondents recognised the need to improve the *computer literacy* levels of production workers / operators, with 23 respondents saying that resources are available to meet this need. Consistent with the earlier feedback on the future skills requirements for this employment category, is the added investment in *flexibility and adaptability*, which suggests that industry is preparing adequately for this skill requirement (20 and 22 "yes" responses on each respective scale).

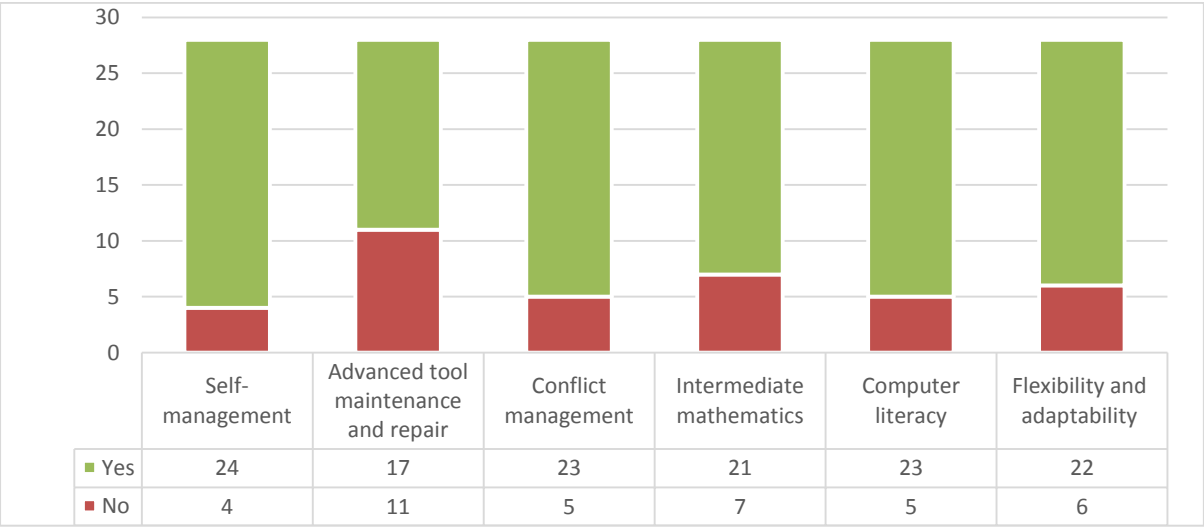
FIGURE 31: FIRMS PLAN TO INVEST IN IMPORTANT PRODUCTION WORKER/OPERATOR SKILLS AS IDENTIFIED BY INDUSTRY



	Self-management	Advanced tool maintenance and repair	Conflict management	Intermediate mathematics	Computer literacy	Flexibility and adaptability	Electronics
Yes	19	9	16	8	21	20	7
No	8	18	11	19	7	7	19

Consistent with the low prioritization in the future skills sub-section, above, *intermediate mathematics* received little attention as well as direct investment (19 "no" responses). However, respondents did note a high level of availability of resources to support this skill development (21 "yes" answers). This suggests that more could be done to develop this competency, even if industry views this as less relevant for the day-to-functions of an operator. Certainly, if operators are to experience career growth e.g. to technician or supervisor level, they will need to improve their quantitative reasoning ability.

FIGURE 32: RESOURCE AVAILABILITY TO ADEQUATELY DEVELOP IMPORTANT PRODUCTION WORKER / OPERATOR SKILLS AS IDENTIFIED BY INDUSTRY



	Self-management	Advanced tool maintenance and repair	Conflict management	Intermediate mathematics	Computer literacy	Flexibility and adaptability
Yes	24	17	23	21	23	22
No	4	11	5	7	5	6

Advanced tool maintenance has been neglected when it comes to existing investments, as well as available resources. This is a potential threat to the industry. If this capability is left underdeveloped it could cripple production, or at the very least, lead to a loss of efficiency due to an overreliance on overseas or remote tool maintenance and repair expertise. At the operator level this is an important consideration and could frustrate the development of workers in this category.

7.7 Summary of quantitative research findings

TABLE 12: SUMMARY OF QUANTITATIVE RESEARCH FINDINGS

		Management	Engineer/ Professional	Supervisor	Artisan	Production worker / operator
Current skills	*Available*	Financial management; operations/production	Teamwork	Health, safety & environment; Communication and team-work	IR & code of conduct; Health, safety & environ.	Health, safety & environ; Communication & team-work
	Neutral	Leadership and teambuilding	Attention to detail; Leadership & mgmt	Leadership	Time mgmt	Mfg techniques; Lean mfg
	Low availability	Lean manufacturing; Global thinking & strategic insight	Adv mathematics; Communication	Time management;	Financial basics; Leadership; Lean mfg	Financial basics
Redundant skills		Quality management; conflict mgt & negotiation	Process mgmt; component building	IR and code of conduct	n/a	Manual intervention
Future skills	*High availability*	Regulatory compliance	Intl quality standards; Process control; Data analytics	Regulatory compliance	New materials;	Self-management; Flexibility & adaptability
	Medium availability	Data analytics	Artificial intelligence	Conflict management	Green mfg;	Electronics; Adv tool maintenance
	Low availability	Robotics; Design capabilities (product & process)	Infotainment	Robotics and automation; Green mfg	Alt. engine technology; Safety	Intermediate maths
Plans to invest	*High priority*	Regulatory compliance; Adv process monitoring	Intl quality standards; Process control	Intermediate mgmt skills; Regulatory compliance	Flexibility & adaptability	Flexibility & adaptability
	Medium priority	Succession mgmt; Risk mgmt	Data analytics	Conflict mgmt.; Safety	Green mfg; Safety	Conflict mgmt; Computer literacy
	Low priority	Green production; Adv computer skills	Infotainment; Artificial intelligence	Green mfg	Alt. engine technology;	Intermediate maths; Adv. tool maintenance
Resource availability	*High availability*	Risk mgmt.; Succession mgmt; Regulatory compliance; Adv computer skills	Computer programming;	Conflict mgmt.; Intermediate mgmt. skills; Regulatory compliance	Flexibility & adaptability	Conflict mgmt; Flexibility & adaptability
	Medium availability	Green production	Mechatronics	Safety	Adv tool maintenance	Intermediate maths
	Low availability	Robotics	Artificial intelligence; Infotainment	Green mfg	Green mfg; Safety	Adv. tool maintenance

7.8 Recommendations to guide skills development and labour directives pertaining to Tier 1 automotive manufacturers

As highlighted in the literature review, the two forces of digitisation and innovation will continue to disrupt global automotive value chains, with the period 2020 – 2030 likely to see accelerated changes in these two areas.

Several key themes emerge out of the quantitative feedback for Tier-1 auto suppliers. The first is the need for global thinking and strategic insight, particularly in relation to upcoming regulatory changes in the motor industry. Compliance can mean the difference between participating in global value chains or being excluded from them, so familiarity with new legislation and regulatory regimes in developed economies will be essential for managers of local component manufacturers. Most of this compliance is driven by environmental considerations, such as minimising or eliminating CO_2 emissions, saving energy, the sustainable use of materials, and waste/scrap reduction. Compliance also drives innovation (EEVs being the most notable example), so an appreciation for how OEMs pass regulatory requirements from their home jurisdictions (e.g. US, EU, Japan) onto their global suppliers should be a key concern.

The second theme is the growing need for advanced technical capabilities, specifically ICT and mathematical reasoning skills. Whether for analysing Big Data sets to improve production efficiencies (managers; engineers), programming of robotic machinery (supervisors; artisans), or performing basic arithmetic tasks (production workers), these skills are likely to become increasingly relevant as process and product technologies evolve (e.g. infotainment, alternative engine technologies, robotics and AI).

7.8.1 Determining the skills development resources that will be required to skill people sufficiently to fulfil future occupations

If South African Tier-1 suppliers are to continue to participate meaningfully in global automotive value chains a few skills interventions will be necessary. Given the growing role of regulatory compliance, South African skills development authorities will need to invest sufficient resources into training and development programmes that emphasise governance considerations within GVCs. While not all personnel will require direct training, it will be critical for senior personnel in Tier-1 firms to be exposed to compliance training through e.g. global study tours, and short courses or seminars with local/foreign industrial policy experts.

From a production perspective, significant resources will be required for investment into Lean Manufacturing and World Class Manufacturing programmes. These programmes may require training of key personnel on reorganisation of workspaces and may redefine existing job categories. Ongoing monitoring and evaluation of these initiatives, and other forms of non-financial support, will also be needed. Providing funding and other forms of support for collaborative platforms which enable firms to collaborate and share knowledge across the value chain (i.e. industry clusters), will allow various role-players to leverage public and private funding to implement the skills changes outlined above.

7.8.2 Identifying priority skills, occupations and associated sub-sectors based on impacting and timing

Skills development authorities will need to take cognisance of these new developments and divert resources towards the following skills development targets:

- Regulatory compliance (managers, professionals);
- Lean (professionals, supervisors);
- ICT – advanced (managers, professionals); intermediate (supervisors; artisans); and basic (production workers);
- Robotics (process)
- Quantitative reasoning: Advanced data analysis (e.g. managers, professionals); and basic numerical skills training (supervisors; artisans; production workers).

RESEARCH STREAM II: AUTOMOTIVE AFTERMARKET SERVICES AND SUPPORT

8. Overview

Automotive Aftermarket Service and Support (AAS&S) services can be broadly understood as a division of the OEM that manages the dealer network (dealer sales; dealer parts sales, maintenance and repairs workshops), support (the importing of vehicles, homologations, branding and marketing; driver assistance programmes; quality assurance, pre-inspection checks, etc.) and the aftermarket distribution (OEM-approved service providers, services networks, dealer networks and franchises and customer interaction management).

This research stream seeks to answer the following questions in relation to AAS&S service providers:

- How will South African Aftermarket Services Support organisations respond to the challenges presented by disruptive technological changes in global automotive value chains?
- What skills development is needed and available for people to adapt and remain relevant to these changes?

Research Stream II has been prepared by the Motor Industry Bargaining Council (MIBCO).

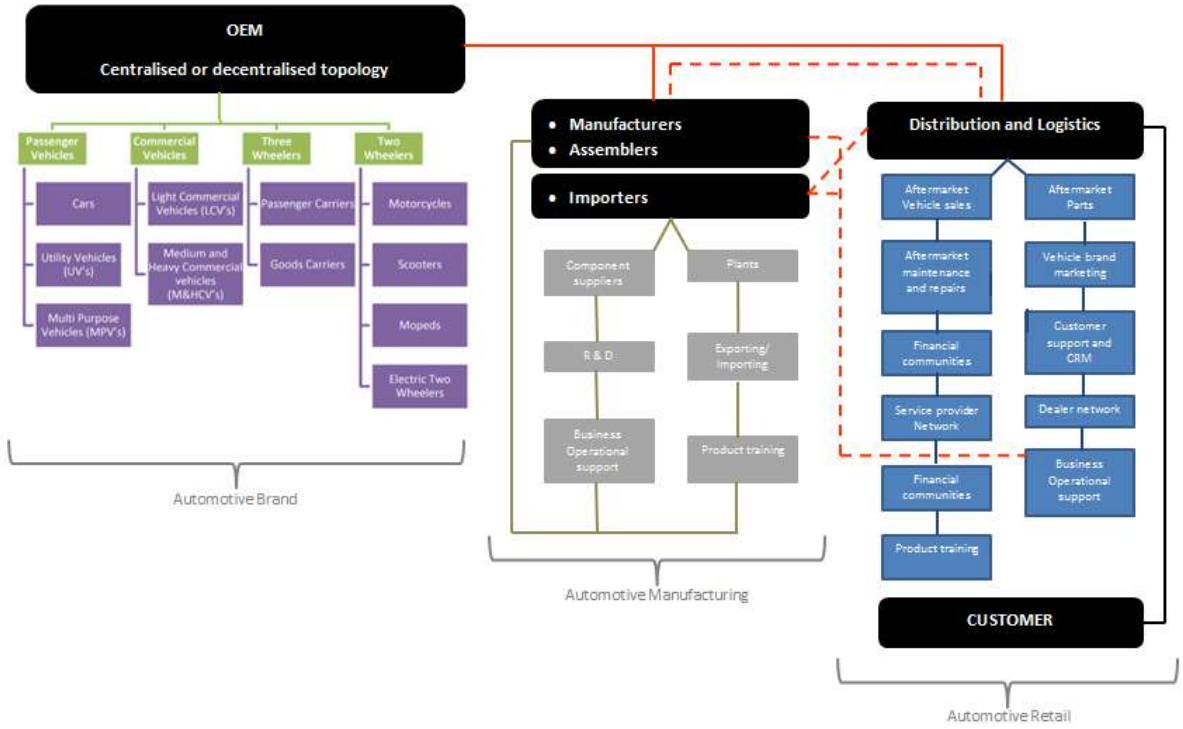
9. AAS&S desktop research

An extensive desktop research process was undertaken in order to identify the most pressing technological changes that are likely to affect the two streams of the motor industry in the same way, namely, Tier 1 automotive manufacturers and AAS&S Industry. The Tier-1 Automotive Component Manufacturing Industry ASCCI research and SAAM mirrors and compliments the Automotive Aftermarket Service and Support industry in many aspects and was consequentially used as a benchmark for both research streams. It is essential to consider the content and information of the Tier 1 automotive manufacturers as it appears in this document. However, the desktop and qualitative literature on AAS&S Industry included the role of the Automotive Vehicle Manufacturers with purpose of understanding the impact on the AAS&S industry. Research findings herein suggest that there is a much closer relationship between the two Motor Industry Streams and the Automotive Vehicle Manufacturers. The outcomes of this part of the desktop research points towards a strong connection between the AAS&S Industry and the Automotive Vehicle Manufacturer Industry in terms of certain skills and omni-channel brand management strategy and platforms.

The Automotive Industry stem from the OEM's and is a very complex network with many topological variables. The OEM's are responsible for vehicle categorisation, the design of vehicles and the launch of new vehicles, which are intended for vehicle users (the customer). The process of producing and selling vehicles to customers has given rise to two sub-sectors in the Automotive Industry, namely, the Automotive Manufacturing and the Automotive Retail sub-sectors:

- Automotive Manufacturing is responsible for manufacturing and supply of vehicles to the automotive retail industry; and
- Automotive Retail is responsible for the aftermarket sales, services and support for vehicles (Including the Tier-1 Automotive Component Manufacturing Industry).

Some OEM's opt for a centralised topology system through which vehicles are manufactured by the OEM's and exported to different to parts of the world. Other OEMs opt for a decentralised topology system through which vehicles are assembled as complete knockdowns or assembled as semi-knockdowns or get manufactured and assembled at multi-national manufacturing plants. The relationship between OEM's, automotive manufacturer establishments and automotive aftermarket retail, distribution and logistics network can vary quite significantly. The picture below provides a basic overview of the Automotive Industry topology:



Source: Davids, M. (2018): Derived from hyperlink URL: OEM Multinational Setup and information from the qualitative research.

There are no automotive brands in South Africa, but there is a good presence of OEM automotive manufacturers and vehicle assemblers as well as an active automotive retail industry with approximately 21 000 automotive retail businesses (according to MIBCO statistics).

The Automotive Industry is a huge contributor to global markets and from information provided by Brand South Africa. (2014): "South Africa's economy: key sectors"; Venter, I. (2016): "Auto industry, Numsa conclude new three-year wage deal" and Cokayne, R. (2017): "Millions depend on SA's motor industry" and Brand South Africa. (2014): "South Africa's economy: key sectors" there are indications that the local Automotive Industry consistently contributed to over 7% of the South African GDP for the last five years, with Automotive Manufacturing contributing in the range of about 4% to GDP and Automotive Retail (the Motor Industry) contributing around 3% to GDP. The registered employee statistics on the MIBCO database in 2017 is at about 300 000 and with NAAMSA and NAACAM employment stats hovering around 30 000 employees year on year, it is can be concluded that there are about 360 000 people directly employed in the South African Automotive Industry. Data obtained from De Lange, R (City Press). (2017: "R256.7 billion – the vehicle industry's massive GDP contribution" shows that about 18% the South African Automotive Industry workforce are highly educated workers, 52% are educated and 30% are semi-educated or uneducated workers.

The global disruptors outlined in the 2013 ASCCI research and changes in the Automotive Industry may present huge challenges for the 30% semi-educated or uneducated workforce, who tends to be the 'heartbeat' of operations (typically known as operative and support labour). It is almost certain that the workforce of the automotive industry will be confronted with an occupational and skills evolution. Hence, merSETA has commissioned research to gain an understanding of the magnitude of change within the Motor Industry and to respond with effective skills development for occupations required in workplaces.

9.1 Identifying foreseen changes in the AAS&S industry over the period 2020-2035

Innovations and technology around services, sales and in automobiles have advanced rapidly and this 'cocktail' has resulted in new occupations and new ways of doing things to meet customer expectations and to satisfy customer expectations.

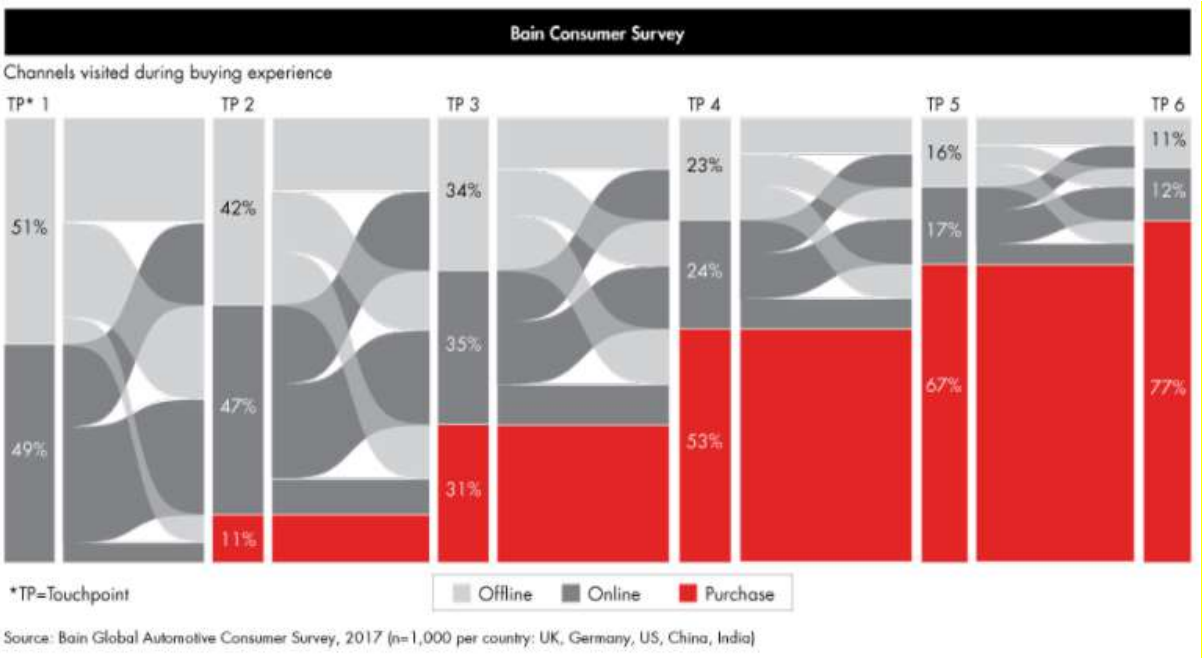
It does appear that dealer organisations have remained somewhat conventional in its approach- by still giving a significant focus on face-to-face sales as well as limiting services centres and parts sales to dealerships. The consumer's sentiment of having things at their 'finger tips' or getting things at a 'click of a button' prohibits confining or restricting products and services to a certain space - traditionally the dealership was the walk-in one stop shop for the OEM by the Omni-channel approach as a disruptive change in the AAS&S Industry which includes:

- Enabling buyers to traverse several different digital channels (websites and mobile apps) to explore automotive vehicle sales or the sale of parts and have the ability to conclude and check out products;
- Giving customers and buyers greater options
- Enabling the buyers to traverse several different digital channels to find maintenance and repair service provides as close as possible; and
- Providing technical support and the ability to access technical information of vehicles through CRM systems.

The automotive vehicle manufacturer is regarded as an intricate part to the CRM value chain in ensuring that products and technical information is managed.

Figure 33 indicates that nearly half of the buying experience begins online and goes back and forth; offline and online as customers gather information to make decisions.

