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Automotive Engineering Education

Centre of Vocational Excellence

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Research and Development

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1. INTRODUCTION

The automotive economy[1] is an essential driver of the European economy and technological progress. In a sector that is constantly changing and innovating, the ability of the labour force to keep pace with changing requirements is crucial. However, despite constant progress and technological revolutions, automotive economy faces a key challenge: the skills gap, which is increasingly proving to be one of the biggest challenges for companies and educational institutions in the automotive industry. [2], [3], [4]

Skill gaps describe the discrepancies between the existing skills of the labour force and the requirements needed by the economy [5]. This gap between the actual skills and the required qualifications not only leads to an imbalance on the labour market, but also impairs the efficiency, innovation and competitiveness of companies and can slow down the greening of European transport system.

The dynamics of the automotive industry are being driven not only by technological developments such as electrification, autonomous driving and connected mobility, but also by changing customer needs and expectations as well as new regulatory requirements. This rapid change puts considerable pressure on educational institutions, companies and the workforce itself to continuously develop and learn new skills. [2], [4] In view of this, this work is primarily aimed at promoting the development of competences within vocational training in the automotive industry. Considering the dynamic developments and the targeted promotion of skills are crucial in order to meet the growing demands and changes in this sector.

[1] The term "*automotive economy*" encompasses all economic entities involved in the production, distribution, maintenance of usability and use of automobiles. The term "*automotive industry*", on the other hand, has a limited definition and refers to the manufacture of motor vehicles and vehicle components. [1]

1.1. Background to the skills gap analysis in the motor trade

The automobile trade[2] comprises a large number of different professional groups, which can generally be categorised into brand-bound and independent companies (see Figure 1).

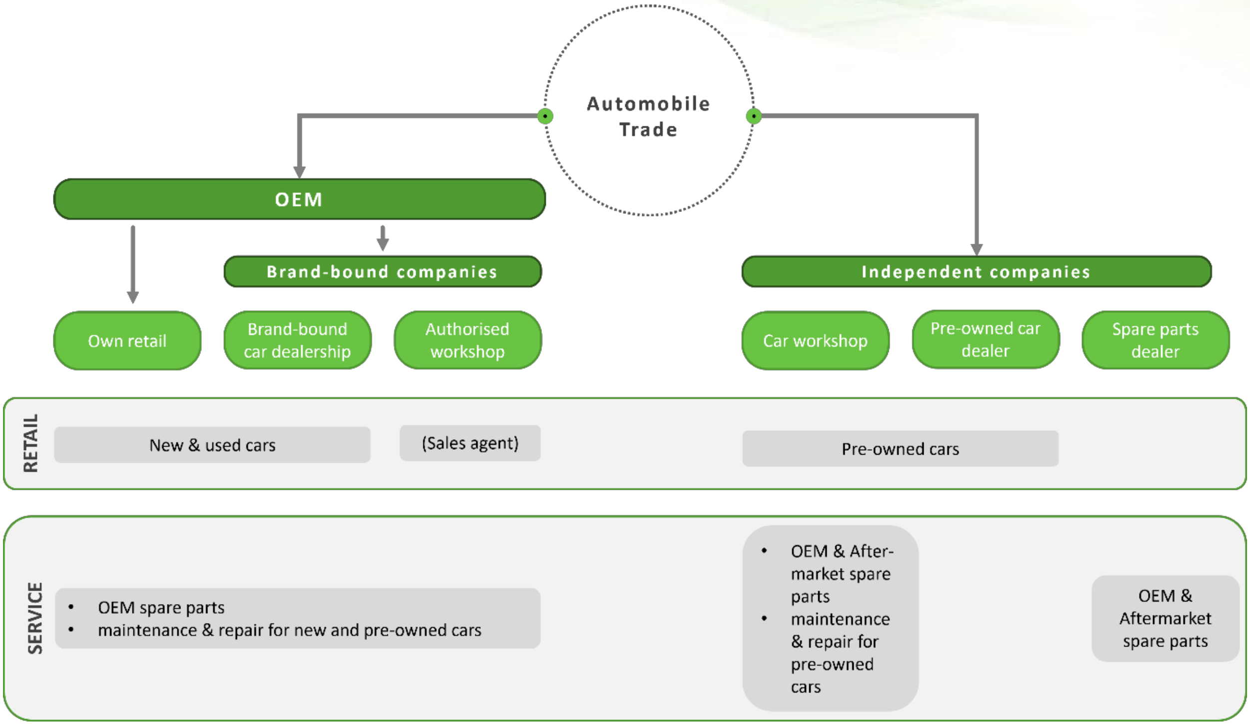

Figure 1: *Classification of the activities of different occupational groups in the automobile trade*
In accordance with: [4, 6]

Brand-bound car dealerships operate on the basis of contracts with car manufacturers and are typically active in all areas - new cars, pre-owned cars and service. In addition to these contractual partners, there are also authorised repair shops that only act as sales agents and primarily operate in the service sector. In addition, car manufacturers have their own branches in direct sales that offer retail and service (so-called own retail).

In contrast, independent garages mainly focus on technical service for older vehicles and may also offer pre-owned car sales. Pure pre-owned car dealers without contractual ties to car manufacturers also operate on the market, as do pure spare parts dealers for the sale of OEM and aftermarket parts. [4], [6]

[2] The term "*Automobile Trade*" comprises the business divisions **Sales**: sales of new and used vehicles (trade function) as well as the aftersales and **Service** divisions: Spare parts, maintenance and repair of motor vehicles (both passenger and commercial vehicles) (service function) [4].

In general, vehicle owners are free to decide which service provider they wish to consider. In practice, however, new car owners show a preference for brand-affiliated service providers. The Allgemeiner Deutscher Automobil-Club (ADAC) (General German Automobile Club) attributes a vehicle age of more than four years to independent garages, although an EU directive also allows independent garages to carry out maintenance and repair work on new vehicles, provided this is carried out in accordance with the manufacturer's specifications. The EU directive legitimises this without any loss of warranty claims. [7] In view of this differentiation between vehicle age and service provider, there is a time lag in the exposure of new vehicle technologies among service providers. It can be assumed that OEM-independent companies have less expertise in alternative drive systems than OEM-dependent companies.

Against this backdrop, vocational training (both purely school-based and dual) represents a neutral and central location for levelling out the existing skills gap between the various service providers in the automotive industry. Through targeted curricula and practice-orientated training, the educational institution can impart uniform and high-quality knowledge regardless of the type of service provider. This could help to ensure that all future professionals are equally familiarised with the latest technologies and developments. An inclusive approach to training, covering both conventional and new drive systems, could help to standardise the knowledge and skills of the future workforce, creating a more balanced skills base within the industry. In this context, it is also necessary to map the status quo of teaching staff in vocational and academic education in relation to current market developments, as it is assumed that the education systems cannot keep pace with the current market dynamics due to their nature in order to prepare the skilled labour force accordingly.

Previous literature has analysed the future requirements within the automobile economy both for skilled workers in the automotive industry [3] and for skilled workers in the automobile trade [2], [4]. The studies emphasise the relevance of vocational education and training, but do not develop any specific measures to meet this demand. In another study, concrete consequences of existing skill gaps in the quality of professional practice are demonstrated. The lack of tacit and explicit knowledge about electric vehicles hinders sales. Employees complained that they lacked extensive information and high-quality training on e-mobility, which is why they are less motivated to offer these vehicles, which are unfamiliar to them, to potential buyers. [8]

In addition to the current effects of the transformation process in the automotive economy, there are also far-reaching changes in the automobile trade that could jeopardise the professional existence of employees without appropriate training and further education measures. In [2], disruptive changes to the business model structure in the automobile trade are predicted, in which a large number of time-intensive and profitable activities, such as oil changes or the replacement of spark plugs and other parts, will become less important. The authors also point out that during the transition phase from conventional motor vehicles to battery electric vehicles, an increased volume of work is initially expected until 2030 (servicing various forms of drive), which will then decrease due to the lower maintenance and repair requirements of battery electric vehicles.

The elimination of services on the combustion system will create challenges for the automobile trade in terms of the range of activities and their revenue structure, the scope and revenue of which cannot be fully subsumed by inspections and analyses of the high-voltage system. According to [2], however, these changes also result in new opportunities for the automobile trade. This includes, for example, assessing the condition of high-voltage batteries for the sale of used battery electric vehicles as well as the potential repair of high-voltage batteries and electric drives that contribute to value creation. Furthermore, new sources of revenue and activity profiles for the automobile trade can be derived from current developments in the automotive industry. Volkswagen [9] and Renault [10] will offer their customers bidirectional charging solutions including their own home storage systems and, in some cases, their own electricity contracts. Based on this, it is conceivable that job profiles in the automobile trade will also expand or change as a result of sector coupling[3].

1.2. Target group of Auto-CoVe 2.0

The primary objective of the project is to adapt vocational qualifications in the automotive economy to the needs of the labour market and to prepare skilled workers for current and future requirements. The secondary objective of the project is the greening of Europe with the support of training for clean technologies in vehicles. The third objective is to facilitate the transition from vocational school to university of applied sciences by providing study modules in maths and physics for all technical students.

Against this background, the target group addressed can be fundamentally differentiated into vocational training and further vocational training. The term vocational training primarily refers to trainees in the motor vehicle trade. This includes trainees in the fields of vehicle mechanics and mechatronics as well as in vehicle and parts sales. In second place are students in the field of (automotive) engineering, where the aim is to identify and close skills gaps in higher education.
In the area of continuing education, existing vocational schoolteachers at secondary level and professors or lecturers at tertiary level should be mentioned. Outside of teaching, the aim is to provide further training for motor vehicle mechanics, motor vehicle salespeople and motor vehicle engineers already working in the industry.

[3] The term "*sector coupling*" refers to the linking of the electricity, heating and transport sectors with the aim of decarbonising them and using resources more efficiently. The ramp-up of electromobility opens up a wide range of opportunities for integrating the automotive industry into the energy industry. [11]

1.3. Objectives and relevance of the research for teachers and industry representatives

The objective of this research is to identify and analyse the current skill gaps in the automobile trade. This includes a detailed mapping of the specific skills gaps in the areas of teachers and industry representatives. In addition, it will also analyse the difference in skills gaps for industry representatives between brand-dependent and brand-independent companies. The relevance of this research for teachers is to gain insights that will enable curricula and teaching methods to be adapted to the changing demands of the automotive industry. This could help to tailor the training of students and professionals to the current needs of the branch.

For industry representatives, this study offers better trained specialists in the long term, whose skills and competences are closely aligned with current research and development aspects within the automotive industry. By aiming to close the skills gaps, industry representatives will be able to recruit qualified employees in the future who are equipped with practical knowledge and are able to meet the challenges and innovations of the automotive industry at the highest level.

In addition, the investigation of skills gaps and their targeted closure results in a low-threshold point of contact for employees of industry representatives with regard to unknown technologies. This helps to reduce fear of change, as employees are encouraged to face new challenges and use innovative technologies more confidently thanks to their increased expertise. At the same time, targeted training helps to reduce the fear of job loss by qualifying employees for new job profiles that arise as the industry continues to develop.

In a European country comparison, analysing the skills gaps provides valuable insights into the different needs and requirements of the automotive industry in the individual countries. The identification of specific skill gaps in the curricula and training programmes of the different European countries enables a cross-national comparison from which best practices and effective teaching methods can be extracted and used. In addition, such a comparison offers the opportunity to identify the individual strengths and weaknesses of the training systems in each country and to promote knowledge exchange and co-operation between countries. This could lead to further harmonisation of training standards and facilitate the mobility of skilled workers within Europe, which could ultimately strengthen the competitiveness of the European automotive industry.

2. METHODS

In order to identify and analyse the current skill gaps in the European automotive industry, an online survey with standardised questions was created and distributed to the target groups in seven European countries (see Figure 2). The online tool "Webropol" was used as the survey software.

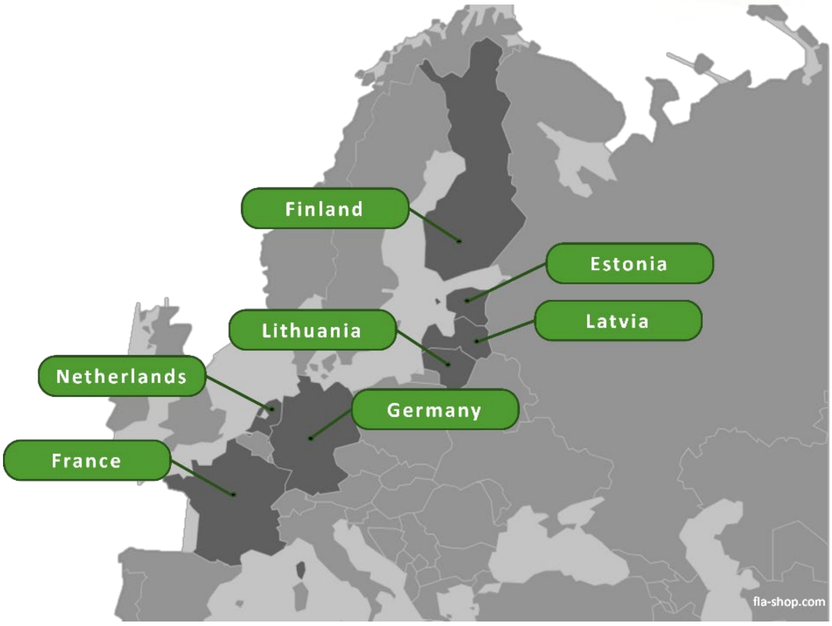

Figure 2: *Geographical distribution of the survey*
Source: fla-shop.com

In view of the intended target group and the thematic niche of "*Auto-Cove 2.0: Greening Europe with support of Clean-tech-vehicle education*", the questionnaire developed contains questions that are relevant both for teachers (vocational school teachers in the automobile trade & professors) and for industry representatives from the automotive industry. The standardised questioning scheme makes it possible to compare the different stakeholder groups within and outside the segments in the evaluation. The basic structure of the questionnaire consists of the following five parts:

- Part 1: Background information
- Part 2: General current and future technological skills and competences in own occupation
- Part 3: General current and future non-technical skills and competences in own occupation
- Part 4: Importance of information sources for own position
- Part 5: Previous education and training.

In order to achieve valid measurement results, it is essential to exclude obvious distortions when developing the questionnaire design. Against this background, possible language barriers among the respondents should be eliminated by having the questionnaire developed in English (see **APPENDIX I: Questionnaire design**) systematically translated into their native language by the project partners from the seven nations. Furthermore, in written surveys it is necessary to give respondents the opportunity to express their indifference to a topic [12]. For this reason, the questionnaire contains a rating scale from "*1 = no competences available*" to "*10 = high competences available*" as well as an additional field "*not relevant for me*". On the one hand, this questionnaire design makes it possible to rule out a so-called "forced choice" and, on the other hand, a clear distinction can be made in the evaluation between non-existent competences and irrelevant topics.

2.1. Data collection

As part of the data collection, a so-called stakeholder pool was formed for the study participants required. This stakeholder pool consisted of 20 vocational school teachers and 20 industry representatives from the fields of vehicle maintenance and vehicle and spare parts sales in each of the seven participating countries. A sample size of 280 participants was therefore expected for this cross-sectional study. Stakeholders were recruited by contacting the participating vocational school teachers personally by telephone or e-mail. The data collection for the skills gap analysis took place from 6 to 24. November 2023. While retaining the questionnaire design, the stakeholder pool was expanded on 13. November 2023 to include professors as a professional group. A total of 375 responses from the stakeholder pool was received during this period.

2.2. Data analysis

For the analysis of the collected data, both statistical and visual analysis methods were used. For both methods, it was first necessary to group the data according to their origin, i.e. by country, occupational group, type of employer company (brand-dependent or brand-independent) and highest educational qualification achieved. Various statistical analyses were then carried out with the aid of a statistics programme (SPSS), the implementation of which is described in more detail in ANNEX XII.

The visual data analysis is essentially limited to identifying the existing skills gaps of the survey participants. For this purpose, the data from Part 2 and Part 3 of the survey is used to identify both specialised and non-specialised skills gaps. A skills gap exists when skills required in the future can no longer be covered by one's own skills. Against this background, the following calculation scheme applies:

$$Skill\ Gap = Level\ of\ Competences_{t_0+5} - \ Level\ of\ Competences_{t_0}$$

$with$:

$Level\ of\ Competences_{t_0+5} = needed\ level\ of\ competences\ in\ 5\ years$

$Level\ of\ Competences_{t_0} = current\ level\ of\ comptences$

In view of the complex and multidimensional data structures resulting from the questionnaire design, the network diagram is identified as the most suitable form of visualisation for visual data analysis. These diagrams make it possible to visualise complex relationships between countries and different competence dimensions. In addition, network diagrams facilitate the identification of patterns, outliers or anomalies in the data and thus enable a quick gain in knowledge.

In order to obtain a visual analysis of the data according to this scheme, an evaluation script is developed in the "MATLAB" software, which creates the desired network diagrams according to the above-mentioned filter criteria. For this purpose, the developed evaluation script imports the data available in CSV format. The current and five-year competence levels of the occupational groups are then calculated using the arithmetic mean (see formulas below).

Calculation of the reference value $\boldsymbol{Level\ of\ Competences_{t_0+5}}$:

$$\bar{x}_{i,\ Level\ of\ Competences_{t_0+5}} = \frac{1}{n}\sum_{i=1}^{n} x_{i,\ Level\ of\ Competences_{t_0+5}}$$

$with$:

$\bar{x}_{i,\ Level\ of\ Competences_{t_0+5}} = arithmetic\ mean\ of\ the\ competences$
$required\ in\ 5\ years\ for\ characteristic\ x$

$x_{i,\ Level\ of\ Competences_{t_0+5}} =\ Competences\ required\ in\ 5\ years\ for\ characteristic\ x$

$n =\ Number\ of\ observations$

Calculation of the value $\boldsymbol{Level\ of\ Competences_{t_0}}$:

$$\bar{x}_{i,\ Level\ of\ Competences_{t_0}} = \frac{1}{n}\sum_{i=1}^{n} x_{i,\ Level\ of\ Competences_{t_0}}$$

$with$:

$\bar{x}_{i,\ Level\ of\ Competences_{t_0}} = arithmetic\ mean\ of\ the\ current\ competences$
$for\ characteristic\ x$

$x_{i,\ Level\ of\ Competences_{t_0+5}} =\ Competences\ required\ in\ 5\ years\ for\ characteristic\ x$

$n =\ Number\ of\ observations$

The number of observations can vary depending on the target group under consideration, which can be differentiated according to occupational group, country of origin, brand dependency or brand independence.

Due to the questionnaire design, Part 2 and Part 3 differ in the depth of the survey. In Part 3, nine surface-level non-technical skills and competences are assessed by the respondents, such as language skills, which are not further differentiated in terms of depth. In contrast, in Part 2, 31 technical skills and competences are surveyed in order to derive a specific, thematically focussed training requirement. Because of the high granularity of Part 2, these 31 technical skills and competences are summarised into seven main groups for the skills gap analysis and their arithmetic mean values for the skills gap analysis are formed from the sub-topics for each country of origin:

- A - Hybrid vehicles
- B - Electric vehicles
- C - Other drives
- D - Batteries and charging
- E - Driver assistance systems
- F - Vehicle communication technologies
- G - Powertrain regulations.

The sub-topics for each group are listed in Annex II.

3. ANALYSIS OF PARTICIPANT PROFILES AND CHARACTERISTICS

The data collection for the skills gap analysis was carried out from 6 to 24 November 2023. During this period, 375 people from the target group were surveyed. As can be seen in Figure 3, the two groups of teachers and industry representatives are roughly equally represented.

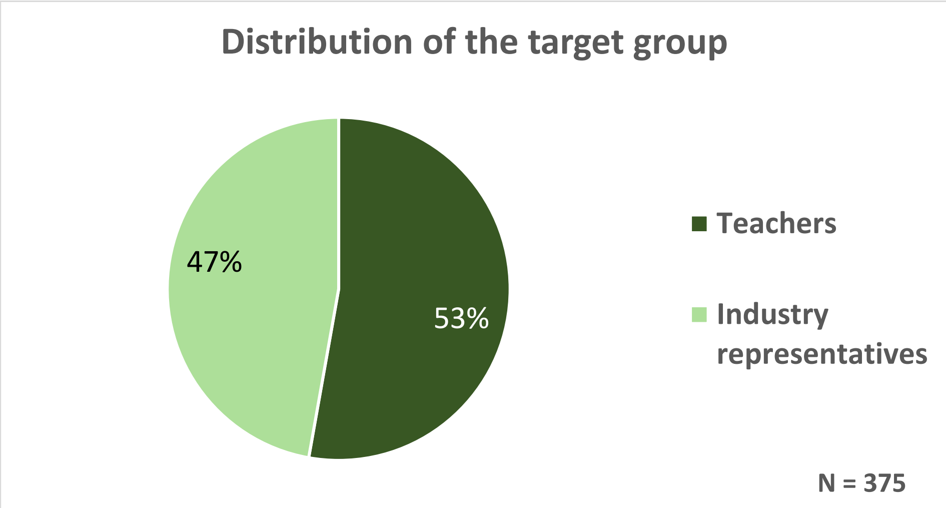

Figure 3: *Distribution of the target group*

As already known, an influence is assumed with regard to the brand bonding of industry representatives and the expertise of staff in relation to new technologies. It is therefore important that both interest groups are also represented here. From Figure 4 it can be seen that 59% of respondents belong to a manufacturer's brand, while 41% of respondents are independent companies.

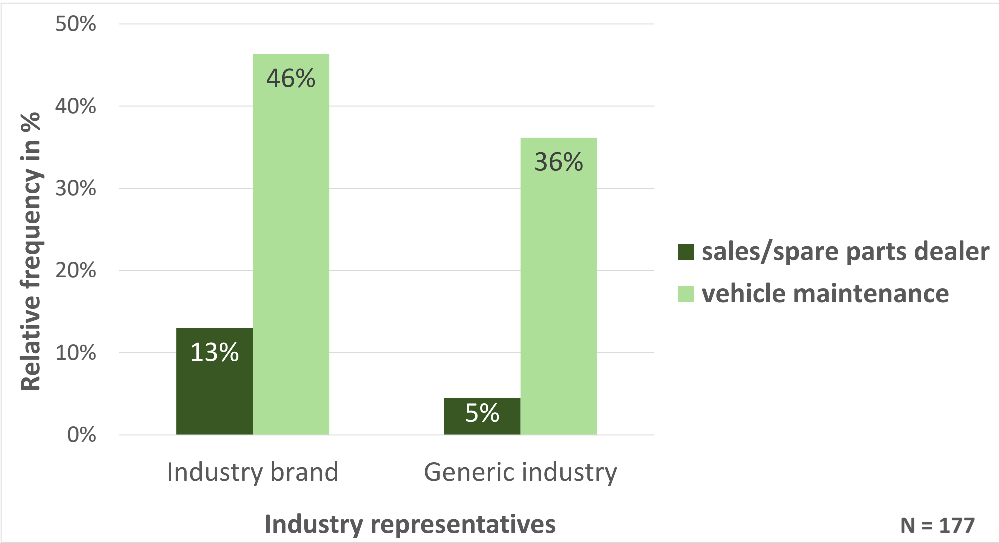

Figure 4: *Relative distribution of industry representatives by degree of OEM commitment*

The origin of the occupational groups surveyed is shown in absolute figures in Figure 5. It can be seen that the composition of the groups of respondents varies from country to country.

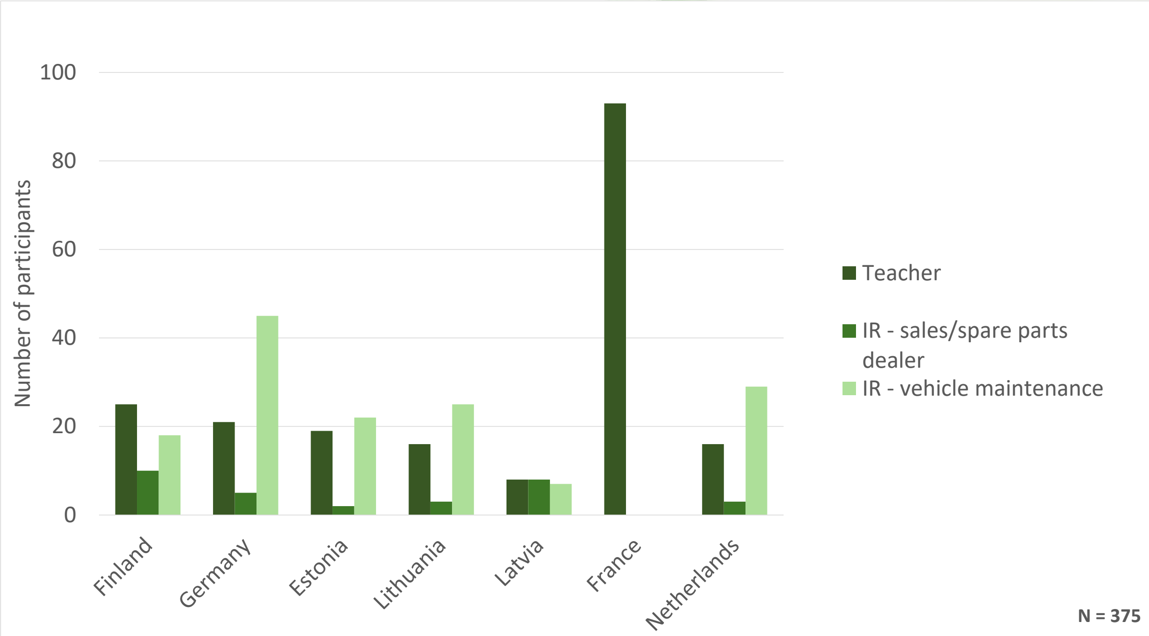

Figure 5: *Absolute frequency of respondents in their geographical location by occupational group*

Furthermore, in France there is a disproportionate share of teaching staff without other representatives of other occupational groups. Figure 6 shows the respective highest educational qualifications of the respondents by occupational group. Due to the survey design, the three occupational groups cannot be directly differentiated further. It is therefore necessary to divide the occupational groups into academic and non-academic professions in order to differentiate, for example, between teachers and professors or motor vehicle mechanics and motor vehicle engineers. For this purpose, the highest educational qualifications of the respondents are divided into academic and non-academic qualifications. Academic qualifications are all qualifications that are higher than or equal to "college". All lower qualifications are categorised as "non-academic".

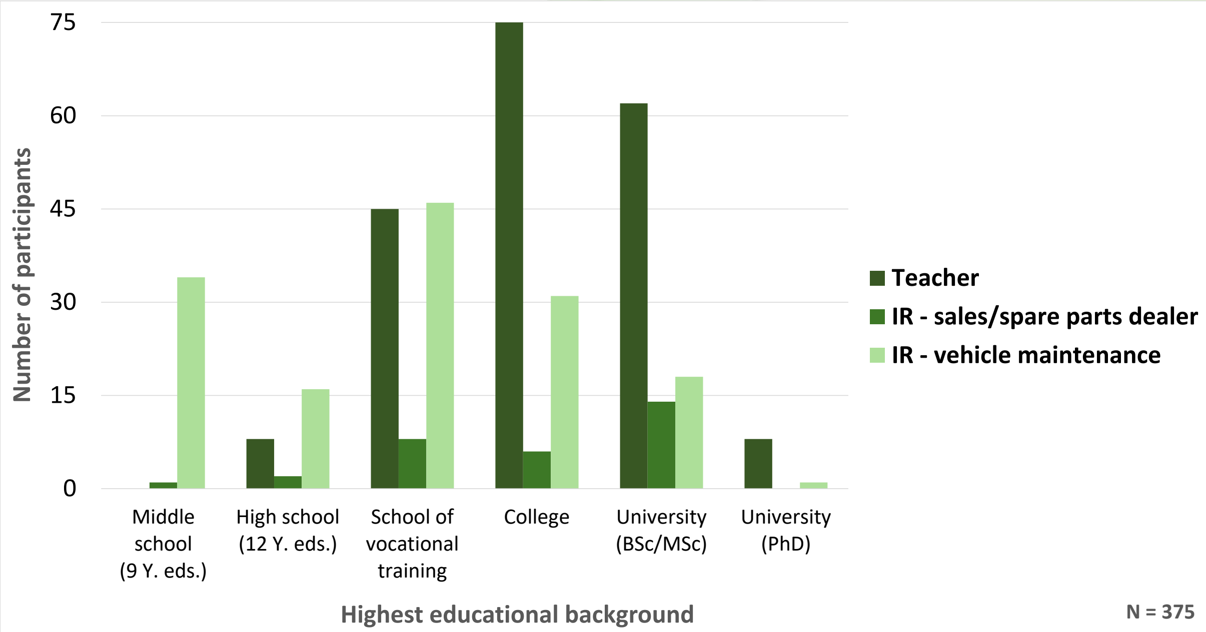

***Figure 6:** Absolute frequency of respondents' highest educational qualification by occupational group*

The professions for which an academic background is generally required (e.g. engineer, manager) can be derived from Figure 7 in the ranks of industry representatives.

