Preparing for the Future in the Automotive Sector Education

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Abstract

The automotive industry is undergoing rapid transformation driven by advances in vehicle technology, transport systems, and changing mobility preferences. These developments are reshaping the knowledge and skills required for vehicle maintenance, repair, and sales, with significant implications for vocational education. The transition from petrol and diesel vehicles to electric powertrains demands substantial changes in energy infrastructure, while increasing vehicle automation alters driver roles and introduces new requirements for automotive services.

Within the AutoCove 2.0 project, key trends in the automotive sector, including powertrain diversification, advanced driver assistance systems, and automation, were analysed alongside differences in national vehicle fleets. A Europe-wide survey of automotive educators and industry representatives revealed the most pronounced knowledge gaps in emerging technologies such as hydrogen systems and vehicle automation, as well as in generic IT, language, and information-seeking skills.

To address these gaps, industry, educational institutions, and research organisations are collaboratively developing future-oriented training courses delivered via an online learning platform. The courses are aligned with European Qualifications Framework levels and will be freely available for five years.

Keywords: skills-gaps; education; electrification; CCAM; hydrogen

1 1 Introduction

The automotive industry is undergoing significant transformation because of advancements in vehicle technology, powertrain development, and evolving mobility preferences. These shifts are directly influencing the knowledge base and skill sets required for vehicle maintenance, repair, and sales, thereby shaping the demands placed on vocational education and the expertise of educators [1, 2, 3]. The transition from traditional petrol and diesel vehicles to hybrid and fully electric models necessitates considerable adjustments to energy infrastructure and the broader energy system [4, 5,

6]. The inherent structural differences between battery electric vehicles (BEVs) and conventional vehicles require changes in maintenance services, particularly regarding the spare parts and accessories that must be replaced throughout the lifecycle of an electric vehicle to ensure optimal performance [7]. Furthermore, developments in vehicle automation [8, 9] are expected to alter the responsibilities of drivers and create new requirements for vehicle maintenance and sales [10, 3].

2 Changes in Well-Established Field

Ongoing advancements in vehicle powertrains and the growing prevalence of advanced driver assistance systems, and eventually automation, present new challenges for the automotive industry, particularly regarding the skills required of maintenance and sales personnel. Over the past century, extensive understanding and established practices have developed around the operation and use of conventional motor vehicles [11, 12]. These established habits strongly influence societal attitudes towards and usage of motor vehicles. The integration of alternative propulsion technologies necessitates adaptations in these behavioural patterns, with the extent of change dependent on how widely the new technologies are adopted [13].

3 3 Skills-Gaps Analysis

3.1 Background

The automotive sector plays a vital role in driving both the European economy and technological advancement. As the industry undergoes continual transformation and innovation, it is imperative that the workforce adapts to evolving demands [7]. Nevertheless, even with ongoing progress and technological breakthroughs, the automotive economy continues to encounter a significant obstacle: the skills gap. This issue increasingly stands out as one of the principal challenges for businesses and educational institutions within the automotive field [14, 15].

Skills-gaps refer to the disparities between the competencies present in the labour force and those demanded by the economy [16, 17]. These variances between actual skills and required qualifications not only contribute to imbalances in the labour market, but also hinder organisational efficiency, stifle innovation and competitiveness, and may impede progress towards a greener European transport system.

Technological advancements in the automotive sector are expected to significantly influence the competencies required of personnel in vehicle maintenance, repair, and sales. This, in turn, will have implications for educational programmes within these professions. The transition from one technology to another directly alters the necessary knowledge and skill sets; as outdated technologies are replaced, related expertise may

become partly obsolete. Concurrently, the adoption of new technological solutions introduces additional requirements for updated knowledge and skills. [13]

3.2 Methodology in AutoCove

Vehicle automation is expected to redefine the responsibilities of drivers and prompt significant changes in vehicle maintenance, repair, and sales processes. Beyond the direct implications for required skills and expertise, it is important to consider secondary effects, such as transformations within the energy sector and evolving business models among stakeholders. To support the AutoCove project's assessment of skill gaps, a structured framework (see Figure 1) has been developed.

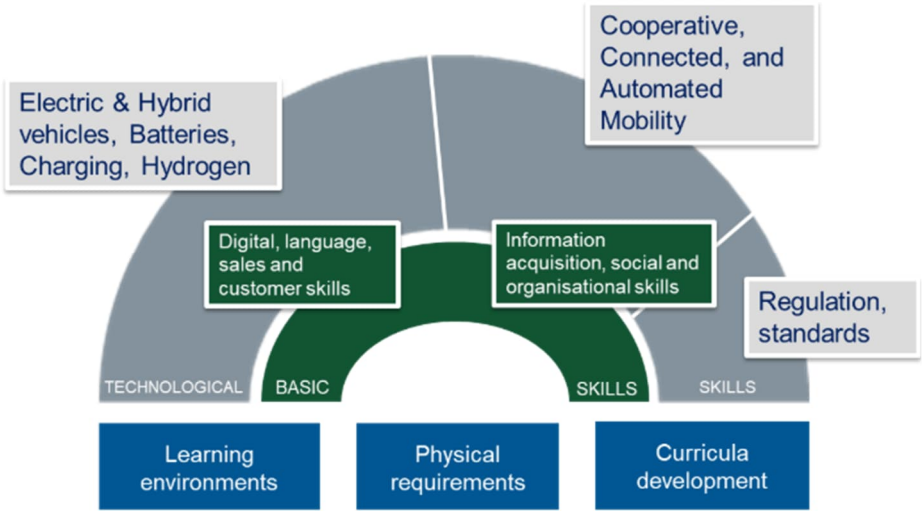

Figure 1. Framework for skills-gaps analysis in AutoCove. [modified from 18]