FIGURE 33: BAIN CONSUMER SURVEY

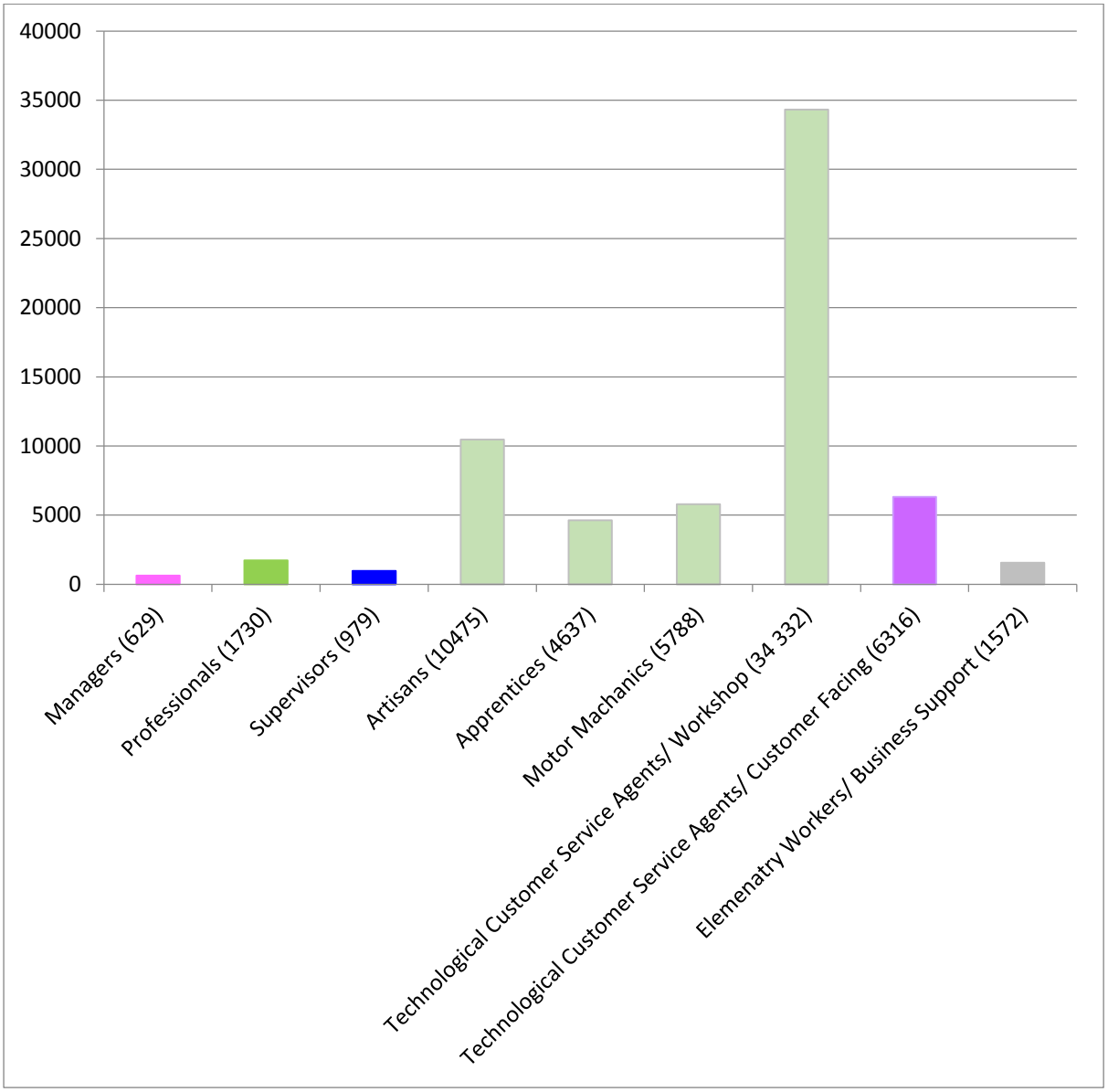


Source: Stricker, K., Tsang, R. & Zayer, E. (2017): The Future of Car Sales Is Omnichannel

Maintenance and Repairs are increasingly become more complex with the introduction of Alternate Engine Technologies; Green operations and eco-friendly waste disposal requirements; new materials used in motor vehicles; Infotainment and vehicle connectivity through which vehicles connect with internal and external devices; robotics and artificial intelligence to enhance the driving experience; the inclusion of improved and highly technical passive and active vehicle safety and restraint systems and autonomous vehicles. These changes require personnel with different levels of qualifications and on different operational levels to understand and work with these disruptors to provide a service to the OEM and/or the customer.

9.2 South African Occupational Data of the AAS&S Industry

The information and data herein gives an indication of occupations within the AAS&S Industry that may be scarce. This area of study focuses on the Artisan occupational category, namely, Motor Mechanics. Unlike other occupations in the AAS&S Industry, information on Motor Mechanics was rife and could be used to test the scarcity of the occupation and set a benchmark when considering other artisan occupations. Various occupational and training data was compared to MIBCO data to draw conclusions. The graph below illustrates that motor mechanics is the rifest occupation amongst artisan and artisan related occupations in the AAS&S Industry.:



MIBCO 2018: AAS&S Occupational data (Sector-4 and Scetor-6)

9.2.1 Strategic Integrated Projects (SIPS)

The 18 SIPS projects provides an opportunity for integrated and work experiential learning skills development to takes place though national South African projects. **Table 13** shows the number of employees required for the listed the occupations (2015), which have been considered in determining the scarce and critical skills of the AAS&S Industry. Noticeably (in order), there is a high demand elementary workers and operators as a collective; professionals; trades and lastly management and services. In the AAS&S Industry this equates (in the same order as the aforementioned) to Technological Customer Service Agents (In workshops); technicians and specialists; artisans and lastly Technological Customer Service Agents (customer facing), supervisors and managers.

TABLE 13: NUMBER OF EMPLOYEES REQUIRED FOR THE LISTED THE OCCUPATIONS (2015)

Occupation	Number Required
Management	180
Professions and associates	4230
Services	225
Trades	2552
Operators	4340
Elementary	9650
TOTALS	**21177**

Source: (2015) SIPS Progress Report.

Table 14 is a list of Scarce Trade occupations. Noticeably, none of the listed trades are from the Motor Industry. Hence and according to this list, none of the AAS&S Industry trades are regarded as scarce for the for national strategic projects (SIPS) which is aimed at industrialising the country and is considered as a key driver to economic growth.

TABLE 14: SCARCE TRADE OCCUPATIONS

Those that are highlighted in red are trades listed on the SIP Scarce Skill List.

No.	Trade	NQF	Credits	AQP	Reg no.
1.	Occupational Certificate: Electrical Line Mechanic (Overheard Lines Mechanic)	4	510	NAMB	671301001
2.	Occupational Certificate: Plumber	4	360	NAMB	642601000
3.	Occupational Certificate: Electrician	4	360	NAMB	671101000
4.	Occupational Certificate: Electroplater	4	411	NAMB	712201000
5.	Occupational Certificate: Melter	4	361	NAMB	684913000
6.	Occupational Certificate: Moulder	4	364	NAMB	615101000
7.	Occupational Certificate: Toolmaker	5	432	NAMB	652201000
8.	Occupational Certificate: Engineering Patternmaker	4	376	NAMB	652204000
9.	Occupational Certificate: Boilermaker	4	395	NAMB	651302000
10.	Occupational Certificate: Welder	4	373	NAMB	651202000
11.	Occupational Certificate: Bricklayer	4	326	NAMB	641201000
12.	Occupational Certificate: Carpenter	4	360	NAMB	602502000
13.	Occupational Certificate: Plastics Manufacturing Machine Setter	4	432	NAMB	714208000
14.	Occupational Certificate : Vehicle Painter (Automobile and Marine Painter)	4	366	NAMB	643202001
15.	Occupational Certificate: Mechanical Fitter	4	410	NAMB	653303000

Source: (2015) SIPS Progress Report.

9.2.2 Top 100 Occupations in Demand in South Africa

Below are the current occupations that can be associated to OEM associated AAS&S Industry as it appears on the Department of Higher Education and Training 2015 top 100 List of occupations. On the list are three (3) artisan occupations within in the AAS&S Industry (I.e. Automotive Motor Mechanic; Diesel Mechanic and Automotive Electrician).

TABLE 15: TOP 100 OCCUPATIONS IN DEMAND IN SOUTH AFRICA

Ranking	Job Title	OFO Code
3	Mechanical Engineer	214401
5	Programme or Project Manager	121905
6	Finance Manager	121101
6	Physical and Engineering Science Technicians	311
8	Industrial and Production Engineers	2141
8	Electrician	671101
12	Accountant (General)	241101
14	Energy Engineer	215103
15	Materials Engineer	214907
16	Electronics Engineer	215201
27	ICT Systems Analyst	251101
29	Fitter and Turner	652302
33	Welder	651202
37	Manufacturing Managers	1321
37	SHEQ Practitioner	226302
37	Automotive Motor Mechanic	653101
45	Toolmaker	652201
45	Mechanical Engineering Technologist	214402
48	Electrical Engineering Technologist	215102
48	Diesel Mechanic	653102
48	Electronic Instrument Trades Worker	672105
52	Sales and Marketing Manager	122101
52	Industrial Machinery Mechanic	653301
56	Automotive Electrician	672106
66	ICT Project Manager	133102
66	Electronics Engineering Technologist	215202
66	Computer Network and Systems	133102
66	Mechatronics Technician	671203
72	Research and Development Manager	122301
72	Retail Manager (General)	142103
79	Computer Network Technician	351301
80	Personnel / Human Resource Manager	121201
80	Production/Operations Manager	134915
80	Industrial Designer	216302
86	Health and Safety Manager	121206
90	Logistics	132402
90	Chief Information Officer	133101
90	Occupational Instructor / Trainer	242402
93	Corporate General Manager	121901
97	Retail Manager (General)	142103
99	Quality Systems Manager	121908

Source: DHET top 100 scarce and critical skills list

9.2.3 MerSETA 2017/18 Sector Skills Plan

Workforce by Occupational Category and Chamber

"Overall, the manufacturing, engineering and related services sector comprises a majority of semi-skilled and skilled workers. One in every 5 workers is skilled across all chambers and a quarter is employed at technician level or higher as demonstrated in **Table 16** below.

TABLE 16: OCCUPATIONAL CATEGORIES OF EMPLOYEES BY CHAMBER

Employment Categories	Chambers					
	Auto	Metal	Motor	Plastics	New Tyre	Total
MANAGERS	8%	8%	11%	7%	8%	11%
PROFESSIONALS	12%	6%	4%	4%	4%	15%
TECHNICIANS AND ASSOCIATE PROFESSIONALS	20%	11%	7%	8%	9%	18%
CLERICAL SUPPORT WORKERS	8%	9%	14%	6%	8%	12%
SERVICE AND SALES WORKERS	2%	3%	11%	2%	4%	2%
SKILLED CRAFT AND TRADES	18%	24%	17%	7%	12%	23%
PLANT & MACHINE OPERATORS AND ASSEMBLERS	29%	19%	18%	63%	29%	9%
ELEMENTARY OCCUPATIONS	3%	20%	18%	2%	26%	10%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

(merSETA, WSP data, 2017)

"The majority of employees in the mer-sector are trades workers. However, the plastics and new tyre chambers have more operators and elementary workers".

TABLE 17: TOP TEN OCCUPATIONS BASED ON EMPLOYMENT

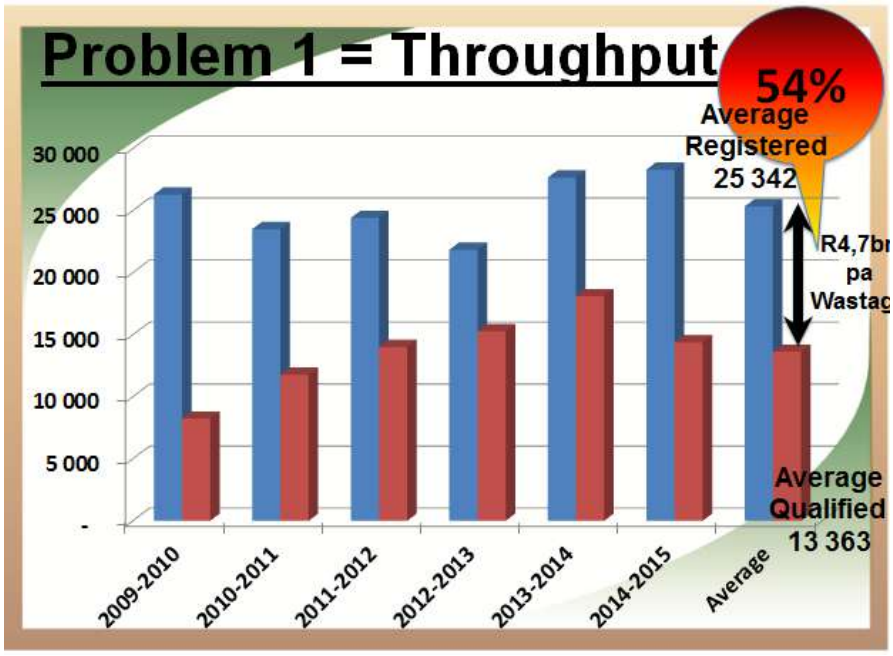
Top 10 Occupations for each Occupational Group			
MANAGERS	Production / Operations Manager (Manufacturing)	SERVICE AND SALES WORKERS	Motorised Vehicle or Caravan Salesperson
	Director (Enterprise / Organisation)		Automotive Parts Salesperson
	Sales Manager		Sales Assistant (General)
	Finance Manager		Sales Clerk / Officer
	Corporate General Manager		Special Forces Operator
	Quality Systems Manager		Service Station Attendant
	Supply and Distribution Manager		Office Cashier
	Customer Service Manager		Security Officer
	Sales and Marketing Manager		Checkout Operator
	Business Training Manager		Caretaker
PROFESSIONALS	Sales Representative / Salesman (Industrial Products)	SKILLED CRAFT AND RELATED TRADES WORKERS	Metal Machinist
	Marketing Practitioner		Welder
	Industrial Engineer		Automotive Motor Mechanic
	Mechanical Engineer		Boiler Maker
	Safety, Health, Environment and Quality (SHE&Q) Practitioner		Mechanical Fitter
	Financial Accountant		Electrician
	Human Resource Advisor		Sheet Metal Worker
	Electrical Engineer		Diesel Mechanic
	Civil Engineer		Quality Controller (Manufacturing)
	Occupational Instructor / Trainer		Rigger
TECHNICIANS AND ASSOCIATE PROFESSIONALS	Production / Operations Supervisor (Manufacturing)	PLANT AND MACHINE OPERATORS AND ASSEMBLERS	Engineering Production Systems Worker
	Integrated Manufacturing Line Process Control Technician		Product Assembler
	Metal Manufacturing Process Control Technician		Delivery Driver
	Mechanical Engineering Technician		Metal Processing Plant Operator
	Draughtsperson		Rubber Production Machine Operator
	Purchasing Officer		Truck Driver (General)
	Office Administrator		Forklift Driver
	Credit or Loans Officer		Plastics Production Machine Operator (General)
	Personal Assistant		Machinery Assembler
	Manufacturing Technician		Crane or Hoist Operator
CLERICAL SUPPORT WORKERS	General Clerk	ELEMENTARY OCCUPATIONS	Store Person
	Production Coordinator		Metal Engineering Process Worker
	Stock Clerk / Officer		Plastics, Composites and Rubber Factory Worker
	Program or Project Administrators		Commercial Cleaner
	Accounts Clerk		Handyperson
	Dispatching and Receiving Clerk / Officer		Mechanic's Assistant
	Enquiry Clerk		Component Fitter
	Cost Clerk		Builder's Worker
	Receptionist (General)		Food and Beverage Factory Worker
	Payroll Clerk		Shelf Filler

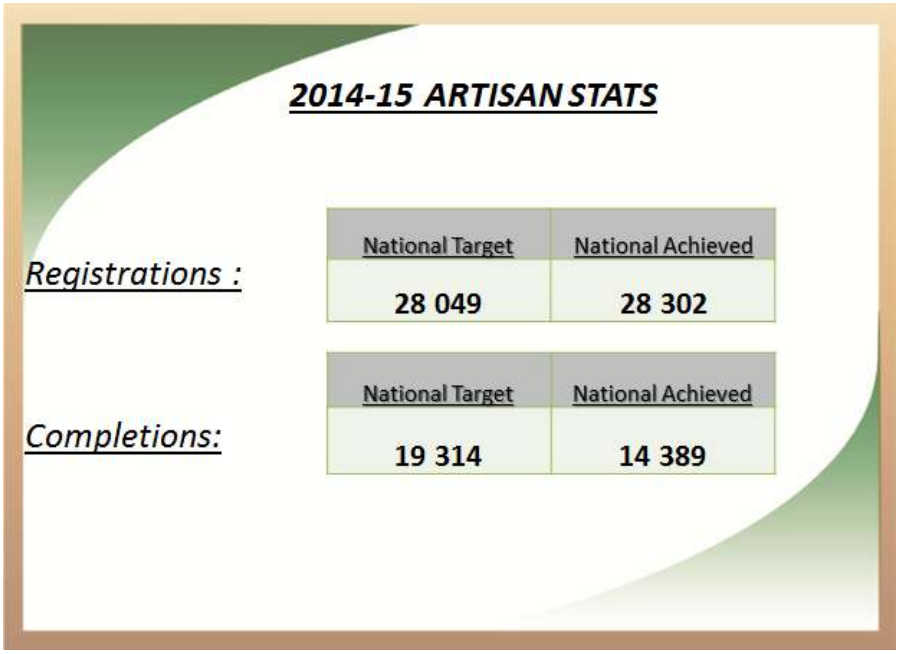
Indications drawn from these sets of data are that 'skilled craft and trades' is second highest occupation category in demand in the AAS&S Industry (Motor Mechanic, Diesel Mechanic and electrical); elementary workers or Technological Customer Service Agents.

9.2.4 Department of Higher Education and Training

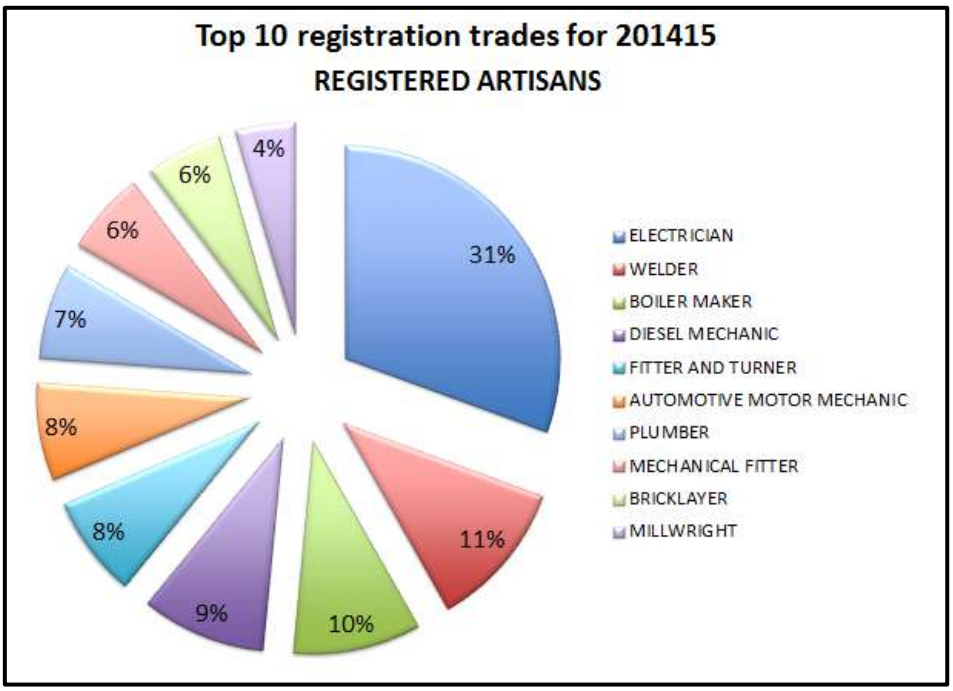
Department of Higher Education and Training (2016). National Artisan Data Management Presentation of the National Artisan Development Service Centre (NADSC).