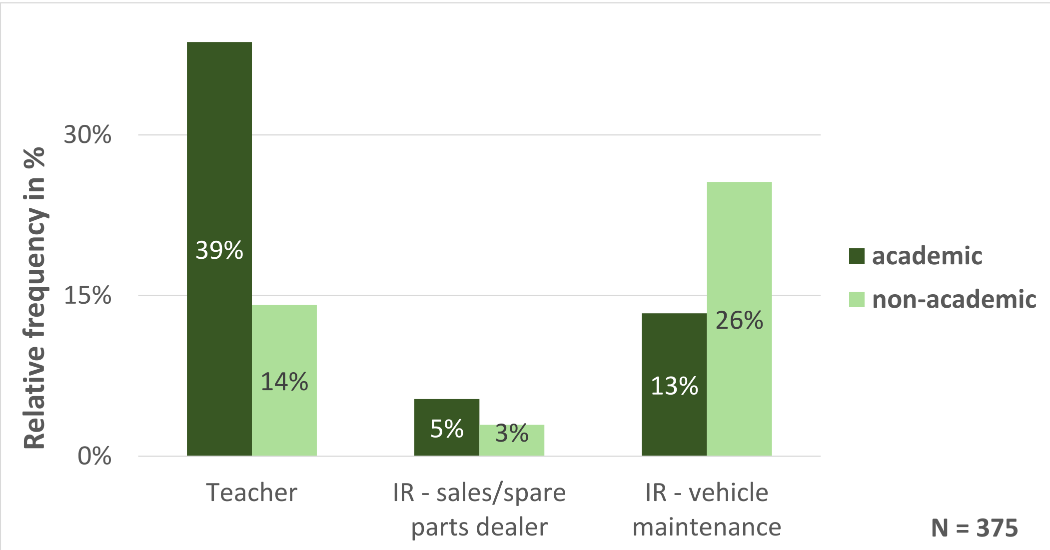

***Figure 7:** Relative distribution of professions according to degree of academisation*

As Figure 6 and Figure 7 show, both academic and non-academic educations qualify for the teaching profession. Further analyses of this occupational group are therefore necessary to ensure that all representatives of the target group are represented.

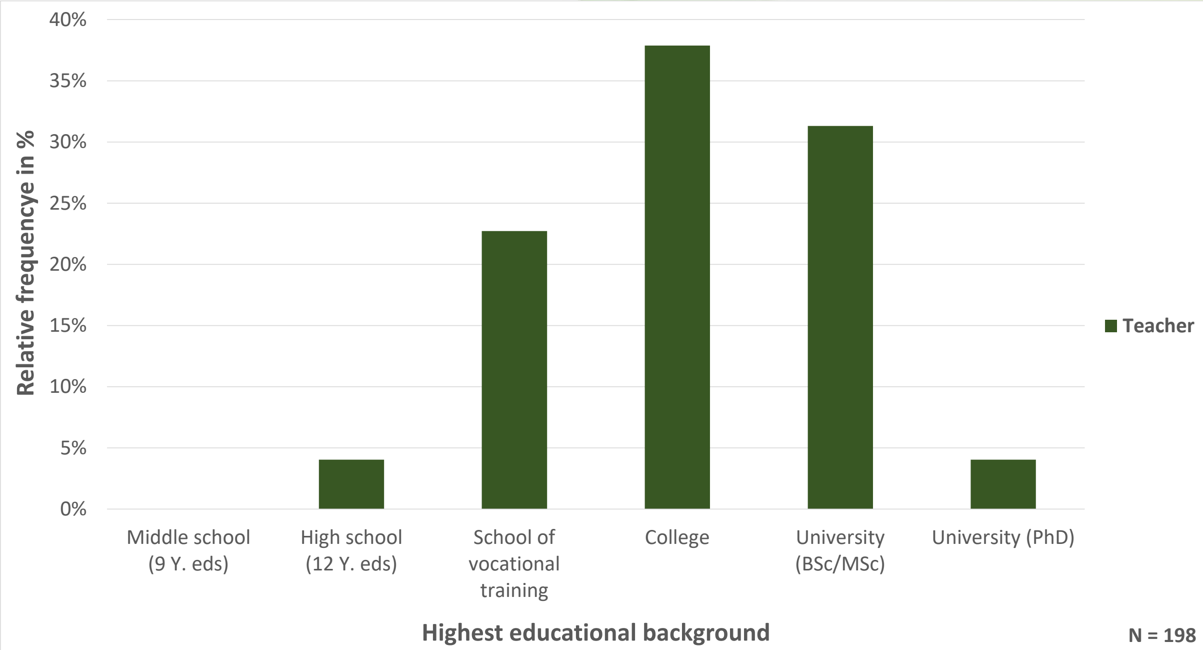

Figure 8: *Relative distribution of the occupational group "Teachers" by level of highest school qualification*

Figure 8 shows a normal distribution of school-leaving qualifications that qualify for a teaching profession. It can be assumed that the 4% of respondents who have a doctor degree teach at a college or university, while all others can be categorised as vocational school teachers. Due to the small sample size of professors, the professional group of teachers is not further differentiated in the following analyses.

4. IMPORTANCE OF DIFFERENT SOURCES OF INFORMATION BY OCCUPATIONAL GROUP

Irrespective of the occupational group, the use of various sources of information serves the basic acquisition of knowledge. The term "knowledge" is defined as the totality of knowledge and skills that individuals use to solve problems. This includes theoretical knowledge as well as practical everyday rules and instructions. Knowledge is always a personalised quantity that results from data and information. It is constructed by individuals and represents their expectations about causal relationships. [13] According to [14], knowledge is an organising achievement of an actor who uses data and information from his environment to create a coherent picture that enables distinctions and causal attributions. In order to generate knowledge from a person-independent resource (signs, data and information), these must be linked to existing knowledge [15], [16]. In other words, knowledge is transferred through information. The various forms of knowledge, which can be both explicit and tacit and differ in the way knowledge is passed on and generated, must be taken into account (see Figure 9).

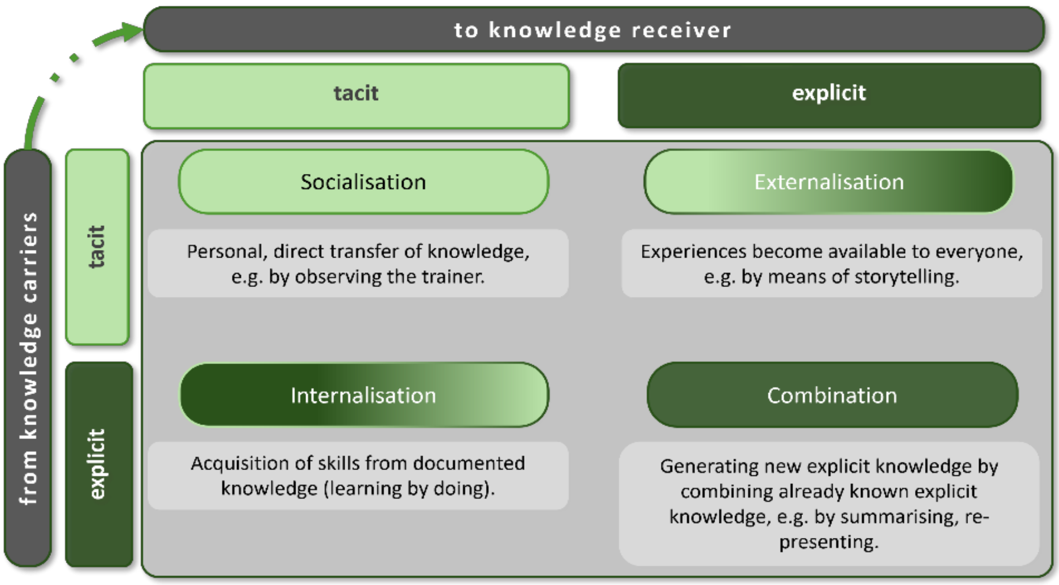

Figure 9: *Four ways of creating and transforming knowledge*
In reference to: [15]

Explicit knowledge is rational knowledge that can be easily communicated and reproduced formally in words, numbers or symbols in a social context. This knowledge can be easily structured, systematised and articulated independently of individuals. The transfer of explicit knowledge can take place, for example, via databases, manuals, patents, plans, etc. [15], [16], [17], [18] Explicit knowledge is also described as specific or methodological knowledge that is logically comprehensible and describable in its application [19].

Tacit knowledge, on the other hand, results from an individual's personal experience and consists of subjective insights, intuitions and hunches. It is deeply rooted in the actions and experiences of the individual as well as in their ideals, values and emotions. This knowledge depends on the individual and is difficult to formalise and transfer.[15], [16], [17], [18] Tacit knowledge describes the internalised skills of an individual and can only be transferred through intensive interaction processes. [19], [20]

The need to make tacit and explicit knowledge of appropriate quality accessible to the target group of this study has already been described in Chapter 1.1. Against this background, the following sections aim to determine the preferred type of knowledge transfer in addition to the preferred sources of information of the professional group. To this end, Table 1 assigns the information sources surveyed in the study to the corresponding types of knowledge transfer, including the transfer medium.

***Table 1:** Type of knowledge transfer by information source*

Information source	**Type of knowledge transfer**	**Medium**
Additional training provided by your employer	Socialisation/Externalisation	Human-to-Human
Learning from the colleagues at work	Socialisation/Externalisation	Human-to-Human
Newspapers (paper or digital)	Internalisation	print/digital
Magazines (paper or digital)	Internalisation	print/digital
Books, e.g. repair manuals	Internalisation	print/digital
Scientific journals	Internalisation	print/digital
Webpages or newsletters from vehicle manufacturers	Internalisation	digital
Autodata (Wikipedia page)	Internalisation	digital
National seminars or exhibitions	Socialisation/Externalisation	Human-to-Human
International seminars or exhibitions	Socialisation/Externalisation	Human-to-Human
Social media	Socialisation/Externalisation Internalisation/Combination	digital, Human-to-Human

For the creation of user-centred learning content, it is important to know the habits of the target groups when obtaining information in order to be able to derive the preferred sources of information. With this in mind, the participants were asked to rate the importance of various sources of information for the respective professional group. The assessment was made on a scale from 1 (*unimportant*) to 10 (*important*). In order to ensure the most accurate assessment possible and to avoid a forced choice, participants also had the option of ticking the "I *don't know*" box if they were unfamiliar with a source of information. When the data was subsequently analysed, it was found that in some cases the respondents did not provide any answers, which were therefore not included in the analysis of this survey.

4.1. Preferred sources of information for teachers

In order to determine teachers' attitudes to the various sources of information, it is necessary to group the available numerical data and relate it to the answers given. Scale values 1-3 are assigned to the "*less important*" group, while scale values 8-10 are assigned to the "*important*" group. The values in between are considered indifferent, i.e. without a clear positioning. This procedure applies analogously to the occupational groups of vehicle and spare parts sales and vehicle maintenance. Due to the use of rounded percentages in the tables (Table 2, Table 6, Table 10), the total may not add up to 100%.

Table 2: *Relative importance of different sources of information for teachers*

Teacher - Information source	less important	indifferent	important	I do not know
Additional training provided by your employer	2%	19%	79%	1%
Learning from the colleagues at work	4%	28%	69%	0%
Newspapers (paper or digital)	15%	60%	24%	1%
Magazines (paper or digital)	9%	54%	37%	1%
Books, e.g. repair manuals	2%	31%	67%	0%
Scientific journals	9%	40%	49%	2%
Webpages or newsletters from vehicle manufacturers	7%	33%	59%	1%
Autodata (Wikipedia page)	5%	32%	58%	4%
National seminars or exhibitions	10%	36%	51%	3%
International seminars or exhibitions	11%	39%	46%	4%
Social media	19%	47%	30%	3%

As can be seen from Table 2, the information sources "*Additional training [...]*" and "*Learning form the colleagues [...]*" are particularly relevant for teachers. Attending trade fairs and participating in seminars are less pronounced but still relevant sources of information for teachers. With regard to vocational education and training, this finding is conclusive insofar as tacit knowledge (experience, know-how, skills), which is difficult to formalise, can be better conveyed through interpersonal interactions, which is the case with these sources of information. Furthermore, the preference for "*books*" for the teaching profession is conclusive in that they contain extensive explicit knowledge in order to a) familiarise oneself with a subject (internalisation) and then b) pass on this acquired tacit knowledge to their students (socialisation).

In general, teachers show a high willingness to use digital sources of information (print media, wikis, OEM websites), while the use of newspapers, magazines and social media tends to play a subordinate role for them.

With the help of statistical analyses, a clear ranking of the information sources can be derived from the data. The mean value of the individual information source preferences is used as the first decision criterion. Secondly, the results of a binomial test determine the ranking. Table 3 lists the information sources favoured by the teachers in the order of their ranking.

Table 3: *Preferred sources of information for teachers*

Ranking	Teacher - Information source	N	Mean	Std. Deviation
1	Additional training provided by your employer	192	8.6	1.7
2	Books, e.g. repair manuals	195	8.2	1.8
3	Learning from the colleagues at work	195	8.0	1.9
4	Autodata (Wikipedia page)	187	7.7	2.2
5	Webpages or newsletters from vehicle manufacturers	193	7.5	2.2
6	National seminars or exhibitions	190	7.1	2.4
7	Scientific journals	193	7.0	2.4
8	International seminars or exhibitions	186	6.9	2.5
9	Magazines (paper or digital)	193	6.6	2.2
10	Newspapers (paper or digital)	194	5.9	2.2
11	Social media	190	5.8	2.6

Further statistical key figures on the preferred sources of information for the various professions can be found in Appendix XIII.

4.2. Preferred sources of information for vehicle and spare parts sales personnel

A similar picture emerges for employees in the sale of vehicles and spare parts with regard to the preference for the information sources "*Additional training [...]*" and "*Learning form the colleagues [...]*" (see Table 4).

Table 4: *Relative importance of different sources of information for industry salesperson*

Industry salesperson - Information source	less important	indifferent	important	I do not know
Additional training provided by your employer	0%	20%	80%	0%
Learning from the colleagues at work	0%	13%	87%	0%
Newspapers (paper or digital)	10%	50%	40%	0%
Magazines (paper or digital)	13%	50%	37%	0%
Books, e.g. repair manuals	3%	43%	47%	7%
Scientific journals	13%	47%	33%	7%
Webpages or newsletters from vehicle manufacturers	10%	17%	70%	3%
Autodata (Wikipedia page)	3%	30%	57%	10%
National seminars or exhibitions	3%	60%	33%	3%
International seminars or exhibitions	13%	50%	33%	3%
Social media	7%	30%	63%	0%

In contrast to teachers, sales staff show a lower affinity for literature, but also for seminars and trade fairs. According to [4], the reasons for the high level of indifference towards seminars and trade fairs may lie in the lack of return on sales in the automotive industry, which has averaged a maximum of 1.7% in Germany in recent years. However, a minimum return of 3% is required for investments in employee training and development. Against this background, it can be assumed that the willingness to invest in these sources of information depends on brand loyalty. Employees from brand-bound car dealerships or workshops are therefore more likely to consider this source of information to be important. In contrast, dealers of vehicles and spare parts consider the newsletters and websites of OEMs, social media and Autodata to be particularly important for obtaining information. This affinity may be due to the familiar sales channels, which is why sales staff also favour these digital channels for knowledge generation.

Analogous to the statistical analysis of teachers' information source preferences, the occupational group of vehicle and parts salespeople also shows clear preferences for certain information sources (see Table 5).

Table 5: *Preferred sources of information for industry salesperson*

Ranking	Industry salesperson - Information source	N	Mean	Std. Deviation
1	Learning from the colleagues at work	30	8.9	1.1
2	Additional training provided by your employer	30	8.6	1.5
3	Books, e.g. repair manuals	28	7.0	2.2
4	Autodata (Wikipedia page)	27	7.7	2.0
5	Webpages or newsletters from vehicle manufacturers	29	7.9	2.2
6	Social media	30	7.3	2.4
7	International seminars or exhibitions	29	6.7	2.3
8	National seminars or exhibitions	29	6.8	1.9
9	Scientific journals	28	6.2	2.6
10	Magazines (paper or digital)	30	6.3	2.4
11	Newspapers (paper or digital)	30	6.7	2.3

4.3. Preferred sources of information for vehicle maintenance personnel

The information sources "*Additional training [...]*" and "*Learning form the colleagues [...]*" are also particularly relevant for employees in vehicle maintenance, which can be attributed to the transfer of tacit knowledge through interpersonal interaction (see Table 6).

Table 6: *Relative importance of different sources of information for industry maintenance*

Industry maintenance - Information source	**less important**	**indifferent**	**important**	**I do not know**
Additional training provided by your employer	4%	22%	71%	3%
Learning from the colleagues at work	2%	20%	77%	1%
Newspapers (paper or digital)	25%	46%	24%	4%
Magazines (paper or digital)	25%	45%	26%	4%
Books, e.g. repair manuals	10%	31%	57%	2%
Scientific journals	15%	53%	29%	3%
Webpages or newsletters from vehicle manufacturers	9%	38%	50%	2%
Autodata (Wikipedia page)	10%	30%	54%	6%
National seminars or exhibitions	12%	46%	35%	6%
International seminars or exhibitions	14%	41%	38%	7%
Social media	12%	43%	41%	4%

Other common and preferred media in this area are the use of repair manuals in the form of books (internalisation: learning by doing) and knowledge databases (combination). In addition, the OEM's website and newsletter are also proving to be important sources of information for this group of people. Another interesting fact is the use of social media as a source of information in the field of vehicle maintenance. For 41% of this target group, social media is a particularly important resource, while 43% are indifferent to this channel. It is quite conceivable that this is due to the type of workshop (brand-independent or brand-dependent workshop). It is possible that employees of brand-independent workshops make greater use of social media formats such as YouTube to carry out a repair or solve a problem.

Vehicle maintenance employees show the least affinity for internalised knowledge in the form of print media ("*scientific journals*", "*newspapers*", "*magazines*"). However, participation in national or international seminars or trade fairs is also less important in vehicle maintenance.
Table 7 shows the preferences of the vehicle maintenance technicians who took part in the survey. It is clear that the first five sources of information in the three professional groups only differ in terms of ranking, with Autodata and vehicle manufacturer websites or newsletters consistently in 4th and 5th place.

Table 7: Preferred sources of information for industry maintenance

Ranking	Industry maintenance - Information source	N	Mean	Std. Deviation
1	Learning from the colleagues at work	142	8.6	1.8
2	Additional training provided by your employer	139	8.3	2.1
3	Books, e.g. repair manuals	139	7.5	2.5
4	Autodata (Wikipedia page)	133	7.4	2.5
5	Webpages or newsletters from vehicle manufacturers	136	7.2	2.6
6	Social media	136	6.7	2.5
7	International seminars or exhibitions	130	6.5	2.6
8	National seminars or exhibitions	132	6.5	2.4
9	Scientific journals	136	6.0	2.5
10	Magazines (paper or digital)	135	5.6	2.8
11	Newspapers (paper or digital)	137	5.5	2.8

5. IDENTIFICATION OF SKILL GAPS IN A COUNTRY COMPARISON

In this chapter, both technical and general skills gaps of the target group are identified and interpreted in a country comparison. As already described in Chapter 2, a skills gap results from the difference between the required and the current level of competence. In this chapter, two different types of network diagrams are used for the visual analysis.

For the general competences, the current competence levels are compared with the required competence levels in the network diagram. The existing skills gap can be visually read from the network diagram as a gap between the two diagrams. International differences are not discussed in detail, as it can be assumed that these competences are equally important for all nations.

In the case of specialised skills, however, national differences are definitely important. For this reason, so-called difference plots are shown here as a network diagram, which can be read directly as a skills gap. The appendix contains further forms of presentation that would overload the report.

5.1. Skill gaps of teachers

Analysis of general competences:

The current skills of the teachers initially show the expected logical result that the qualification required in 5 years is always one higher than the current level (see Figure 10).

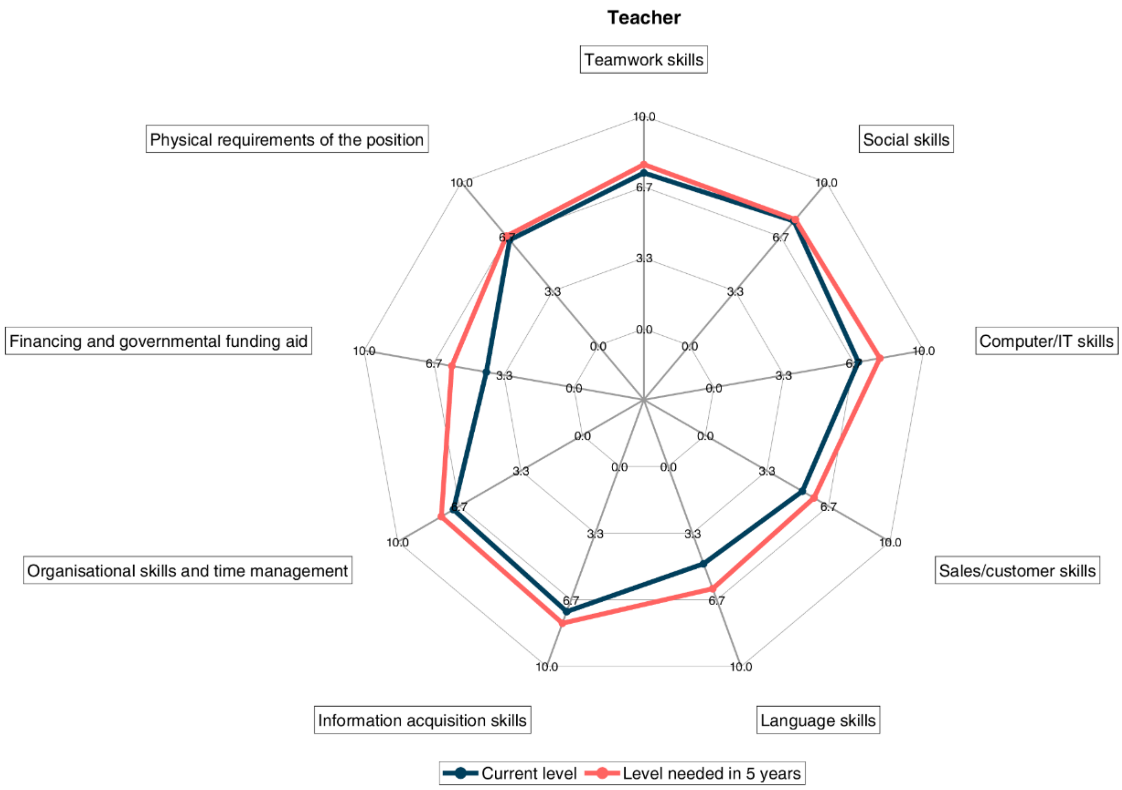

Figure 10: *Skill gaps of teachers in general competences - network diagram*

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Interestingly, the respondents see a greater future need for skills in the areas of "Financing and governmental funding aid", "Language skills" and "Sales/Customer skills". In the areas of "Social skills", "Teamwork skills" and "Physical requirements of the position", little or no significant deficits are recognisable and therefore no relevant educational mandate for this project can be identified. On the contrary, other areas such as "Computer/IT skills", "Language skills" and in particular "Financing and governmental funding aid" show deficits and therefore a need for action.

Analysis of professional competences:

In a country comparison, the skills gap in the area of professional competences is greatest in Latvia, with large deviations of more than 3.3 points particularly evident in the areas A to D, as well as G (see Figure 11).

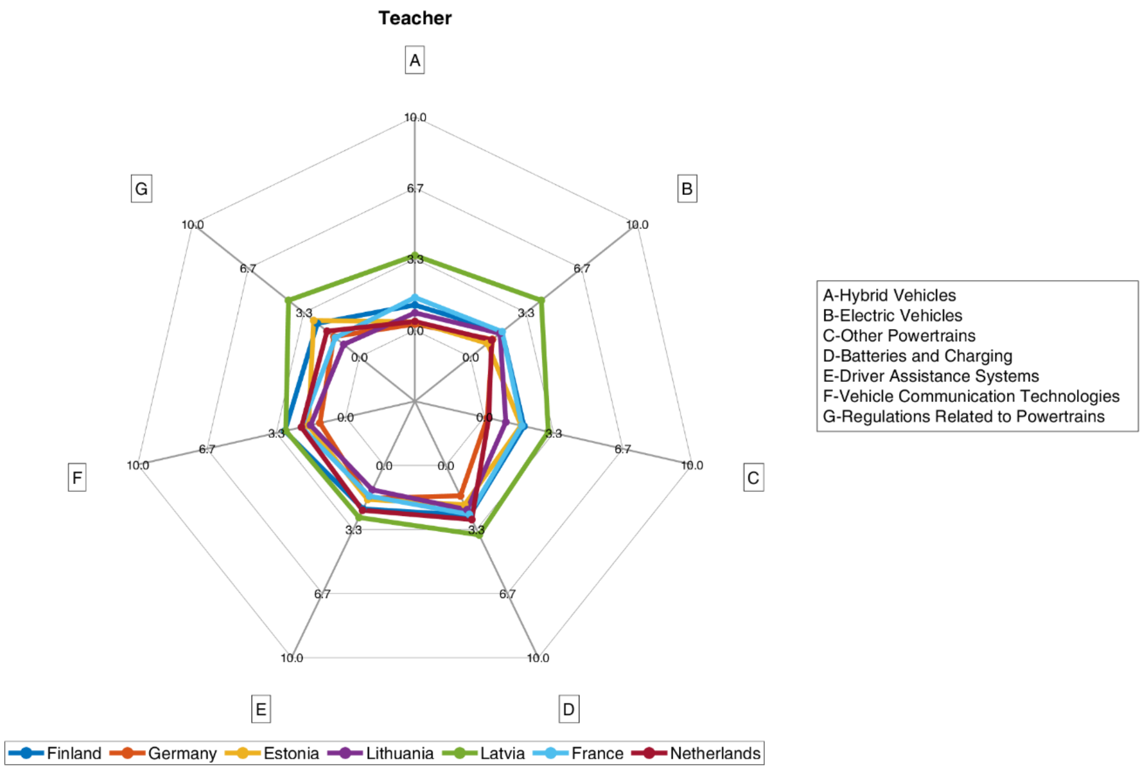

Figure 11: *Skill gaps of teachers in professional competences - network diagram*

All other nations show similarly distributed deficits of less than 3 points in all segments. All other nations show similarly distributed deficits in all segments of less than 3 points. Germany and the Netherlands show particularly low demand in the field of "Other Powertrains" and "Hybrid Vehicles". Here, the respondents stated that they already had a sufficient level of knowledge. In contrast, demand is particularly evident in the areas of "Batteries and Charging", "Driver Assistance Systems" and "Vehicle Communication Technologies" in all countries.

5.2. Skill gaps of vehicle and spare parts salesperson

Analysis of general competences:

The skills of industry salespersons in Figure 12 shows two differentiated results. Firstly, the expected logical result for generic industry salespersons is that the qualification required in 5 years is always greater than that of the current level. The difference is particularly notable in the areas of "Financing and governmental funding aid", "Computer/IT skills" and "Language skills". In all other areas, the skills are in a comparable range.

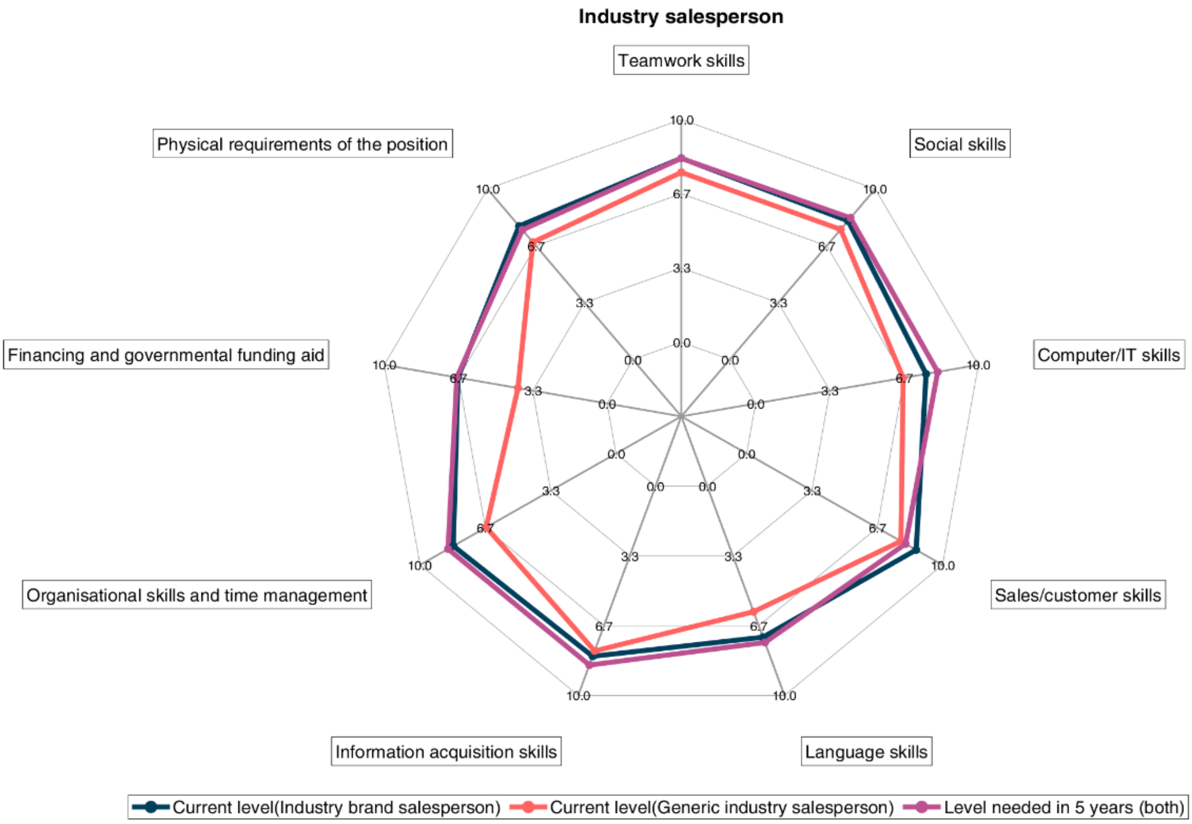

Figure 12: Skill gaps of vehicle and spare parts salespersons in general competences - network diagram

In contrast, no relevant skills gap is recognisable for industry brand salespersons. Here, the current qualification is already sufficient for the future in almost all areas and, in particular, there is a theoretical overqualification in the areas of "Sales/customer skills" and "Physical requirements often the position".