The framework served as the foundation for designing a comprehensive skills-gaps survey targeting automotive field educators and industry stakeholders across Finland, Estonia, Latvia, Lithuania, Germany, France, and the Netherlands. The analysis of survey responses aimed to address the following key research questions (RQs):

1) Which vehicle technology sectors are presently experiencing a skills-gap, or are likely to face one within the next five years? (RQ1)
2) To what extent is the identified skills-gap evident among teaching, sales, and maintenance personnel? (RQ2)
3) What fundamental competencies are required or prove beneficial for professionals in teaching, sales, and maintenance roles involving emerging vehicle technologies? (RQ3)

4) In what ways do skills-gaps differ across various service and maintenance organisations? (RQ4)

A web-based survey was developed to address the research questions. The survey consisted of the following sections:

- Part 1 – Background information
- Part 2 – Current and future technological skills and competencies relevant to the profession
- Part 3 – Current and future non-technological skills and competencies relevant to the profession
- Part 4 – Significance of information sources for the respondent's position
- Part 5 – Educational background and previous training

3.3 3.3 Main Results of the Skills-Gaps Analysis

In total, 375 responses were collected via an online survey (webropol) across Finland, Estonia, Latvia, Lithuania, Germany, France, and the Netherlands. Participants were recruited through the project partners' existing networks within educational institutions and sales organisations. As recruitment was based on convenience sampling, the dataset is not a random sample and the findings should be interpreted accordingly. Nevertheless, this approach enabled rapid data collection, and the country-level responses were considered to reflect the perspectives of the partner organisations. Responses comprised 47% industry professionals and 53% educators in the automotive sector. [19]

Analysis of technical competency for sales and maintenance roles indicates significant variation in skill-gaps across countries and job categories. Employees associated with specific industry brands tend to report fewer competency gaps, whereas those occupying more general positions experience substantially larger deficits. This pattern is particularly pronounced in the maintenance sector, where considerable skill-gaps are observed across nearly all technologies. Project insights from an original equipment manufacturer (OEM) revealed that industry brands frequently offer comprehensive training programmes designed to align personnel capabilities with field requirements. [19]

For educators, the range of skills-gaps is notably broad. In Germany and the Netherlands, skill shortages tend to be minor or moderate. Conversely, more substantial gaps are evident in Finland, France, and Estonia, particularly concerning vehicle communication systems and regulatory expertise. Latvia demonstrates the most pronounced deficiencies, with nearly all areas of competence affected. [19]

Across all occupational categories, three technical fields consistently present the greatest challenges: batteries and charging systems, vehicle communication technologies, and regulatory compliance for alternative powertrains. Further significant gaps are observed, especially among maintenance staff and educators, in hybrid technology, hydrogen applications, and the calibration of advanced driver assistance systems. [19]

The assessment identifies several areas for improvement in soft skills, namely IT proficiency, organisational and time management capabilities, financial literacy, and language competency. The survey also highlights preferred learning modalities among respondents. Teachers, sales professionals, and maintenance personnel predominantly favour employer-provided supplementary training, peer-to-peer learning, and the use of books. Given the practical and vocational orientation of these roles, which depend significantly on tacit knowledge, social interaction and shared experience are considered the most effective methods for skill development. Accordingly, employer-led training and insights gained from colleagues are highly valued, while books provide important factual and theoretical context. [19]

A significant observation is the differing perspectives on the use of social media as an educational tool: industry professionals regard it as highly beneficial, while educators appear less inclined to utilise these platforms, potentially due to generational gaps or limited familiarity with their capabilities for effective knowledge dissemination. Nonetheless, platforms such as YouTube can provide both explicit content (including battery assembly through infographics and tutorials) and applied, experience-driven knowledge (such as vehicle repair methods). In summary, direct sharing of practical experience remains the preferred approach to knowledge transfer within these groups, whether facilitated by structured training programmes, workshops, or digital social networks. [19]

4 Developing the Educational Courses in AutoCove Project

The identification of skills-gaps informed the selection of topics for development on the e-learning platform. The following courses have been developed by project participants:

1) For battery electric vehicles: battery technologies; charging technologies; fire safety of high-voltage batteries; dismantling and recycling of batteries
2) Hybrid technologies
3) Fundamentals of hydrogen
4) Advanced driver assistance systems (ADAS) and automated driving systems
5) For sales personnel: alternative fuels, ADAS and automated driving systems – courses separately for sales representatives and spare parts sales.

In addition to these courses, which are designed for the Electude platform, supplementary learning materials covering mathematics and physics have also been produced over the course of the project. The implementation and translation process for the platform are going on and will be finalised by the end of 2026, after which the material will be available for free.

The development tasks have been allocated to the partners based on their respective areas of expertise. To ensure alignment of course materials with various EQF levels, development teams convene biannually to review each other's work, offer constructive feedback, and exchange best practices. These workshops are further supported by technical specialists from the e-learning platform, guaranteeing that project-based courses remain consistently coordinated with the other educational resources offered on the platform.

5 Conclusions

The automotive sector is experiencing significant transformation due to advancements in vehicle powertrains and the introduction of enhanced systems to support drivers, paving the way for increased automation. Furthermore, the European automotive industry faces mounting competition from emerging players, particularly Asian car manufacturers. Consequently, it is of outmost importance to remain competitive by ensuring that employees in the automotive sector possess current, relevant knowledge and skills.

The AutoCove project commenced with an assessment of anticipated sector requirements, followed by a thorough analysis of skills-gaps. Project development topics were selected according to these identified needs. By collaborating across industry, educational institutions, and research organisations, the project brings together essential partners to develop educational materials addressing both current and imminent demands. The project's success is driven by effective collaboration among stakeholders.

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