Artisan registration datasheet of South Africa:





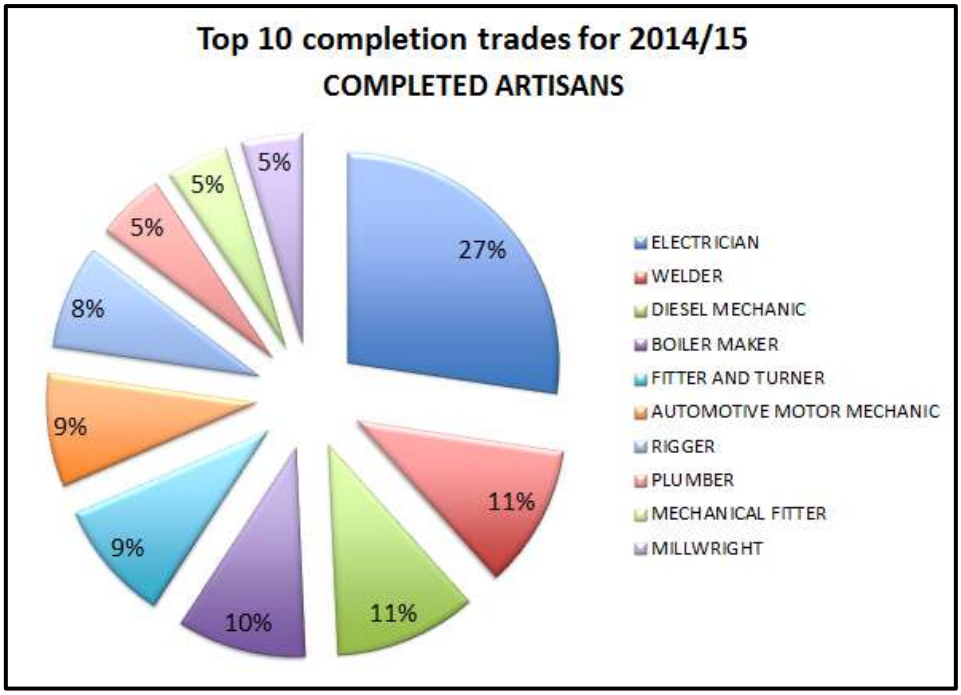
Source: DHET National Artisan Development Advisory Body (2016): National Artisan Data Management Presentation



Source: DHET National Artisan Development Advisory Body (2016): National Artisan Data Management Presentation

The analysis indicates of the data provided indicates that out the Automotive Industry related trades:

- 2547 Diesel Mechanics apprentices were registered in the 2014/15 skills year.
- 3113 Motor Mechanics apprentices were registered in the 2014/15 skills year.
- 2264 Fitter and Turner apprentices were registered in the 2014/15 skills year.
- 1132 Millwright apprentices were registered in the 2014/15 skills year.



Source: DHET National Artisan Development Advisory Body (2016): National Artisan Data Management Presentation

The analysis indicates of the data provided indicates that out the Automotive Industry related trades:

- 1582 Diesel Mechanics apprentices qualified in the trade during the 2014/15 skills year.
- 1438 Motor Mechanics apprentices qualified in the trade during the 2014/15 skills year.
- 1295 Fitter and Turner apprentices qualified in the trade during the 2014/15 skills year.
- 719 Millwright apprentices qualified in the trade during the 2014/15 skills year.

The data herein indicates that artisan training for the AAS&S Industry is focussed on Motor Mechanic, Diesel mechanic and Electrical.

9.2.5 MIBCO Auto-body Repair Industry Occupational Data

The evidence below indicates that the national data on qualified Automotive Body Repairer and Spraypainter (Vehicle Painter) artisans are low when considering that there are 1956 registered Autobody repair shops on the MIBCO database (2017). Refer to the 2017 MIBCO employee stats below:

OccupationCode	OccupationDesc	Chapter	Sector	PartyAssociation	EmployeeTotal
BG	GENERAL WORKERS	1	4 and 6	All Parties and Non Parties	33613
QT	BODY SHOP ASSISTANTS	1	4 and 6	All Parties and Non Parties	2293
XA	AUTOMOTIVE BODY REPAIRER	1	4 and 6	All Parties and Non Parties	1560
XK	SPRAYPAINTERS	1	4 and 6	All Parties and Non Parties	906
YA	APPRENTICE AUTO BODY REPAIR	1	4 and 6	All Parties and Non Parties	467
YK	APPRENTICE SPRAYPAINTERS	1	4 and 6	All Parties and Non Parties	311
TOTAL					**39150**

Source: MIBCO (2017)

9.2.6 Conclusion (Sample of occupational data of the AAS&S Industry)

The consistent featuring of the Motor Mechanic occupation in some of the data sets seems to indicate that there is a demand for the occupation. However, the absence of the same occupation from other sets of data together with employment figures from MIBCO seems to contradict the aforementioned. Motor Mechanics did not feature as a scarce skill according to AAS&S Industry employment statistics; instead, Spraypainting (Vehicle painting) appears as most scarce industry trade/artisan occupation (according 2017/18 MIBCO occupational data). Below are comparative statistics between the Motor Mechanic and Spraypainting occupations in the AAS&S Industry:

Motor Mechanics:

Motor Mechanic Establishments with Motor Mechanics as a primary and secondary function in the AAS&S Industry	4704
Motor Mechanics employed in the AAS&S Industry	5788

Spraypainters:

Automotive Body Repair Establishments with Spraypainters as a primary and secondary function in the AAS&S Industry:	1956
Spraypainters employed in the in the AAS&S Industry	906

More research was needed to provide clarity on the artisan skill category to analyse the trends of the Motor Mechanic occupation, which was used as a benchmark.

In addition, the consistent indication towards a high demand for elementary and semi-skilled workers in all the data warranted the need for more in depth research into the occupational category. The occupational category for the AAS&S Industry according to the research scope is defined as 'Technological Customer Service Agents'.

The managers, professional and supervisor skills categories appears to be consistent in most sets of data and further research is intended to confirm the desktop research finding, but may or could reveal other anomalies.

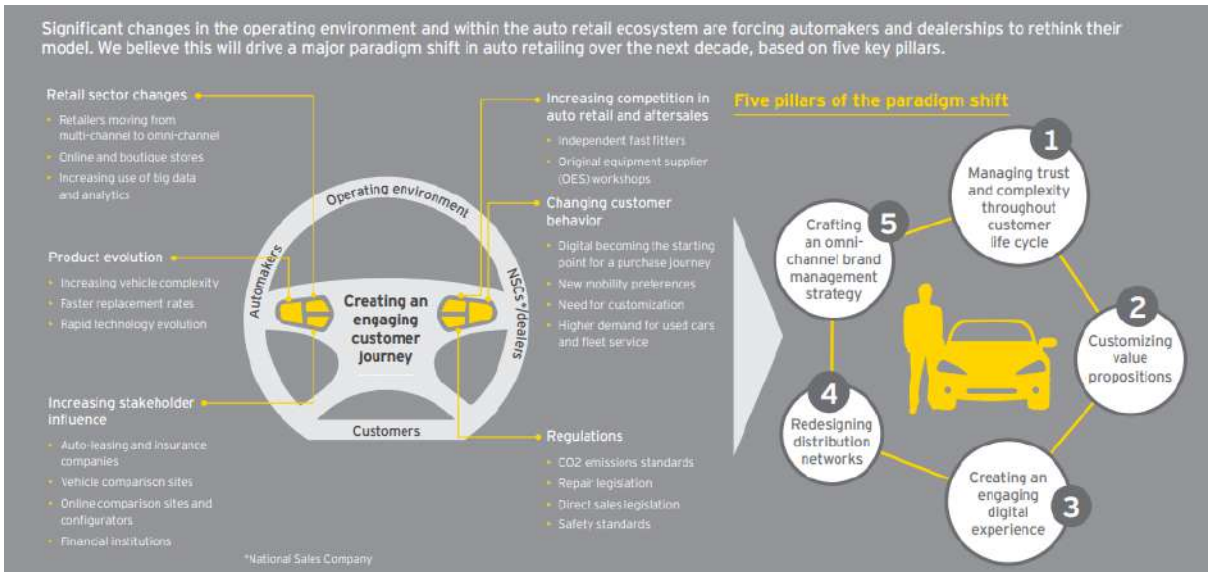
9.3 Drivers of change for the future of the AAS&S Industry

In this section the research intends to provide an understanding of the relationship between the AAS&S, the Tier-1 Automotive Vehicle Component Manufacturers and the Automotive Vehicle Manufacturers. The desktop research showcased in **section 4** painted a picture of trends and disruptors in the vehicle manufacturing industry which also apply to the AAS&S industry. The commonality in technological, skills and occupations changes are largely influenced by OEMs.

The key focus the AAS&S industry is centred on improving on service delivery for the vehicle owner as well as improving the customer experience for potential, new and existing customers. As the SAAM's vision and key objectives aim to substantially increase its contribution to the SA economy to 2035 through efficient production techniques, the AAS&S aims to implement efficient work process to lower maintenance and repair costs on motor vehicles, which make cars affordable and push up local vehicle market sales. An example of this is the substantially lower cost of repairing motor

vehicle panels instead of replacing those panels and where such services become possible for the OEM when the skills to repair is available.

9.3.1 Potential changes and the future of the AAS&S industry



Source: Ernst & Young. (2015): "Future of Automotive Retail"

The automotive dealer network and distribution network disruptors appear as technical, services, customer expectations and regulatory changes.

Stakeholders in this instance are the service providers, employees and customers. Essential to the future of the AASA& industry will be closer synergy and operations the Automotive Vehicle Manufacturing Industry and component manufacturing industry to drop costs (from the factory to the services provider or customer).

In addition, aftermarket support will be paramount to gaining customer loyalty through customer analytics driving performance: large amounts of data generated from customer interactions will be analysed to impact all facets of the retail organization (through customer interaction systems and accessibility to vehicle data).

Skills and the ability to interact with the customer and vehicle of various platforms will be required and skills and competencies in that regard will become a greater requirement. More importantly is to use the data to provide services or to establish how best to attend to the customers wants and needs.

Industry research papers consistently reveal the objectives of the AAS&S Industry as the:

- Ability to offer a seamless customer experience: Automotive retailers will ensure seamless and consistent customer experience throughout stationary, mobile and virtual sales and communication channels.
- Activation of management of all communication channels: Automakers, service centres and dealerships will have advanced integrated customer relations management systems that ensure access to holistic customer data and information to all employees at each level and each point of the customer's journey.

9.3.2 Other influences on the AAS&S industry

Antich, M. (2015) identifies the following key trends that are likely to influence the AAS&S industry:

1. More Sophisticated Vehicle Connectivity

"As vehicles get 'smarter,' maintenance and repair diagnostics will be sent directly from the vehicle and, based on the diagnostic results."

2. More Dealer-Based Repairs

Many non-dealer shops will only provide preventive maintenance services, due to more sophisticated technology. Complex and specialized, resulting in more reliance on dealerships."

3. Vehicle Complexity to Increase Downtime

As manufacturers race to implement new technology that improves safety and fuel economy, isolated delays due to complex failure diagnosis will increase.

4. Maintenance Data Management

"Similar to many other areas, when it comes to maintenance, managing technology, information, and data will be our biggest challenge in the future. We continue to see incredible growth in the amount of vehicle data and information, and the challenge going forward will be how we manage all the information and turn it into useful analytics."

5. Predictive Maintenance & Analysis

"Our ability to sort mechanical condition data in real time affords us opportunities to provide predictive analysis like we have never seen before. Our ability to manage large amounts of data creates the opportunity to predict component failure, provide real-time transactional repair cost intervention, provide best-in-class maintenance policies and procedures, and identify and provide economic equipment specifications and procurement."

6. Expansion of Preventive Maintenance Reminders

"There will be an increase in on-board reminders for preventive maintenance beyond traditional oil changes and tire pressure. Sensors in filters and fluids and other maintenance items will trigger dashboard reminders to alert the driver of due or overdue maintenance. This growing technology should help reduce related component failures and roadside breakdowns"

7. Use of Big Data to Support Predictive Analysis

"At ARI, we are working with increasingly complex fleets that need to manage Big Data to support predictive analysis, downtime management, driver safety, productivity, and total cost of ownership. New technology means better communication, including equipment that 'talks back to us,' providing mechanical self-diagnosis, increased driver behaviour data, and driver support systems, among other things".

8. Changing Preventive Maintenance Parameters

"We are already seeing advancements in maintenance where we now schedule preventive maintenance based on fuel burn and appropriate utilization supported by telematics, rather than just time and miles. This trend will continue."

9. Longer PM Intervals

"Over the past few years, we've seen maintenance intervals lengthen, largely through the use of synthetic oils. The extended intervals make it critically important for drivers to monitor oil levels as all engines consume some amount of oil, and, over time, an engine failure can occur from low oil levels."

10. Greater Tool Standardization

"The continuing move by OEMs to develop global vehicle platforms will help reduce the need for unique tools required by automotive technicians."

11. Improved Communication with Drivers

"More automation and interactions with vendors will provide improved communications for drivers (such as text messaging repair status updates and apps to schedule service appointments, and communicate local pricing promotions) as well as improved data for FMCs to monitor and rate a shop's performance."

12. Light-weighting of Parts

"We will see more parts being made from carbon-fiber and composite plastics. This will reduce the weight, which improves fuel economy, but will also be more expensive to replace and more complicated to repair."

13. Diesel Engines Become Mainstream

"The growth of automobile diesel engines will help the OEMs achieve the government fuel economy goals. Customers will be more accepting of diesel engines and past complaints of smelly exhaust and noisy engines will be reduced with improved emissions and quieter engines. The automobile diesel engine evolution in the U.S. will require some repair facilities to recruit diesel engine technicians while the auto/truck industry is facing a shortage of trained technicians."

14. Ongoing Parts Shortages

"We will continue to see isolated cases of part shortages due to manufacturer redesigns and manufacturing plant issues."

15. Ongoing Technician Shortage

"Enrolments in auto and truck trade schools have also been slowly declining. I believe this trend will continue, which could cause a slight shortage of technicians in future years."

16. Higher Labour Rates

"The complexity of new technology will cause higher demand for highly skilled technicians. The impact of this will be labour rates increasing at a rate higher than normal inflation as well as some increased repair downtime," said Whiteside. Singly, the most fundamental."

10. Primary research findings (Qualitative)

10.1 Summary and presentation of data gathered

The qualitative research process consisted of a series of workshops and interviews held with industry participants and stakeholders in Johannesburg/Pretoria, Port Elizabeth and Durban. A full list of research participants for Research Stream II is shown in **APPENDIX B** – Quantitative research participants (Tier 1 automotive manufacturers) . Participants were questioned about the impact of the foreseen technological changes to global automotive value chains (as detailed in the literature review in **section 4.3**), and the implications for occupations and skills requirements for the South African AAS&S Industry and Automotive Vehicle Manufacturers.

Participants were specifically asked to consider the following research questions:

- What skills are needed for these existing occupations and what new skills will be required?
- What skills development resources are required to skill people sufficiently to fulfil these occupations?
- What will be the new occupations for the future (i.e. occupations that bear little or no resemblance to existing occupations)?
- What will be the skills requirements for future occupations?
- What skills development resources will be required to skill people sufficiently to fulfil these occupations?
- What occupations and skills will become redundant as processes / technologies change?

Participants were asked to reflect on the availability of current skills in the South African AAS&S industry and Automotive Vehicle Manufacturers, and to anticipate new skills needs for the period 2020 – 2035. Focus groups were also prompted to reflect on the required changes that will need to be implemented in order to develop the skills that will be required. Participants were asked to reflect on these questions as they apply to five job categories.

- Management;
- Professionals / Engineers;
- Supervisors;
- Artisans; and
- Technological Customer Service Agents (for the AAS&S industry)

10.2 Availability of current skills, new skill requirements and required changes

The current management, professional, supervisor and artisan occupational activities and skills that follow were drawn from the Automotive Tier-1 Component Manufacturing research (Stream I). These are considered generic skills within the Automotive Industry. The current Technological Customer Service Agents skills have been drawn from the MIBCO Main Collective Agreement and the occupational activities are unique to the AAS&S Industry.

The "current skills" were presented in the workshop engagements and participants were asked to reflect on the proposed skills and anticipate what skill changes may take place between 2020 and 2035. The following are additional occupational activities and skills that are presented as the views of respondents. Current skills that will not be applicable post 2020 have a strikethrough.

10.2.1 Management

TABLE 18: CURRENT MANAGEMENT SKILLS, NEW SKILL REQUIREMENTS, AND REQUIRED CHANGES

Current skills	Required changes	New skills
• Industrial and labour relations skills • Product knowledge • Lean operational skills • Financial management • Leadership and team-building • Organisational development skills • Attention to Detail • Computer literacy / ICT • Operations management knowledge and skills • Conflict management • Negotiation skills • Communication skills • Performance management Skills • Industrial and labour relations skills • Global thinking / strategic insight • Creative Thinking • Trade, technician or Engineer • Diagnostic skills	• Ability to lead teams and use teams effectively. • Talent management and the development of the workforce. • Lead change as a change agent- adapt to the technological changes, operational and system changes in all aspects of the business.	• Work flow • Regulatory compliance • Tactical skills • Very good listening skills • Green operations • Delegation skills • Ethical behaviour- Ability to earn respect and strong leadership skills • Succession planning • Crises management

10.2.2 Professionals (engineers / technicians)

TABLE 19: CURRENT PROFESSIONAL SKILLS, NEW SKILL REQUIREMENTS, AND REQUIRED CHANGES

Current skills	Required changes	New skills
• Creative Thinking • Computer Modelling • Attention to Detail • Advanced Mathematics • Communication Skills • Leadership and management • Teamwork • Electronics • Mechanical skills • Machining • Fitter skill • Diagnostic skills	• Continuous professional development in the field of practice • Project management skills. • Continuous Organisational system and operational skills to keep up with industry trends.	• Automation • Workflow • Data analytics • Regulatory compliance • Ethical behaviour • Crises management • Advanced Business Information systems • Robotics • Data analytics • Artificial intelligence • New skills that is relevant to area of work • Coaching and mentoring skills • Supervisory skills • Process control techniques

10.2.3 Supervisors

TABLE 20: CURRENT SUPERVISOR SKILLS, NEW SKILL REQUIREMENTS, AND REQUIRED CHANGES

Current skills	Required changes	New skills
• Industrial Relations and Code of Conduct • Health, Safety & Environment • Financial Basics • (Individual & business) • Communication & Team-work	• Continuous professional development in the field of practice • Project management skills. • Organisational system and operational skills. • Lead change as a change agent- adapt to the technological changes,	• Automation • Workflow • Data analytics • Regulatory compliance • Very good listening skills • Ability to earn respect and strong leadership skills • Ethical behaviour

• Time Management • Leadership • Lean Operations • Product knowledge • System and operational skills	operational and system changes in all aspects of the business.	• Crises management • Advanced Business Information systems • Robotics • Artificial intelligence • Coaching and mentoring skills • Supervisory skills • Intermediate management skills • Process control techniques • Green skills for various operations • Passive and active safety specifications • Conflict management • Adequate waste disposal • Health, Safety & Environment

10.2.4 Artisans

TABLE 21: CURRENT ARTISAN SKILLS, NEW SKILL REQUIREMENTS, AND REQUIRED CHANGES

Current skills	Required changes	New skills
~~• IR & Code of Conduct~~ • Health, Safety & Environment • Financial Basics • (Individual & business) • Communication & Team-work • Time Management • Leadership • Lean operations • Product knowledge ~~• Trade qualifications~~ • Advanced specialised technical trade skills (skills above generic trade qualifications)	• Continuously be engaged in professional development in the field of practice. • Continuous competency assessments and gap analysis • Basic education needs to support artisan development • Know and be able to apply employee rights and code of conduct. • Acknowledge trades of part qualifications • Emotional intelligence-company and shared values	• Workflow • Robotics and automation • Regulatory compliance • Ethical behaviour • Coaching and mentoring skills • Process control techniques • Green skills for various operations • Conflict management • New materials • Advanced tool maintenance and repair • Alternative engine technologies (e.g. electric vehicles) • Flexibility and adaptability • Computer software and programming • Telemetry systems • Infotainment and vehicle connectivity (IoT) • Compliance with OEM specifications and standards • Driving

10.2.5 Technological customer services agents

Technological Customer Service Agents job category includes the following job profiles: service and maintenance booking clerks; service advisors; technical support call centre agents; roadside assistance call centre agents; workshop assistants; general workers; body shop assistants; roadside assistance technicians; vehicle sales persons and parts sales persons.