Analysis of professional competences:

In the country comparison, a distinction is now also made graphically in the skills gap between the persona "industry brand salesperson" (left) and "generic industry salesperson" (right) (see Figure 13).

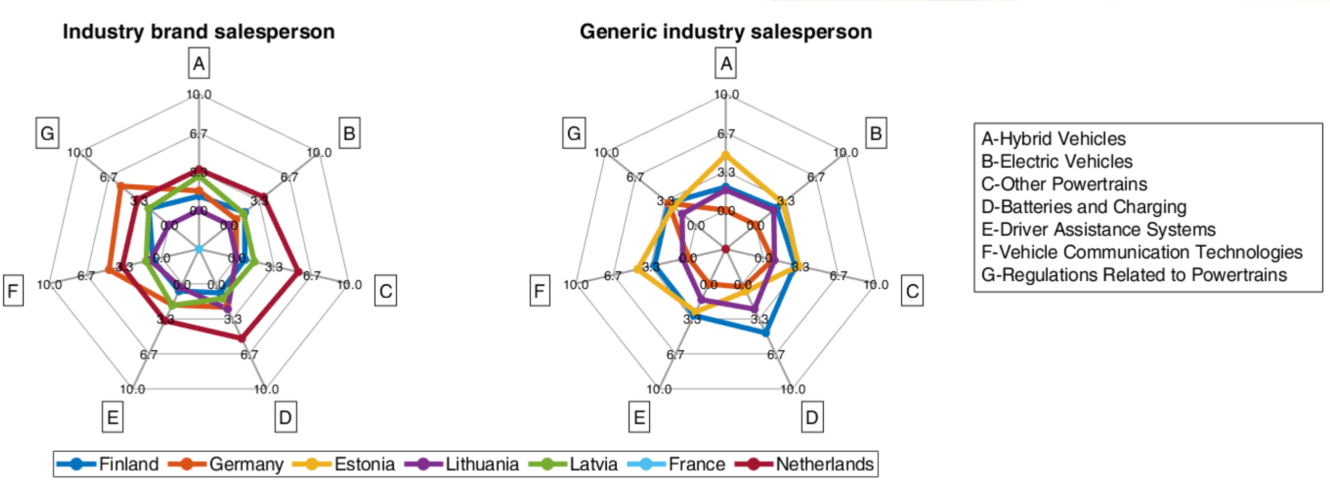

Figure 13: Skill gaps of vehicle and spare parts salespersons in professional competences - network diagram

In the case of industry brand salespersons, the largest skill gap can be seen in the areas of "Electric Vehicles", "Other Powertrains" and "Batteries and Charging" in the Netherlands. It is also clear in the areas of "Vehicle Communication Technologies" and "Regulations related to powertrains" in Germany. All other nations are more evenly distributed and have differences of less than 3.3 points each. Lithuania has no significant skill gaps except in the areas of "Batteries and Charging" and "Vehicle Communication Technologies". The data from France and Estonia could not be utilised.

The greatest deficits in generic industry salespersons are found in Estonia, particularly in the fields A, "Electric Vehicles", "Other Powertrains" and "Vehicle Communication Technologies". In Finland, too, larger skill gaps are recognisable in the areas of "Other Powertrains", "Batteries and Charging", E and F than in the other nations. In conclusion, it is clear that Germany has no significant skills gaps except in the field of "Regulations related to powertrains". The data from Latvia, France and the Netherlands could not be utilised.

5.3. Skill gaps of vehicle maintenance personnel

Analysis of general competences:

As shown in Figure 14, the current skills and the expectation in 5 years are almost symmetrically distributed. Current skills are always below the skills expected or required in the future.

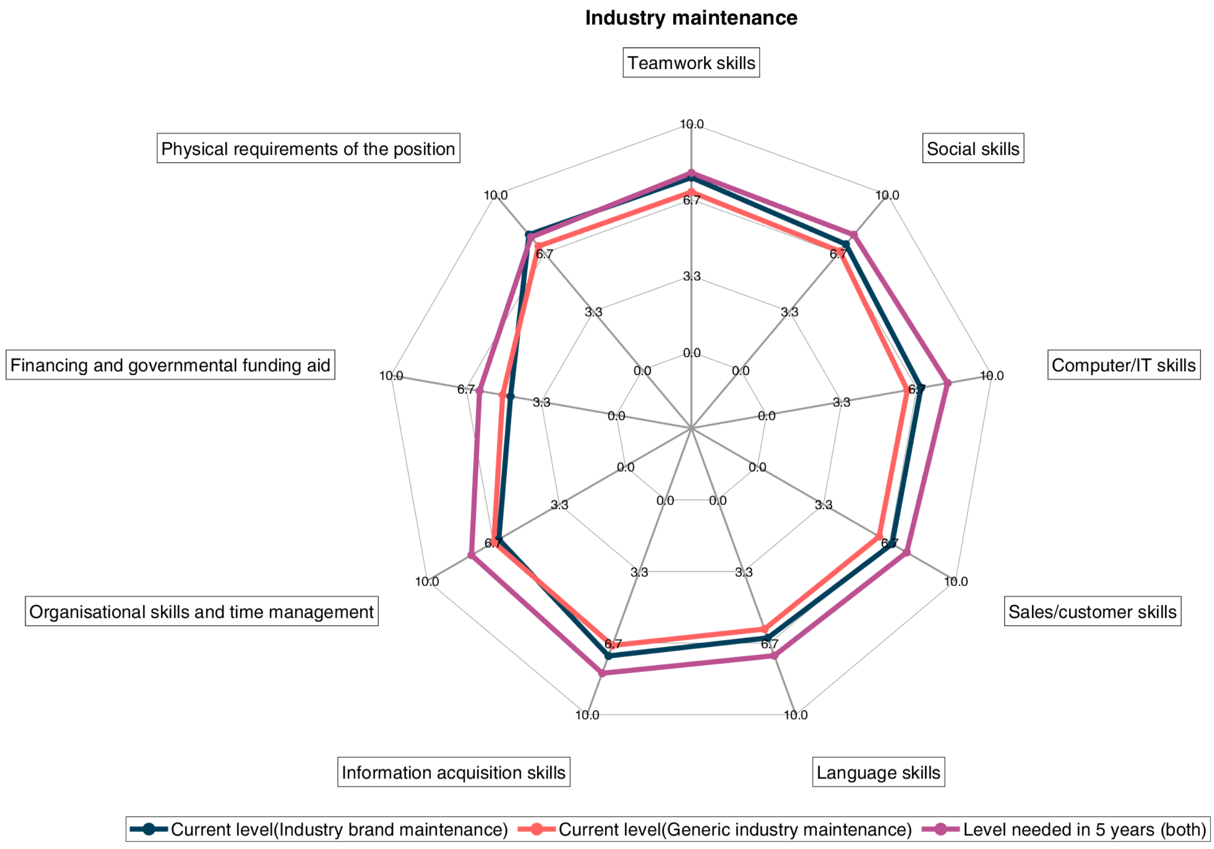

__Figure 14:__ Skill gaps of vehicle maintenance in general competences - network diagram

On the one hand, it is noteworthy that people in Generic industry maintenance currently have lower skills in almost all areas than people in Industry brand maintenance. The only exceptions here are the fields "Organisaitional skills and time management" and "Fanancing and governmental funding aid". In the latter field, there is generally a lower level of aptitude as well as a lower future demand. The area of industry brand maintenance shows no need for action in the fields of "Physical requirements of the position" and "Teamwork skills", as the required skills have already been achieved based on the survey results.

Analysis of professional competences:

In the country comparison, a distinction is also made here graphically in the skills gap between the persona "industry brand maintenance" (left) and "generic industry maintenance" (right) (see Figure 15).

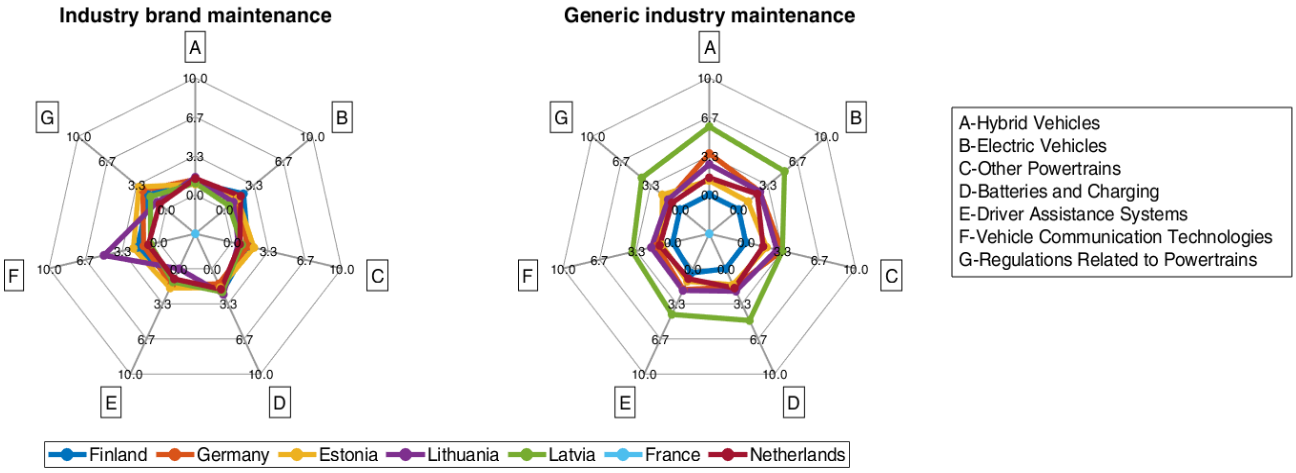

***Figure 15:** Skill gaps of vehicle maintenance in professional competences - network diagram*

At first glance, it is clear that there are almost no relevant skill gaps reported by the industry brand maintenance persons in any of the countries. The only exception is Lithuania in the field of "Vehicle Communication Technologies". All other fields show differences of less than 3.3 points in the survey.

In the area of generic industry maintenance, large deficits are recognisable across all surveyed subject areas, especially in Latvia. Only in the area of "Other Powertrains" is a skills gap comparable with other countries achieved. Remarkable are the results from Finland, which show almost no deficits. All other nations are in between, with even more significant gaps in the areas of "Hybrid Vehicles" and "Other Powertrains".

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6. CONCLUSION

In summary, this research quantified the current and future skills needs in the automotive industry for seven European countries and identified existing skills gaps. These findings are crucial to ensure that workers in the automotive industry can keep pace with innovations in the automotive industry in the future. In addition, the research enables early proactive action to reduce the gap between existing skills and the requirements needed in five years' time. In this way, this research contributes not only to securing the professional existence of employees in the automotive industry, but also enables an increase in the performance, innovation and competitiveness of companies in the automotive industry by taking the future development trends into account. This research thus follows on from the researches by [2], [3] on the employment effects in the motor vehicle trade and in the automotive industry. In the following, the most important results of this research are summarised once again and the research questions defined at the beginning are answered. Finally, an outlook on further research work is given.

6.1. Key findings of the skills gap analysis in the automobile trade

The previous research identified the preferred sources of information for the intended target group: teachers, sales personnel and maintenance staff. In view of the information from Tables: Table 3, Table 5 and Table 7, which are shown more clearly in Figure 16, clear preferences of the target group for the information sources: 'Additional training provided by employer', 'Learning from the colleagues' and 'Books' can be recognised. Against the background of vocational training and the performance of a professional activity that requires a high degree of implicit knowledge, this knowledge transfer can only take place through socialisation and externalisation. It is therefore understandable that the first two sources of information mentioned are highly favoured by the target group. The information from books supplements the existing implicit knowledge with additional data and facts. Another interesting finding is the very different assessment of social media as a source of information. While social media is highly significant for industry representatives, it is the last choice for teachers when it comes to obtaining information.

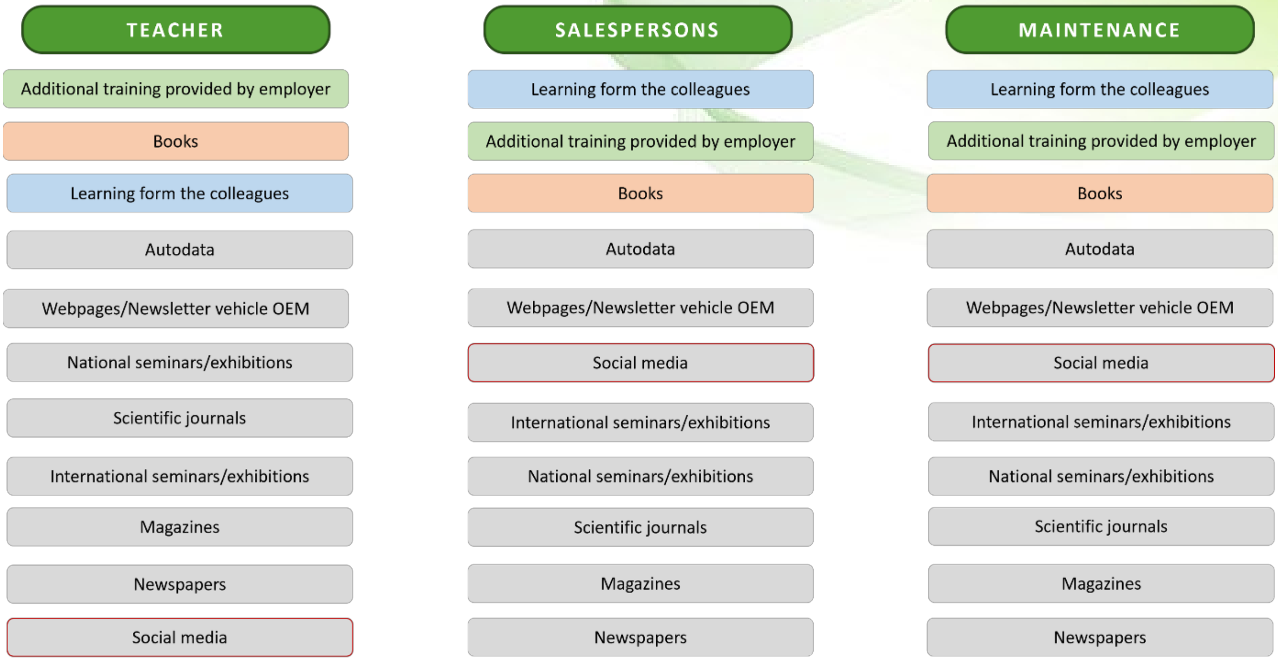

Figure 16: *Summary of preferred sources of information by professional group*

It is reasonable to assume that the teachers (possibly due to their age) are not familiar of the versatility of social media as a knowledge transfer medium. Social media offers the opportunity to impart both explicit knowledge in the form of infographics or informative instructional videos (e.g. general structure of a lithium-ion battery) and implicit knowledge about repairing or troubleshooting a car (internalisation/externalisation) by means of a YouTube tutorial. It can therefore be stated that the preferred form of knowledge transfer is the personal exchange of experiential knowledge (implicit knowledge) from person to person for the intended target group. This can take place both directly, i.e. via training courses or workshops, and indirectly via social media formats.
Another important result of the study is the identification and quantification of existing skills shortages in the three known occupational fields and those that can be expected in five years' time. These results were analysed and interpreted in detail in Chapter 5. In order to finally answer the associated research questions RQ1 and RQ2, it is necessary to convert the network diagrams presented in these chapters into a tabular form. Table 8 and Table 9 show the numerically quantified skill gaps for each occupational group and each country. For reasons of clarity, the individual sub-topic areas surveyed are coded from A1 to G1 in the tables. A legend for this coding can be found in Appendix II. The individual numerical values are underlaid with a heat map function that visualises between dark green (no skill gap in the category) and dark red (very high skill gap in the category). As the tables show, the existing skills in the subject areas surveyed are very heterogeneously distributed across the countries. In some cases, both dark green and dark red areas can be recognised, but yellow areas predominate. This means that there are currently already skills gaps in the subject areas surveyed, the extent of which can be seen from the tables. In addition, the tables clearly show confirmation of the hypothesis put forward at the beginning that the skill gaps of the "generic industry representives" tend to be higher than those of the "industry brand representives". This can be deduced from a comparison of the calculated mean values and the calculated median between the employee types of company. Against this background, research questions RQ1, RQ2 and RQ4 can be considered answered.

Furthermore, this study shows which basic skills are required in the areas of training/sales/maintenance for (new) vehicle technologies (RQ3). In order to answer the associated research question, the survey participants assessed general competences or basic skills as they will be required in their specialist area in the future (see network diagrams in Chapter 5). Table 10 shows the results of the skills gap analysis for the basic skills in a tabular heat map, analogous to the specialised skills. It can be seen across all sectors that there is a particular need for training in the areas of "Computer/IT skills", "Language skills", "Organisational skills & time management" and "Financing & government funding aid". The individual analyses of the various stakeholder groups yielded further interesting findings.
In the case of teachers, the greatest deficits are in the areas of "Financing & governmental funding aid", "Computer/IT skills" and "Language skills".

In the area of vehicle and spare parts sales, a differentiated picture of competences emerges. While the brand-related sales personnel do not have any significant skills gaps, there is certainly a need for qualification among the non-brand-related sales personnel. The areas of "Financing & governmental funding aid", "Computer/IT skills", "Language skills" and "Organisational skills & time management" show an existing deficit. In contrast, marginal deficits are evident in the areas of "Physical requirements of the position", "Teamwork skills" and "Social skills".
For maintenance employees, there are skill gaps in almost all areas. As already known from the answer to research question RQ4, the skills of brand-independent employees are generally less developed than those of brand-dependent employees. An exception to this rule can be seen in the competences "Financing & governmental funding aid" and "Organisational skills & time management", where brand-independent employees have a higher but nevertheless lower level of competence for the future. Furthermore, it became clear that the brand-dependent employees are already adapting their competences in the areas of "Physical requirements of the position" and "Teamwork skills" to future competence requirements and therefore there is no skills gap.

All in all, the study provides a detailed insight into the European automotive industry and the professions in particular: Trainers, sales personnel and maintenance personnel. Clear preferences for knowledge transfer and existing skill gaps in both technical and non-technical areas were identified and quantified. The heat maps of the skill gaps showed a heterogeneous distribution across the countries and confirmed higher deficits among generic industry representatives compared to brand-specific ones. In the area of basic skills, there is a general need for action, particularly in the areas of "Computer/IT skills", "Financing & government funding aid" and "Language skills".

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Profession: industry brand salesperson	Hybrid vehicle		Electric Vehicle			Other Powertrains						Batteries & Charging															Driver Assistance Systems			Vehicle Communication Technologies	Regulations Related to Powertrains
Country	A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	E1	E2	E3	F1	G1
Finland	0.7	1.8	1.6	2.6	1.1	0.7	3.0	0.6	1.7	-1.2	-0.2	0.4	1.8	1.6	2.4	1.3	0.1	-0.3	1.6	0.8	2.0	-0.7	1.3	1.1	-0.4	-0.2	-0.7	1.9	0.8	0.8	2.2
Germany	1.0	2.3	0.3	0.3	1.7	1.0	2.0	-2.0	-2.0	-4.3	-4.3	4.3	1.7	3.7	2.0	2.0	3.3	2.3	1.3	3.3	0.7	0.0	3.0	2.3	1.7	1.7	1.3	2.3	2.3	4.7	5.3
Estonia																															
Lithuania	0.0	0.0	-1.0	0.0	0.0	0.0	2.0	-1.0	-1.0	-3.0	-3.0	-1.0	-1.0	0.0	3.0	4.0	4.0	3.0	2.0	3.0	7.0	8.0	2.0	2.0	0.0	0.0	1.0	0.0	0.0	1.0	-5.0
Latvia	2.6	3.3	2.1	2.0	0.6	2.6	1.4	1.4	1.4	1.4	1.4	0.8	1.0	1.8	2.3	2.8	1.6	0.9	0.8	-1.3	1.9	1.9	1.4	2.4	1.4	1.4	2.0	2.0	2.1	1.4	2.3
France																															
Netherlands	3.5	3.5	3.5	3.5	4.5	3.5	7.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.5	5.0	4.5	4.5	4.5	3.5	3.5	3.5	3.5	3.5
Mean	1.6	2.2	1.3	1.7	1.6	1.6	3.2	0.9	1.1	-0.3	-0.1	2.0	1.8	2.5	3.0	3.1	2.9	2.3	2.2	2.3	3.4	2.7	2.5	2.5	1.4	1.5	1.4	1.9	1.7	2.3	1.7
Median	1.0	2.3	1.6	2.0	1.1	1.0	2.0	0.6	1.4	-1.2	-0.2	0.8	1.7	1.8	2.4	2.8	3.3	2.3	1.6	3.0	2.0	1.9	2.0	2.3	1.4	1.4	1.3	2.0	2.1	1.4	2.3

Profession: generic industry salesperson	Hybrid vehicle		Electric Vehicle			Other Powertrains						Batteries & Charging															Driver Assistance Systems			Vehicle Communication Technologies	Regulations Related to Powertrains
Country	A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	E1	E2	E3	F1	G1
Finland	2.0	2.0	2.0	2.0	3.0	2.0	5.0	1.0	1.0	4.0	4.0	6.0	5.0	5.0	6.0	6.0	6.0	5.0	6.0	5.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Germany	0.0	0.0	0.0	0.0	-0.5	0.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.5	0.5	0.5	2.5	-1.5	0.0	0.0	-1.5	-1.0	1.5	1.0	1.0	0.0	0.0	0.0	0.0	3.0
Estonia	4.0	5.5	4.0	0.0	5.0	4.0	5.5	2.5	3.5	1.0	2.5	-0.5	-0.5	0.0	0.5	-1.0	-0.5	5.0	1.0	0.0	0.0	1.5	1.0	5.5	-1.0	-0.5	4.0	-1.5	5.5	4.5	2.5
Lithuania	2.5	1.0	2.0	2.0	2.0	2.5	2.5	0.0	0.0	0.0	1.0	2.0	2.0	3.5	4.0	3.0	2.5	2.0	2.0	1.5	3.0	2.0	2.5	2.0	2.0	2.0	0.5	2.5	1.5	0.5	1.5
Latvia																															
France																															
Netherlands																															
Mean	2.1	2.1	2.0	1.0	2.4	2.1	3.5	1.1	1.4	1.5	2.1	1.9	1.9	2.1	2.8	2.1	2.1	3.6	1.9	1.6	1.8	1.5	1.4	3.0	1.3	1.4	1.9	1.0	2.5	2.0	2.5
Median	2.3	1.5	2.0	1.0	2.5	2.3	3.8	1.0	1.0	1.0	1.8	1.0	1.5	1.8	2.3	1.8	1.5	3.8	1.5	0.8	1.5	1.8	1.8	2.5	1.5	1.5	1.8	1.3	2.3	1.8	2.8

Table 8: *Summary of technical skills gaps by professions 1/2*

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Profession: industry brand maintenance	Hybrid vehicle		Electric Vehicle			Other Powertrains						Batteries & Charging															Driver Assistance Systems			Vehicle Communication Technologies	Regulations Related to Powertrains
Country	A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	E1	E2	E3	F1	G1
Finland	1.3	0.8	2.7	1.2	2.6	1.3	3.6	1.9	1.5	0.5	0.1	2.1	2.2	2.5	2.8	1.9	2.2	2.8	2.1	2.3	1.3	2.9	2.3	2.4	1.6	1.6	1.0	0.9	1.5	1.9	2.0
Germany	1.2	1.4	0.7	1.2	2.0	1.2	2.7	1.1	1.2	1.4	1.2	1.1	1.2	2.1	2.4	1.0	1.4	1.9	0.9	1.4	2.5	1.8	1.5	1.3	0.4	0.6	0.9	1.4	2.1	1.4	2.6
Estonia	0.8	1.1	2.0	0.5	1.9	0.8	3.9	1.8	1.7	2.1	1.8	1.5	1.9	2.5	2.5	1.3	1.5	1.0	0.1	1.5	2.5	2.8	2.5	2.0	1.5	1.7	1.8	1.0	2.6	2.3	3.1
Lithuania	1.5	1.5	1.0	1.0	1.0	1.5	5.0	-1.5	-2.0	0.0	0.5	2.0	1.5	2.0	2.0	3.5	3.0	3.0	3.5	3.0	3.5	2.5	3.5	2.0	0.5	1.0	0.5	-4.0	0.0	5.0	1.0
Latvia	1.0	1.0	1.0	-0.5	1.0	1.0	2.8	0.0	0.5	0.5	0.8	1.0	0.5	-1.8	4.0	2.8	2.3	1.3	4.0	3.3	0.8	4.5	3.0	0.5	3.5	3.5	0.0	0.3	3.5	0.8	1.8
France																															
Netherlands	1.4	1.3	1.8	1.5	2.2	1.4	3.3	0.1	-0.2	-0.1	-0.2	2.2	1.6	3.1	1.4	1.3	2.3	2.1	3.6	1.3	1.9	1.1	2.1	1.8	1.7	1.6	1.0	0.6	1.3	0.9	0.7
Mean	1.2	1.2	1.5	0.8	1.8	1.2	3.5	0.6	0.4	0.7	0.7	1.6	1.5	1.7	2.5	2.0	2.1	2.0	2.4	2.1	2.1	2.6	2.5	1.7	1.5	1.7	0.9	0.0	1.8	2.1	1.9
Median	1.3	1.2	1.4	1.1	1.9	1.3	3.4	0.6	0.8	0.5	0.6	1.7	1.5	2.3	2.5	1.6	2.2	2.0	2.8	1.9	2.2	2.6	2.4	1.9	1.5	1.6	1.0	0.8	1.8	1.6	1.9

Profession: generic industry maintenance	Hybrid vehicle		Electric Vehicle			Other Powertrains						Batteries & Charging															Driver Assistance Systems			Vehicle Communication Technologies	Regulations Related to Powertrains
Country	A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	E1	E2	E3	F1	G1
Finland	-0.8	-0.6	-0.6	-0.4	-0.2	-0.8	2.6	-0.6	-1.4	0.0	-0.4	1.4	1.0	1.2	0.0	0.2	0.2	0.4	-0.2	-2.0	-1.4	-0.2	-0.4	-0.4	-2.0	-1.8	0.4	0.6	0.2	-0.8	-1.4
Germany	3.2	3.9	2.3	2.5	2.5	3.2	4.5	2.6	2.8	3.2	3.3	2.7	1.8	3.0	2.4	1.6	1.2	1.2	0.7	1.7	2.7	1.8	2.8	1.7	0.0	0.7	1.3	1.8	2.8	1.5	1.3
Estonia	1.6	0.9	1.2	1.7	0.3	1.6	2.3	1.7	1.7	2.0	2.1	2.2	2.8	2.1	1.8	1.6	2.7	2.1	0.8	1.7	1.3	1.2	1.0	0.4	0.4	0.7	1.7	0.7	1.2	1.0	2.0
Lithuania	2.4	2.8	2.3	3.6	1.5	2.4	3.0	2.2	2.8	3.1	3.4	1.5	2.1	2.8	2.9	2.8	2.4	1.5	1.4	2.7	2.9	1.9	2.3	2.2	1.3	1.3	1.7	2.0	2.5	2.0	1.3
Latvia	5.7	6.0	6.0	6.0	3.7	5.7	5.0	1.3	1.3	3.3	3.3	5.3	6.0	7.0	6.0	6.3	6.0	2.7	3.7	3.3	6.3	5.3	5.7	6.0	2.0	2.0	3.7	4.7	4.7	3.7	4.3
France																															
Netherlands	1.5	1.4	1.5	2.5	2.4	1.5	3.6	0.6	0.6	1.3	1.7	1.6	1.4	1.7	0.6	0.8	0.9	3.9	3.0	1.4	1.9	2.2	2.1	1.9	1.8	2.2	0.7	0.5	1.6	1.2	0.9
Mean	2.3	2.4	2.1	2.6	1.7	2.3	3.5	1.3	1.3	2.2	2.2	2.5	2.5	3.0	2.3	2.2	2.2	2.0	1.6	1.5	2.3	2.0	2.2	2.0	0.6	0.8	1.6	1.7	2.2	1.4	1.4
Median	2.0	2.1	1.9	2.5	1.9	2.0	3.3	1.5	1.5	2.5	2.7	1.9	2.0	2.5	2.1	1.6	1.8	1.8	1.1	1.7	2.3	1.9	2.2	1.8	0.9	1.0	1.5	1.3	2.1	1.3	1.3

Table 9: *Summary of technical skills gaps by professions 2/2*

Profession	Teamwork skills	Social skills	Computer/IT skills	Sales/customer skills	Language skills	Information acquisition skills	Organisational skills & time management	Financing & governmental funding aid	Physical requirements of the position
Teacher	0.39	0.10	1.03	0.63	1.25	0.58	0.66	1.65	0.24
Industry brand salesperson	-0.13	0.22	0.70	-0.30	0.35	0.22	0.22	0.91	0.00
Generic industry salesperson	0.75	0.63	1.38	0.00	1.38	0.88	2.00	1.88	0.50
Industry brand maintenance	0.87	1.00	1.55	0.94	0.93	1.15	1.54	1.29	0.13
Generic industry maintenance	0.17	0.48	1.42	1.19	1.14	0.95	0.97	1.11	0.23
Mean	0.41	0.48	1.21	0.49	1.01	0.75	1.08	1.37	0.22
Median	0.39	0.48	1.38	0.63	1.14	0.88	0.97	1.29	0.23

***Table 10:** Summary of non-technical skills gaps by professions*

6.2. Outlook

The identification and analysis of skill gaps in the automobile trade has shown that these vary not only between different occupational groups, but also between European countries. In order to get to the ground of these differences, further research is needed into the causes of country differences in skill gaps. In this context, national education systems, economic framework conditions and industrial developments could be considered as potential influencing factors that complement the research already conducted on development trends in vehicle fleets, vehicle sales and maintenance services (D2.1) in this project. A deeper understanding of these causes could enable customised educational measures and further strengthen the competitiveness of the European automotive trade.