TABLE 22: CURRENT TECHNOLOGICAL CUSTOMER SERVICES AGENT SKILLS, NEW SKILL REQUIREMENTS, AND REQUIRED CHANGES

Current skills	Required changes	New skills
• Financial Basics (Individual & business) • Health, Safety & Environment • Financial Basics • (Individual & business) • Communication & Team-work • Time Management • Product understanding • Technical knowledge of the product • Operational and system skills • Systems understanding • Conflict management • Negotiating skill • Computer Skills • Driving skills	• Continuously be engaged in professional development in the field of practice. • Continuous competency assessments and gap analysis • Know and be able to apply employee rights and code of conduct. • Acknowledge part qualifications • Emotional intelligence-company and shared values	• Workflow • Regulatory compliance • Ethical behaviour • Process control techniques • Green skills for various operations • New materials • Flexibility and adaptability • Compliance with OEM specifications and standards.

10.3 Summary of Redundant Skills and Additional New Skills identified by respondents

10.3.1 Redundant skills

- **IR & code of conduct:** This skill will not be required for artisans or production workers/operators. Employers and labour authorities make resources available for employees to be represented according to the Labour Relations Act and Basic Conditions of Employment Act.
- **Trade Qualifications:** The skill will not be required for all aspects of journeymen work. The vocational skills system makes provision for part qualifications though which employees can qualify to parts of a trade or journeymen's work.
- **Leadership skills:** The skill is not required for production workers / operators as they cannot be expected to make leadership decision and be held accountable.
- **Self-management:** Production workers / operators and cannot work on entirely own and will at least require supervision.
- **Intermediate mathematics:** Is much more than required Production workers / operators. Basic numeracy or mathematics literacy is sufficient.
- **Electronics:** Is much more than required Production workers / operators. A partly qualified employer, supervisor or journeymen should be available to attend to occupations that require electrical work.
- **Oxy-Acetylene welding/Gas welding*:*** The skill and function I no longer allowed or required in OEM approved workshops.
- **Lead filling:** This function is illegal, and the skill is no-longer required in autobody repair workshops.
- **Fitter qualifications:** The qualification is becoming redundant in OEM automotive Vehicle manufacturing and assembly plants as most fitting is pre-seated or automated.

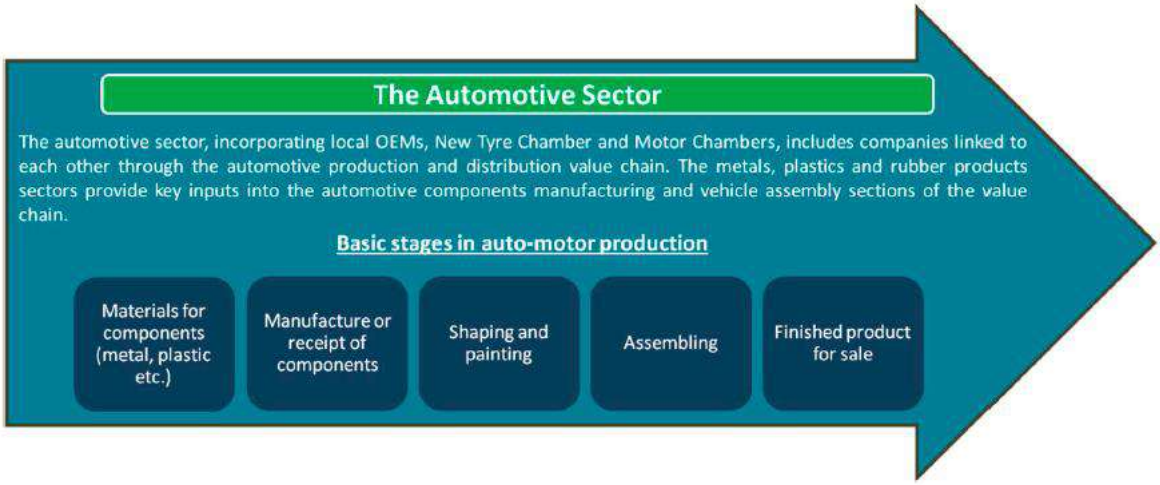
10.3.2 Additional new skills

- **Laser cutting:** Has been introduced into OEM approved workshops to replace Oxy-Acetylene cutting.
- **MIG and TIG welding:** Has been introduced into OEM approved workshops to replace Oxy-Acetylene welding for metals of different thicknesses.
- **Millwright:** The Millwright qualification has been introduced to address fitting, automation and robotic maintenance in the OEM automotive Vehicle manufacturing and assembly plants.
- **Occupational part qualifications:** The skills authorities have introduced vocational part qualifications or modules of employable skills across industry to recognise and certify employees for their job roles or occupations.

10.3.3 General

Trade qualifications will be regarded as fundamental and basic qualification to enter the workplace as an artisan or advance to technician level, but tradesmen will need to undergo continuous professional (CPD) development and product training. Product knowledge will be an OEM requirement for all occupations in the AAS&S environment. CPD is proving to be a requirement by OEM's and becoming more expensive than national accredited training. Authorities should consider ways of funding CPD and product training (it will be of great assistance to businesses) i.e. funding for the old 'top-up training'. Trainer-the-trainer and the associated skills (like coaching, mentoring and assessor skill) will be needed for OEM's to transfer knowledge and skills through the value chain.

Part qualifications may work for industry, but accountability must be regulated and managed correctly by labour authorities (like MIBCO). The Automotive Industry seems to be too divided in terms skills development. Skills authorities are called upon to close the divide, but still need to consider the uniqueness of sub-sectors. For instance; skills like motor mechanics, diesel mechanics, auto electrical, millwright, mechatronics, vehicle painters and panelbeaters are used in the AAS&S industry and the Automotive Manufacturing industry, but are regulated differently. The recommended consolidation of the Automotive industry is supported by 2017 WSP report of merSETA in which the Automotive Industry is composed of to three (3) sub-sectors that are clasped together, namely, vehicle manufacturing, motor industry (including component manufacturing) and New Tyres (or Tyres). The consolidated Automotive Industry is depicted below:



Source: MerSETA integrated depiction of the Automotive Sector. MerSETA (2017). 2017-18 Sector Skills Plan

Part qualifications are the way to go for all technological customer services agents. Recognised occupations for technological customer services agents will ensure that the workforce is recognised; it will enable skills portability and form the basis for progressive development.

The methods for vocational training are uncertain: The NQF (unit standard system) seems to be the most suitable because of the provision of 'Range Statements', which made the delivery of training customisable to suit training providers and businesses. Industry views are that the NQF (unit standard system) was not reviewed and managed adequately and became outdated. Industry is not sure about the flexibility and customisability of the new occupational qualifications and whether or not authorities have the ability to review and manage the programme.

Authorities need to consider more advanced ways of conducting training and must consider the cost of training. There are very modern and advanced training methods used across the globe, which authorities should consider using (like self-learning through digital and e-learning). The days of 'face-to face learning' are gone and integrated learning is the new global norm.

Those on the ground in the AAS&S industry need to be made aware of the changes and dynamics of coping mechanisms to respond the changes.

There are new ways to support customers through call centres: Customers needing technical assistance dial into a call centre and is assisted by an agent who will deploy a field technician to assist the customer. These field technicians have the job title as technicians, but are not qualified as artisans or technicians; they have basic product specific and technical abilities to resolve arbitrary problems- 'to get the customer mobile'. The vehicle will be towed to a workshop if the field technician cannot resolve the problem and other arrangements are made to get the customer mobile. At the workshop qualified artisans or technicians will attend to the problem.

Authorities should also consider the impact that third parties have on the AAS&S industry- like the insurance industry.

11. Primary research findings (Quantitative)

11.1 Summary and presentation of data gathered

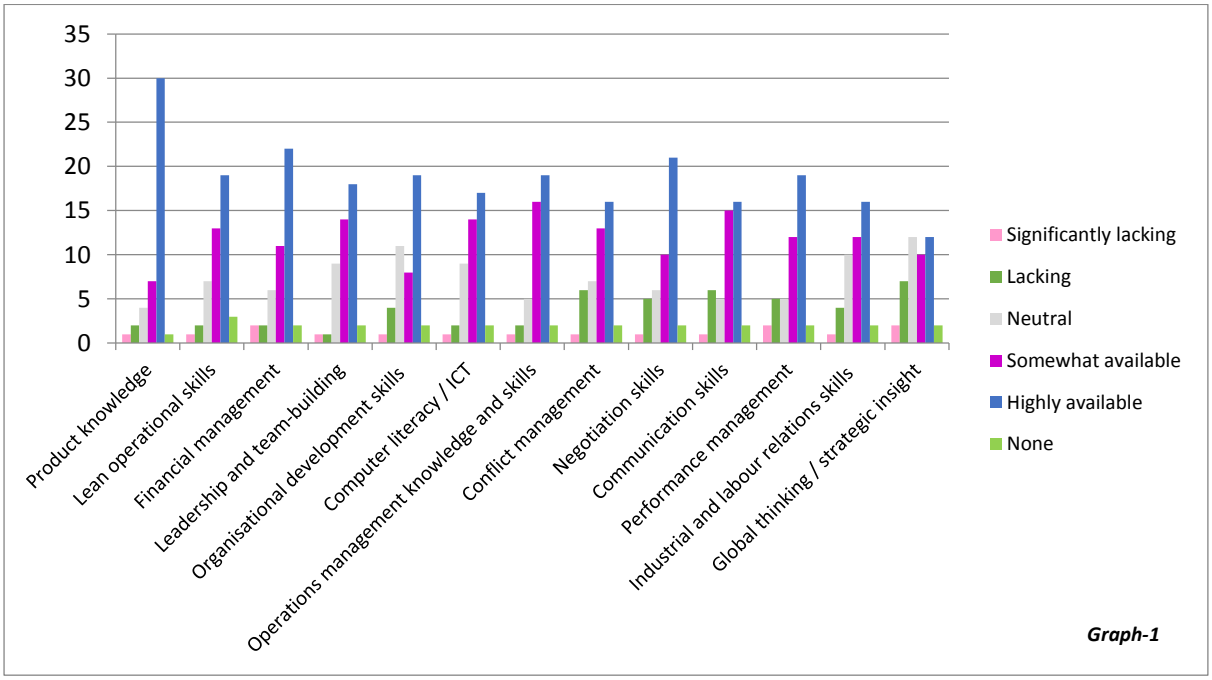
Electronic questionnaires were sent out to relevant businesses on the MIBCO database, through which leading questions based on the desktop and qualitative research were presented. The questions presented were aimed at getting an understanding of industry's views on:

- What the current levels of skill proficiencies are (*the Likert rating used were: Significantly lacking; Lacking; Neutral; Somewhat Available and Highly Available*);
- What the future skills will be in the period 2020 to 2035 (*the Likert rating used were: Irrelevant; Somewhat Irrelevant; Neutral; Somewhat Relevant; Highly relevant*);
- Whether or not current investments and planning is taking place for skills perceived to be important for the industry (*the options were YES or NO*);
- Whether or not industry perceives/believes there are resources available to acquire the skills perceived to be important (*the options were YES or NO*); and
- What skills are most likely to become redundant in the period 2020 to 2035 (*Open text responses*).

The above-mentioned questions were presented and asked for management, professional, supervisor, artisan and technical support services agents' occupational categories. There were 45 detailed responses covering thirty-eight (38) small enterprises, (3) medium enterprises and four (4) large enterprises from the AAS&S Industry (all have some affiliation with OEM's). The respondents were responsible or involved in human resources and human capital development of their respective organisations. The list of respondents is shown in **appendix D**.

11.2 Management

11.2.1 Current management skills proficiency



Graph-1

The 'highly available' rating in graph-1 indicates that managers are proficient in most skills apart from 'Global thinking'. Global thinking has the highest rating under the 'significantly lacking' and 'lacking' categories which indicates that work needs to be done for managers to understand and deal with global markets, cultures and business dynamics of different economies.

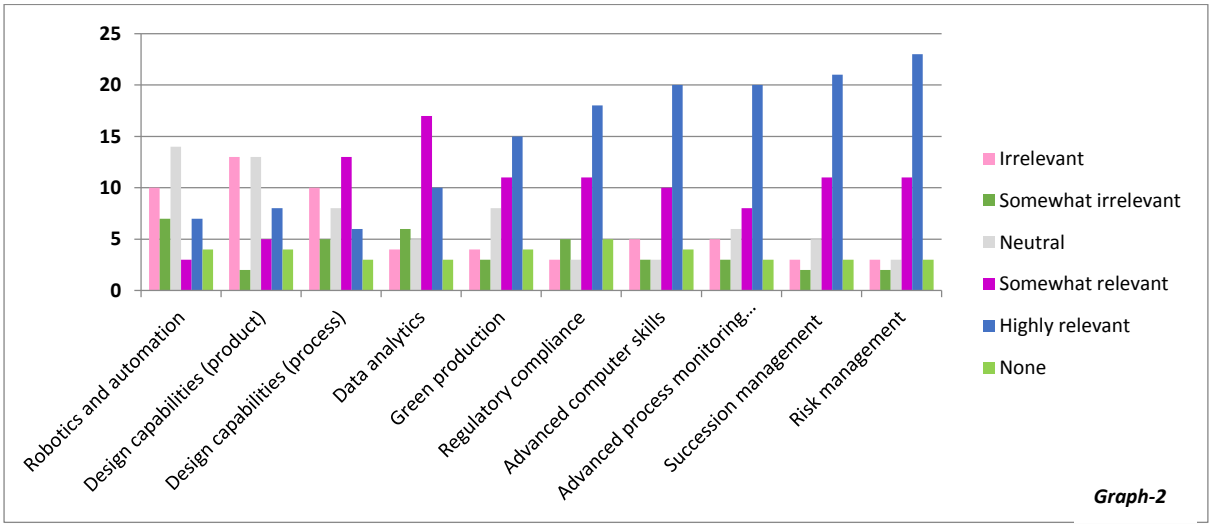
Although 'product knowledge' is rated as 'highly available', accessibility in terms of costs and as a compliance requirement by OEM's makes it difficult for businesses and employers to acquire the skills (almost as a licence to practices). In many ways product training is perceived as a means of controlling technical risk and compliance in terms of OEM specifications (As indicated in graph-3 and graph-4). The product knowledge component is also associated with risk management; process control techniques; flexibility and adaptability and regulatory compliance (linked to legislation and OEM specifications), which are skills that feature most prominently in all five (5) occupation categories. This notion is also supported by the low rating of the product knowledge for supervisors which indicates that managers and supervisors complement each other on different aspects of compliance. Evidently and according to the different responses in the manager and supervisor categories:

- In terms of compliance: There is a high focus on managers regarding risk management as opposed to the high focus on supervisors regarding health, safety and environment- complimenting each other- complimenting each other; and
- In terms of business acumen: there is a high focus on managers product knowledge as opposed high focus on supervisors regarding system and operational skills - complimenting each other.

'Teamwork' has the highest value in the 'highly available' column which is indicative of managers' ability and reliance to delegate and depend on other occupational roles.

A series of variables in 'organisational development skills' coupled with a relatively high rating as a current skill proficiency (as indicated in the 'highly available column) indicates that it is a skill that is needed and needs to be developed.

11.2.2 Future management skills



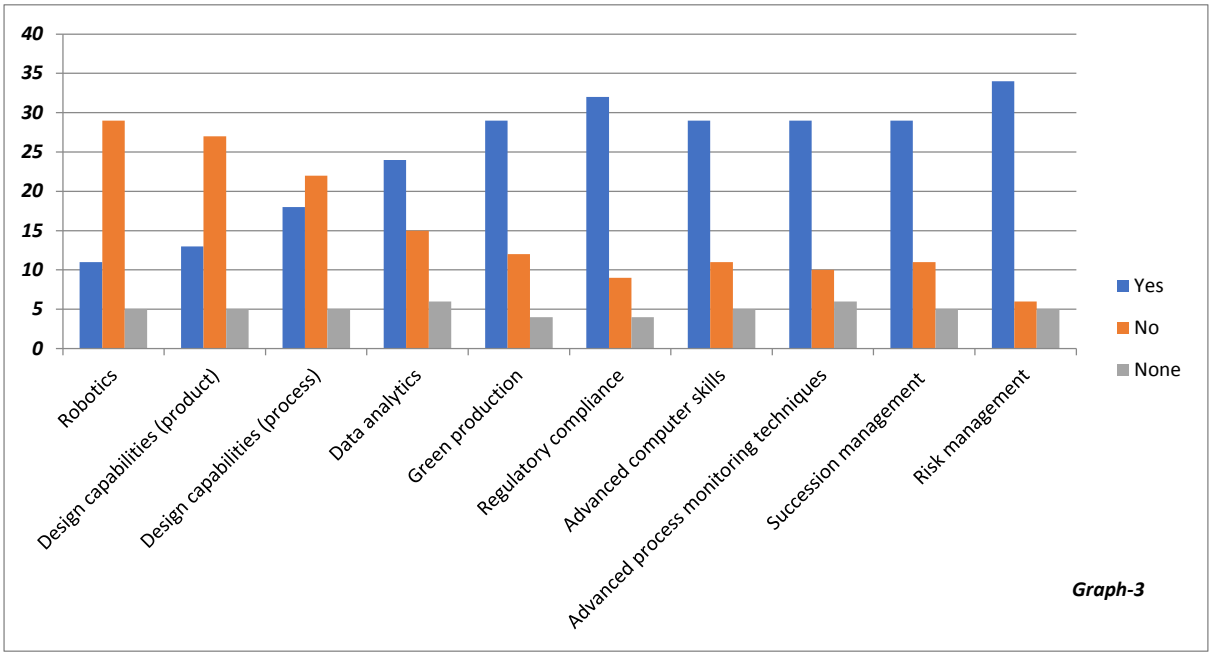
Graph-2

'Risk management' appears as the most relevant future skill for managers, which includes regulatory compliance (in terms of legislation and OEM requirements). This relates to the views of respondents from the qualitative research who have suggested that labour and skills regulations should be standardised as far as possible. Risk management and compliance is a big concern for businesses.

The low design capabilities of both 'product' and 'process' under 'highly relevant' as well as it high rating under 'irrelevant' indicates that the products, workspaces and process within the AAS&S industry will be determined by OEM's, which supports the movement towards the Omni-channel system (feedback that also came through very strongly in the desktop research).

11.2.3 Investment and planning considerations for critical management skills

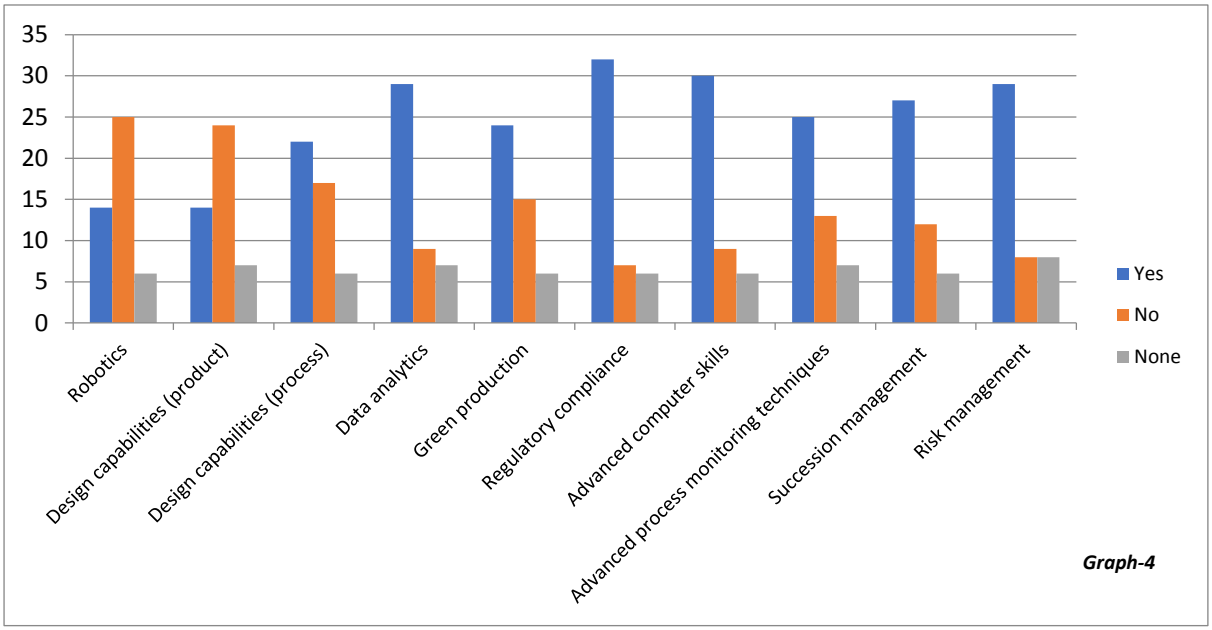
The graph below represents responses of investments and planning for important management skills:



Graph-3

Graph-3 indicates that current investments in understanding and applying risk management are the highest and substantially higher than any of the other skill areas, which supports the interpretations of graph-1 and graph-2. The low skill investment in 'robotics' and 'design capabilities' (of both 'product' and 'processes') supports the movement towards the Omni-channel system.

11.2.4 Resource availability for critical management skills



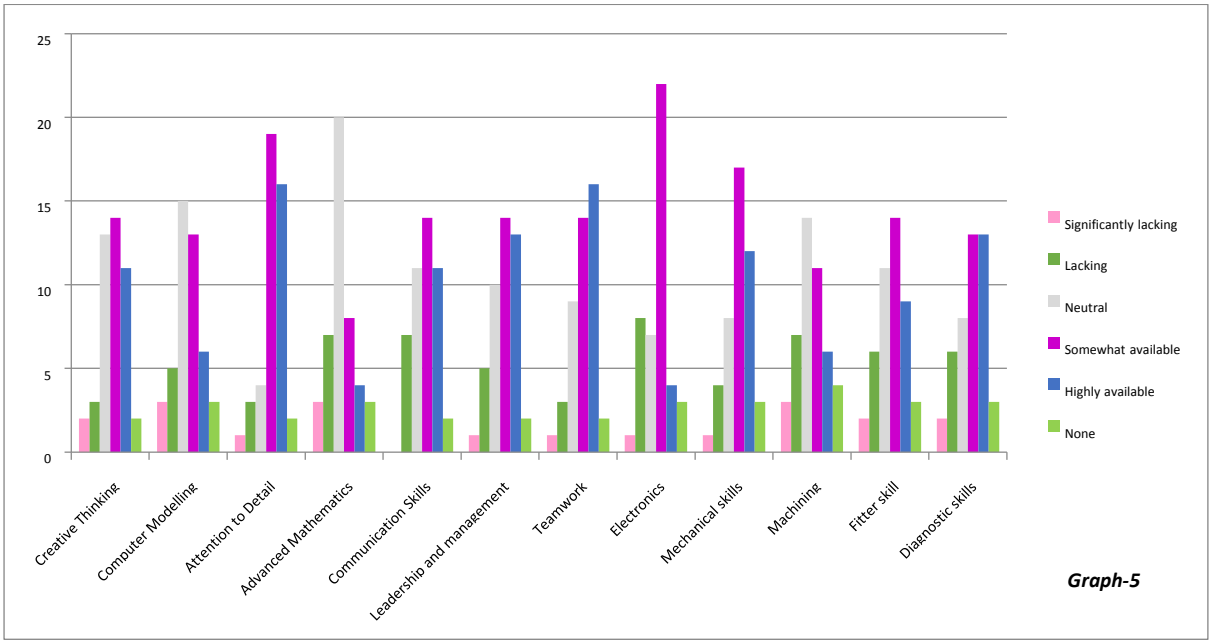
Graph-4

The high rating of training resources available on the compliance issues, namely, 'green production, 'regulatory compliance' and 'risk management' indicates that training fraternities and industry are very active and currently addressing compliance on all levels.

The other high rating in 'data analytics' also suggest that management needs to have the understand and ability work with the products and processes that OEM's provide.

11.3 Engineers / Technicians

11.3.1 Current engineering / technician skills proficiency

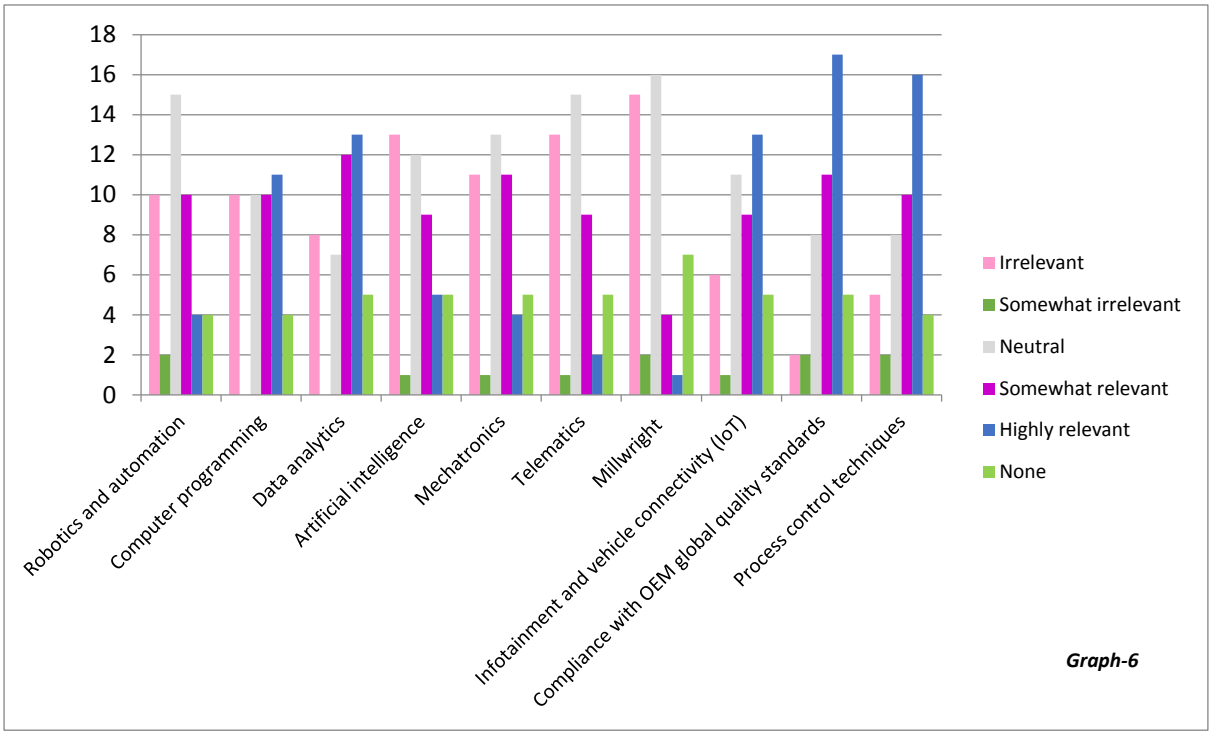


Graph-5

The high value in 'Electronics' coupled with other high values of technical vocation skills indicate that qualifications skills and abilities are adequate, which is also supported by average responses in all the Likert ratings across the 'electronics' skill. The same values in the 'highly available' column would have indicated skills are good, but that is not the case.

The low value in 'advanced mathematics' coupled with the high value of uncertainty (the Neutral and None columns) indicate that engineers and technicians are practical and use applied principles and concepts instead of needing to just have the academic proficiencies. This also supports the analysis of the management category that suggests OEM's are taking more control of design capabilities of products.

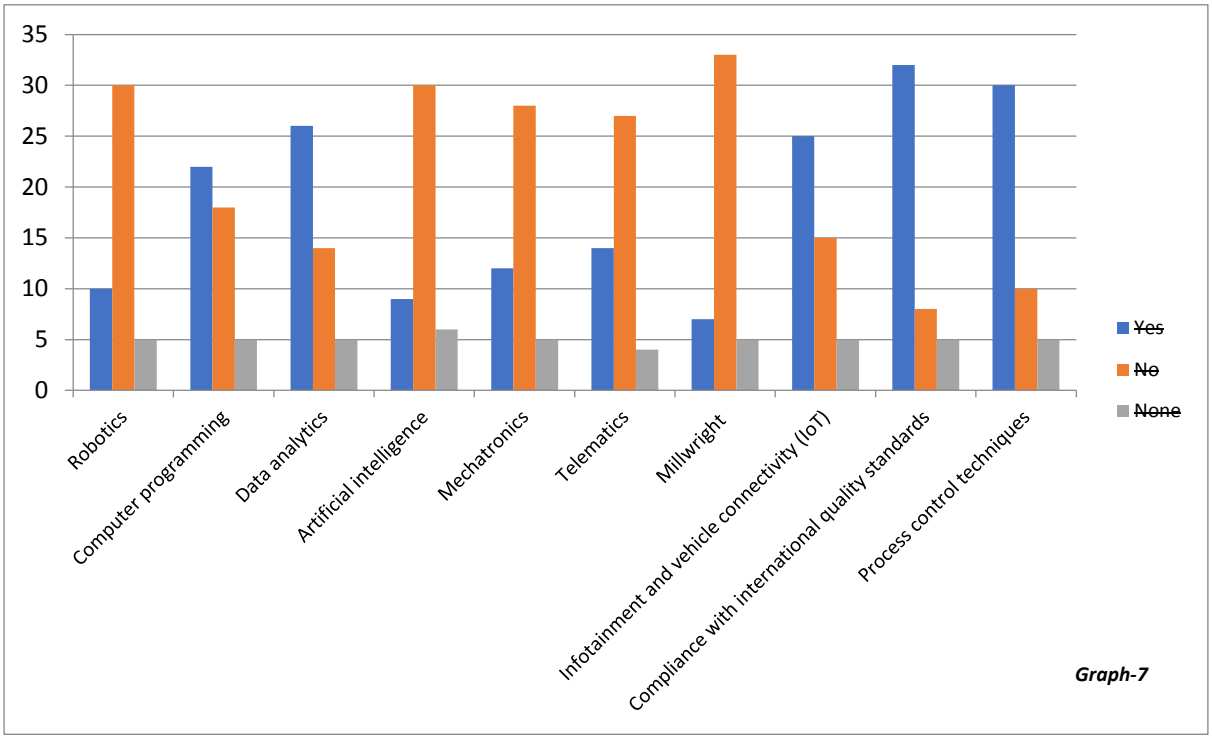
11.3.2 Future engineering / technician skills



Graph-6

The dominance of uncertainty ratings shows that is industry is unsure of the future of technical skills needed in the AAS&S industry. However, the next most featured rating in which 'data analysis' is rated as 'somewhat relevant' and 'highly relevant' supports the analysis that engineers and technicians will work off OEM products; not self-designed products (as indicated and supporting graph-5). Technicians and engineers will instead be more involved in fault finding and diagnostics within the AAS&S industry.

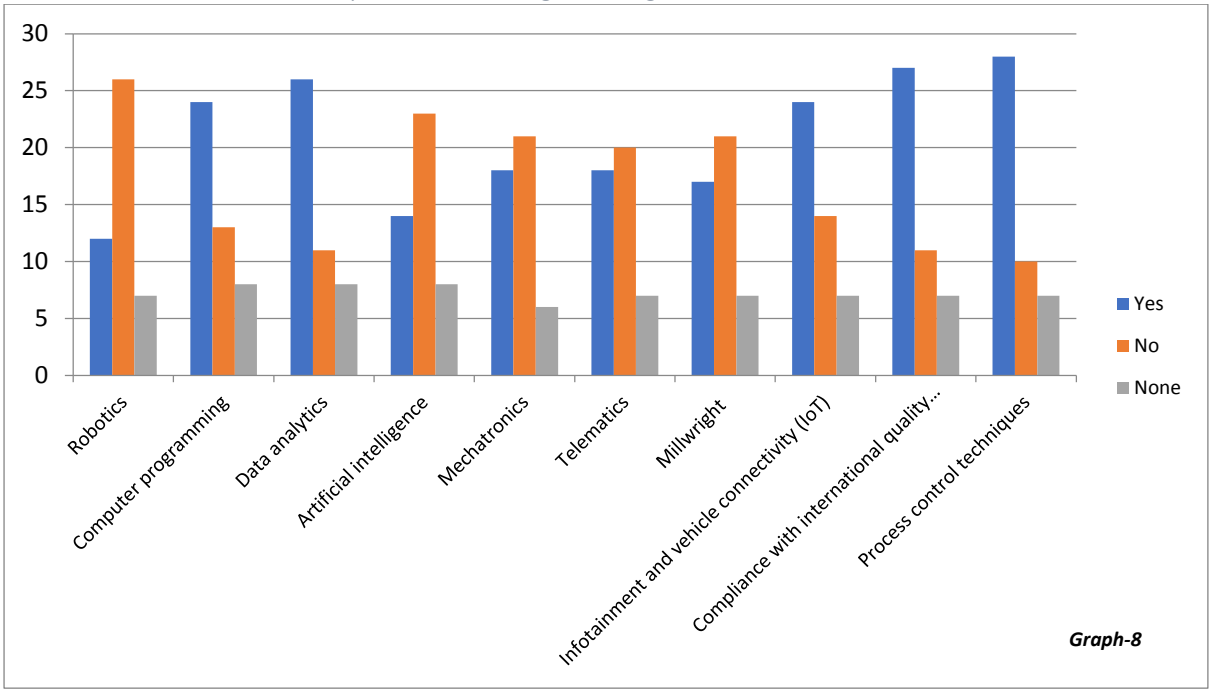
11.3.3 Investment and planning considerations for critical engineering / technician skills



Graph-7

The data and information is very similar to graph-6; showing uncertainty and strongly revealing that 'data analysis is a skill of the future. These investments coupled with the high rating of 'Process control techniques' in the 'highly relevant' column of graph-6 support the analysis that technicians and engineers will doing fault finding and diagnostics.

11.3.4 Resource availability for critical engineering / technician skills

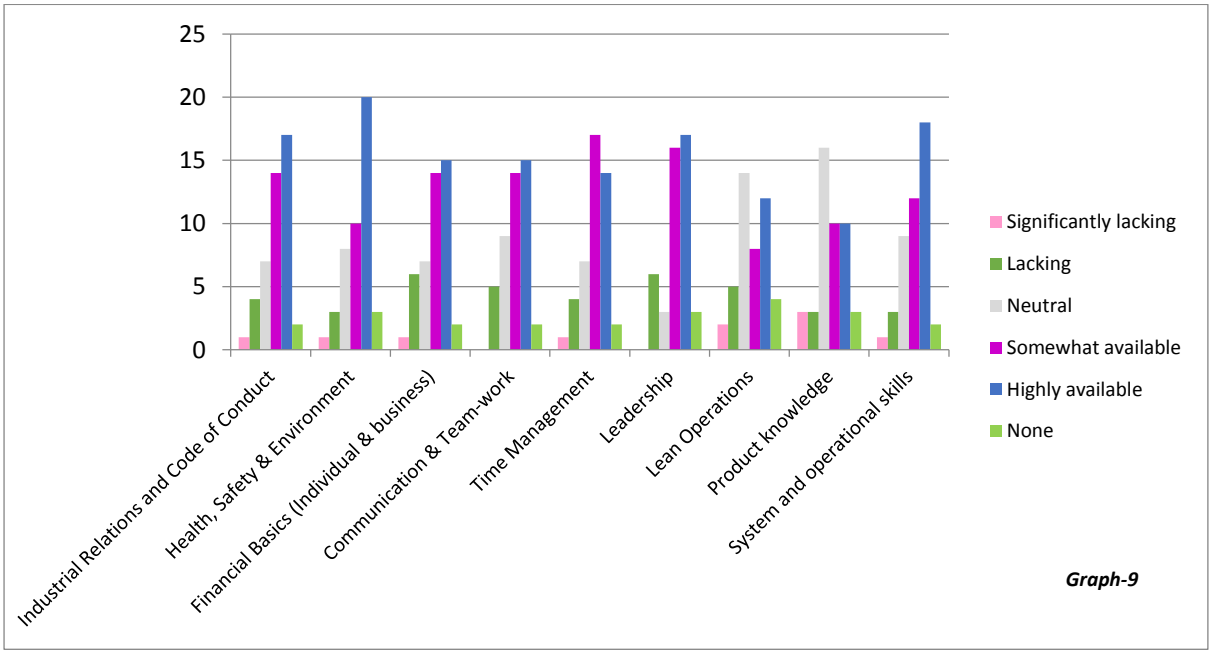


Graph-8

The overwhelming 'yes' in the availability of resources in computerised; digital and electronic diagnostics training interventions indicates that initiatives are talking place to improve the human competency levels in resolving technological faults. This too supports the analysis that technicians and engineers will do in fault finding and diagnostics within the AAS&S industry and work on OEM products.

11.4 Supervisors

11.4.1 Current supervisor skills proficiency

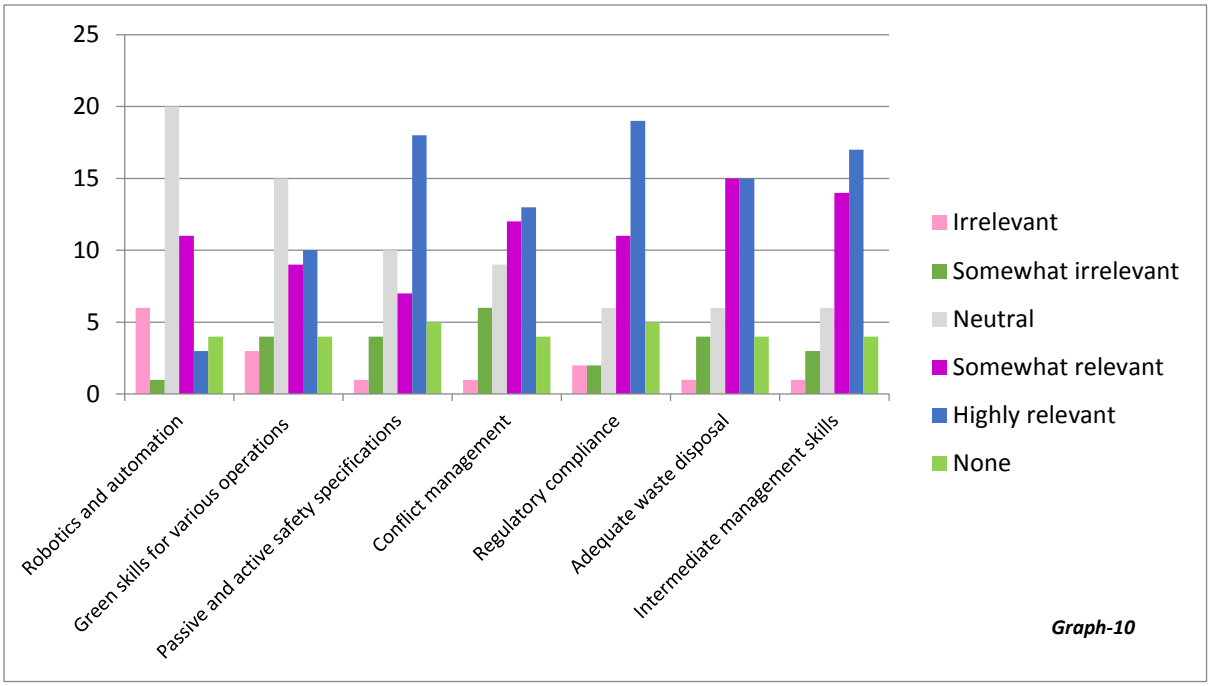


Graph-9

The data herein supports the discussion that the supervisors and managers complement each other. Skills required for supervisors are 'highly available', apart from product 'knowledge'. Product knowledge has the lowest rating in the 'highly available' column and rated higher than any other skill in 'significantly lacking' which indicates that it is not a fundamental skill for the supervisory role. This data points to managers, professionals and artisan occupational categories and shows the reliance of supervisors on managers, artisans and specialist with regards to products and product knowledge (basically getting informed). However, the aggregated ratings of product knowledge in the uncertainty columns; the 'significantly lacking' column and the 'lacking' column coupled with feedback from qualitative data suggest that product knowledge will be required by supervisors to support lean operations.

The very high rating in 'Health, Safety & Environment' column and second highest rating in 'system and operational skills' in the 'highly available' column indicates that supervisors are systems, processes and operations orientated (not decision makers or strategic).