Another promising approach for future research would be an in-depth comparison of curricula and training programmes in different EU countries. A systematic analysis could identify similarities and differences, which would make it possible to identify best practices and promote the exchange of teaching materials and teaching methods. This comparison could help to promote the harmonisation of training standards within Europe and facilitate the mobility of professionals.

In order to transfer the results of this study to the entire European Union and improve the generalisability of the findings, it would be advisable to extend the target group to all EU member states. This would allow an increase in the sample size and cover a wider variety of national contexts. More comprehensive data collection could provide a more accurate picture of skill gaps across the EU, which in turn would allow for a more informed development of educational strategies and policies.

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APPENDIX : RELATED DOCUMENTS

ID	Related Document	Link/Location
1	*English Questionnaire*	A.1_Qustionnaire
2		
3		
4		
5		
6		
7		
8		
9		

APPENDIX I: Questionnaire design

AUTOCOVE – questionnaire for the teachers and industry representatives

Auto-Cove 2.0 -project aims at combating on climate change by developing the European Education and Training Area in Vehicle Sector of VET towards greener innovations.

The existing curricula in VET schools and the training provided by the VET sector in Europe does not cover the subjects necessary to keep up with the emerging technologies in transport such as electrification, automation and communication technologies.

Hence, the project group is collecting information on the current skills and competencies related to new and existing vehicle technologies, to be able to later in the project, develop relevant study modules to complement the current curricula in VET schools in each participating country (Finland, Estonia, Latvia, Lithuania, Germany, France, and the Netherlands).

All the data collected with this questionnaire will be used solely on research and development purposes and handled as whole with the statistical methods. No individual answers neither individual respondents can be recognized from the data.

By participating this questionnaire, you will help us in developing the future VET training courses. As a reward for the participation, you will be provided by an access to our dissemination event to learn more about our project results!

Part 1. Background information

1. **Country?**
    a. Finland
    b. Germany
    c. Estonia
    d. Lithuania
    e. Latvia
    f. France
    g. Netherlands

2. **Your profession?**
    a. teacher (if selected, the survey jumps to the question 4)
    b. industry representative – sales/spare parts dealer
    c. industry representative – vehicle maintenance

3. **for industry representatives only:**
    a. Are you representing certain brand(s) OR
    b. A generic spare parts/maintenance

Part 2. Current and future technological skills and competencies in one's own profession in general.

a) How would you rate the current level of skills and competencies in your profession in general. And b) how would you rate the needed level of skills in 5 years.

Please use the scale: 1 = low, …., 10 = high, 0 = not relevant to me, for answering a and b!

1. Hybrid vehicle systems in general
2. Maintenance of Hybrid vehicle systems
3. Hydrogen vehicle systems in general
4. Maintenance of Hydrogen systems
5. Electric vehicle systems in general
6. Maintenance of HV Electric vehicle systems
7. Hybrid LPG (liquified petroleum gas) systems in general?
8. Maintenance of Hybrid LPG systems?
9. Hybrid CNG (City Natural Gas) systems in general?
10. Maintenance of Hybrid CNG systems?
11. Structure and function of lithium-ion batteries
12. Task & function of a BMS (battery management system)
13. Balancing of lithium-ion batteries (active/passive)
14. Dealing with damaged batteries
15. Hazards & Risks when Handling Li-Ion Batteries
16. Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity
17. Condition assessment of aged/obsolete batteries
18. Battery assembly basics
19. Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation).
20. Warranty claims for used BEVs and batteries.
21. Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)
22. Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)
23. General charging behavior of Li-ion batteries
24. Effects of cold weather into batteries and charging
25. Effects of hot weather into batteries and charging
26. Particularities of chassis or other support structures of electric vehicles
27. Driver information systems, such as driver drowsiness monitoring/warning, speed alert…
28. Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)
29. Data processing and automation related to Driver Assistance Systems (ADAS)
30. Vehicle communication technologies
31. Regulation related to vehicle technologies and powertrains

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Part 3. Current and future generic skills and competencies in one's own profession in general

a) How would you rate the current level of skills and competencies in your profession in general.

And

b) how would you rate the needed level of skills in 5 years.

Please use the scale: 1 = low, …., 10 = high, 0 = not relevant to me, for answering a and b!

1. Teamwork skills
2. Social skills
3. computer/IT skills
4. sales/customer skills
5. language skills
6. information acquisition skills
7. Organizational skills and time management
8. Financing and (governmental) funding aid (e.g. via taxation) for different power trains
9. physical requirements of the position

Part 4. Importance of information sources for your profession

How important are the following information sources for you in your profession?

(scale 1 = not important at all, …, 10 very important, 0 = I don't know)

1. Additional training provided by your employer or a training organization
2. Learning from the colleagues at work
3. Newspapers (paper or digital)
4. Magazines (paper or digital)
5. Books, e.g. repair manuals
6. Scientific journals
7. Webpages of or newsletters from vehicle manufacturers
8. Autodata (Wikipedia-page)
9. National seminars or exhibitions
10. International seminars or exhibitions
11. Social media

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Part 5. Past education and trainings

1. **What is your educational background? Select the highest that apply.**
   a. middle school (9 years of education)
   b. high school (12 years of education)
   c. School of vocational training
   d. college
   e. university (BSc or MSc)
   f. university (PhD)

2. **How many additional (at least 1-day long) trainings have you attended during the past 5 years?**
   a. 0
   b. 1 – 2
   c. 3 – 5
   d. 6 – 10
   e. More

3. **If you have attended additional trainings during the past years, which subjects have been they covering (select all that applies).**
   a. hybrid vehicles
   b. electric vehicles
   c. other powertrains (hydrogen, LPG, CNG)
   d. batteries and charging
   e. driver assistance systems
   f. vehicle communication technologies
   g. regulations related to powertrains
   h. something else

APPENDIX II: Legend for visual data analysis

A1-Hybrid vehicle systems in general
A2-Maintenance of hybrid vehicle systems
B1-Hydrogen vehicle systems in general
B2-Maintenance of Hydrogen systems
B3-Electric vehicle systems in general
C1-Maintenance of HV Electric vehicle systems
C2-Hybrid LPG (liquified petroleum gas) systems in general
C3-Maintenance of Hybrid LPG systems
C4-Hybrid CNG (Compressed Natural Gas) systems in general
C5-Maintenance of Hybrid CNG systems
C6-Structure and function of lithium-ion batteries
D1-Task & function of a BMS (battery management system)
D2-Balancing of lithium-ion batteries (active/passive)
D3-Dealing with damaged batteries
D4-Hazards & Risks when Handling Li-Ion Batteries
D5-Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity
D6-Condition assessment of aged/obsolete batteries
D7-Battery assembly basics
D8-Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation).
D9-Warranty claims for used BEVs and batteries.
D10-Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)
D11-Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)
D12-General charging behavior of Li-ion batteries
D13-Effects of cold weather into batteries and charging
D14-Effects of hot weather into batteries and charging
D15-Particularities of chassis or other support structures of electric vehicles
E1-Driver information systems, such as driver drowsiness monitoring/warning, speed alert…
E2-Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)
E3-Data processing and automation related to Driver Assistance Systems (ADAS)
F1-Vehicle communication technologies
G1-Regulation related to vehicle technologies and powertrains

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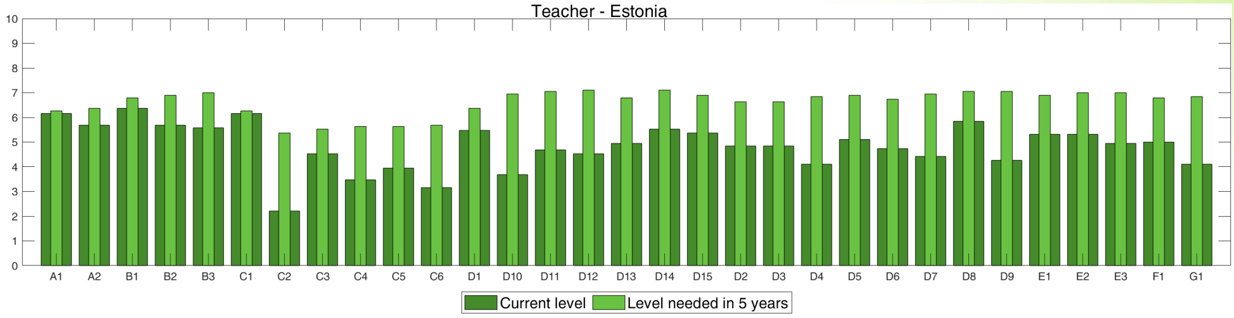
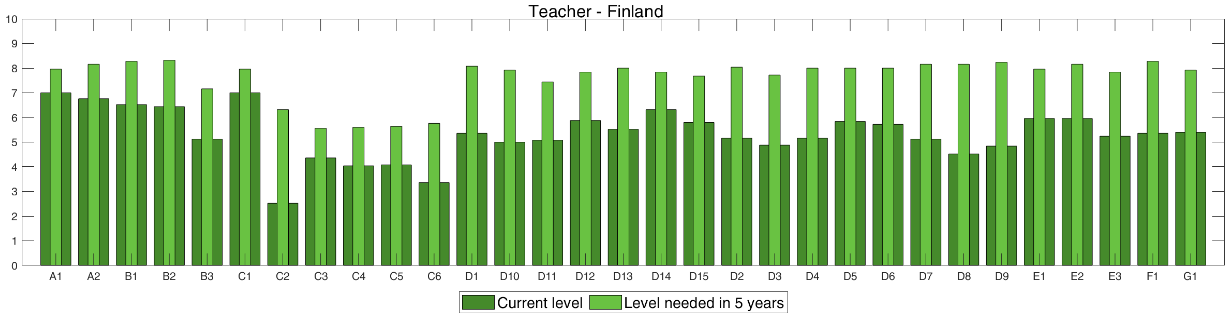
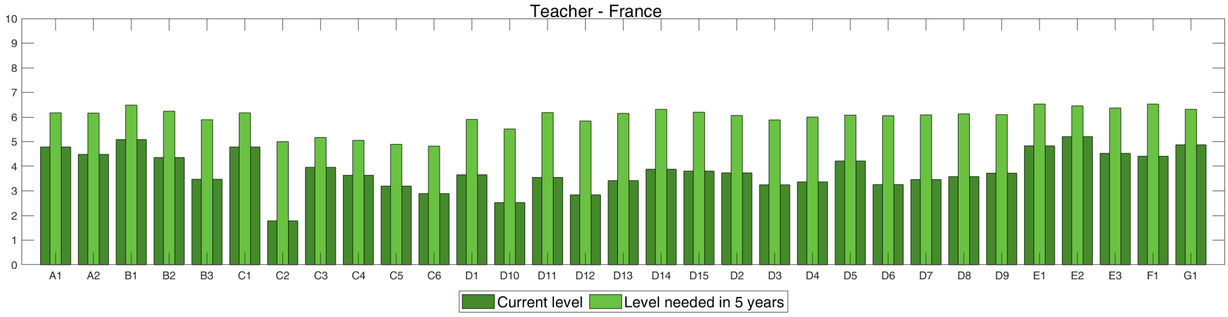
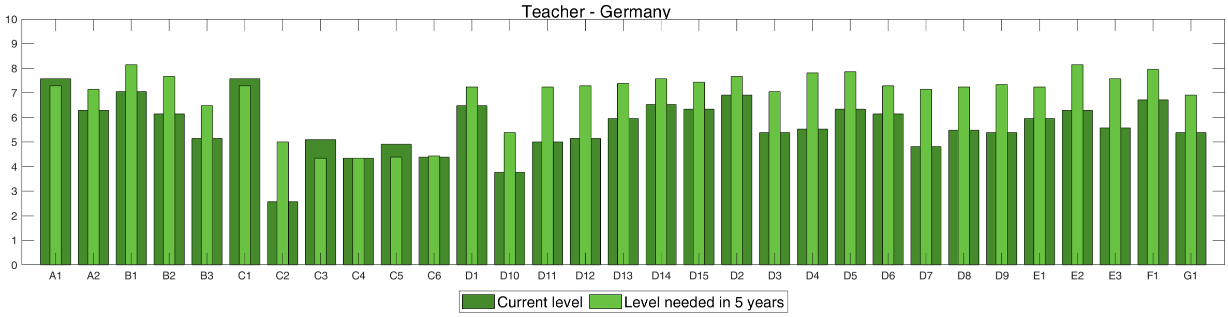
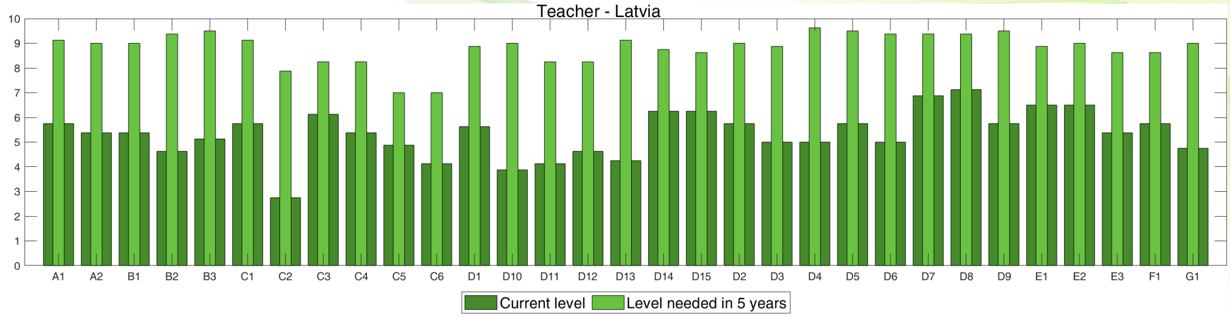
APPENDIX III: Detailed skill-gap block diagram of teachers per country

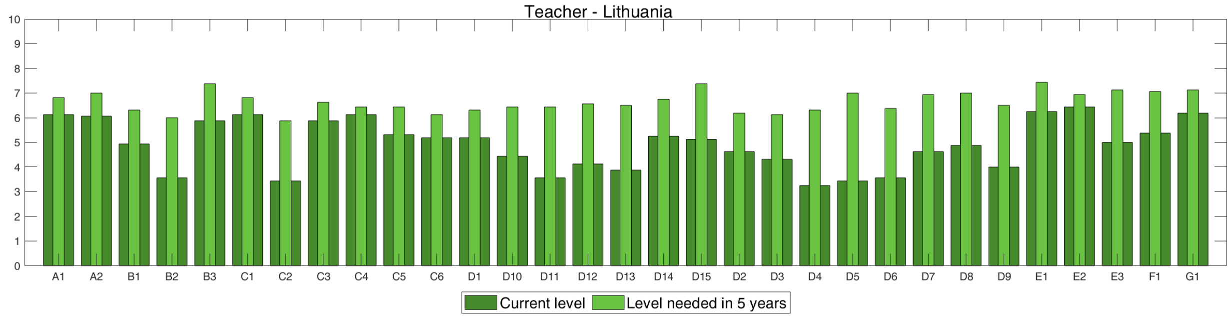


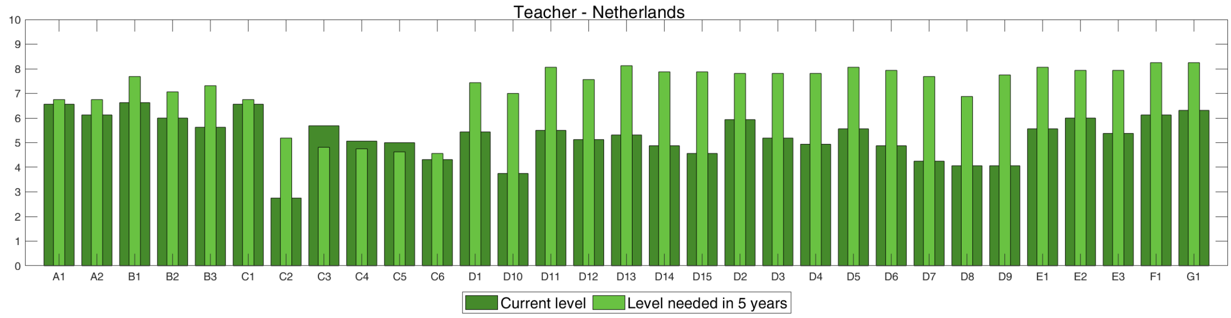




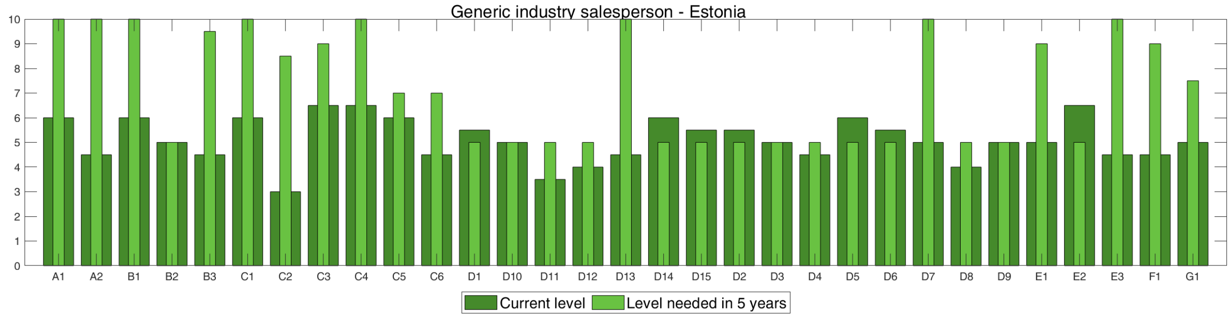


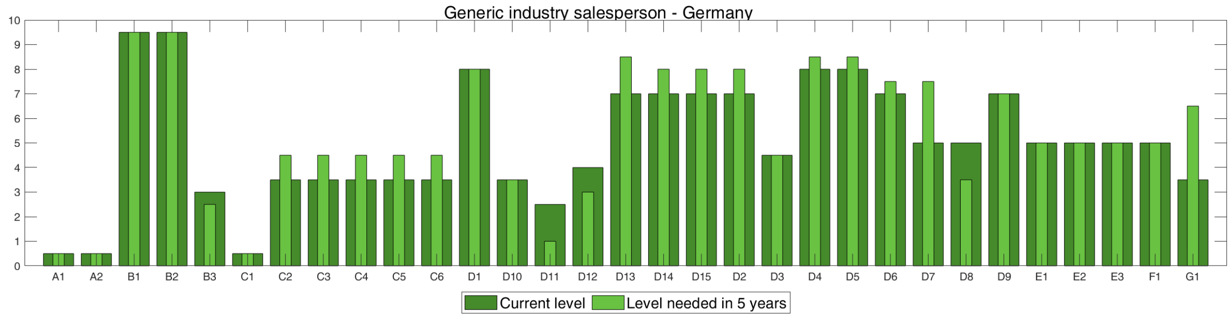

Teacher - Latvia
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years


Teacher - Lithuania
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years


Teacher - Netherlands
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

APPENDIX IV: Detailed skill-gap block diagram of vehicle and spare parts sales personnel per country





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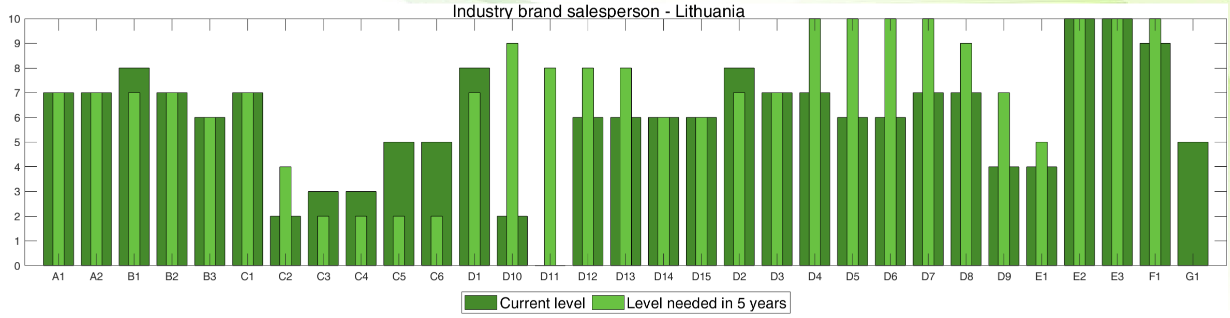
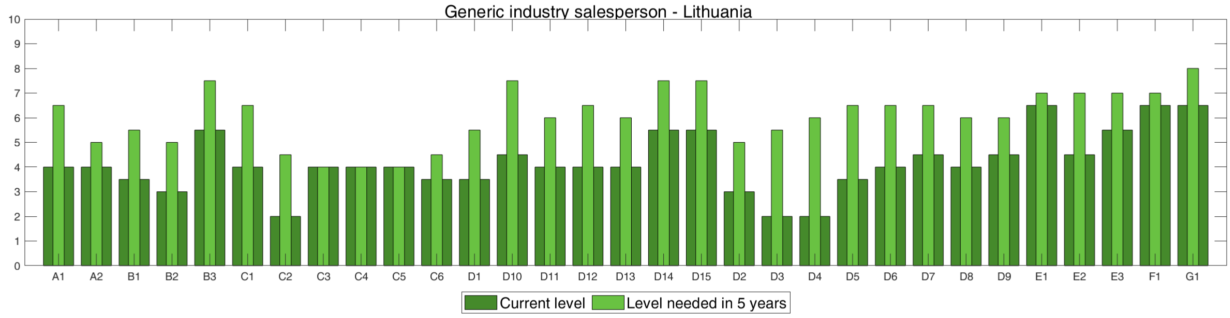
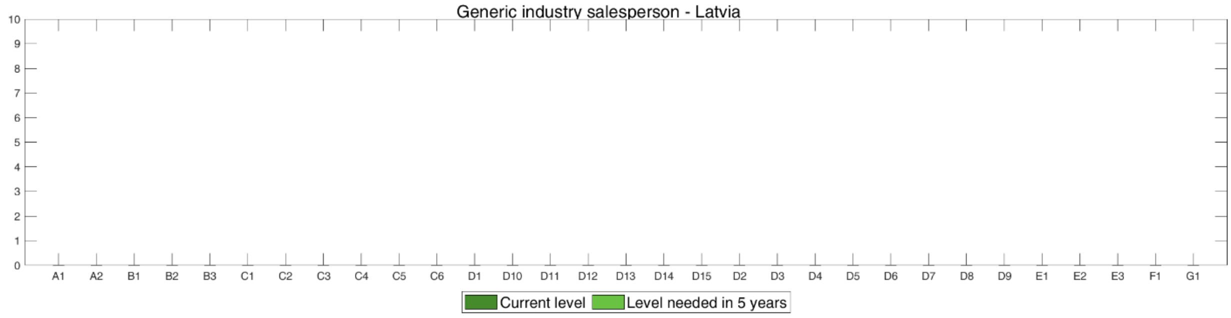
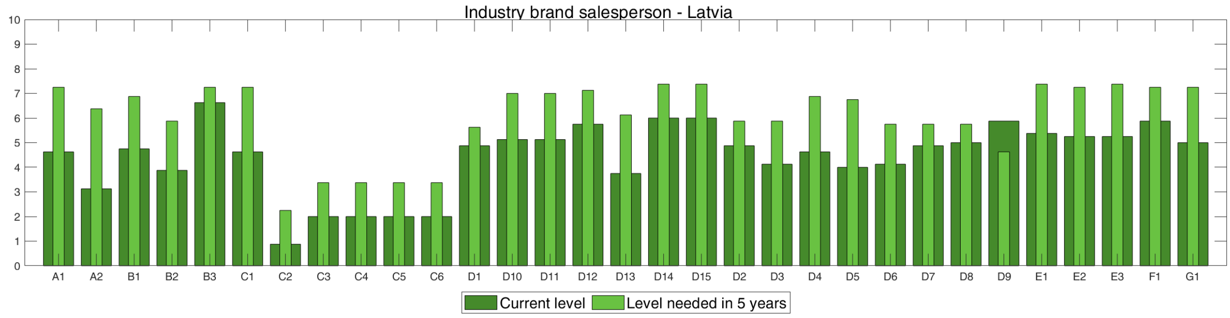
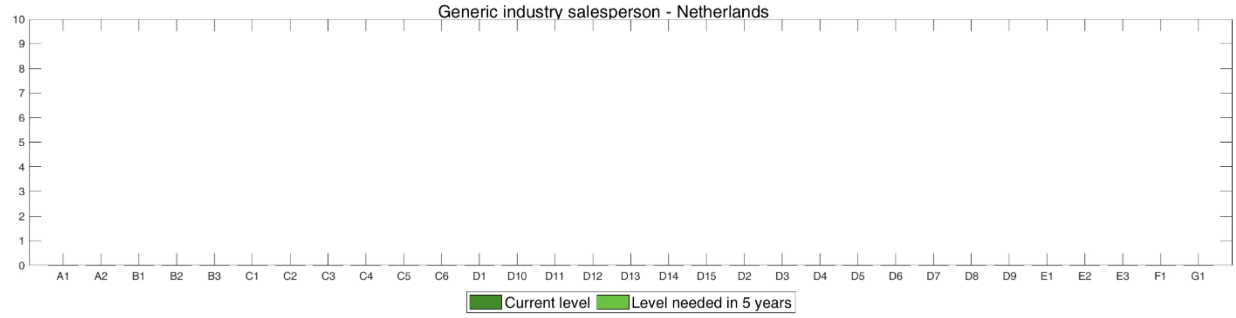

Industry brand salesperson - Lithuania
Current level
Level needed in 5 years


Generic industry salesperson - Lithuania
Current level
Level needed in 5 years

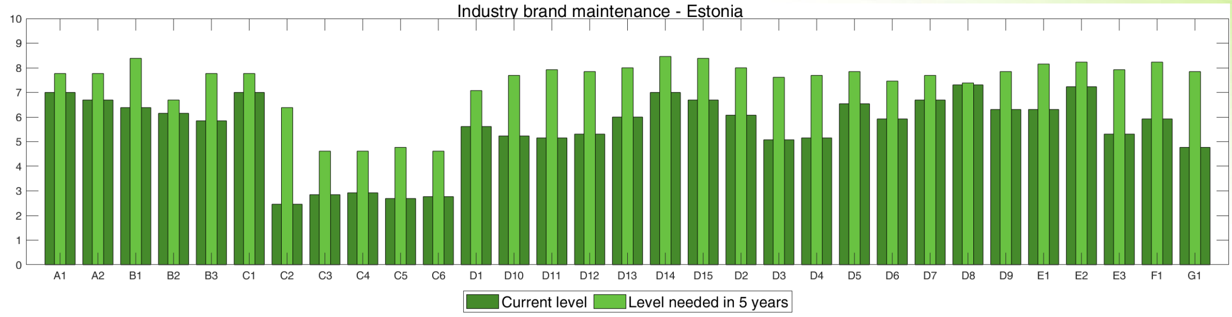

Generic industry salesperson - Latvia
Current level
Level needed in 5 years

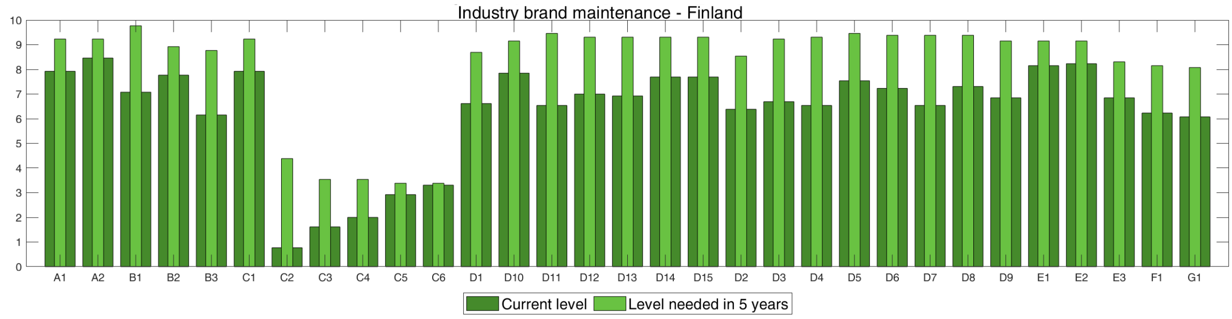

Industry brand salesperson - Latvia
Current level
Level needed in 5 years

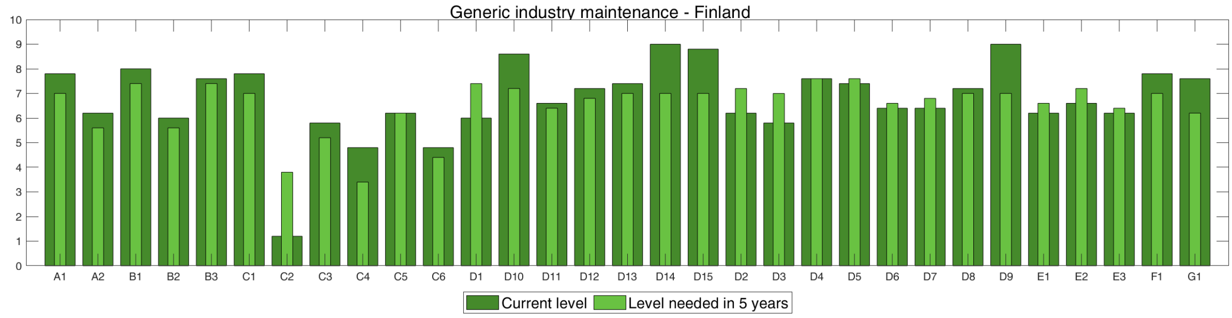

Industry brand salesperson - Netherlands
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

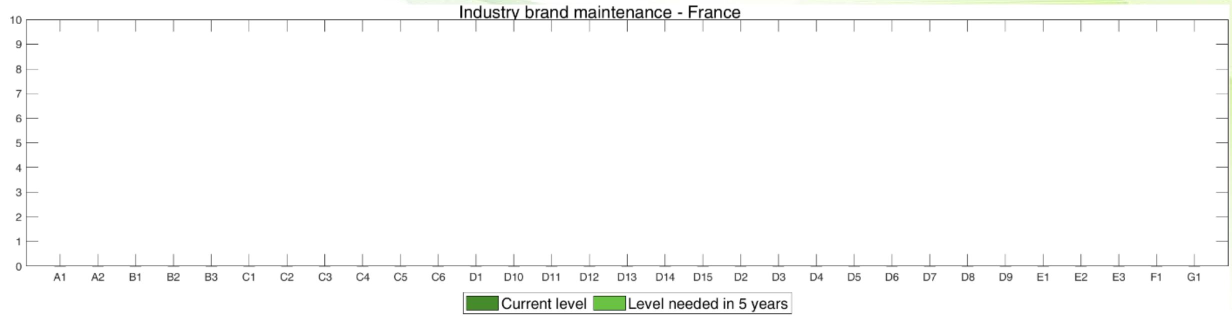

Generic industry salesperson - Netherlands
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

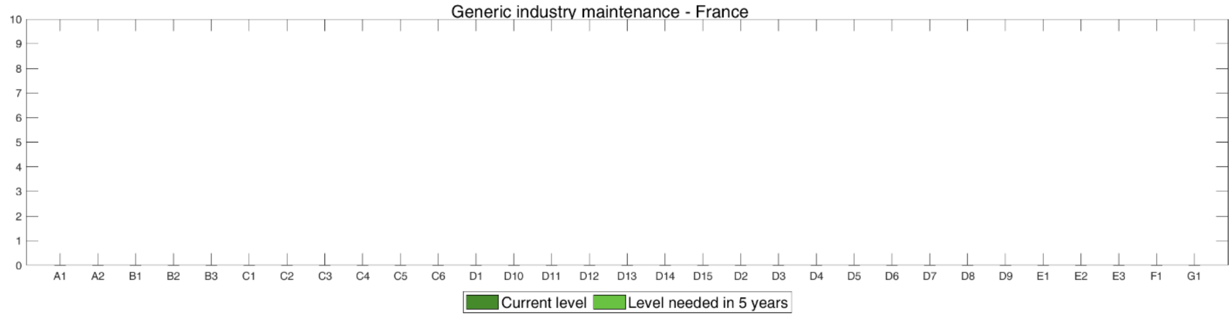
APPENDIX V: Detailed skill-gap block diagram of vehicle maintenance personnel per country



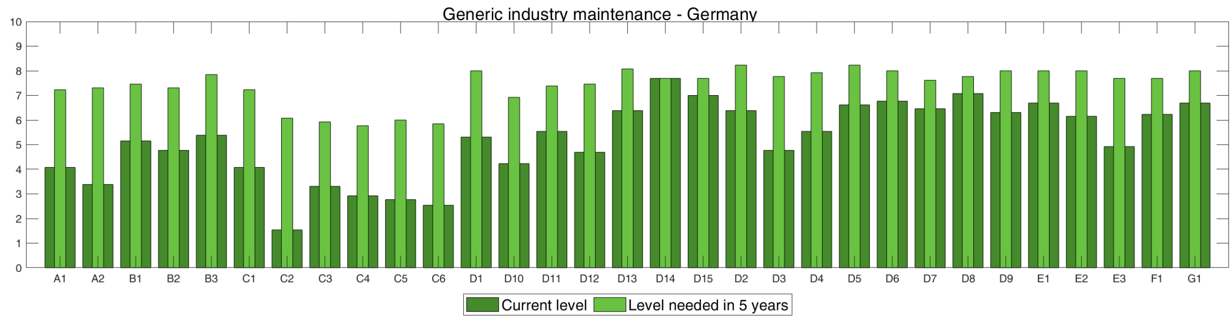


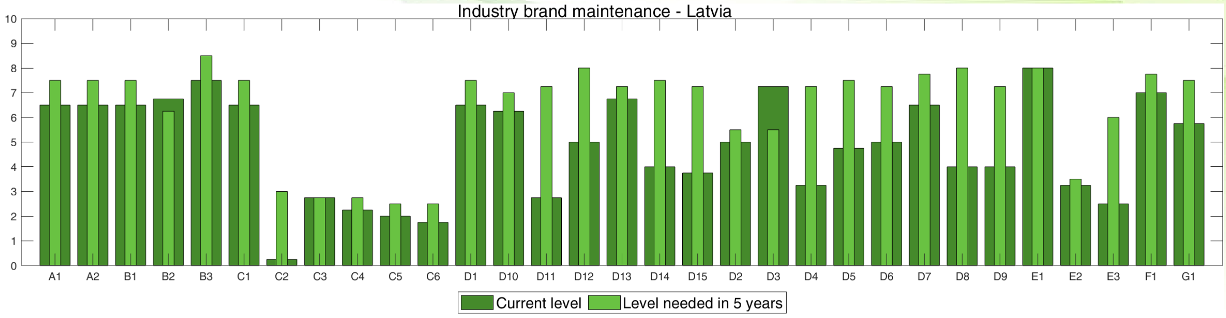


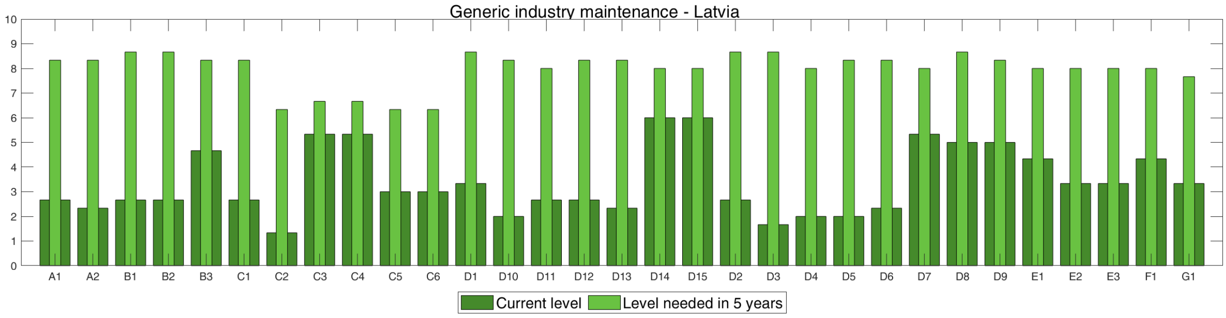

Industry brand maintenance - France
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

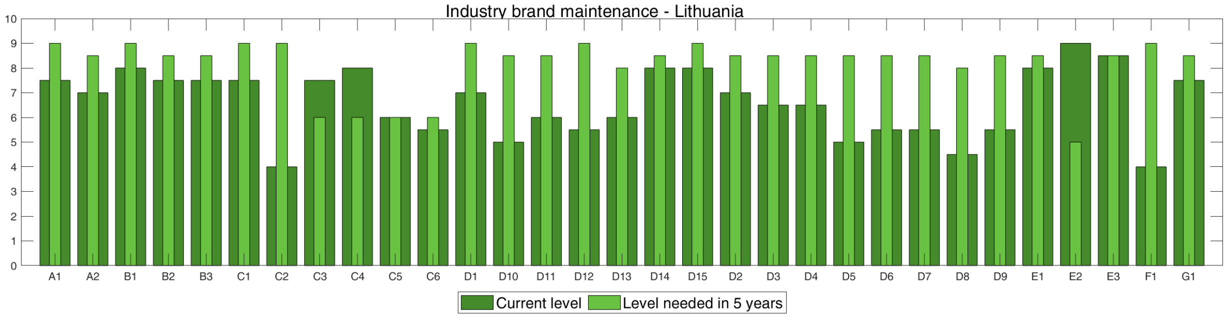

Generic industry maintenance - France
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

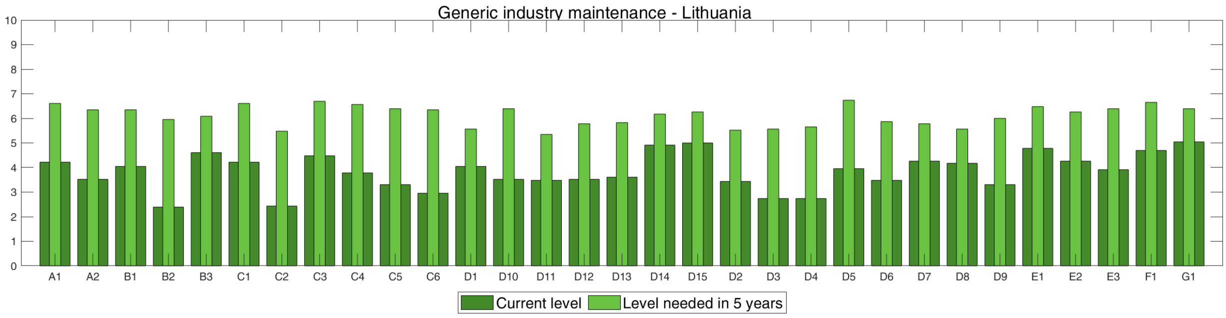

Industry brand maintenance - Germany
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years


Generic industry maintenance - Germany
A1 A2 B1 B2 B3 C1 C2 C3 C4 C5 C6 D1 D10 D11 D12 D13 D14 D15 D2 D3 D4 D5 D6 D7 D8 D9 E1 E2 E3 F1 G1
Current level
Level needed in 5 years

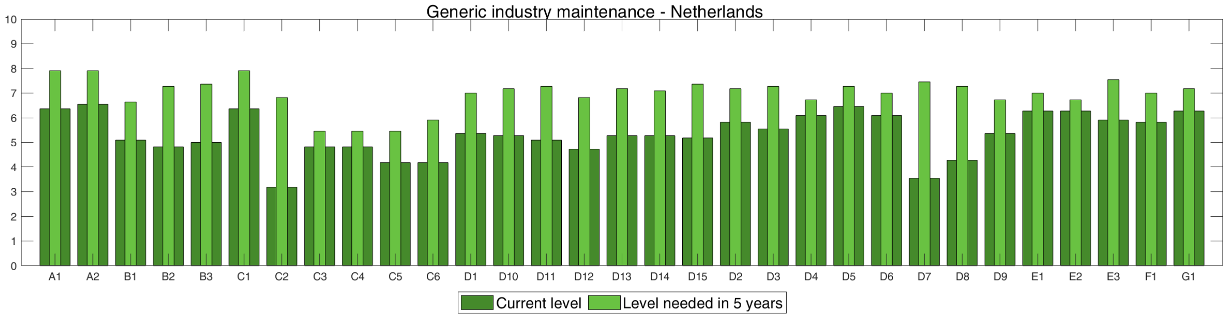






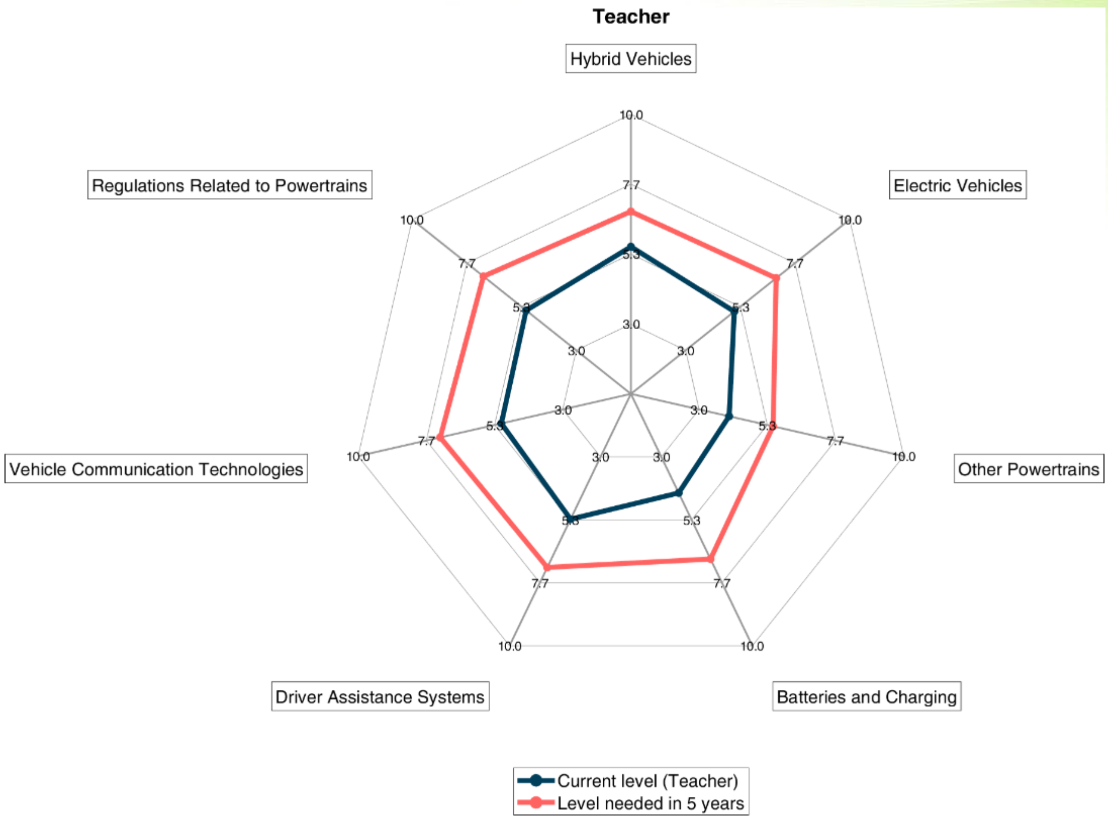


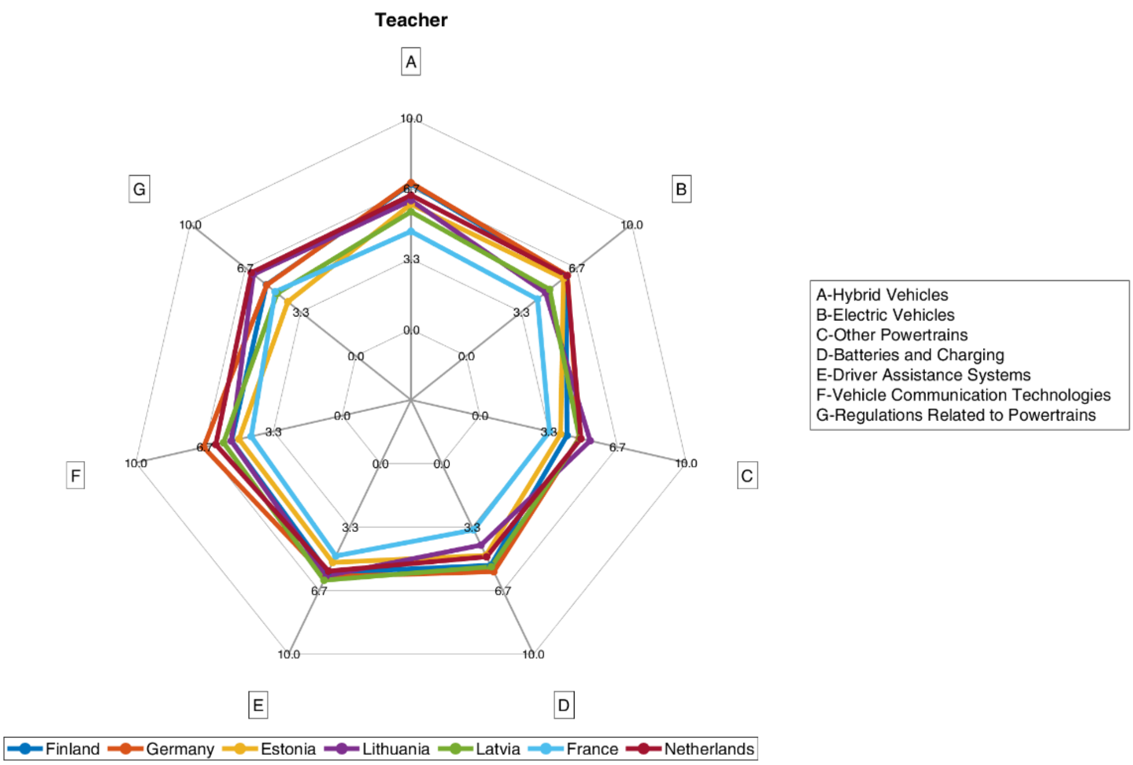
Co-funded by the European Union



Co-funded by
the European Union

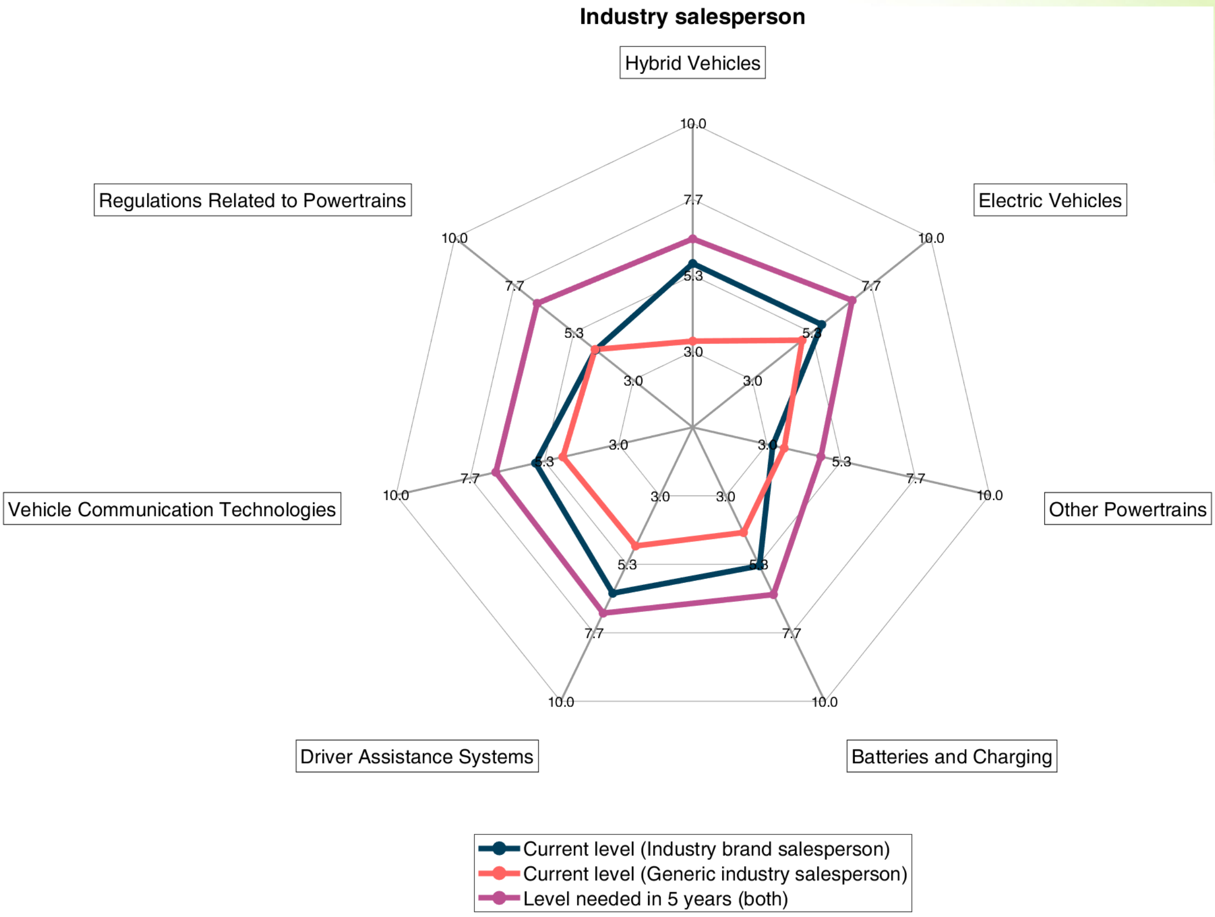
APPENDIX VI: Current competences of teachers

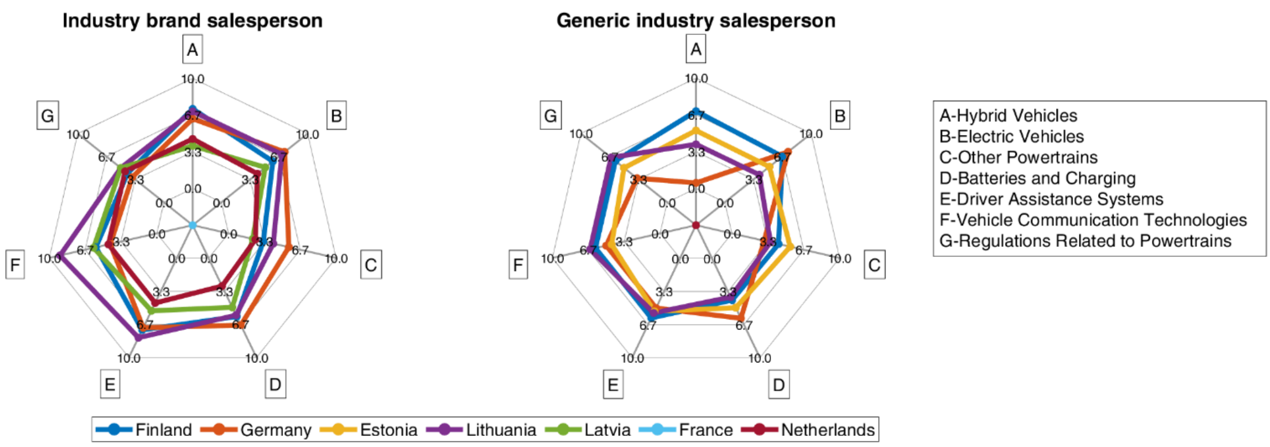




Co-funded by the European Union

APPENDIX VII: Current competences of vehicle and spare parts sales personnel





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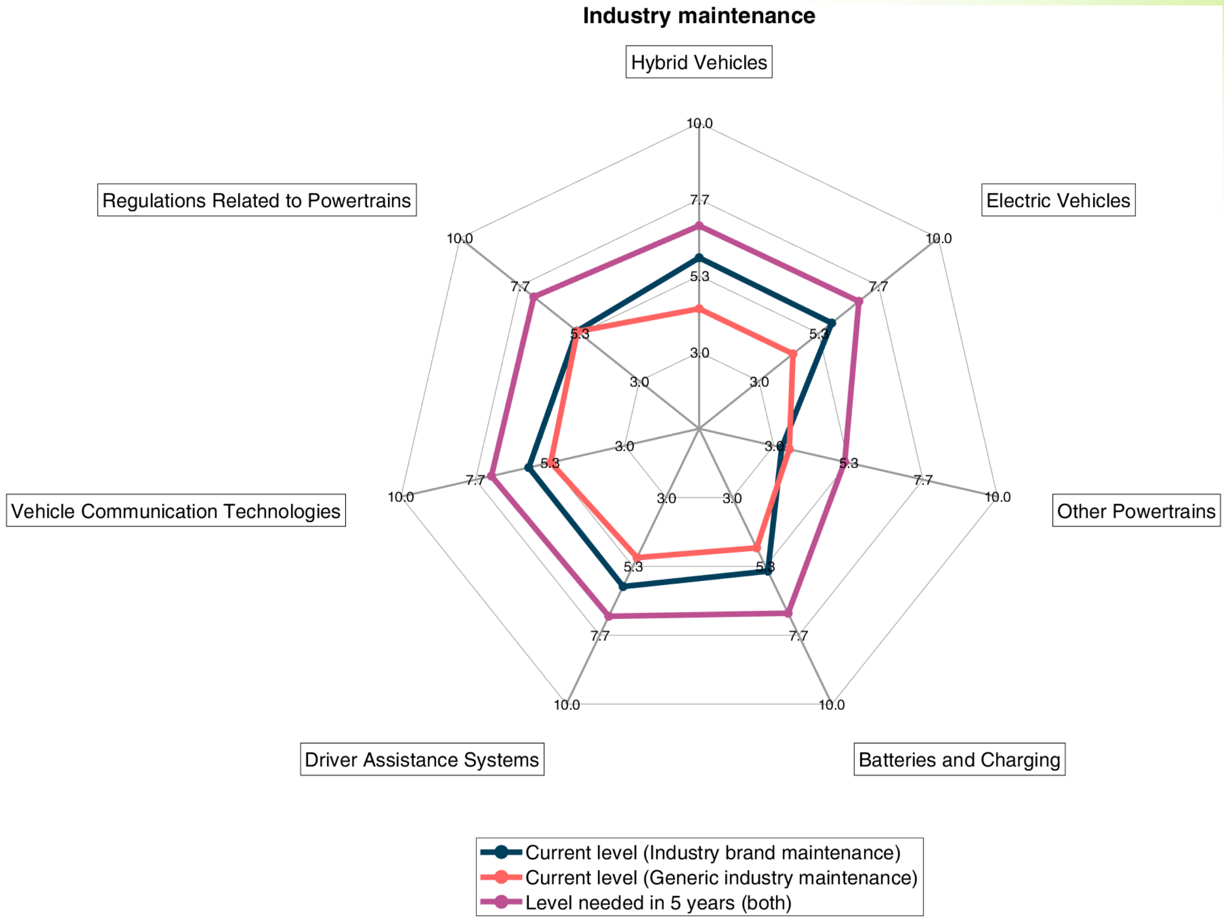
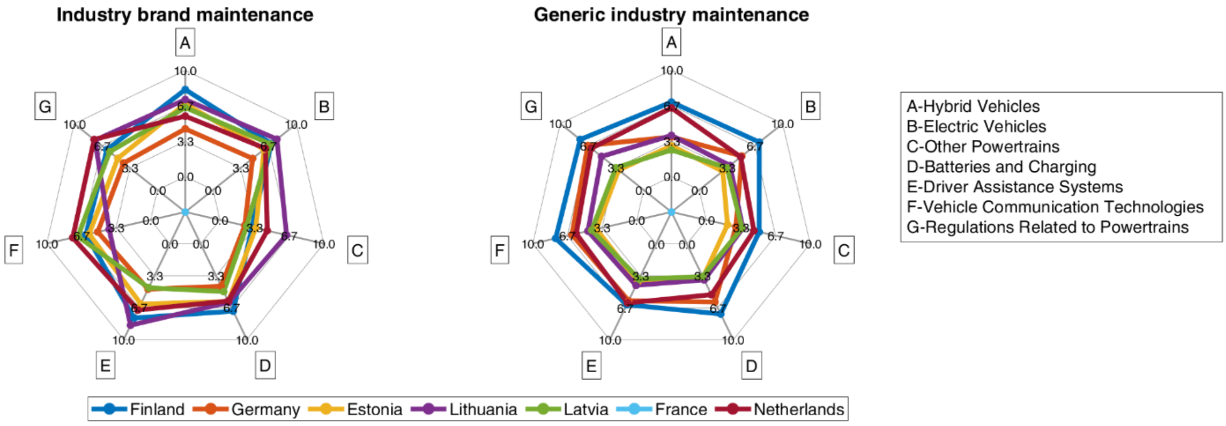
APPENDIX VIII: Current competences of vehicle maintenance personnel