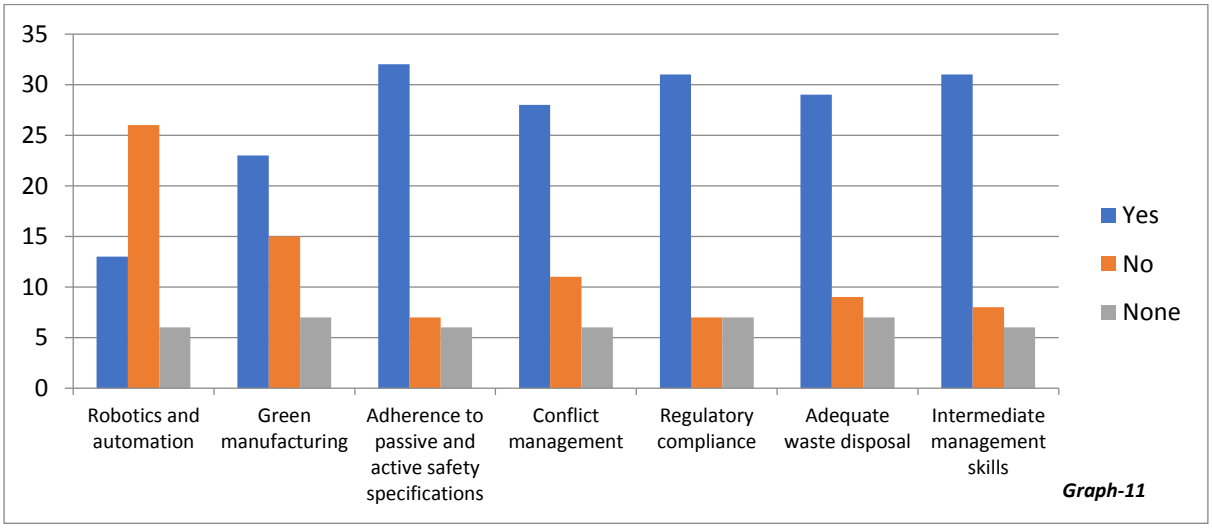
11.4.2 Future supervisor skills



Graph-10

The 'regulatory compliance' rating followed by life-and-limb 'passive and active safety specifications' rating are related and supports the need for supervisors being the custodians of in 'Health, Safety & Environment'- performing a fundamental systems roles, quality checks and process operations.

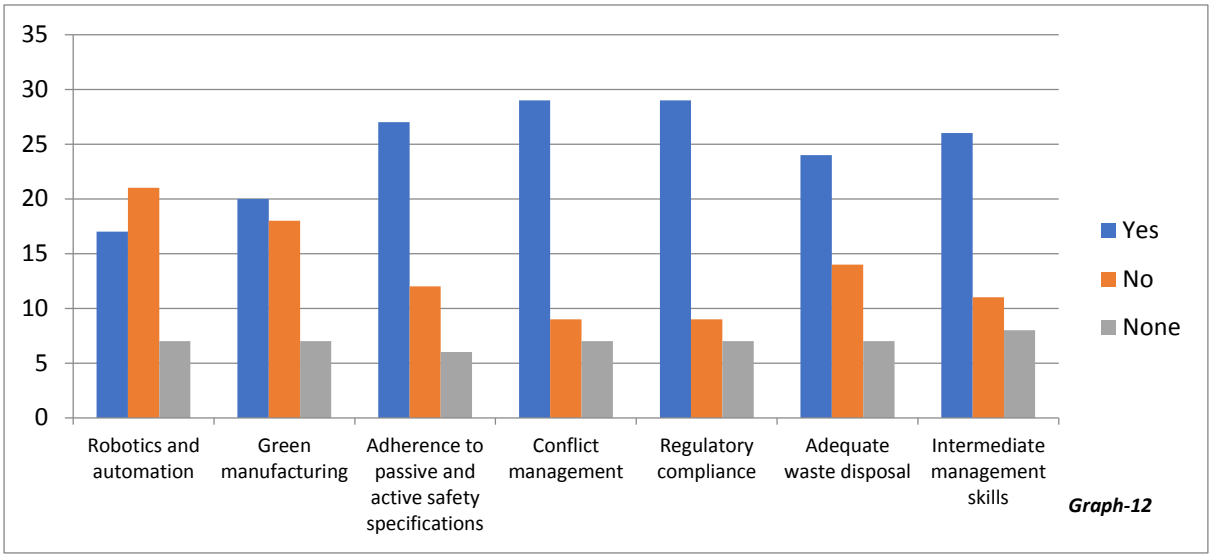
11.4.3 Investments and planning considerations for critical supervisor skills



Graph-11

Graph-3 indicates that current investments in understanding and 'adherence to passive and active safety specifications' and 'regulatory compliance' have the highest rating, which supports the interpretations of graph-9 and graph-10. There are also high investments in management skills, namely, 'intermediate management skills' and 'conflict management' which indicate that industry is investing and actively engaged in interventions to help supervisors manage systems and process operations.

11.4.4 Resource availability for critical supervisor skills

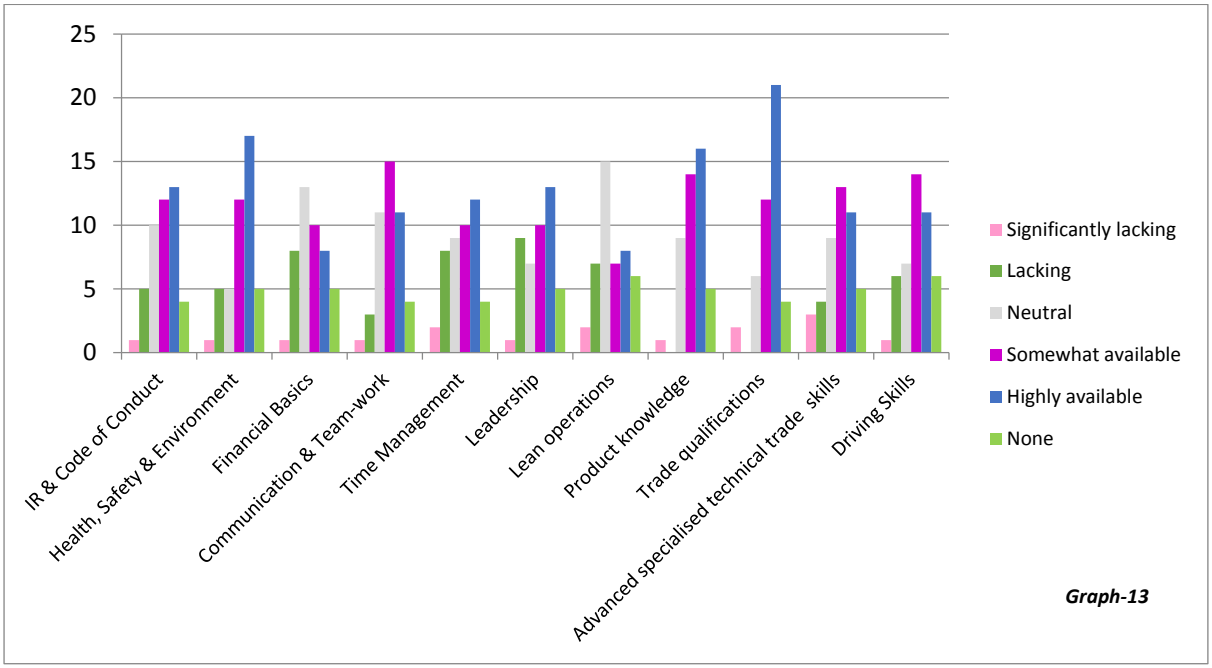


Graph-12

The high availability of training resources in all the areas of graph-11 in which skill investments are focussed indicates that initiatives are talking place to maintain and improve supervisor skills to manage occupational compliance; occupational safety, health and environment and manage systems and processes.

11.5 Artisans

11.5.1 Current artisan skills proficiency



Graph-13

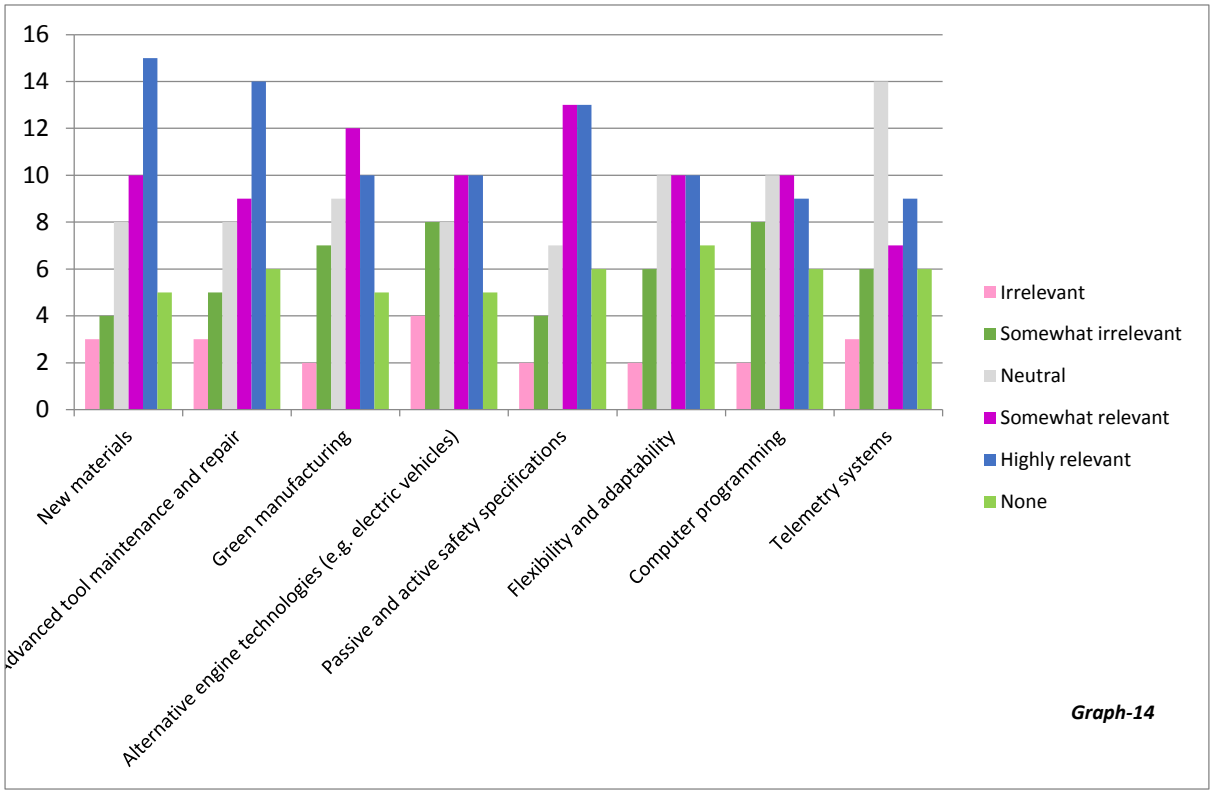
Most skills are rated as 'highly available' and indicates that trade qualifications are available to industry.

The ''advanced specialised technical trade skills' is rated highest in the 'significantly lacking' column. This is typically the platform for artisans to progress to technicians. The rating indicates:

- That even though trade qualifications are mostly available, there are still trades skills and qualifications with specialisations that are lacking. The desktop research specifically points to vehicle painting and panel-beating as some of lacking skills.
- The skills to do fault finding, diagnostics and repairs in specialised functions are lacking (like automotive safety restraint systems; transmissions; multiplex electronics, etc.). This is supported by the interpretations and data of graph-5 and graph-6.

'Lean operations' is lacking as indicated through the unavailable rating (Low available and high lacking), which indicates that artisans' involvement in waste management and work efficiencies require attention.

11.5.2 Future artisan skills



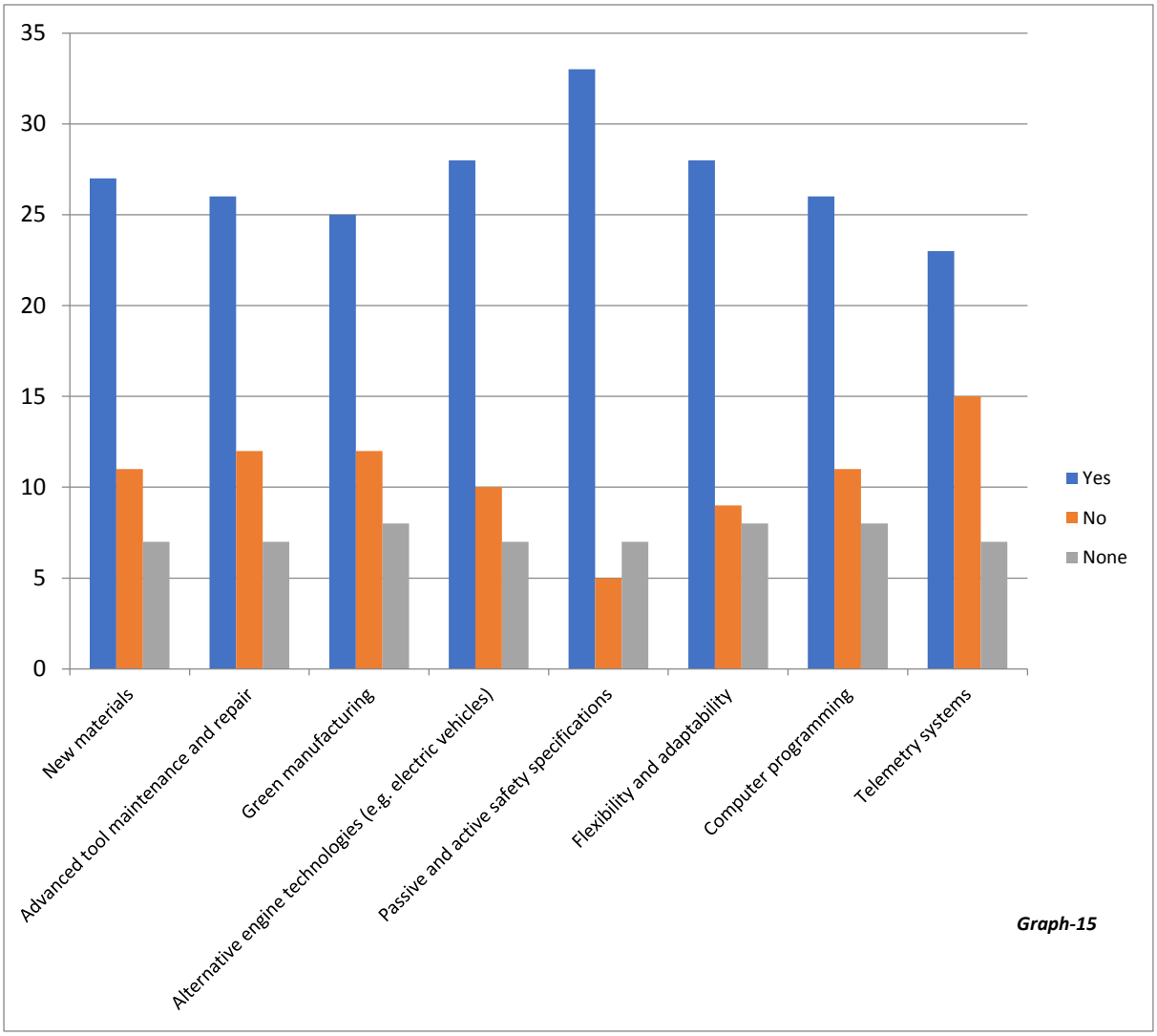
Most of the future skills provided were rated as highly relevant for the future.

'New materials' is the highest rated in the 'highly relevant' column, which indicates that new technologies are changing and that artisans must adapt and learn to work with new technologies. This is supported by the second highest rated skill, 'Advanced tool maintenance and repair', as it features in the 'highly relevant' column

'Alternative engine technologies (e.g. electric vehicles)' has a high uncertainty rating with scattered variances, which indicate that industry is still unsure of how these technologies will affect the industry. Data in the qualitative research (especially in stream-1) shows that these technologies exist and will be entering the market and industry quite aggressively. Hence, both sets of outcomes must be considered and in doing so, there has to be an inclination to prepare artisans for alternative engine technologies with hybrid and electric vehicles.

'Computer programming' and 'Telemetry systems' are rated as irrelevant, which supports the analysis that data interrogation, fault-finding, and diagnostics will mainly be done by technicians and engineers.

11.5.3 Investments and planning considerations for critical artisan skills

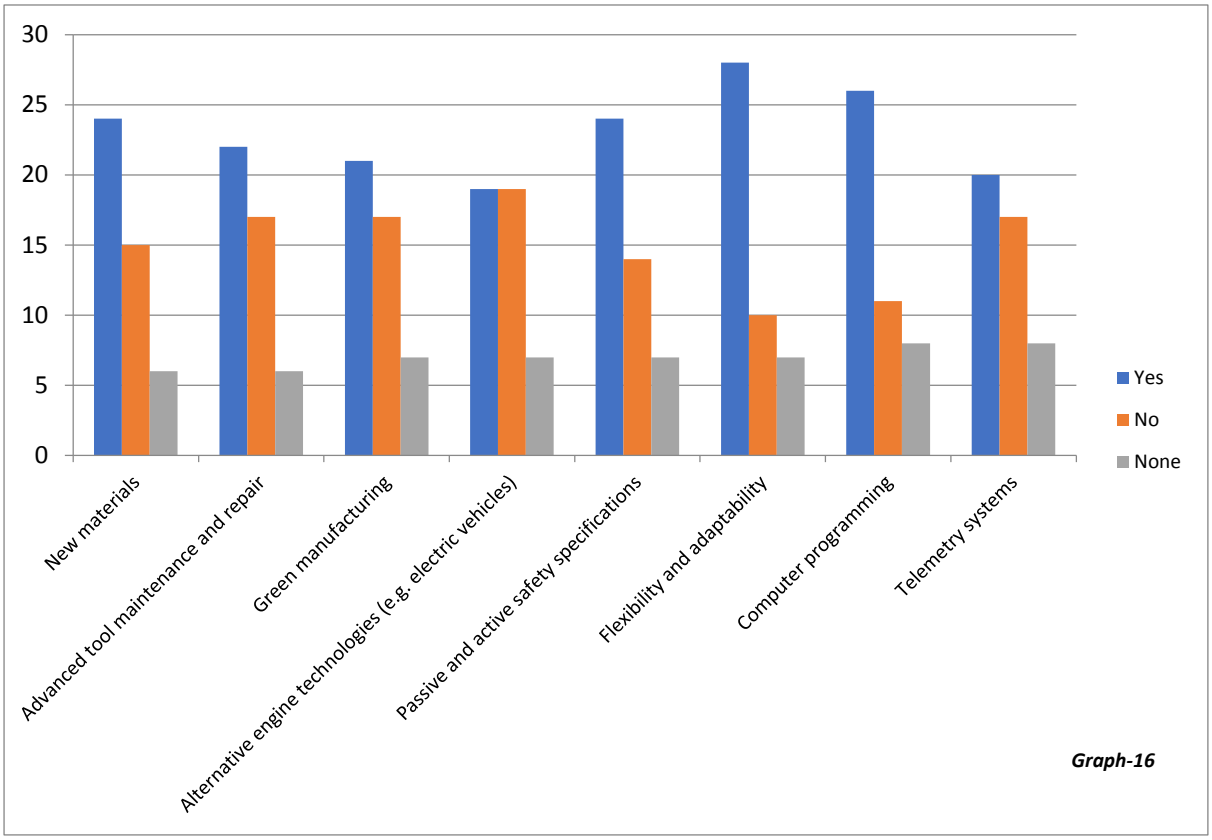


Graph-15

Graph-16 indicates that there is a high training investment in 'passive and active safety specifications' with 'new materials' second on the list; this coincides with the interpretations of graph-13 and graph-14, supporting the need for artisans to work with new technologies. This also supports the data from the desktop research, which suggest that the workforce will be working on components of the trade (as specialist or partly qualified). The 'Suspension Fitter' occupation is an example. However, regulation and the management of accountability still remain as a concern.

The rational of the relatively and equally high investments in 'advanced tool maintenance and repair' and 'computer programming' is another indication that artisan are being developed to become technicians.