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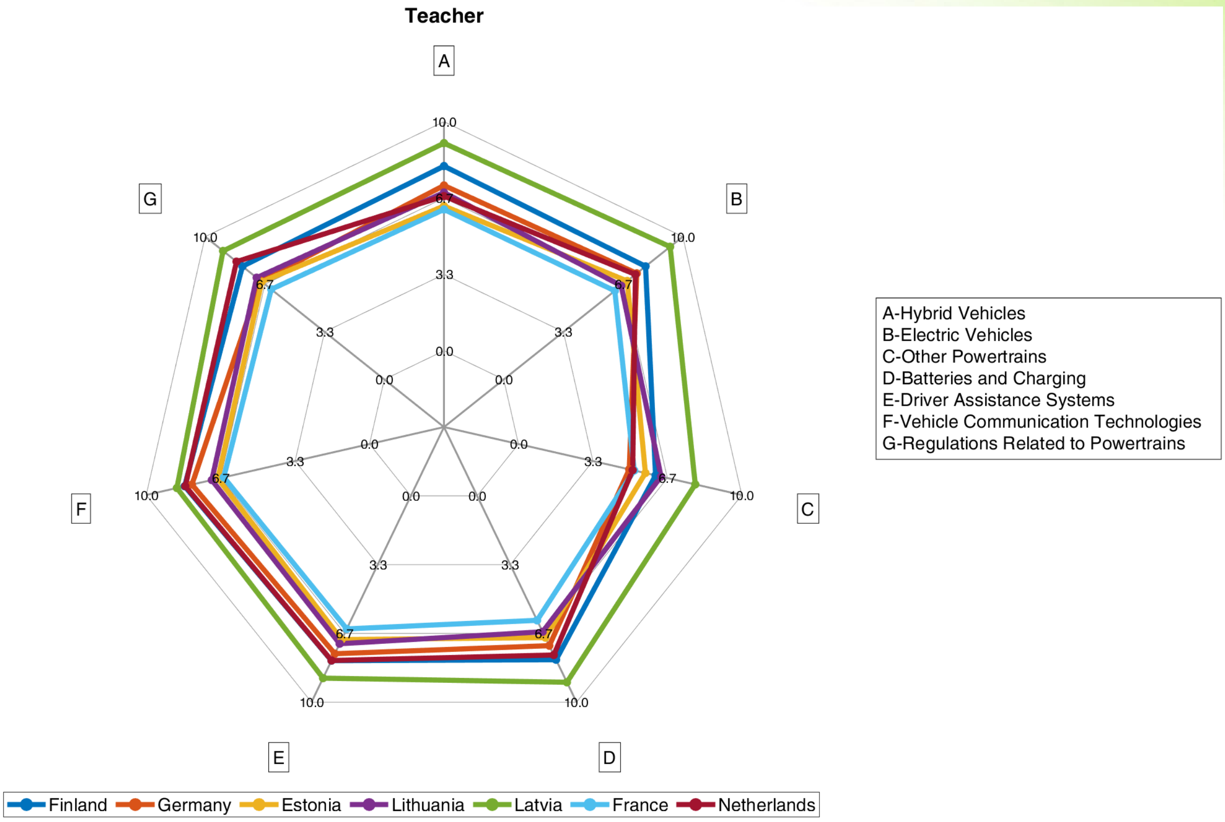
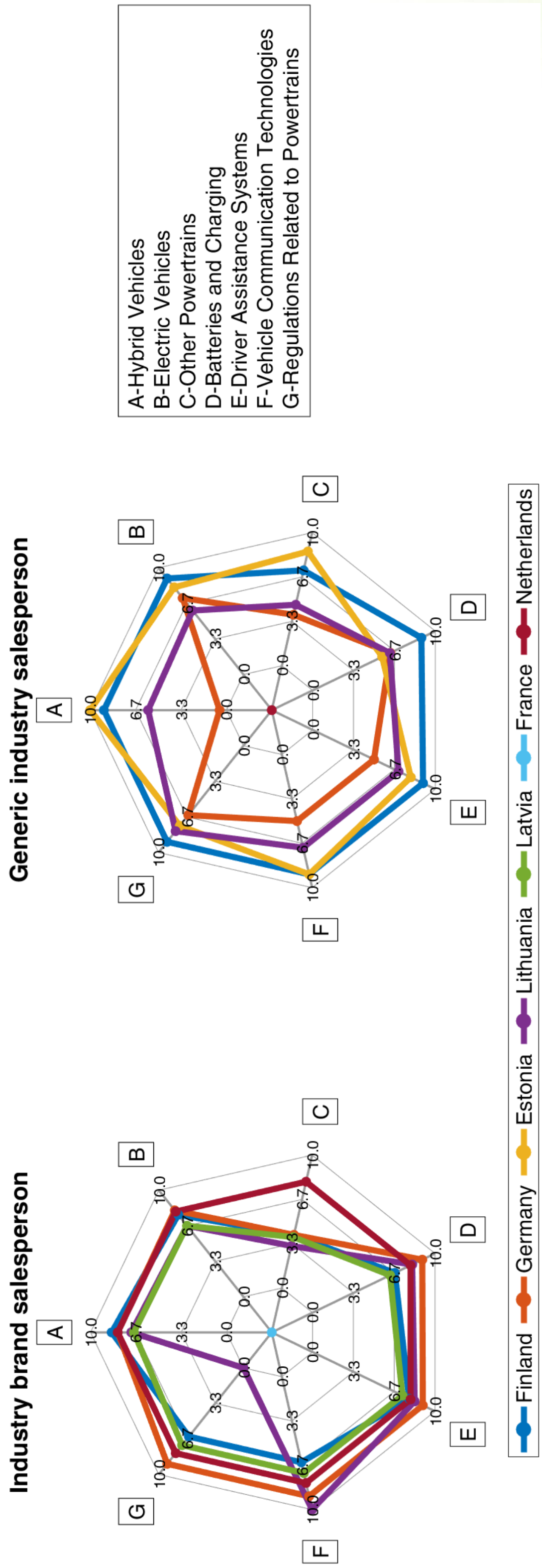
the European Union

APPENDIX IX: Needed competences of teachers

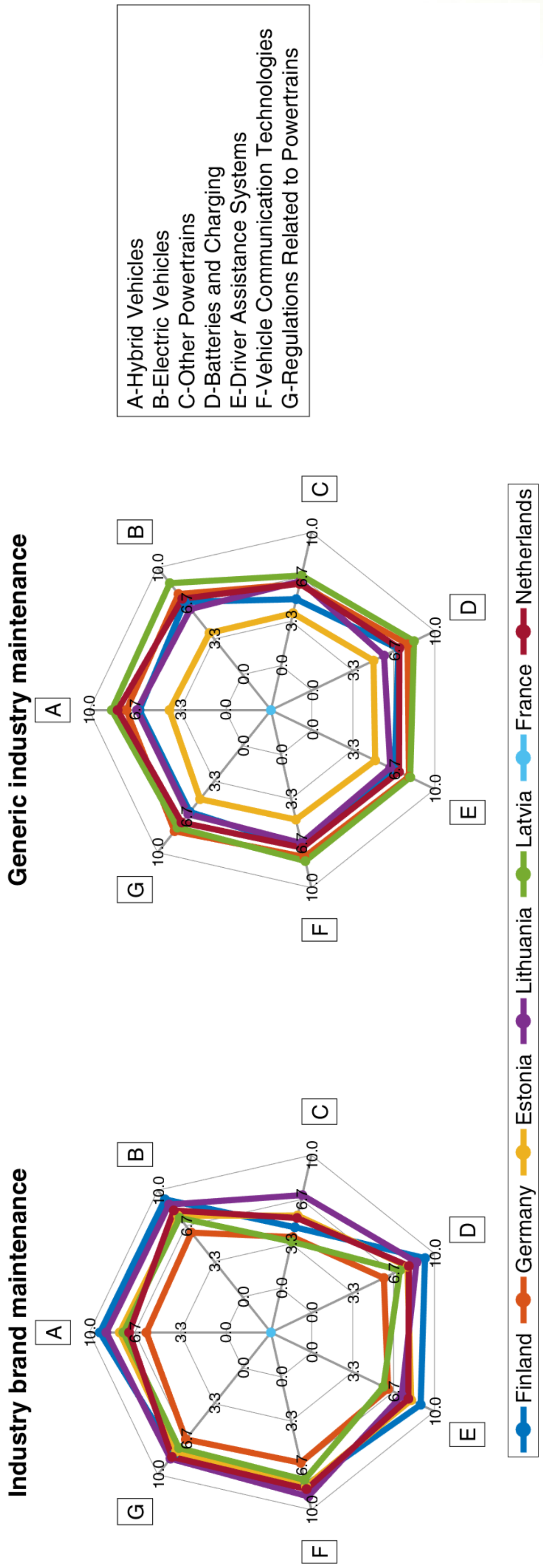


APPENDIX X: Needed competences of vehicle and spare parts sales personnel



Co-funded by
the European Union

APPENDIX XI: Needed competences of vehicle maintenance personnel



APPENDIX XII: Description of the statistical data analysis

The respondents of the questionnaire involved three subgroups: automotive teachers, industry representatives working in vehicle maintenance and industry representatives working in sales of vehicles or spare parts. The analysis of technological skills, non-technical skills and preferred sources of information was carried out separately for these three subgroups, as they are likely to have different requirements for skills and knowledge. The analysis was carried out using the SPSS software package (version 29).

The analysis of technological skills, non-technical skills and preferred sources of information was started by calculating the frequencies of different responses to the statements included in the questions of the survey. Frequencies were calculated for numeric answers, other response options (e.g. not relevant to me) and missing answers.

After the frequencies had been calculated, other than numeric answers were excluded and descriptive statistics were calculated for responses related to current or future skills and preferred sources of information. The descriptive statistics calculated for responses related to each skill or source of information were mean, standard deviation, median, skewness and kurtosis. Mean and median were used to compare the relative importance of skills and information sources. Standard deviation was used to describe how much the responses differed from the mean of responses on average. Skewness and kurtosis were calculated to understand the shape of response distribution for each skill or information source. This was necessary to find out whether analysis methods based on assumption of normally distributed data would be appropriate. Skewness measures the asymmetry of the data distribution around its mean. For a data distributed around a single peak, negative value of skewness usually indicates the “tail” of the distribution is on the left side of the peak of the distribution (and vice versa for positive values). For a distribution symmetric around the mean, the value of skewness would be zero.

In addition to other descriptive statistics, kurtosis was calculated for responses regarding each current or future skill or information source. The SPSS software package calculates the excess kurtosis which indicates the kurtosis of the data in relation to the normal distribution (value of excess kurtosis is zero for the normal distribution). In general, distributions with low peak but much of the observations in the tails have negative excess kurtosis. Correspondingly, distributions with high peak but thin tails typically have positive values of excess kurtosis. Large absolute values of excess kurtosis indicate that the distribution of the data differs from the normal distribution.

After the descriptive statistics had been calculated, the distributions of responses regarding technical skills, non-technical skills and information sources were tested for normality. To test for normality, both Kolmogorov-Smirnov and Shapiro-Wilk tests were calculated. Both tests involve the null hypothesis that the data follow the normal distribution. In both tests, a p-value less than 0.05 indicates that the distribution of the data differs from normal distribution in a statistically significant manner.

A comparison was made between the rated importance of the technical and non-technical skills at present and in future. The difference between current importance of skill or knowledge and the anticipated importance of the skill or knowledge in future was analysed by calculating paired T-tests for the pairs of values provided by survey participants. The paired T-test calculated with the SPSS statistical package provided the test statistic (t value), degrees of freedom and the two-sided p value. The p-value indicated whether the paired differences differed from zero in a statistically significant manner (with p-value less than 0.05 indicating a statistically significant difference). The paired T-test procedure of SPSS provided also descriptive statistics (mean and standard deviation) and 95% confidence interval for the difference score.

The sources of information used by automotive teachers, vehicle and spare parts sales staff and vehicle maintenance personnel were also ranked from the most important to least important, based on the means of answers regarding each information source. Binomial sign test for paired data was then calculated to identify statistically significant differences between adjacent pairs of information sources on the ranked list. The null hypothesis of the binomial sign test is that the median of differences of two variables is zero in a data set consisting of paired data. Binomial sign test was used for the analysis due to its nature of a non-parametric statistical test not involving an assumption on the normality of the data.

APPENDIX XIII: Results from the statistical analysis of preferred sources of information

Teacher

Basic statistical figures such as mean, median, standard deviation, skewness and kurtosis were calculated for teachers' responses regarding the importance of various information sources (Table 1). The information sources were then arranged from the most important to least important based on the means of responses. For three information sources perceived as most important, the standard deviation is clearly smaller than for other information sources. For these information sources, automotive teachers' opinions were slightly more uniform. For all information sources, the distributions of answers were skewed to the left (skewness was negative).

Table 1. Statistical evaluation of importance of different sources for teachers

Teacher - Information source	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Additional training provided by your employer	192	8.6406	9	1.67239	-1.548	3.068
Books, e.g. repair manuals	195	8.1692	8	1.78686	-0.981	0.995
Learning from the colleagues at work	195	8.041	8	1.86071	-1.404	2.809
Autodata (Wikipedia page)	187	7.6952	8	2.21387	-1.027	0.664
Webpages or newsletters from vehicle manufacturers	193	7.544	8	2.21956	-1.063	0.857
National seminars or exhibitions	190	7.1316	8	2.37459	-0.851	0.077
Scientific journals	193	7.0311	8	2.36711	-0.661	-0.22
International seminars or exhibitions	186	6.9247	7	2.50075	-0.769	-0.137
Magazines (paper or digital)	193	6.5803	7	2.17347	-0.541	-0.073
Newspapers (paper or digital)	194	5.9278	6	2.22444	-0.388	-0.209
Social media	190	5.8053	6	2.61639	-0.303	-0.809

Teachers' answers were also tested for normality by calculating the Kolmogorov-Smirnov test and Shapiro-Wilk test for answers regarding the importance of each information source (Table 2). The results of Kolmorov-Smirnov test indicated that the answers regarding the importance of various information sources were not normally distributed. In other words, the observed distributions different from the normal distribution in a statistically significant manner ($p < 0.001$ for all information sources). The results of Shapiro-Wilk test were consistent with the result obtained with Kolmogorov-Smirnov test.

Table 2. Test for normal distribution of teachers' preferred sources of information

Teacher - Information source	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			
	Test statistic	df	p-value	Test statistic	df	p-value	Data normally distributed
Additional training provided by your employer	0,245	192	<0.001	0,789	192	<0.001	No
Learning from the colleagues at work	0,178	195	<0.001	0,852	195	<0.001	No
Newspapers (paper or digital)	0,127	194	<0.001	0,957	194	<0.001	No
Magazines (paper or digital)	0,141	193	<0.001	0,951	193	<0.001	No
Books, e.g. repair manuals	0,171	195	<0.001	0,875	195	<0.001	No
Scientific journals	0,161	193	<0.001	0,925	193	<0.001	No
Webpages or newsletters from vehicle manufacturers	0,182	193	<0.001	0,885	193	<0.001	No
Autodata (Wikipedia-page)	0,166	187	<0.001	0,879	187	<0.001	No
National seminars or exhibitions	0,169	190	<0.001	0,907	190	<0.001	No
International seminars or exhibitions	0,15	186	<0.001	0,911	186	<0.001	No
Social media	0,11	190	<0.001	0,945	190	<0.001	No

After the information sources had been ranked based on their importance reported by teachers, an attempt was made to identify statistically significant differences in their reported importance (Table 2). Binomial sign tests were calculated for all pairs of information sources adjacent to each other on the list ranked on the basis of the mean of answers. The binomial sign test includes a null hypothesis that the median of the differences between two variables in paired data equals zero. The alternative hypothesis is that the median of the differences of the variables is not zero. The results of the binomial sign test indicated that some of the differences between ranked information sources used by automotive teachers were statistically significant. This was the case, for example, for additional training provided by the employer and books such as repair manuals and web sites or newsletters from vehicle manufacturers and national seminars or exhibitions.

Table 3. Results of the binomial test of teachers' preferred sources of information

Teacher - Information source Null hypothesis: the median of differences between variables 1 and 2 equals zero.							
Variable 1	**Variable 2**	**N**	**p-value (two-sided test)**	**Test Statistic**	**Standardised test statistic**	**Standard error**	**Null hypothesis**
Additional training provided by your employer	**Books, e.g. repair manuals**	**191**	**0,001**	**35**	**-3,236**	**5,099**	**Rejected**
Books, e. g. repair manuals	Learning from the colleagues at work	194	0,519	55	-0,644	5,431	Retained
Learning from the colleagues at work	Autodata (Wikipedia-page)	186	0,718	59	-0,361	5,545	Retained
Autodata (Wikipedia-page)	Webpages or newsletters from vehicle manufacturers	186	0,108	47	-1,606	5,292	Retained
Webpages or newsletters from vehicle manufacturers	**National seminars or exhibitions**	**188**	**0,025**	**49**	**-2,245**	**5,568**	**Rejected**
National seminars or exhibitions	Scientific journals	188	0,931	66	-0,086	5,788	Retained
Scientific journals	International seminars or exhibitions	184	0,589	58	-0,541	5,545	Retained
International seminars or exhibitions	**Magazines (paper or digital)**	**184**	**0,008**	**49**	**-2,641**	**5,679**	**Rejected**
Magazines (paper or digital)	**Newspapers (paper or digital)**	**192**	**<0.001**	**8**	**-5,795**	**3,696**	**Rejected**
Newspapers (paper or digital)	Social media	**188**	0,611	**66**	**-0,509**	**5,895**	**Retained**

Vehicle and spare part salespersons

Basic statistical figures (mean, median, standard deviation, skewness and kurtosis) were calculated for the relative importance of various information sources for salespersons in vehicle sector (Table 4). The most important sources of information for salespersons were learning from colleagues at work (mean: 8.93), additional training provided by the employer (mean: 8.63) and web pages and newsletters from vehicle manufacturers (mean: 7.90). These were also the information sources with the highest median of answers (median: 9). The number of responses was relatively small ($N \leq 30$) which increases the impact of random variation on the results. The two information sources reported as most important (learning from colleagues at work and additional training provided by employer) had the lowest values of standard deviation. For all the information sources, the distributions of answers were skewed to the left side of the distribution (values of skewness were negative).

Table 4. Statistical evaluation of importance of different sources for industry salesperson

Industry salesperson - Information source	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Learning from the colleagues at work	30	8,9333	9	1,11211	-0,989	0,357
Additional training provided by your employer	30	8,6333	9	1,49674	-0,904	-0,162
Books, e.g. repair manuals	28	7	7	2,17732	-0,232	-1,224
Autodata (Wikipedia page)	27	7,6667	8	2,01914	-1,473	3,468
Webpages or newsletters from vehicle manufacturers	29	7,8966	9	2,19325	-1,473	1,574
Social media	30	7,2667	8	2,36254	-0,914	0,206
International seminars or exhibitions	29	6,6552	7	2,30335	-0,656	0,023
National seminars or exhibitions	29	6,8276	7	1,87214	-0,117	-0,469
Scientific journals	28	6,1786	7	2,63949	-0,364	-0,954
Magazines (paper or digital)	30	6,3333	7	2,44009	-0,508	-0,534
Newspapers (paper or digital)	30	6,7	7	2,32156	-0,654	-0,025

The answers provided by industry salespersons regarding each information source were tested for normality (Table 5) by calculating Kolmogorov-Smirnov and Shapiro-Wilk tests. According to the results of Kolmogorov-Smirnov and Shapiro-Wilk tests, answers regarding the different information sources were mostly not normally distributed. The exceptions for this were newspapers (paper or digital), scientific journals and national seminars or exhibitions. The results of the tests for normality were interpreted conservatively: if either of the tests provided a statistically significant result ($p < 0.05$), answers regarding the information source were considered as not normally distributed. The results of normality tests (Table 5) were consistent with the statistical basic figures: information sources having larger absolute values of skewness or kurtosis (e.g. answers regarding Autodata) were identified as not normal also for the statistical tests for normality (Table 4).

Table 5. Test for normal distribution of industry salespersons' preferred sources of information

Industry salesperson - Information source	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			
	Test statistic	df	p-value	Test statistic	df	p-value	Data normally distributed
Additional training provided by your employer	0,219	30	<0.001	0,837	30	<0.001	No
Learning from the colleagues at work	0,257	30	<0.001	0,834	30	<0.001	No
Newspapers (paper or digital)	0,139	30	0,144	0,936	30	0,069	Yes
Magazines (paper or digital)	0,174	30	0,021	0,947	30	0,142	No
Books, e.g. repair manuals	0,177	28	0,025	0,922	28	0,039	No
Scientific journals	0,158	28	0,072	0,935	28	0,081	Yes
Webpages or newsletters from vehicle manufacturers	0,243	29	<0.001	0,809	29	<0.001	No
Autodata (Wikipedia-page)	0,195	27	0,01	0,864	27	0,002	No
National seminars or exhibitions	0,157	29	0,064	0,957	29	0,27	Yes
International seminars or exhibitions	0,215	29	0,001	0,929	29	0,053	No
Social media	0,255	30	<0.001	0,894	30	0,006	No

Finally, the information sources were ranked in terms of the means of answers regarding their importance for industry salespersons. The binomial sign test did not indicate statistically significant differences between the analysed pairs (Table 6). The null hypothesis (median of differences of variable 1 and variable 2 in paired data set is zero) was therefore retained for all analysed pairs. This result can be explained by the relatively small N (30 or less) in the paired comparisons carried out.

Table 6. Results of the binomial test of industry salespersons' preferred sources of information

Industry salesperson - Information source Null hypothesis: the median of differences between variables 1 and 2 equals zero.							
Variable 1	**Variable 2**	**N**	**p-value (two-sided test)**	**Test Statistic**	**Standardised test statistic**	**Standard error**	**Null hypothesis**
Learning from the colleagues at work	Additional training provided by your employer	30	1,000	6,000	0,000	1,658	Retained
Additional training provided by your employer	Webpages or newsletters from vehicle manufacturers	29	0,143	5,000	-1,455	2,062	Retained
Webpages or newsletters from vehicle manufacturers	Autodata (Wikipedia page)	27	0,664	9,000	-0,436	2,291	Retained
Autodata (Wikipedia page)	Social media	27	1,000	10,000	0,000	2,179	Retained
Social media	Books, e.g. repair manuals	28	1,000	9,000	0,000	2,179	Retained
Books, e.g. repair manuals	National seminars or exhibitions	28	0,648	8,000	-0,459	2,179	Retained
National seminars or exhibitions	Newspapers (paper or digital)	29	0,503	8,000	-0,671	2,236	Retained
Newspapers (paper or digital)	International seminars or exhibitions	29	1,000	11,000	0,000	2,291	Retained
International seminars or exhibitions	Magazines (paper or digital)	29	0,664	9,000	-0,436	2,291	Retained
Magazines (paper or digital)	Scientific journals	28	1,000	5,000	0,000	1,658	Retained

Vehicle maintenance persons

Basic statistical figures (mean, median, standard deviation, skewness and kurtosis) were calculated for vehicle maintenance persons' answers regarding the importance of each information source (Table 7). The information sources were then ranked based on the means of answers. The information sources reported as most important by vehicle maintenance personnel were learning from colleagues at work (mean: 8.56, median: 9) and additional training provided by employer (mean: 8.31, median: 9). The most important written sources such as books (e.g. repair manuals) (mean: 7.51, median: 8), Autodata (mean: 7.43, median: 8) or web pages or newsletters from vehicle manufacturers (mean: 7.18, median: 8) were only the third, fourth and fifth most important. Especially for the information sources with the highest mean of answers, the distributions of answers were skewed to the left (negative values of skewness). Answers regarding two information sources had large positive values of excess kurtosis (learning from the colleagues at work: 2.99 and additional training provided by your employer: 2.46). Due to the substantial excess kurtosis, answers regarding these two sources of information are less likely to be from the normal distribution.

Table 7. Statistical evaluation of importance of different sources for industry maintenance

Industry maintenance - Information source	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Learning from the colleagues at work	142	8,5634	9	1,78435	-1,613	2,989
Additional training provided by your employer	139	8,3094	9	2,12251	-1,576	2,458
Books, e.g. repair manuals	139	7,5108	8	2,47997	-0,862	-0,169
Autodata (Wikipedia page)	133	7,4286	8	2,54739	-0,91	-0,002
Webpages or newsletters from vehicle manufacturers	136	7,1765	8	2,56727	-0,756	-0,236
Social media	136	6,6838	7	2,47866	-0,703	-0,068
International seminars or exhibitions	130	6,5462	7	2,57932	-0,463	-0,642
National seminars or exhibitions	132	6,5227	7	2,44782	-0,488	-0,356
Scientific journals	136	5,9706	6	2,50611	-0,155	-0,653
Magazines (paper or digital)	135	5,637	6	2,79287	-0,107	-0,984
Newspapers (paper or digital)	137	5,5474	6	2,76791	-0,09	-0,944

Answers regarding the importance of various information sources were then tested for normality by calculating Kolmogorov-Smirnov test and Shapiro-Wilk tests (Table 8). According to the tests, vehicle maintenance personnels' answers regarding the importance of various information sources were not normally distributed.

Table 8. Test for normal distribution of industry maintenances' preferred sources of information

Industry maintenance - Information source	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			
	Test statistic	df	p-value	Test statistic	df	p-value	Data normally distributed
Additional training provided by your employer	0,219	139	<0.001	0,782	139	<0.001	No
Learning from the colleagues at work	0,223	142	<0.001	0,782	142	<0.001	No
Newspapers (paper or digital)	0,093	137	0,005	0,944	137	<0.001	No
Magazines (paper or digital)	0,095	135	0,005	0,943	135	<0.001	No
Books, e.g. repair manuals	0,161	139	<0.001	0,872	139	<0.001	No
Scientific journals	0,121	136	<0.001	0,954	136	<0.001	No
Webpages or newsletters from vehicle manufacturers	0,151	136	<0.001	0,895	136	<0.001	No
Autodata (Wikipedia-page)	0,16	133	<0.001	0,873	133	<0.001	No
National seminars or exhibitions	0,123	132	<0.001	0,942	132	<0.001	No
International seminars or exhibitions	0,124	130	<0.001	0,934	130	<0.001	No
Social media	0,146	136	<0.001	0,92	136	<0.001	No

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The information sources were ranked in terms of their importance reported by vehicle maintenance personnel. Differences between information sources adjacent to each other on the ranked list were analysed by calculating the binomial sign test (Table 9). In most cases, no statistically significant difference was identified, and the null hypothesis was retained (median of paired differences is zero).

Table 9. Results of the binomial test of industry maintenances' preferred sources of information

Industry maintenance - Information source Null hypothesis: the median of differences between variables 1 and 2 equals zero.							
Variable 1	**Variable 2**	**N**	**p-value (two-sided test)**	**Test Statistic**	**Standardised test statistic**	**Standard error**	**Null hypothesis**
Learning from the colleagues at work	Additional training provided by your employer	138	0,614	29	-0,504	3,969	Retained
Additional training provided by your employer	**Books, e.g. repair manuals**	**135**	**<0.001**	**20**	**-3,926**	**4,33**	**Rejected**
Books, e.g. repair manuals	Autodata (Wikipediapage)	132	0,828	44	0,217	4,61	Retained
Autodata (Wikipedia-page)	Webpages or newsletters from vehicle manufacturers	129	0,064	33	-1,855	4,583	Retained
Webpages or newsletters from vehicle manufacturers	Social media	132	0,484	46	-0,7	5	Retained
Social media	International seminars or exhibitions	129	0,913	41	-0,109	4,583	Retained
International seminars or exhibitions	National seminars or exhibitions	129	0,766	21	-0,298	3,354	Retained
National seminars or exhibitions	**Scientific journals**	**130**	**0,001**	**30**	**-3,323**	**4,796**	**Rejected**
Scientific journals	Magazines (paper or digital)	132	0,349	32	-0,936	4,272	Retained
Magazines (paper or digital)	Newspapers (paper or digital)	135	0,472	13	-0,718	2,784	Retained

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APPENDIX XIV: Results from the statistical analysis of generic competences

Teacher

Basic statistical figures (mean, median, standard deviation, skewness and kurtosis) were calculated for automotive teachers' answers regarding the current level of generic competences in their profession (Table 10). Social and teamwork skills were rated to have the highest current level (mean: 7.74 and 7.44) while language skills were perceived to have the lowest current level (mean: 5.29).

Table 10. Current level of generic competencies – reported by automotive teachers.

How would you rate the current level of skills and competencies in your profession in general? (profession: Teacher, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Teamwork skills	195	7.4410	8	1.75580	-1.047	1.485
Social skills	195	7.7436	8	1.73974	-1.243	2.331
Computer/IT skills	196	6.9592	7	1.74778	-0.746	0.882
Sales/customer skills	170	6.1235	6	2.26943	-0.444	-0.248
Language skills	182	5.2912	5	2.54199	-0.045	-1.015
Information acquisition skills	196	7.3316	8	1.80802	-0.784	0.597
Organisational skills and time management	194	7.1289	7	1.76579	-0.768	0.727
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	166	4.9759	5	2.51288	-0.130	-1.047
Physical requirements of the position	185	6.9189	7	2.19161	-0.754	0.157

Automotive teachers were also asked to rate the needed level of generic competencies in five years in their profession. The results were summarised by calculating the basic statistical figures (Table 11). For all the generic skills covered by the survey, the mean of the answers regarding future need of the skill was higher than the current level of the skill.

Table 11. Future need for generic competencies – reported by automotive teachers

How would you rate the needed level of skills in 5 years? (profession: Teacher, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Teamwork skills	187	8.1765	8	1.69309	-1.349	2.388
Social skills	187	8.1765	8	1.74315	-1.456	2.668
Computer/IT skills	189	8.2910	9	1.77901	-1.502	2.743
Sales/customer skills	165	7.0606	7	2.25966	-0.814	0.120
Language skills	176	6.8750	8	2.63737	-0.687	-0.657
Information acquisition skills	188	8.2553	9	1.73320	-1.478	2.764
Organisational skills and time management	185	8.1784	8	1.63374	-1.364	2.814
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	165	6.9152	8	2.53850	-0.717	-0.380
Physical requirements of the position	179	7.3520	8	2.10514	-0.656	-0.215

Automotive teachers answers regarding the current level of generic competences and the level of generic competencies needed in future (in five years) were tested for normality (Table 12 and Table 12). According to the results of Kolmogorov-Smirnov and Shapiro-Wilk tests, the answers did not follow the normal distribution.

Table 12. Current level of generic competencies – reported by automotive teachers, tests of normality.