11.5.4 Resource availability for critical artisan skills

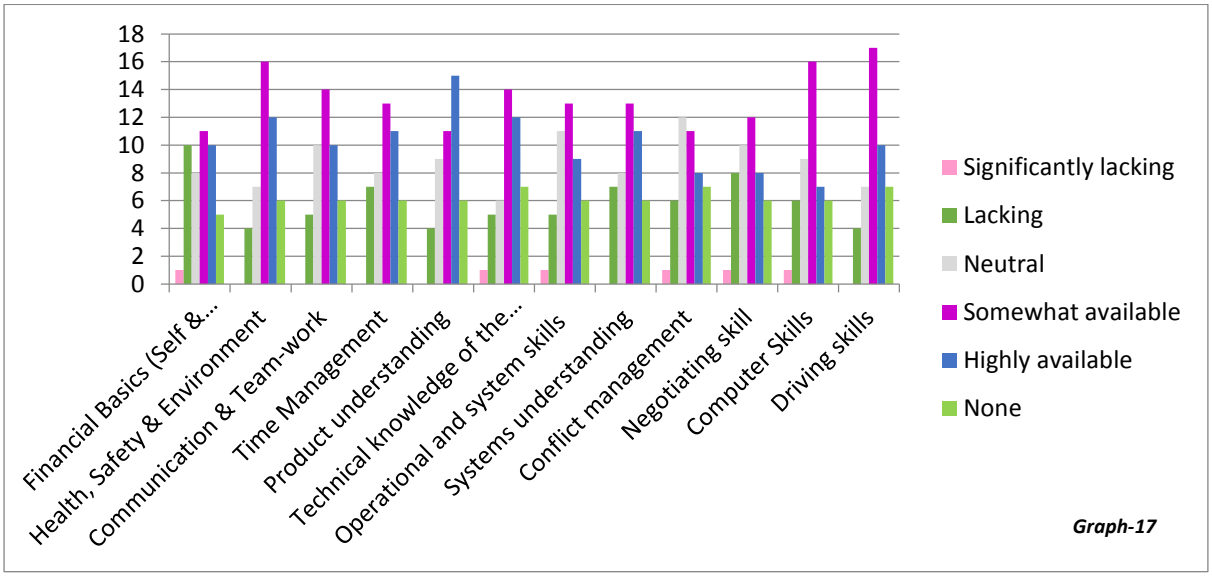


Graph-16

The 'high availability' rating of training resources for 'flexibility and adaptability' development is related to product and OEM training that artisans must undergo to obtain and retain the right to work on OEM approved vehicles. The uncertainty of the future of artisans with regards to 'alternative engine technologies' is further supported by the equal responses of 'yes'- there are training resources and 'no'- there are no training resources available. The clear indications of the unavailability of ''alternative engine technologies' coincides with the analysis in the technological customer service agent based in the workshop.

11.6 Technological customer services agents

11.6.1 Current technological customer services agent skills proficiency



Graph-17

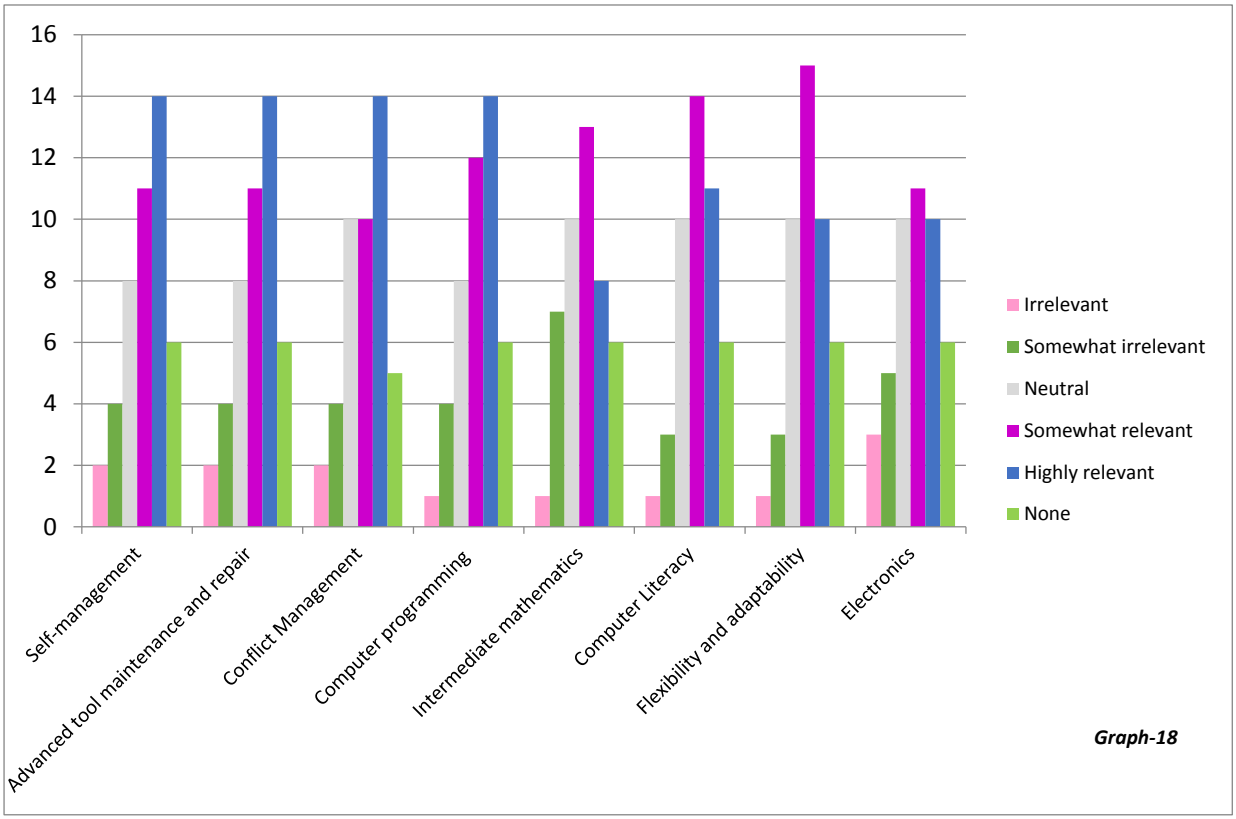
Most of the skills sets provided for the technological customer services agents are 'somewhat available', like driving skills (for particular agents); basic operational computer skills; health, safety & environment and communication skills seem to be the relevant and basic skill for agents to do their work.

'Technical knowledge' is a constant in all Likert rating and seems to be another basic skill that is required by agents. The technical knowledge component should be considered as 'applied technical knowledge' for agents in workshop or as field technicians and as understanding for customer facing agents.

As with most of the skills categories, product knowledge comes up as a skill with the lowest level of proficiency, but it is required by agents on different competency levels to apply themselves in their respective job roles. The future of product knowledge will be of particular importance to customer facing agents, as suggested by stream-1 research and desktop research of the Omni-channel strategy.

The 'financial basics' and 'conflict management' are equally rated; these are soft skills and personal management development skills required for personal wellbeing. The personal management and wellbeing are important for job satisfaction and the retention of agents. The rationale is that most customer service agents are trained in-house: so to retain such resources would contribute to undisruptive operations as well as lessen the burden on internal capacity building and training.

11.6.2 Future technological customer services agent skills



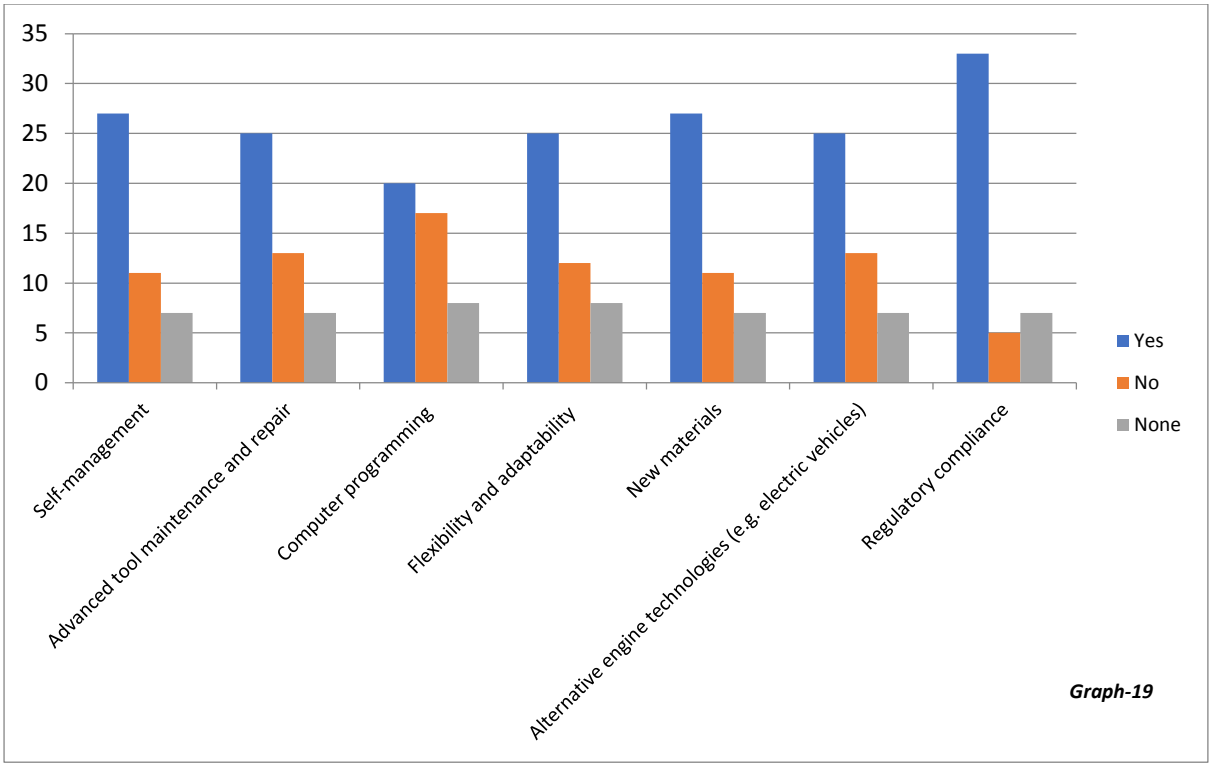
Graph-18

Through the highest rating of 'flexibility and adaptability' in the 'somewhat relevant' column, it is clear that requirements are similar to artisans and technicians. Technological customer services agents have to adapt to the global disruptors and will need to understand and apply themselves in ways that are relevant to their work. This includes needing to have relevant product knowledge, technical skills, and regulatory compliance knowledge.

The 'highly relevant' and the high rating of 'computer literacy' are related to customer interacting staff; where access to information and capturing is prominent. Three out the four rating makes reference to personal wellbeing skills, which highlights the importance agents needing to be satisfied in their jobs in order for businesses to retain those agents. Retaining agents means that businesses do not have to invest in retraining time after time.

The other highly rated skill is 'advanced tool maintenance and repair', which is related to technical skills needed by agents in workshops or field technicians. The lowest rating out of the Likert rating is 'intermediate mathematics', which is supports the qualitative research responses indicating that there is a greater need for mathematics literacy and numeracy.

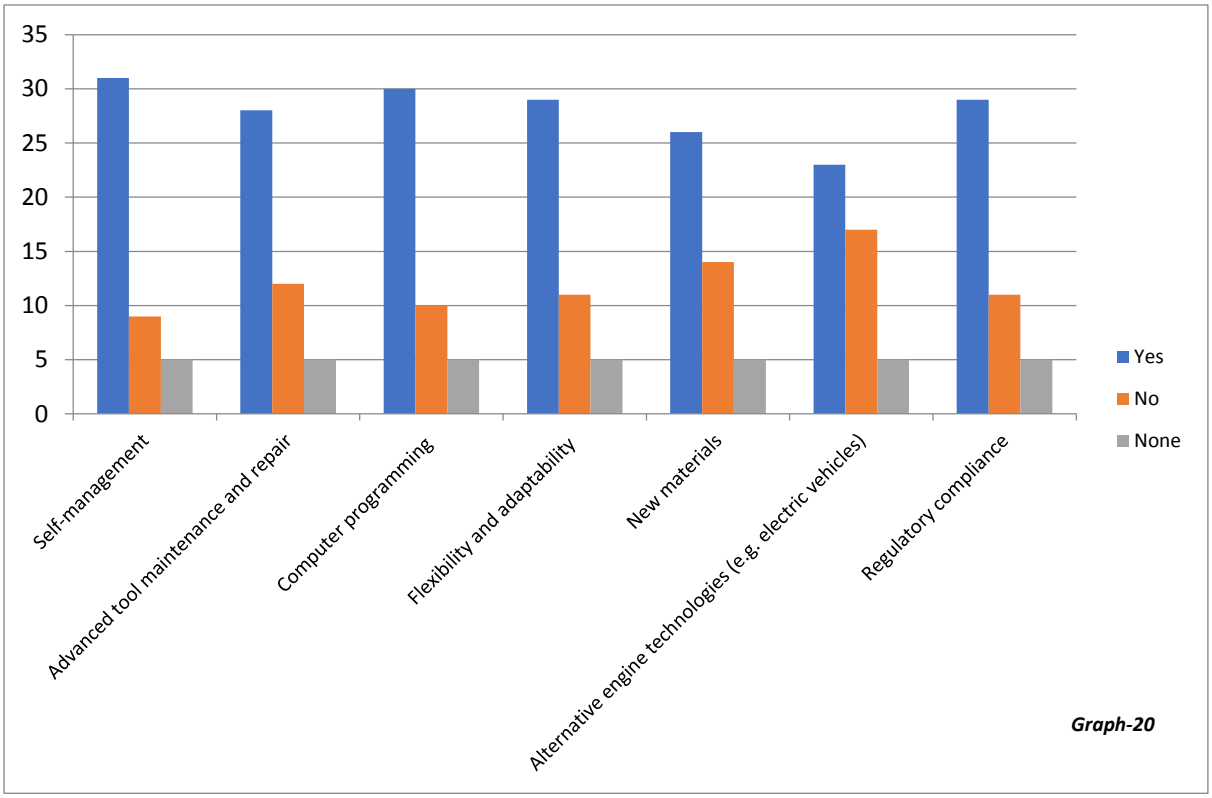
11.6.3 Investment and planning considerations for critical technological customer services agent skills



Graph-19

Graph-19 indicates that there is a high training investment in 'Regulatory compliance'. The second highest investment in 'new materials' coincides with the interpretations of graph-17 and graph-18, supporting the need for agents to work with new technologies and to comply with OEM and regulatory standards. The high rating indicates that computer training is relevant (according to graph-18) for customer facing agents. Coupled with the 'personal wellbeing' interpretations; indications are that computer and systems training is done in-house; on the job and are job specific- not formalised and outsourced. This coupled with consistent responses in graph-17 on 'operational and system skills' and the initiatives to retain agents indicates prominence in internal training resources to provide quality standards and internal training to agents.

11.6.4 Resource availability for critical technological customer services agent skills



The high availability of training resources in 'self-management' initiatives is related to personal wellbeing development and agent retention, which supports the interpretations of graph-17 and graph-18. The clear indications of the unavailability of ''alternative engine technologies' coincides with the analysis in the artisan occupational category.

11.7 Identifying new occupations

11.7.1 Determining the skills development resources that will be required to skill people sufficiently to fulfil future occupations

- Capacity and resources are required by authorities to provide up-to-date learning programmes that can be customised for businesses;
- Learning interventions and content is required that will make the standards of South African skills equivalent to the rest of the world;
- OEM's are the driving force behind CPD, technical and product skills and ways must be found to get the train-the-trainer approach accepted by OEM's, so that skills can be transferred in a more cost-effective manner.
- More needs to be done by authorities to get an accurate measurement of the scarce and critical skills; to embark on effective and directed skills develop;
- There must be a closer relationship between skills and labour authorities to change and adapt to reorganisation of workplaces; and
- The Automotive Industry requires closer collaboration and synergy with regards to the policies and regulation for skills and labour.

11.7.2 Identifying priority skills, occupations and associated sub-sectors based on impacting and timing

Below is the skills analysis on the relevancy of skills in the Automotive Aftermarket Service and Support Industry:

Future skills that be required for the period 2020 to 2035						
Skills	**Managers**	**Professionals (Technicians/ Engineers)**	**Supervisors**	**Artisans**	**Technological customer support Agents**	
					Workshop	**Customer Engaged**
Trade qualifications		√		√		
Product CPD	√	√	√	√	√	√
Millwright				√		
Mechatronics		√				
Train the trainer	√	√	√	√	√	√
Global thinking and insights	√					
Data analysis, fault finding and diagnosis		√		√		
Organisational Development	√					
Lean operations		√		√		
Advanced specialised technical trade skills				√		
New materials and technologies		√		√	√	
Alternative engine technologies		√		√	√	
Mathematics literacy and numeracy			√		√	√
Occupational part qualifications			√	√	√	√
Business information computer training						√
Operational processes and systems	√	√	√	√	√	√
Road side assistant call centre agent skills						√
Road side assistance field technician skills						√
Skills that will become redundant during the period 2020 to 2035						
Skills	**Managers**	**Professionals (Technicians/ Engineers)**	**Supervisors**	**Artisans**	**Technological customer support**	
					Workshop	**Customer Engaged**
Oxy-Acetylene welding/Gas welding				√	√	
Lead filling				√	√	
Fitter				√		
Intermediate mathematics			√		√	√

11.8 Recommendations to guide skills development and labour directives pertaining to automotive dealer and distribution establishments

- MerSETA needs to consider ways of consolidating initiatives between the Automotive Industry Chambers, namely, Automotive Chamber, Motor Chamber and New Tyre Chamber.
- Department of labour and labour authorities need to consider ways of regulating the automotive industry in a uniform manner.
- Skills authorities need to find ways of keeping skills development initiatives relevant to industry needs, align training to industry norms and standards and ensure that skills development initiatives are ‘world class’.
- Skills and labour authorities need to work together to do regular continuous action research within automotive industry; to understand how skills and occupations change and to respond.

JOINT CONCLUSION AND FINDINGS

This final report has surveyed the literature relating to the disruptive effects of new technology on global automotive value chains. The two parallel Research Streams of Tier 1 automotive manufacturers and automotive aftermarket services and support providers have each sought to understand the likely impact of these GVC disruptors on the current skills profile of the domestic motor industry, and to anticipate the future skills development initiatives that will be needed to maintain South Africa's global competitiveness position. This analysis has in turn been viewed through the prism of the South African Automotive Master Plan framework in order to anticipate the industrial policy responses that will be required, and the related policy considerations for human capital and skills development.

Research findings reveal that significant investments in skills development will be needed across various job categories, particularly in the areas of new materials design, electronics and mechatronics (to respond to the rapidly emerging trend of EEVs and light-weighting). Process technology will be deeply affected by the rise of machine learning and artificial intelligence, and the trend towards automation is likely to accelerate. Given SA producers' reliance on a large, low-skilled workforce comprised primarily of production workers / operators, this job category will become increasingly vulnerable to disruption, and even displacement. South Africa's already low contribution in terms of production volumes, value addition, and levels of domestic content in locally assembled vehicles is clearly a vulnerability; particularly as value addition becomes progressively concentrated in the hands of the international OEMs and the related automotive branding, sales, and aftermarket service providers.

The stringent nature of modern regulatory requirements will have a significant effect on automotive production in South Africa. Regulators in developed markets, and by extension, OEMs, are likely to continue pushing ever more onerous compliance obligations onto global suppliers, and SA's skills training programmes should seek to align local producers with these requirements. Similarly, the growing demand for high-level ICT and quantitative reasoning skills will require local skills authorities to invest in relevant training programmes to fill the skills gaps that are currently evident in this area.

On the policy level, the MerSETA should consider ways of coordinating its various initiatives between the Automotive Industry Chambers (i.e. the Automotive Chamber, Motor Chamber and New Tyre Chamber). In conjunction, the Department of Labour and other relevant labour authorities will also need to consider ways of regulating the automotive industry in a more harmonised fashion. It is evident that skills must be used as a component of job grading, but the accountability; complexity and description of work as well as the administrative processes must also be considered. Moreover, skills authorities should find ways of keeping skills development initiatives relevant to new technological trends, while ensuring that these initiatives align South African producers and automotive services providers with international standards. As highlighted throughout the report, skills and labour authorities will need to collaborate and conduct regular research into the dynamic skills requirements of the automotive industry to understand how skills and occupations are changing, and to respond accordingly.

The economic and social consequences of the disruptive trends outlined in this report are potentially dire. Conversely, opportunity exists to get ahead of the technology curve by making the necessary interventions as soon as possible, to ensure South Africa's ongoing competitiveness in the global automotive industry.