How would you rate the current level of skills and competencies in your profession in general? (profession: Teacher, numeric answers only) Tests of normality	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.211	195	<0.001	0.895	195	<0.001	No
Social skills	0.205	195	<0.001	0.879	195	<0.001	No
Computer/IT skills	0.167	196	<0.001	0.936	196	<0.001	No
Sales/customer skills	0.121	170	<0.001	0.953	170	<0.001	No
Language skills	0.106	182	<0.001	0.955	182	<0.001	No
Information acquisition skills	0.185	196	<0.001	0.930	196	<0.001	No
Organisational skills and time management	0.162	194	<0.001	0.935	194	<0.001	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.116	166	<0.001	0.942	166	<0.001	No
Physical requirements of the position	0.170	185	<0.001	0.928	185	<0.001	No

Table 13. Future need for generic competencies – reported by automotive teachers, tests of normality

How would you rate the needed level of skills in 5 years? (profession: Teacher, numeric answers only) Tests of normality	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.202	187	<0.001	0.857	187	<0.001	No
Social skills	0.208	187	<0.001	0.845	187	<0.001	No
Computer/IT skills	0.197	189	<0.001	0.831	189	<0.001	No
Sales/customer skills	0.186	165	<0.001	0.917	165	<0.001	No
Language skills	0.199	176	<0.001	0.897	176	<0.001	No
Information acquisition skills	0.202	188	<0.001	0.84	188	<0.001	No
Organisational skills and time management	0.186	185	<0.001	0.863	185	<0.001	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.181	165	<0.001	0.910	165	<0.001	No
Physical requirements of the position	0.157	179	<0.001	0.926	179	<0.001	No

The differences between future needs and current levels of generic skills were analysed by calculating difference scores for each generic skill (difference between the level of the skill needed in five years and the current level of the skill reported by the respondent). The results were summarised by calculating the mean, standard deviation and standard error of the mean of the difference score (Table 14). Language skills and computer/IT skills had the largest mean of difference between the current level and future need of the skills reported by automotive teachers (mean: 1.49 and 1.32). In addition, paired T-tests were calculated for all paired differences (future need and current level of each skill). For all generic skills covered by the survey, the difference between current level and needed future level of the skill had a statistically significant difference ($p < 0.001$ for all generic skills). The paired T-test procedure of SPSS provides also confidence intervals for the paired differences. These confidence intervals need to interpreted with caution, as the paired T-test assumes the differences to be normally distributed. In this case, the normality assumption may be violated, as the answers regarding current and future need for skills were found to be not normally distributed (Table 12 and Table 13). The largest difference scores were obtained for automotive teachers' current and future level of skills in financing and (governmental) funding aid (e.g. via taxation) for different power trains (1.83), language skills (1.49) and computer/IT skills (1.32).

Table 14. Differences between needed level of generic skills in 5 years and current levels of the skills, automotive teachers.

Differences between the need for each skill in 5 years and the current level of the skill								
(profession: Teacher, numeric answers only)								
Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" – "How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	Mean	Std.deviation	Standard error of the mean	Lower CI	Upper CI	t	df	two-sided p-value
Teamwork skills	0.74866	1.43532	0.10496	0.54160	0.95573	7.133	186	<0.001
Social skills	0.42246	1.26921	0.09281	0.23936	0.60556	4.552	186	<0.001
Computer/IT skills	1.32275	1.57661	0.11468	1.09652	1.54898	11.534	188	<0.001
Sales/customer skills	0.86503	1.51338	0.11854	0.63095	1.09911	7.298	162	<0.001
Language skills	1.48571	1.79032	0.13534	1.21860	1.75283	10.978	174	<0.001
Information acquisition skills	0.87766	1.55158	0.11316	0.65442	1.10090	7.756	187	<0.001
Organisational skills and time management	1.05946	1.59882	0.11755	0.82754	1.29137	9.013	184	<0.001
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	1.83230	2.28374	0.17998	1.47685	2.18775	10.18	160	<0.001
Physical requirements of the position	0.39665	1.49313	0.11160	0.17642	0.61688	3.554	178	<0.001

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The difference scores and related confidence intervals were depicted in Figure 1 and Figure 2.

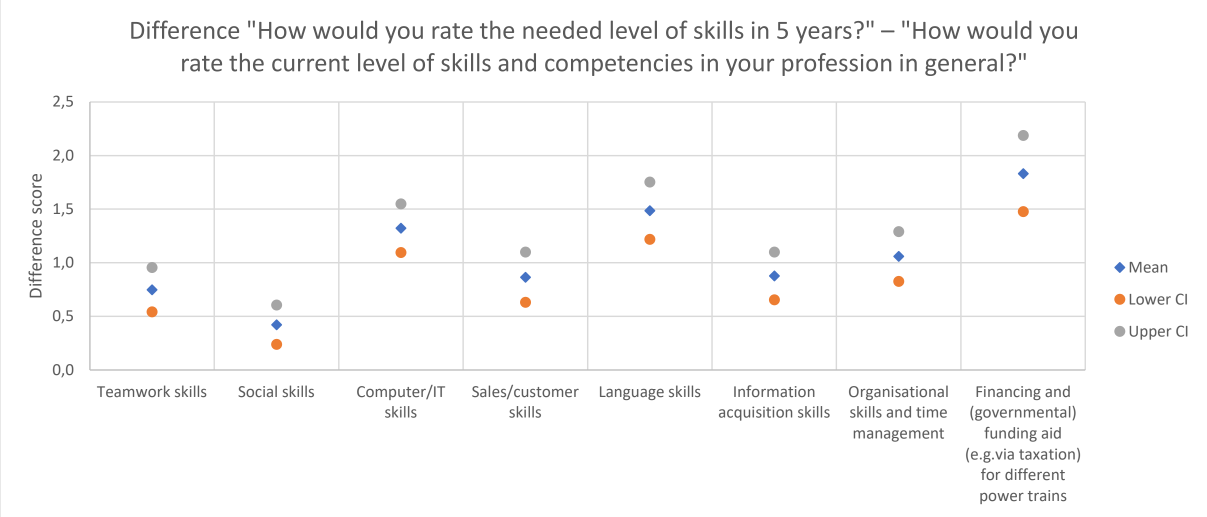

Figure 1. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, automotive teachers (1).

Figure 2. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, automotive teachers (2).

<u>Vehicle and spare part salespersons</u>

Basic statistical figures were calculated for current level of generic competencies of vehicle and spare parts salespersons (Table 15). Highest current levels were rated for sales/customer skills (mean: 8.73, median: 9) and organisational skills and time management (mean: 8.41, median 9) while skills related to financing and governmental funding aid for different power trains were assessed to have the lowest level (mean: 6.89, median: 7).

Table 15. Current level of generic competencies – reported by vehicle and spart parts salespersons

How would you rate the current level of skills and competencies in your profession in general? (profession: Industry representative – sales/spare parts dealer, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Teamwork skills	30	8.3667	8	1.60781	-1.075	1.102
Social skills	30	8.2667	8	1.25762	-0.544	0.113
Computer/IT skills	30	7.6333	8	1.47352	-0.349	-0.033
Sales/customer skills	30	8.7333	9	1.22990	-0.881	-0.152
Language skills	30	7.1333	7.5	1.83328	-0.606	-0.057
Information acquisition skills	30	8.3333	8.5	1.34762	-0.480	-0.368
Organisational skills and time management	29	8.4138	9	1.21059	-0.367	-0.731
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	27	6.8889	7	2.25889	-0.543	0.343
Physical requirements of the position	29	7.7241	8	1.79078	-0.635	0.084

Vehicle and spare parts salespersons' assessments for generic competencies needed in future in five years are summarised in Table 16. In terms of the mean and median of answers, most differences in perceived importance of various generic competences are relatively small. In other words, the mean of answers was close to 8 or 9 for all generic competencies, and the median was the same (9) for all.

Table 16. Future need for generic competencies – reported by vehicle and spare parts salespersons

How would you rate the needed level of skills in 5 years? (profession: Industry representative – sales/spare parts dealer, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Teamwork skills	29	8.7586	9	1.59587	-1.330	1.043
Social skills	29	8.8966	9	1.37178	-1.049	-0.096
Computer/IT skills	29	8.8276	9	1.33815	-1.007	-0.056
Sales/customer skills	29	8.7931	9	1.56706	-1.366	0.869
Language skills	29	8.0345	9	2.09562	-1.299	1.215
Information acquisition skills	29	9.0345	9	1.17967	-1.052	0.145
Organisational skills and time management	29	9.1379	9	1.09297	-1.349	1.349
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	27	8.2222	9	1.98714	-0.904	-0.293
Physical requirements of the position	29	8.2414	9	2.02934	-1.124	0.410

Vehicle and spare parts salespersons' answers regarding the importance of various generic competencies were tested for normality (Table 17). Normality tests were carried out also for perceived future need for the skills in five years (Table 18). For most of the generic competences, the answers were not normally distributed ($p < 0.05$, provided by the Kolmogorov-Smirnov test or Shapiro-Wilk test).

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Table 17. Current level of generic competencies – reported by vehicle and spare parts salespersons, tests of normality.

How would you rate the current level of skills and competencies in your profession in general? (profession: industry representative – sales/spare parts dealer, numeric answers only) Tests of normality	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.243	30	<0.001	0.827	30	<0.001	No
Social skills	0.187	30	0.009	0.918	30	0.024	No
Computer/IT skills	0.134	30	0.181	0.948	30	0.189	Yes
Sales/customer skills	0.286	30	<0.001	0.840	30	<0.001	No
Language skills	0.182	30	0.013	0.936	30	0.070	No
Information acquisition skills	0.190	30	0.007	0.906	30	0.012	No
Organisational skills and time management	0.203	29	0.004	0.906	29	0.014	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.125	27	0.2	0.941	27	0.127	Yes
Physical requirements of the position	0.176	29	0.022	0.925	29	0.041	No

Table 18. Future need for generic competencies – reported by vehicle and spare parts salespersons, tests of normality

How would you rate the needed level of skills in 5 years? (profession: industry representative – sales/spare parts dealer, numeric answers only) Tests of normality	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.264	29	<0.001	0.756	29	<0.001	No
Social skills	0.272	29	<0.001	0.779	29	<0.001	No
Computer/IT skills	0.241	29	<0.001	0.807	29	<0.001	No
Sales/customer skills	0.277	29	<0.001	0.760	29	<0.001	No
Language skills	0.252	29	<0.001	0.833	29	<0.001	No
Information acquisition skills	0.276	29	<0.001	0.795	29	<0.001	No
Organisational skills and time management	0.268	29	<0.001	0.774	29	<0.001	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.222	27	0.001	0.830	27	<0.001	No
Physical requirements of the position	0.232	29	<0.001	0.828	29	<0.001	No

Differences between current levels and future needs for generic skills were analysed by calculating the difference scores (difference between future level of the skill in 5 years and current level of the skill) and performing a paired T-test (Table 19). The largest differences between current level and future needs were reported for financing and (governmental) funding aid (e.g. via taxation) for different powertrains (mean of difference: 1.33) and computer/IT skills (mean of difference: 1.28).

However, many of the average differences between current level and future need for of the competence were small. Due to small differences and relatively small sample size (30 respondents or less), the paired T-test did not indicate a statistically significant difference for all generic competences between the current level and future need for the competence.

Table 19. Differences between needed level of generic skills in 5 years and current levels of the skills, vehicle and spare parts salespersons.

Differences between the need for each skill in 5 years and the current level of the skill (profession: industry representative – sales/spare parts dealer, numeric answers only) Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" – "How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	Mean	Std.deviation	Standard error of the mean	Lower CI	Upper CI	t	df	two-sided p-value
Teamwork skills	0.44828	1.18280	0.21964	-0.00164	0.89819	2.041	28	0.051
Social skills	0.68699	0.84951	0.15775	0.36652	1.01279	4.372	28	<0.001
Computer/IT skills	1.27589	1.30648	0.24261	0.77890	1.77282	5.259	28	<0.001
Sales/customer skills	0.10345	1.08050	0.20064	-0.30755	0.51445	0.516	28	0.610
Language skills	0.96552	1.67934	0.31185	0.32673	1.60431	3.096	28	0.004
Information acquisition skills	0.75862	0.95076	0.17655	0.39697	1.12027	4.297	28	<0.001
Organisational skills and time management	0.75000	0.88715	0.16766	0.40600	1.09400	4.473	27	<0.001
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	1.33333	1.81871	0.35001	0.61388	2.05279	3.809	26	<0.001
Physical requirements of the position	0.51724	1.68228	0.31239	-0.12266	1.15714	1.656	28	0.054

The difference scores and their confidence intervals are illustrated in Figures 3 and Figure 4. The confidence intervals listed in Table 19 and presented in Figures 3 and 4 should be interpreted with caution, as the respondents' answers regarding the skills were mostly not normally distributed (Table 17 and Table 18).

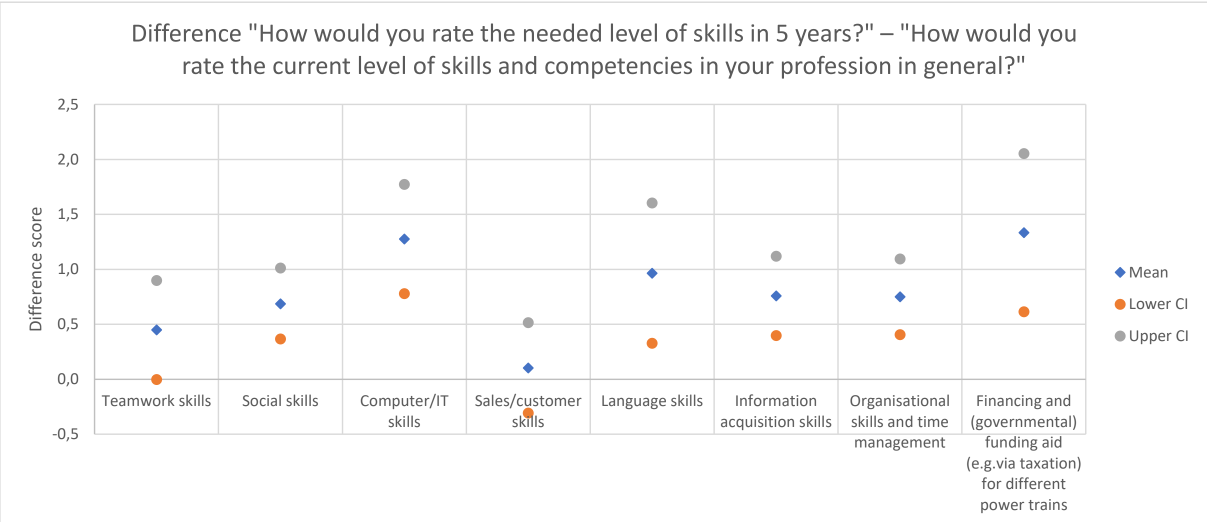

Figure 3. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, vehicle and spare parts salespersons (1).

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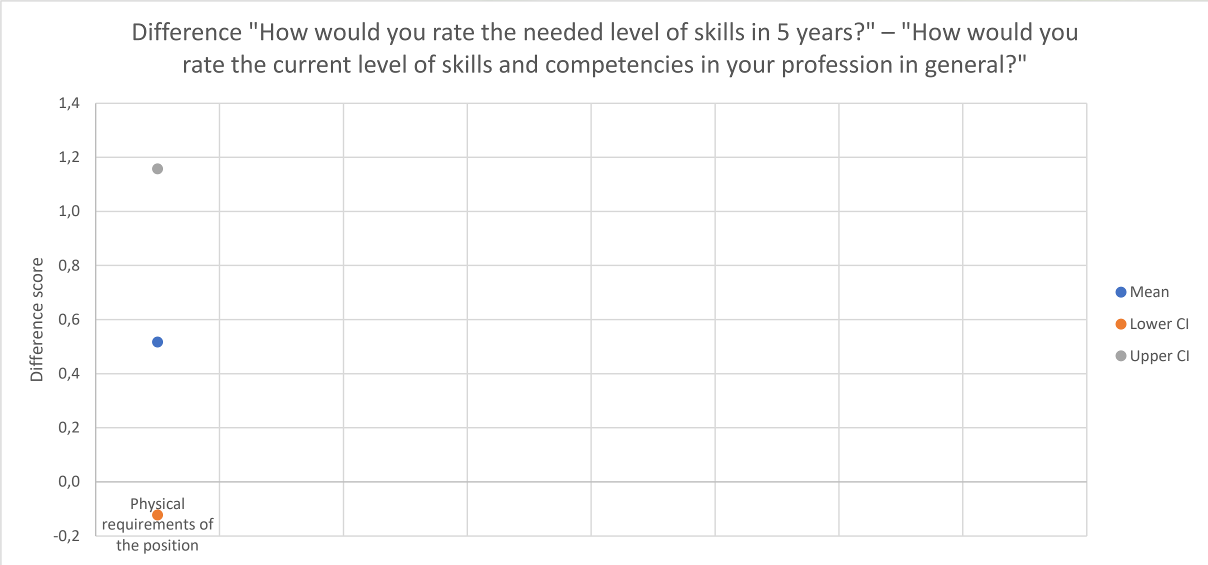

Figure 4. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, vehicle and spare parts salespersons (2).

Vehicle maintenance persons

Basic statistical figures were calculated for the vehicle maintenance persons' answers regarding the current level of generic competences in the profession (Table 20). The competences rated at the highest level were physical requirements of the position (mean: 7.75, median: 8), teamwork skills (mean: 7.62, median: 8) and information acquisition skills (mean: 7.41, median: 8) while the skill with perceived lowest level was financing and (governmental) funding aid (e.g. via taxation) for different power trains (mean: 5.62, median: 6). The distributions of answers were quite symmetric around the mean (absolute values of skewness were relatively low) and had only limited excess kurtosis (absolute value of kurtosis less than 1 for all competences).

Table 20. Current level of generic competencies – reported by vehicle maintenance persons

How would you rate the current level of skills and competencies in your profession in general?						
(profession: industry representative - vehicle maintenance, numeric answers only)						
1 = low, 10 = high						
	N	**Mean**	**Median**	**Std. Deviation**	**Skewness**	**Kurtosis**
Teamwork skills	141	7.6170	8	1.78749	-0.655	0.335
Social skills	141	7.2411	7	1.97086	-0.768	0.673
Computer/IT skills	141	6.8227	7	1.96862	-0.541	0.058
Sales/customer skills	137	6.9343	7	1.93347	-0.414	-0.240
Language skills	139	6.5612	7	2.13363	-0.474	0.063
Information acquisition skills	139	7.4101	8	1.64102	-0.602	0.525
Organisational skills and time management	136	6.9779	7	1.97940	-0.679	0.291
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	126	5.6190	6	2.37944	-0.261	-0.566
Physical requirements of the position	140	7.7500	8	1.78372	-0.565	-0.304

The perceived level of generic skills needed in five years in future in vehicle maintenance profession is summarised in Table 21. All the skills covered by the study were considered at least somewhat important in future, as the mean of answers was more than 7 and the median for answers was 8 or 9 for all the generic competences covered by the study.

Table 21. Future need for generic competencies – reported by vehicle maintenance persons

How would you rate the needed level of skills in 5 years?						
(profession: industry representative - vehicle maintenance, numeric answers only)						
1 = low, 10 = high						
	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Teamwork skills	140	8.2571	9	1.79276	-1.010	0.429
Social skills	139	8.0791	8	1.92642	-1.138	1.209
Computer/IT skills	139	8.4892	9	1.69982	-1.445	2.559
Sales/customer skills	137	8.0511	8	1.76286	-0.659	-0.394
Language skills	138	7.6884	8	2.07804	-0.918	0.609
Information acquisition skills	138	8.5870	9	1.52224	-1.226	1.085
Organisational skills and time management	137	8.2993	9	1.67317	-1.192	2.090
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	123	7.1951	8	2.44835	-0.877	0.214
Physical requirements of the position	137	8.1095	8	1.80147	-0.771	-0.044

Vehicle maintenance persons' answers regarding the current level and future need for generic skills were tested for normality. Answers regarding all generic competences were found to be not normally distributed (Table 22 and Table 23).

Table 22. Current level of generic competencies – reported by vehicle maintenance personnel, tests of normality.

How would you rate the current level of skills and competencies in your profession in general?							
(profession: industry representative - vehicle maintenance, numeric answers only)							
Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.173	141	<0.001	0.920	141	<0.001	No
Social skills	0.168	141	<0.001	0.928	141	<0.001	No
Computer/IT skills	0.144	141	<0.001	0.951	141	<0.001	No
Sales/customer skills	0.155	137	<0.001	0.955	137	<0.001	No
Language skills	0.116	139	<0.001	0.951	139	<0.001	No
Information acquisition skills	0.171	139	<0.001	0.936	139	<0.001	No
Organisational skills and time management	0.174	136	<0.001	0.936	136	<0.001	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.135	126	<0.001	0.957	126	<0.001	No
Physical requirements of the position	0.170	140	<0.001	0.921	140	<0.001	No

Table 23. Future need for generic competencies – reported by vehicle maintenance personnel, tests of normality

How would you rate the needed level of skills in 5 years?							
(profession: industry representative - vehicle maintenance, numeric answers only)							
Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Teamwork skills	0.182	140	<0.001	0.859	140	<0.001	No
Social skills	0.173	139	<0.001	0.866	139	<0.001	No
Computer/IT skills	0.208	139	<0.001	0.823	139	<0.001	No
Sales/customer skills	0.158	137	<0.001	0.888	137	<0.001	No
Language skills	0.168	138	<0.001	0.897	138	<0.001	No
Information acquisition skills	0.223	138	<0.001	0.829	138	<0.001	No
Organisational skills and time management	0.166	137	<0.001	0.859	137	<0.001	No
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	0.157	123	<0.001	0.893	123	<0.001	No
Physical requirements of the position	0.171	137	<0.001	0.883	137	<0.001	No

The difference between current level of generic skills and level of generic skills needed in five years was analysed by calculating the difference between the future and current levels of the skill reported by the respondent. Statistical figures for this difference score have been summarised in Table 24. For most of the generic competences, the mean of the difference between current and needed future level was relatively small or moderate (close to one or less). The mean of the difference score was largest for financing and (governmental) funding aid (e.g. via taxation) for different power trains (mean: 1.54, standard deviation 2.31).

Table 24. Differences between needed level of generic skills in 5 years and current levels of the skills, vehicle maintenance persons.

Differences between the need for each skill in 5 years and the current level of the skill								
(profession: industry representative - vehicle maintenance, numeric answers only)								
Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" – "How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	Mean	Std.deviation	Standard error of the mean	Lower CI	Upper CI	t	df	two-sided p-value
Teamwork skills	0.65714	1.62167	0.13706	0.38616	0.92813	4.795	139	<0.001
Social skills	0.85612	1.78789	0.15165	0.55626	1.15597	5.645	138	<0.001
Computer/IT skills	1.69065	1.86053	0.15781	1.37861	2.00268	10.713	138	<0.001
Sales/customer skills	1.15441	1.91632	0.16432	0.82943	1.47939	7.025	135	<0.001
Language skills	1.16176	1.85481	0.15905	0.84722	1.47631	7.304	135	<0.001
Information acquisition skills	1.16912	1.55185	0.13307	0.90595	1.43229	8.786	135	<0.001
Organisational skills and time management	1.29104	1.88314	0.16268	0.96927	1.61282	7.936	133	<0.001
Financing and (governmental) funding aid (e.g.via taxation) for different power trains	1.54098	2.31469	0.20956	1.12610	1.95587	7.353	121	<0.001
Physical requirements of the position	0.32117	1.60850	0.13742	0.04940	0.59293	2.337	136	0.021

The difference scores and their confidence intervals are illustrated in figures 5 and 6.

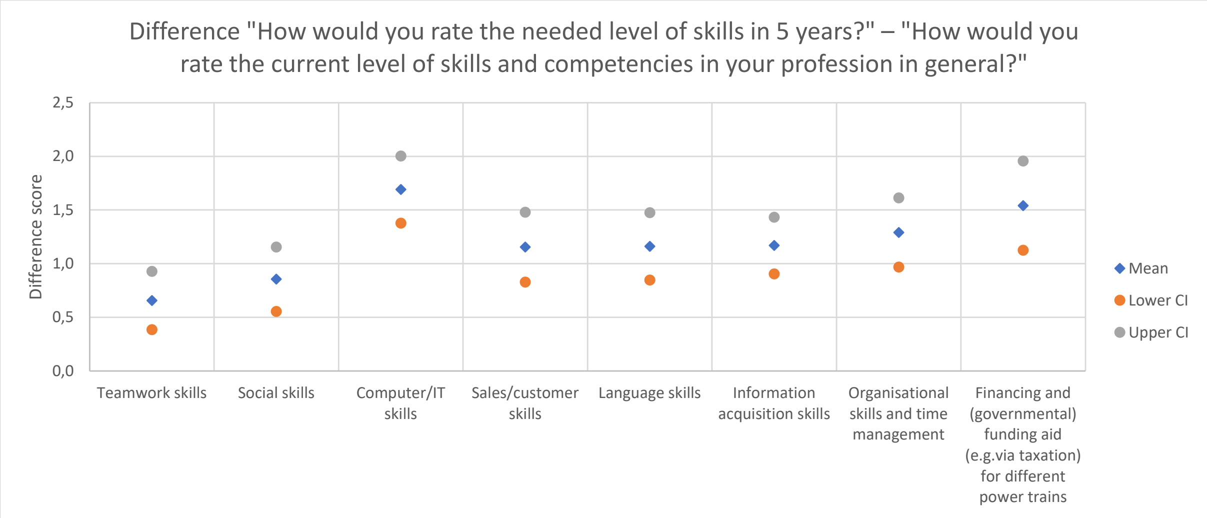

Figure 5. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, vehicle maintenance personnel (1).

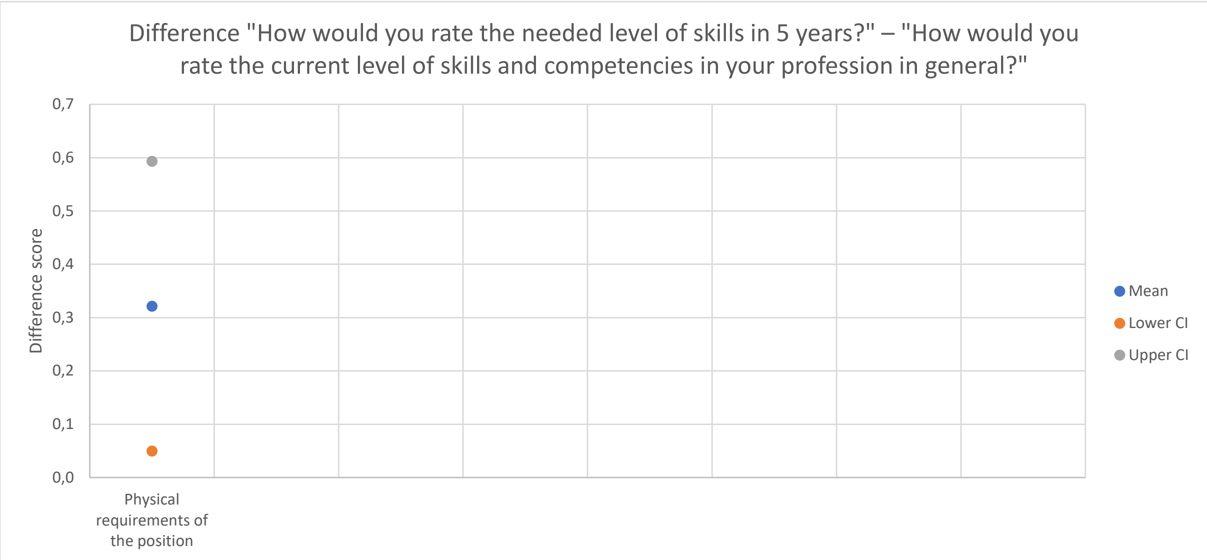

Figure 6. Difference in the needed levels of generic skills in 5 years and the current levels of the skills, vehicle maintenance personnel (2).

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APPENDIX XV: Results from the statistical analysis of professional competences

Teacher

Automotive teachers participating in the survey were requested to rate the current level of professional competencies in their profession in general. Basic statistical figures calculated for the answers have been summarised in Table 25. Professional competencies perceived to be on the highest level were hybrid vehicle systems in general (mean: 6.03, median: 6.5) and electric vehicle systems in general (mean: 6.03, median: 6). Professional competences perceived to be on the lowest level were maintenance of hydrogen systems (mean: 2.41, median: 2) and hydrogen vehicle systems in general (mean: 3.02, median: 2). In general, lower perceived skills levels were reported by automotive teachers for professional competencies (Table 25) than generic competencies (Table 10).