REFERENCES – Research Stream I

- Arbib, J. & Seba, T. (2017) "Rethinking Transportation 2020-2030 The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries" Rethink X
- Automotive Supply Chain Competitiveness Initiative (2017): "High Level Skills Framework"
- Barnes, J. (2017): "GVC disruptors and the South African automotive industry" Durban Automotive Cluster (DAC) Executive Development Programme (workshop); B and M Analysts
- Barnes, J. & Black, A. (2017): "Developing a South African automotive Masterplan to 2035 in the context of Global Value Chain drivers: Lessons for second tier automotive economies," paper prepared for the GERPISA Colloquium, Paris, France
- Barnes, J., Black, A., Comrie, D. & Hartogh, T. (2016) "An analysis of the South African automotive industry status quo"
- Barnes, J., Black, A., Comrie, D. & Hartogh, T. (2017) "Geared for Growth South African automotive industry masterplan to 2035: Report 4 of 4 of the South African Automotive Masterplan Project"
- Blackrock Investment Institute (2017): "Future of the vehicle: Winners and losers - from cars and cameras to chips"
- Bloomberg New Energy Finance (2017) "Electric Vehicle Outlook 2017 – Executive Summary"
- Cameron, I. (2015): "Skills needs in the changing global manufacturing landscape," SMMT Industry Forum Ltd
- Centre for Automotive Research (2011), "Automotive Technology: Greener Products, Changing Skills – Lightweight Materials & Forming Report"
- Centre for Automotive Research (2013) "Automotive Employment & Skills Needs Outlook"
- Collins, Richard (2017), "Composite materials for the automotive sector - who needs who more?" IDTechEx: https://www.idtechex.com/research/articles/composite-materials-for-the-automotive-sector-who-needs-who-more-00011640.asp
- Durban Automotive Cluster, Executive Development Programme (October 2017) "GVC disruptors and the South African automotive industry"
- European Parliament and Council Directive 2000/53/EC on End of Life Vehicles (2000) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000L0053-20130611&qid=1405610569066&from=EN
- Thyagarajan, H. (2018), "The Impact of Digitization in Automotive Manufacturing" Hashed In https://hashedin.com/impact-digitization-automotive-manufacturing/
- McKinsey (2012), "Lightweight, heavy impact: How carbon fiber and other lightweight materials will develop across industries and specifically in automotive"
- McKinsey Global Institute (2016) "Automotive revolution – perspective towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry"
- McKinsey Global Institute (2017), "Jobs lost, jobs gained: Workforce transitions in a time of automation"
- McKinsey (2018), "Artificial intelligence: automotive's new value-creating engine"
- NAAMSA (2013-2016); AIEC (2012-2016). Cited in Barnes, et al (2016) "South African automotive industry Masterplan to 2035 Phase 1 report: An analysis of the South African automotive industry status quo"
- National Productivity Commission (of the Australian Federal Government) (2013), "Australia's
  Automotive Manufacturing Industry: Productivity Commission Preliminary Findings Report" cited in Sturgeon, T., Chagas, L. & Barnes, J. (2017): "Inovar Auto: Evaluating Brazil's Automotive Industrial Policy to Meet the Challenges of Global Value Chains" World Bank

- OICA, production statistics (2017)
- OICA vehicle sales statistics (2005 – 2017) http://www.oica.net/category/production-statistics/2017-statistics/
- PWC (2013), "The highway to growth: Strategies for automotive innovation"
- Reuters (9 Jan 2018), "Samsung Electronics unveils driverless car parts, infotainment platform" https://www.reuters.com/article/us-samsung-elec-harman/samsung-electronics-unveils-driverless-car-parts-infotainment-platform-idUSKBN1EY0D6
- Reuters (10 July 2017): "Nissan expects up to 20 percent of Europe sales to be zero emission cars by 2020" https://www.reuters.com/article/us-nissan-sales/nissan-expects-up-to-20-percent-of-europe-sales-to-be-zero-emission-cars-by-2020-idUSKBN19V28R
- Reuters (24 June 2016): "Collaborative robots open new fronts in automation" https://www.reuters.com/article/us-robots-collaborative/collaborative-robots-open-new-fronts-in-automation-idUSKCN0Z920S
- Stats SA. (2016). Statistics South Africa. Manufacturing Employment Data. www.statssa.gov.za Cited in Barnes, et al (2016) "South African automotive industry Masterplan to 2035 Phase 1 report: An analysis of the South African automotive industry status quo"
- Stratistics MRC (2017) "Automotive Infotainment Systems - Global Market Outlook (2017-2023)"
- The Economist (11th March 2017) "Recasting steel"
- UK Automotive Council (2016) "Employers' Views of the Jobs and Skills Required for the UK Automotive Industry"
- White, J. & Ellis, S. (2017): "Supplier skills needs assessment and leadership needs analysis project" Automotive Supply Chain Competitiveness Initiative (ASCCI)
- World Economic Forum (2018), "Electric Vehicles for Smarter Cities: The Future of Energy and Mobility"
- World Economic Forum (2017), "The Future of Jobs and Skills in Africa: Preparing the Region for the Fourth Industrial Revolution"
- World Bank (2016) "World Development Report 2016: Digital Dividends"

REFERENCES – Research Stream II

- Venter, I. (2016): "Auto industry, Numsa conclude new three-year wage deal" http://www.engineeringnews.co.za/article/auto-industry-numsa-sign-new-three-year-wage-deal-2016-09-09/rep_id:4136
- Cokayne, R. (2017): "Millions depend on SA's motor industry" https://www.iol.co.za/business-report/economy/millions-depend-on-sas-motor-industry-8020463
- Brand South Africa. (2014): "South Africa's economy: key sectors" https://www.brandsouthafrica.com/investments-immigration/economynews/south-africa-economy-key-sectors
- Morrissey, R.; Stricker, K.; Tsang, R.; & Zayer, E. (2017): "The Future of Car Sales Is Omnichannel" http://www.bain.com/publications/articles/the-future-of-car-sales-is-omnichannel.aspx
- Ernst & Young. (2015): "Future of Automotive Retail" http://www.ey.com/Publication/vwLUAssets/EY-future-of-automotive-retail/$FILE/EY-future-of-automotive-retail.pdf
- Frieda, K. (2017). "6 Keys to the Car Dealership of the Future from NADA 2017" https://www.digitaldealer.com/6-keys-car-dealership-future-nada-2017/
- Kessler, S. (2017): "The connected car of the future could kill off the local auto repair shop" https://qz.com/1054261/the-connected-car-of-the-future-could-kill-off-the-local-auto-repair-shop/
- McKinsey & Company. (2014): "Innovating Automotive Retail" https://www.mckinsey.de/files/brochure_innovating_automotive_retail.pdf
- Singh, S. (2015): "Future of Automotive Aftermarket and Car Servicing: Consumers will have more channels to shop around" https://www.forbes.com/sites/sarwantsingh/2015/06/02/future-of-automotive-aftermarket-and-car-servicing-consumers-will-have-more-channels-to-shop-around/#6606ddab27f8
- Antich, M. (2015): "Fleet Management 2025 Forecast: Vehicle Maintenance" http://www.automotive-fleet.com/article/story/2015/01/fleet-management-circa-2025-trends-in-fleet-vehicle-maintenance.aspx
- Parkin, R.; Wilk, R.; Hirsh, E. & Singh, A. (2017): "Automotive Trends" https://www.strategyand.pwc.com/trend/2017-automotive-industry-trends
- Wheels24. (2017): "5 things you should know about the SA car industry" http://www.wheels24.co.za/News/SA_vehicle_sales/5-things-you-should-know-about-the-sa-car-industry-20170705
- KPMG. (2016): "Automotive Executive Survey 2016" https://home.kpmg.com/za/en/home/industries/automotive.html
- De Lange, R (City Press). (2017: "R256.7 billion – the vehicle industry's massive GDP contribution" https://city-press.news24.com/Business/r2567-billion-the-vehicle-industrys-massive-gdp-contribution-20170310
- Bottyan, K. (2017): "Scarce Skills in South Africa 2017" http://teenzonemagazine.co.za/scarce-skills-south-africa-2017/
- Duxbury, P. (2017): "The Future of the Auto Mechanic is...Clean" https://www.mtawa.com.au/membership/member-communication/latest-news/item/3005-the-future-of-the-auto-mechanic-is-clean.html
- OICA. Economic Impact. http://www.oica.net/category/economic-contributions/

- NAAMSA (2017): "NAAMSA Media release) http://www.naamsa.co.za/papers/2017_1stquarter/NAAMSA_QUARTERLY_REVIEW_1STQUARTER2017.pdf
- Researcher information used for Overview picture: https://www.google.co.za/search?q=illustration+of+an+automotive+OEM+multinational+setup&tbm=isch&tbs=rimg:CabWiduLmHPVIjiYL_1c_1oMioe6PlXrnod7RWnRz-YvEZUv4HC66AnFcvyse2fcgxkC11T8w276Y238IlqXMZvkOGUSoSCZgv9z-gyKh7EYqabl8DUCeKKhIJo-Veueh3tFYRcZ1_1IEq2A28qEgmdHP5i8RlS_1hEVlfPvE3a-MCoSCQcLroCcVy_1KEYaDf_11MkTXXKhIJx7Z9yDGQLXURnCkNCTpduRUqEglPzDbvpjbfwhGuKbMeieFGwSoSCSWpcxm-Q4ZREecw59smdFGG&tbo=u&sa=X&ved=2ahUKEwi12-WqqLLaAhVGOxQKHRpBCmEQ9C96BAgAEBs&biw=1745&bih=855&dpr=1.1#imgrc=_

APPENDIX A – Qualitative research participants (Tier 1 automotive manufacturers)

Organisation	Name	Designation	Location	Date
TI Automotive	Anthony Kreiner	Human Resources Manager	Pretoria	19 Feb 2018
TI Automotive	Andrew Drake	Plant Manager	Pretoria	19 Feb 2018
TI Automotive	Arrie Vermeulen	Application Engineer	Pretoria	19 Feb 2018
Acoustex	Rowan von Benecke		Port Elizabeth	21 Feb 2018
Acoustex	Thandi Mabiza	HR Consultant	Port Elizabeth	22 Feb 2018
Adient	Glen Klopper	Regional HR Director	Port Elizabeth	22 Feb 2018
Lumotech	Leon Stoltz	General Manager: HR	Port Elizabeth	22 Feb 2018
Lumotech	Gerald Pietersen	Training Manager	Port Elizabeth	22 Feb 2018
Faurecia	Nolubabalo Noqobo	HR	Port Elizabeth	22 Feb 2018
Groupo Antolin	Joanne Ashburner	HR Manager	Port Elizabeth	22 Feb 2018
Duys Components Manufacturers	Bongiwe Sithole	HR	Durban	27 Feb 2018
Duys Components Manufacturers	Jason Kista	Industrial Engineer	Durban	27 Feb 2018
KAP Automotive (Feltex)	Malcolm Nadaraju	Plant Manager	Durban	27 Feb 2018
Brace Able Manufacturing	David Davies	Operations Director	Durban	27 Feb 2018
National Tooling Initiative Program	Praneel Avadianund	Technical Coordinator	Durban	27 Feb 2018
Production Logix (Pty) Ltd	Shilpa Mehta	Director	Durban	27 Feb 2018
Production Logix (Pty) Ltd	Anton Van Rensburg	Technical Manager	Durban	27 Feb 2018
Production Logix (Pty) Ltd	John Goncalves	Director	Durban	27 Feb 2018
Production Logix (Pty) Ltd	Nhlanhla Ngubane	Human Resources Administrators	Durban	27 Feb 2018
Smiths Manufacturing	Luke Jevon	Specialist- Aftermarket Service	Durban	27 Feb 2018
National Tooling Initiative Program	Varsho Dookie		Durban	27 Feb 2018

APPENDIX B – Quantitative research participants (Tier 1 automotive manufacturers)

Organisation	First Name	Last Name	Designation
Acoustex	Thandi	Mabiza	Other
Acoustex	Rowan	von Benecke	Other
Acoustex	Mark	Hartslief	Operations director
Acoustex	Brett	Wilkinson	Technical/product manager
Action Bolt	Luke	Hattingh	Other
Altech Netstar	William	Murray	General manager
Altech UEC South Africa	Andre	Schwager	Technical/product manager
Auto Industrial Group	Andrea	Moz	Other
Brenntag SA	Leandri	Steyn	Other
Brink Towing Systems	Mark	Gutridge	Other
Croatia High Precision Engineering	Ronell	Kraljevic	General manager
Duys Component Manufacturers	Henk	Duys	Other
Duys Component Manufacturers	Bongiwe	Sithole	HR director/manager
Foxtec-Ikhwezi	Leigh	Briggs	General manager
Hesto Harnesses	Khanya	Vilakazi	Other
Jamsco Automotive Assemblies	Hayley	Eagle	Operations director
Linde + Wiemann Rsa	Oscar	Gonzalez	Operations director
Lumotech	Gerald	Pietersen	Training manager
NAACAM	Ophay	Chawane	Other
National Tooling Initiative Program	Praneel	Avadianund	Other
Schaeffler	Marshal	Myburgh	General manager
Senior Flexonics	Anthony	Mancini	General manager
Shatterprufe	Valda	Bezuidenhout	HR director/manager
Smiths Manufacturing	Luke	Jevon	Technical/product manager
TI Automotive	Anthony	Kreiner	HR director/manager
TNT Performance Exhaust Systems	Michelle	Botes	Other
Torre Parts and Components	Rajesh	Orie	Other
Webroy	Rob	Royston	Operations director
WEIDPLAS South Africa (Pty) Ltd	David	Krumbock	General manager

APPENDIX C - Qualitative research participants (Automotive aftermarket services and support)

Organisation	Name	Designation	Location	Date
KIA South Africa	Marnus Van Wyk	Product Manager	Johannesburg (Focus Group)	19-Feb-18
BMW South Africa	Nathaniel Gounden	Product and Technical Trainer		
TTi-Global	Corne Viviers	Maintenance and Technical Service Manager Support for Volvo, Jaguar, Landrover, Citroen, Chrysler		
TTi-Global	Mary-Ann Prince	Maintenance and Technical Training Manager Support for Volvo, Jaguar, Landrover, Citroen, Chrysler		
BASF	Marius Nel	Training Manager		
FAW Assembly Plant	Ashley Main	HR Manager	Port Elizabeth	21-Feb-18
FAW Assembly Plant	Haiyang Yao (Yang)	Administration Manager	Port Elizabeth	21-Feb-18
VW South Africa	Riaan Stander	Product and Technical Manager	Uitenhage- Port Elizabeth	22-Feb-18
VW South Africa	Michael Robinson	Assistant Product and Technical Manager		22-Feb-18
VW South Africa	Gerald Hooper	Technical Training Centre Manager		22-Feb-18
TTi-Global	Corne Viviers	Maintenance and Technical Service Manager Support for Volvo, Jaguar, Landrover, Citroen, Chrysler	Johannesburg	23-Feb-18
TTi-Global	Mary-Ann Prince	Maintenance and Technical Training Manager Support for Volvo, Jaguar, Landrover, Citroen, Chrysler	Johannesburg	23-Feb-18
TTi-Global	Aubrey Ross Allen	Training Centre Manager and Multi-franchise OEM Body Repair Training Manager	Johannesburg	23-Feb-18
Phoenix Technica School of Toyota	Daniel Vallihu	Head of Technical Training Department	Durban	27-Feb-18
Toyota South Africa	Samantha Visagie	Plant HR Manager	Durban	27-Feb-18
Toyota South Africa	Owen Dickson	Product Training Manager	Durban	27-Feb-18
ABS	Eddie Da Silva	CEO	Midrand	05-Mar-18
Technicolour	Jeanne Esterhuizen	CEO	OR Tambo International	09-Mar-18
D-Motors	Diana Esdar Pfeffer	CEO	Alberton	09-Mar-18
Porsche South Africa	Marco Cabula	Bodyshop Manager	Paulshof	19-Mar-18

APPENDIX D – Quantitative research participants (Automotive aftermarket services and support)

First Name	Last Name	Organisational function	Organisation Name	Approximately how many employees does your company have in total
Neil	Bosman	HR director/manager	Bidvest McCarthy	250 or more employees
Nico	Haasbroek	Other (please specify)/ Aftermarket Manager	Maemo Motors (PTY) Ltd	50 to 249 employees
MARINA	PARKER	Other (please specify)/ Business Administration	JOHN PARKER AUTO SALES CC	1 to 4 employees
Phil	Cells	Other (please specify)/ Key Account Manager	Leaderquip Auto Services	10 to 49 employees
Thabo	Sobeya	Other (please specify)/ Managing Director	SOBEYA TRADING AND PROJECTS (PTY) LTD	1 to 4 employees
Jared	Moore	General manager	TM Trucking	10 to 49 employees
Ronel	Fourie	HR director/manager	FAW	50 to 249 employees
Tarryn	Elliott	Other (please specify)/ HR Manager	Giorgio Express Auto Body Repairs	10 to 49 employees
Burgert	van der Walt	General manager	Victory Ticket 838cc T/A EDEN Coachworks Auto Body Repair Specialists	10 to 49 employees
Knapie	Swanepoel	HR director/manager	Swan Craft Panelbeaters	10 to 49 employees
Marco	Cabula	General manager	Porsche Centre Johannesburg	50 to 249 employees
Lynne	Roux	HR director/manager	Annrob Motors	10 to 49 employees
Gail	Blochlinger	Other (please specify)/ Administrator/ Reception/ Assessor	Titanium Body Works	10 to 49 employees
GORDON	MCManus	General manager	MCMANUS NISSAN VRYHEID	10 to 49 employees
Clive	Thompson	Operations director	thompson motors	10 to 49 employees
Cecily	van der Westhuizen	Financial manager	Nisren (Pty) Ltd t/a Oudtshoorn Nissan and Renault	10 to 49 employees
Steve	Kessell	Operations director	Collision Repairers Association (CRA)	250 or more employees
Sandy	Meyer	General manager	Premier Panelbeaters	5 to 9 employees
Carmen	Marques	HR director/manager	Steimar Automotive and Industrial Refinishers (Pty)Ltd	10 to 49 employees
KOENIE	NIEMAND	Financial manager	DME AUTOBODY REPAIRS CC	10 to 49 employees
Fanus	de Swart	General manager	GPH Auto Body Shop	10 to 49 employees
johan	heyns	General manager	revamp body shop	10 to 49 employees
Eve	Pearson	HR director/manager	Louis Auto Body Repairs	5 to 9 employees
Elsie	Bezuidenhout	Other (please specify) HR Administrator	Botha & Deysel Motors 101	10 to 49 employees
Suzette	maass	HR director/manager	WESTVAAL MOTOR HOLDINGS	250 or more employees
LINDI	VERMEULEN	Other (please specify) Business Administrator	DAL PANEELKLOPPERS	10 to 49 employees
PETRO	LE ROUX	HR director/manager	CERES LANDBOU MIDAS	10 to 49 employees
Sandra	de Gouveia	HR director/manager	Classiq Autobody	10 to 49 employees
Maria Vuyiswa	Bengu	HR director/manager	Siphumele Panel beaters	5 to 9 employees
Francois	van Zyl	HR director/manager	Van Zyls auto	1 to 4 employees
Andre'	Botha	General manager	Trucktec Southern Africa PTY Ltd	5 to 9 employees
Andile	Mbentse	Training manager	Bluespec Holdings (Pty) Ltd	250 or more employees
Sarah	smit	Other (please specify) Administrator/ Bookkeeper	dent doctor hennopspark	10 to 49 employees
Phyllis	Knight	Other (please specify)/ Business Administrator	Pro West Car Sales	5 to 9 employees
Ida	Petersen	HR director/manager	JL Panelbeaters	10 to 49 employees
Riaan	Oelofse	General manager	N6 Panelbeaters	10 to 49 employees
ALTA	NICHOLSON	HR director/manager	AUTOCAR PANEL BEATERS & BREAKDOWN CC	10 to 49 employees
ELSIE	PIENAAR	HR director/manager	ABEL PIENAAR PANEL BEATERS	10 to 49 employees
Jackie	Van Wyk	General manager	Quantum Coachworks	10 to 49 employees
Dushern	Behari	HR director/manager	Mortprop(Pty)Ltd T/A Farm Maintenance Services	10 to 49 employees
SHAHEEN	MOHAMED	General manager	TIGER WHEEL AND TYRE KIMBERLEY	10 to 49 employees
Warren	Hardman	Financial manager	Pandoras Motors cc T/As Ballito Auto Body and Restoration	10 to 49 employees
UVASHEN	BRAMIAH	Operations director	TCTS AUTOBODY	1 to 4 employees
Maggi	Bothma	General manager	Precision Panelbeaters	5 to 9 employees
Sonja	Smit	HR director/manager	Accident Guru	10 to 49 employees