Table 25. Current level of professional competencies – reported by automotive teachers

How would you rate the current level of skills and competencies in your profession in general? (profession: teacher, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Hybrid vehicle systems in general	190	6.0263	6.5	2.40905	-0.447	-0.541
Maintenance of hybrid vehicle systems	188	5.6596	6	2.44754	-0.393	-0.718
Hydrogen vehicle systems in general	186	3.0215	2	2.19078	1.051	0.567
Maintenance of Hydrogen systems	185	2.4108	2	1.93197	1.543	2.001
Electric vehicle systems in general	188	6.0266	6	2.4395	-0.406	-0.571
Maintenance of HV Electric vehicle systems	185	5.3676	6	2.73365	-0.169	-1.082
Hybrid LPG (liquified petroleum gas) systems in general	187	4.8342	5	2.71382	0.135	-1.065
Maintenance of Hybrid LPG systems	185	4.4216	4	2.71781	0.339	-1.036
Hybrid CNG (Compressed Natural Gas) systems in general	186	4.1989	4	2.65049	0.396	-0.929
Maintenance of Hybrid CNG systems	183	3.7705	3	2.56172	0.58	-0.782
Structure and function of lithium-ion batteries	188	4.9415	5	2.80026	0.034	-1.195
Task & function of a BMS (battery management system)	187	4.9626	5	2.89302	0.106	-1.223
Balancing of lithium-ion batteries (active/passive)	187	4.3904	4	2.87976	0.395	-1.089
Dealing with damaged batteries	187	4.3155	4	2.75367	0.505	-0.787
Hazards & Risks when Handling Li-Ion Batteries	186	5.1505	5	2.92961	0.05	-1.292
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	185	4.5405	4	2.83222	0.297	-1.166
Condition assessment of aged/obsolete batteries	187	4.4492	4	2.85328	0.409	-1.074
Battery assembly basics	188	4.6383	4	2.93003	0.359	-1.091
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	188	4.4468	4	2.83454	0.399	-1.039
Warranty claims for used BEVs and batteries	176	3.8125	3	2.78856	0.679	-0.769
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	184	4.5054	4	2.7421	0.247	-1.057
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	186	4.2473	4	2.73182	0.470	0.355
General charging behavior of Li-ion batteries	188	4.5532	4	2.77351	0.286	-1.101
Effects of cold weather into batteries and charging	190	5.1211	5	2.72187	0.061	-1.092
Effects of hot weather into batteries and charging	188	4.97747	5	2.73714	0.131	-1.088
Particularities of chassis or other support structures of electric vehicles	189	4.709	5	2.6807	0.22	-0.958
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	190	5.6053	6	2.60178	-0.14	-0.807
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	189	5.9101	6	2.64924	-0.249	-0.891
Data processing and automation related to Driver Assistance Systems (ADAS)	187	5.1979	5	2.83002	0.048	-1.192
Vehicle communication technologies	188	5.3723	5.5	2.7614	-0.042	-1.192
Regulation related to vehicle technologies and powertrains	189	5.3228	6	2.73989	-0.072	-1.082

Automotive teachers participating in the study were also asked to rate the levels of professional skills needed in five years in future. Basic statistical figures calculated for the levels of professional skills needed in future are summarised in Table 26. Most of the professional skills covered by the study were considered at least moderately important in future, as mean of answers was close to 7 or 8 for most professional skills. Exceptions for this were some skills related to hydrogen, CNG and LPG technology.

Table 26. Future need for professional competencies – reported by automotive teachers

How would you rate the needed level of skills in 5 years? (profession: industry representative - teacher, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Hybrid vehicle systems in general	184	7.2554	8	2.40104	-0.889	0.074
Maintenance of hybrid vehicle systems	183	7.3224	8	2.38583	-0.933	0.128
Hydrogen vehicle systems in general	183	6.0765	7	2.74455	-0.403	-0.952
Maintenance of Hydrogen systems	181	5.9116	6	2.77547	-0.308	-1.028
Electric vehicle systems in general	183	7.6831	8	2.38772	-1.171	0.691
Maintenance of HV Electric vehicle systems	182	7.4945	8	2.53973	-1.056	0.233
Hybrid LPG (liquified petroleum gas) systems in general	181	5.884	6	2.71064	-0.319	-0.924
Maintenance of Hybrid LPG systems	179	5.8827	6	2.70303	-0.321	-0.916
Hybrid CNG (Compressed Natural Gas) systems in general	180	5.7111	6	2.66676	-0.257	-0.895
Maintenance of Hybrid CNG systems	179	5.6983	6	2.66870	-0.253	-0.893
Structure and function of lithium-ion batteries	183	7.1858	8	2.51117	-0.941	0.111
Task & function of a BMS (battery management system)	184	7.3261	8	2.48980	-1.007	0.220
Balancing of lithium-ion batteries (active/passive)	183	7.1475	8	2.56671	-0.950	0.089
Dealing with damaged batteries	183	7.4044	8	2.51597	-1.056	0.338
Hazards & Risks when Handling Li-Ion Batteries	182	7.5714	8	2.47481	-1.172	0.606
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	183	7.3661	8	2.55325	-1.14	0.462
Condition assessment of aged/obsolete batteries	183	7.4372	8	2.60286	-1.187	0.547
Battery assembly basics	183	7.4153	8	2.57677	-1.146	0.482
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	182	7.5	8	2.5157	-1.145	0.485
Warranty claims for used BEVs and batteries	174	7.1437	8	2.67228	-0.957	0.017
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	182	7.3901	8	2.50227	-1.061	0.303
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	181	7.2873	8	2.64686	-1.06	0.116
General charging behavior of Li-ion batteries	183	7.4481	8	2.50851	-1.123	0.477
Effects of cold weather into batteries and charging	184	7.5054	8	2.50899	-1.132	0.437
Effects of hot weather into batteries and charging	183	7.4754	8	2.52203	-1.124	0.439
Particularities of chassis or other support structures of electric vehicles	177	7.3842	8	2.53372	-1.131	0.506
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	184	7.6522	8	2.47141	-1.216	0.726
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	183	7.7486	8	2.39555	-1.234	0.782
Data processing and automation related to Driver Assistance Systems (ADAS)	184	7.5543	8	2.52361	-1.184	0.58
Vehicle communication technologies	185	7.6973	8	2.46833	-1.19	0.611
Regulation related to vehicle technologies and powertrains	182	7.5714	8	2.48373	-1.193	0.655

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Automotive teachers' responses regarding the current level of professional skills as well as the expected levels of the skills needed in five years were tested for normality (Table 27 and Table 28). According to the results of Kolmogorov-Sminrnov tests and Shapiro-Wilk-tests, the answers were not normally distributed.

Table 27. Current level of professional competencies – reported by automotive teachers, tests of normality.

How would you rate the current level of skills and competencies in your profession in general? (profession: teacher, numeric answers only) Tests of normality	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.157	190	<0.001	0.948	190	<0.001	No
Maintenance of hybrid vehicle systems	0.155	188	<0.001	0.943	188	<0.001	No
Hydrogen vehicle systems in general	0.206	186	<0.001	0.847	186	<0.001	No
Maintenance of Hydrogen systems	0.259	185	<0.001	0.756	185	<0.001	No
Electric vehicle systems in general	0.139	188	<0.001	0.951	188	<0.001	No
Maintenance of HV Electric vehicle systems	0.136	185	<0.001	0.937	185	<0.001	No
Hybrid LPG (liquified petroleum gas) systems in general	0.125	187	<0.001	0.939	187	<0.001	No
Maintenance of Hybrid LPG systems	0.154	185	<0.001	0.921	185	<0.001	No
Hybrid CNG (Compressed Natural Gas) systems in general	0.141	186	<0.001	0.918	186	<0.001	No
Maintenance of Hybrid CNG systems	0.171	183	<0.001	0.893	183	<0.001	No
Structure and function of lithium-ion batteries	0.135	188	<0.001	0.929	188	<0.001	No
Task & function of a BMS (battery management system)	0.131	187	<0.001	0.926	187	<0.001	No
Balancing of lithium-ion batteries (active/passive)	0.144	187	<0.001	0.905	187	<0.001	No
Dealing with damaged batteries	0.133	187	<0.001	0.916	187	<0.001	No
Hazards & Risks when Handling Li-Ion Batteries	0.134	186	<0.001	0.924	186	<0.001	No
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.145	185	<0.001	0.916	185	<0.001	No
Condition assessment of aged/obsolete batteries	0.149	187	<0.001	0.91	187	<0.001	No
Battery assembly basics	0.146	188	<0.001	0.912	18	<0.001	No
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.141	188	<0.001	0.912	188	<0.001	No
Warranty claims for used BEVs and batteries	0.214	176	<0.001	0.868	176	<0.001	No
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.122	184	<0.001	0.924	184	<0.001	No
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.138	186	<0.001	0.913	186	<0.001	No
General charging behavior of Li-ion batteries	0.138	188	<0.001	0.924	188	<0.001	No
Effects of cold weather into batteries and charging	0.124	190	<0.001	0.943	190	<0.001	No
Effects of hot weather into batteries and charging	0.113	188	<0.001	0.941	188	<0.001	No
Particularities of chassis or other support structures of electric vehicles	0.103	189	<0.001	0.94	189	<0.001	No
Driver information systems, such as driver drowsiness monitoring/warning, speed alert...	0.097	190	<0.001	0.954	190	<0.001	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.12	189	<0.001	0.948	189	<0.001	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.117	187	<0.001	0.935	187	<0.001	No
Vehicle communication technologies	0.121	188	<0.001	0.941	188	<0.001	No
Regulation related to vehicle technologies and powertrains	0.111	189	<0.001	0.943	189	<0.001	No

Table 28. Future level of professional competencies – reported by automotive teachers, tests of normality.

How would you rate the needed level of skills in 5 years?							
(profession: teacher, numeric answers only)							
Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.187	184	<0.001	0.895	184	<0.001	No
Maintenance of hybrid vehicle systems	0.207	183	<0.001	0.886	183	<0.001	No
Hydrogen vehicle systems in general	0.156	183	<0.001	0.927	183	<0.001	No
Maintenance of Hydrogen systems	0.144	181	<0.001	0.932	181	<0.001	No
Electric vehicle systems in general	0.214	183	<0.001	0.847	183	<0.001	No
Maintenance of HV Electric vehicle systems	0.222	182	<0.001	0.851	182	<0.001	No
Hybrid LPG (liquified petroleum gas) systems in general	0.124	181	<0.001	0.937	181	<0.001	No
Maintenance of Hybrid LPG systems	0.124	179	<0.001	0.939	179	<0.001	No
Hybrid CNG (Compressed Natural Gas) systems in general	0.124	180	<0.001	0.945	180	<0.001	No
Maintenance of Hybrid CNG systems	0.106	179	<0.001	0.946	179	<0.001	No
Structure and function of lithium-ion batteries	0.19	183	<0.001	0.885	183	<0.001	No
Task & function of a BMS (battery management system)	0.21	184	<0.001	0.872	184	<0.001	No
Balancing of lithium-ion batteries (active/passive)	0.182	183	<0.001	0.879	183	<0.001	No
Dealing with damaged batteries	0.195	183	<0.001	0.863	183	<0.001	No
Hazards & Risks when Handling Li-Ion Batteries	0.206	182	<0.001	0.845	182	<0.001	No
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.21	183	<0.001	0.849	183	<0.001	No
Condition assessment of aged/obsolete batteries	0.209	183	<0.001	0.836	183	<0.001	No
Battery assembly basics	0.218	183	<0.001	0.845	183	<0.001	No
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.205	182	<0.001	0.847	182	<0.001	No
Warranty claims for used BEVs and batteries	0.2	174	<0.001	0.869	174	<0.001	No
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.223	182	<0.001	0.86	182	<0.001	No
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.236	181	<0.001	0.846	181	<0.001	No
General charging behavior of Li-ion batteries	0.215	183	<0.001	0.851	183	<0.001	No
Effects of cold weather into batteries and charging	0.23	184	<0.001	0.846	184	<0.001	No
Effects of hot weather into batteries and charging	0.244	183	<0.001	0.846	183	<0.001	No
Particularities of chassis or other support structures of electric vehicles	0.206	177	<0.001	0.854	177	<0.001	No
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	0.224	184	<0.001	0.836	184	<0.001	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.214	183	<0.001	0.835	183	<0.001	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.206	184	<0.001	0.84	184	<0.001	No
Vehicle communication technologies	0.197	185	<0.001	0.836	185	<0.001	No
Regulation related to vehicle technologies and powertrains	0.206	182	<0.001	0.843	182	<0.001	No

Differences between current levels of professional skills and needed levels of the skills in five years were analysed by calculating the difference between the needed future level and current level of the skill reported by the respondent. Statistical figures (mean, standard deviation and standard error of the mean) of these difference scores calculated for each professional skill are summarised in Table 29. The means of the difference scores were positive for all the analysed professional competencies. This means that automotive teachers considered the levels of the skills needed in five years to be higher on the average than the current level of the skills in their profession.

According to the results of paired T-tests, the means of the current level of the competence and the level of the competence needed in five years were different for all the analysed professional skills (p-value <0.001 and null hypothesis rejected for all professional skills). For many of the professional competences, there was a large difference between the current level of the competence and the competence needed in five years (difference scores close to 3 or higher).

Table 29. Differences between needed level of professional skills in 5 years and current levels of the skills, automotive teachers

Differences between the need for each skill in 5 years and the current level of the skill								
(profession: teacher, numeric answers only)								
Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" –								
"How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	Mean	Std.deviation	Standard error of the mean	Lower CI	Upper CI	t	df	two-sided p-value
Hybrid vehicle systems in general	1.19231	2.61558	0.19388	0.80750	1.57486	6.15	181	<0.001
Maintenance of hybrid vehicle systems	1.63333	2.68640	0.20023	1.23821	2.02845	8.157	179	<0.001
Hydrogen vehicle systems in general	3.05028	3.09997	0.23170	2.59304	3.50752	13.165	178	<0.001
Maintenance of Hydrogen systems	3.50847	3.01157	0.22636	3.06174	3.95521	15.499	176	<0.001
Electric vehicle systems in general	1.64246	2.58030	0.19286	1.26187	2.02305	8.516	178	<0.001
Maintenance of HV Electric vehicle systems	2.17614	2.87803	0.21694	1.74798	2.60429	10.031	175	<0.001
Hybrid LPG (liquified petroleum gas) systems in general	1.00559	2.96325	0.22148	0.56851	1.44266	4.54	178	<0.001
Maintenance of Hybrid LPG systems	1.43182	2.83769	0.21390	1.00967	1.85397	6.694	175	<0.001
Hybrid CNG (Compressed Natural Gas) systems in general	1.48315	3.03506	0.22749	1.03421	1.93208	6.52	177	<0.001
Maintenance of Hybrid CNG systems	1.92529	2.94460	0.22323	1.48468	2.36589	8.625	173	<0.001
Structure and function of lithium-ion batteries	2.22905	3.01272	0.22518	1.78468	2.67342	9.899	178	<0.001
Task & function of a BMS (battery management system)	2.32961	3.02569	0.22615	1.88333	2.77589	10.301	178	<0.001
Balancing of lithiumion batteries (active/passive)	2.75978	3.05812	0.22857	2.30871	3.21084	12.074	178	<0.001
Dealing with damaged batteries	3.06180	3.08479	0.23121	2.60551	3.51809	13.242	177	<0.001
Hazards & Risks when Handling Li-Ion Batteries	2.34091	2.95833	0.22299	1.90081	2.78101	10.498	175	<0.001
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	2.77273	3.07516	0.23180	2.31525	3.23021	11.962	175	<0.001
Condition assessment of aged/obsolete batteries	2.99441	3.04184	0.22736	2.54575	3.44308	13.17	178	<0.001
Battery assembly basics	2.76111	3.12918	0.23324	2.30087	3.22136	11.838	179	<0.001
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation).	3.02247	3.19066	0.23915	2.55052	3.49442	12.638	177	<0.001
Warranty claims for used BEVs and batteries	3.29762	3.16144	0.24391	2.81607	3.77916	13.52	167	<0.001
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	2.87429	3.00118	0.22687	2.42652	3.32205	12.669	174	<0.001
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	3.01130	3.16764	0.23809	2.54141	3.48119	12.647	176	<0.001
General charging behavior of Li-ion batteries	2.92737	2.95287	0.22071	2.49183	3.36291	13.264	178	<0.001
Effects of cold weather into batteries and charging	2.39560	3.05341	0.22633	1.94901	2.84220	10.584	181	<0.001
Effects of hot weather into batteries and charging	2.46927	3.08911	0.23089	2.01364	2.92491	10.695	178	<0.001
Particularities of chassis or other support structures of electric vehicles	2.68571	3.11625	0.23557	2.22078	3.15065	11.401	174	<0.001

Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	2.03297	2.87281	0.21295	1.61279	2.45314	9.547	181	<0.001
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	1.88889	2.75415	0.20528	1.48380	2.29397	9.201	179	<0.001
Data processing and automation related to Driver Assistance Systems (ADAS)	2.42458	2.90653	0.21724	1.99587	2.85329	11.161	178	<0.001
Vehicle communication technologies	2.34254	2.90666	0.21605	1.91622	2.76886	10.843	180	<0.001
Regulation related to vehicle technologies and powertrains	2.26111	2.98294	0.22234	1.82238	2.69985	10.17	179	<0.001

The difference scores and related confidence intervals presented in Table 29 were illustrated in Figures 7–10. The confidence intervals presented in the figures were obtained with the paired T-test procedure of SPSS which involves an assumption of normality of data. The answers provided by automotive teachers regarding professional skills were found to be not normally distributed (Table 27 and Table 28), and the confidence intervals therefore need to be interpreted with caution.

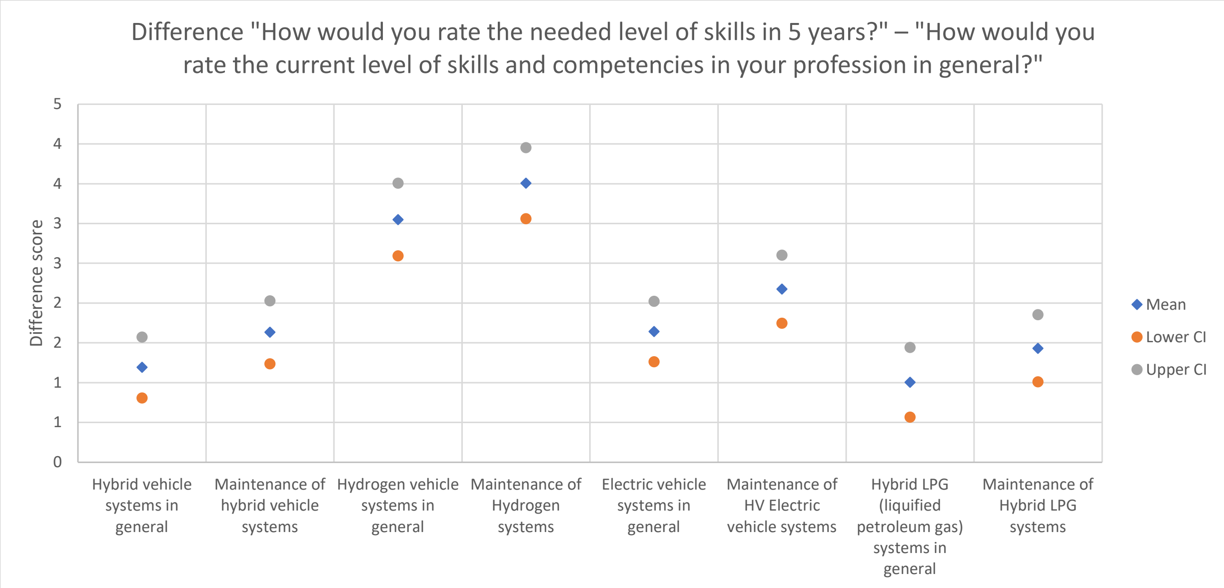

Figure 7. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, automotive teachers (1).

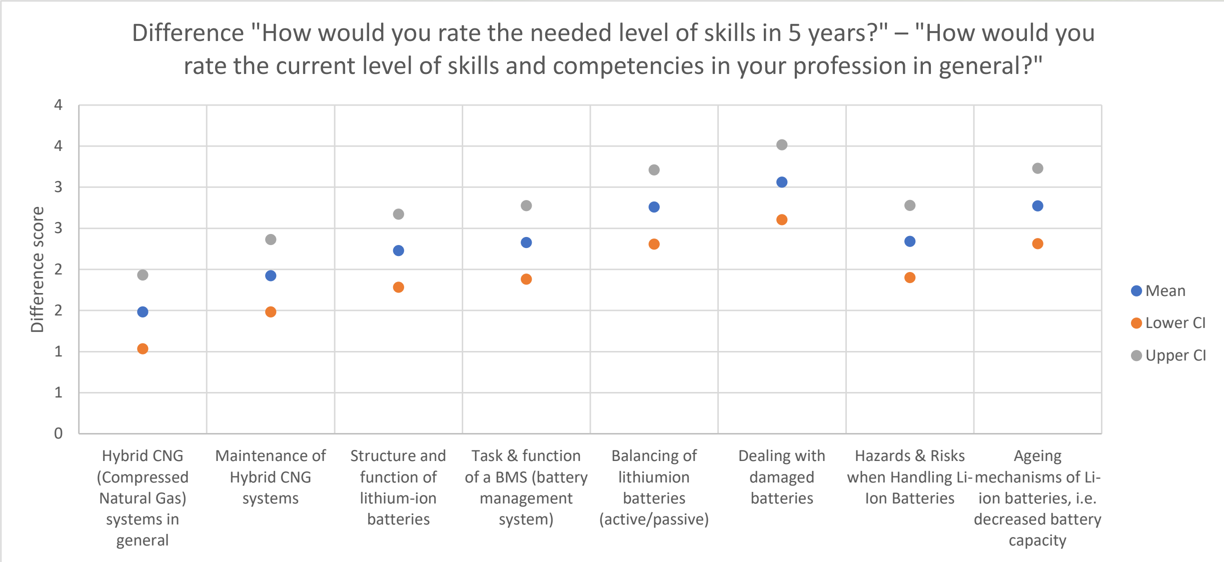

Figure 8. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, automotive teachers (2).

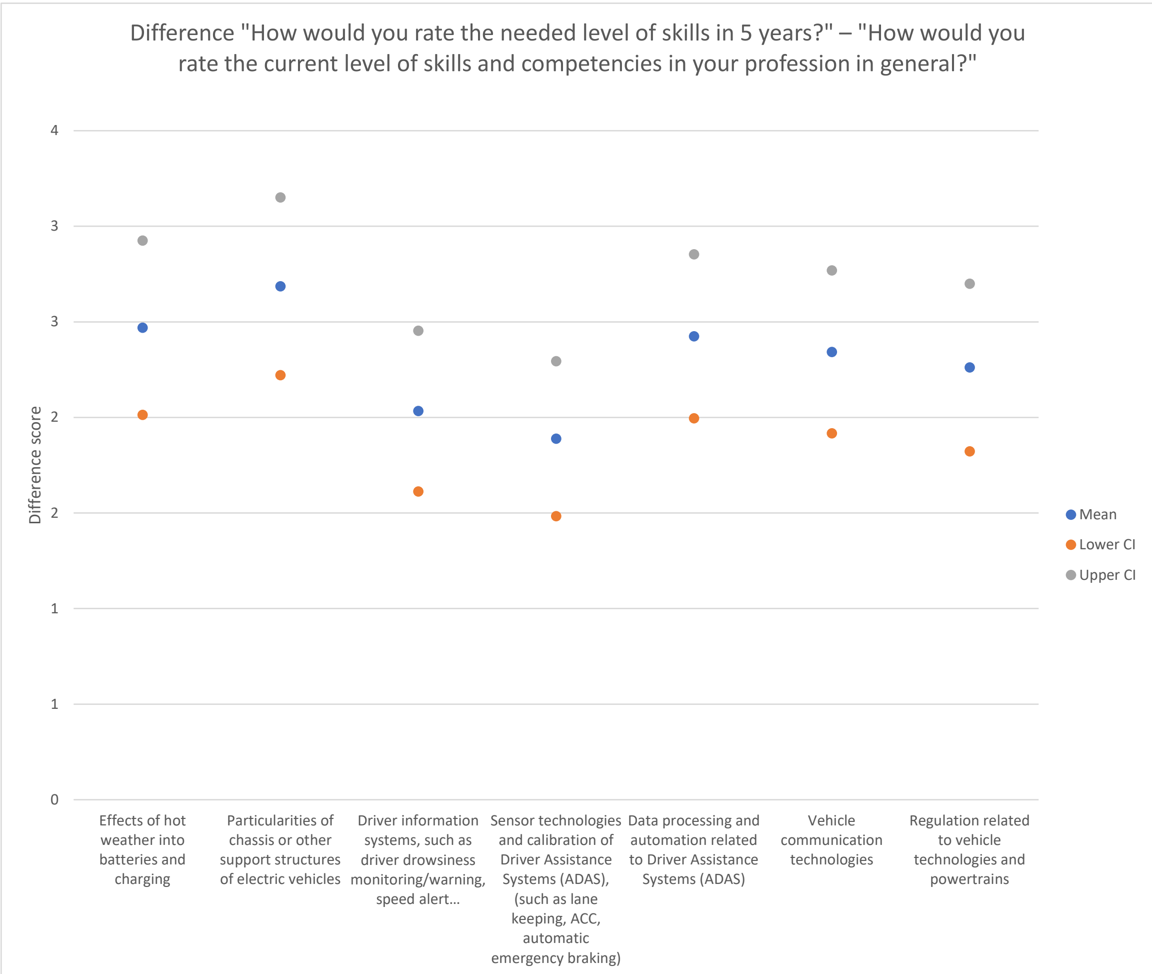

Figure 9. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, automotive teachers (3).

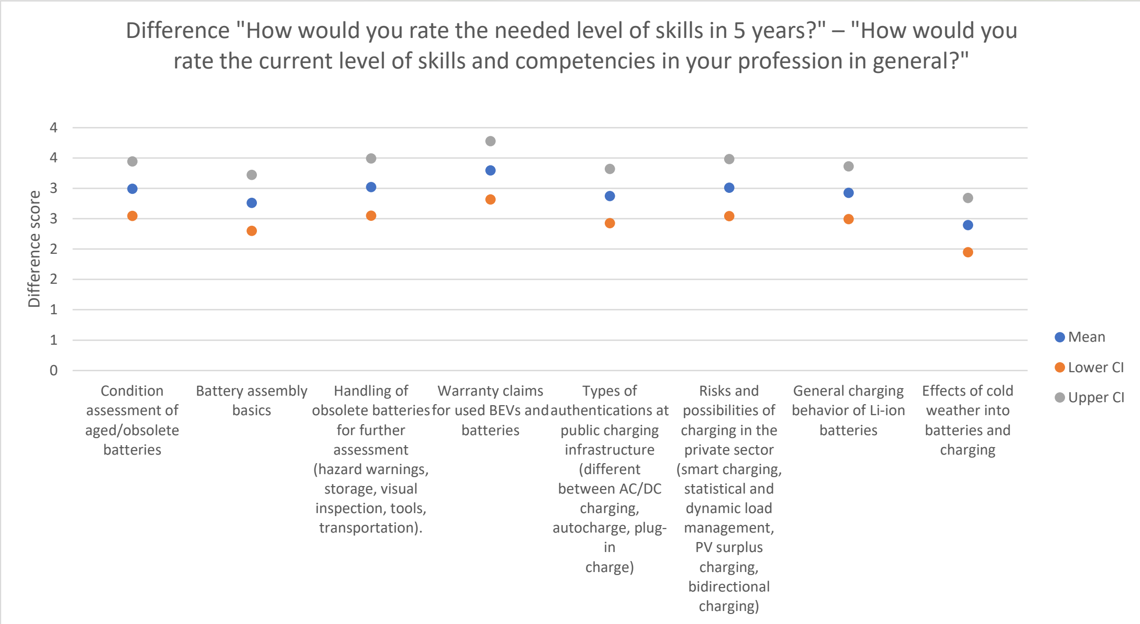

Figure 10. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, automotive teachers (4).

<u>Vehicle and spare part salespersons</u>

Vehicle and spare parts salespersons were asked to rate the current level of various professional skills and competences in their profession in general. Results related to each professional were summarised by calculating the basic statistical figures (mean, median, standard deviation, skewness and kurtosis) (Table 30). The highest level of competence were reported in driver information systems, such as driver drowsiness warning/monitoring, speed alert etc. (mean: 8.00, median: 9) and electric vehicle systems in general (mean: 7.61, median: 8.5). Lowest levels of competence were reported in technologies related to hydrogen (maintenance of hydrogen systems, mean: 2.75, median: 3; hydrogen vehicle systems in general, mean: 3.53, median: 3).

Table 30. Current level of professional competencies – reported by vehicle and spare parts salespersons

How would you rate the current level of skills and competencies in your profession in general? (profession: Industry representative - sales/spare parts dealer, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Hybrid vehicle systems in general	26	7.0000	7	2.56125	-0.944	0.528
Maintenance of hybrid vehicle systems	21	6.3333	7	2.97209	-0.675	0.528
Hydrogen vehicle systems in general	19	3.5263	3	2.41220	0.521	-1.157
Maintenance of Hydrogen systems	16	2.7500	3	1.84391	1.003	0.595
Electric vehicle systems in general	26	7.6154	8.5	2.49923	-1.422	1.361
Maintenance of HV Electric vehicle systems	22	7.1364	7.5	2.62398	-1.033	0.321
Hybrid LPG (liquified petroleum gas) systems in general	18	5.4444	6	2.20220	-0.009	0.074
Maintenance of Hybrid LPG systems	16	5.0625	5	2.56824	0.110	-0.561
Hybrid CNG (Compressed Natural Gas) systems in general	19	5.7368	7	2.70477	-0.404	-1.185
Maintenance of Hybrid CNG systems	17	5.5882	6	2.39945	-0.339	-1.151
Structure and function of lithium-ion batteries	25	6.3200	7	2.24944	-0.722	0.384
Task & function of a BMS (battery management system)	23	6.2609	7	2.37826	-0.628	-0.095
Balancing of lithium-ion batteries (active/passive)	21	5.5714	6	2.78516	-0.368	-0.998
Dealing with damaged batteries	22	6.0909	6	2.52434	-0.112	-0.602
Hazards & Risks when Handling Li-Ion Batteries	23	6.2609	6	2.59751	-0.382	-0.731
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	24	6.2500	7	2.26984	-0.557	-0.047
Condition assessment of aged/obsolete batteries	22	6.4545	7	2.48284	-0.310	-0.309
Battery assembly basics	22	6.5000	6.5	2.77317	-0.206	-1.081
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	25	6.2400	6	2.61852	-0.088	-1.026
Warranty claims for used BEVs and batteries	24	6.5000	7	2.67029	-0.456	-0.836
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	24	6.8750	7	2.52488	-0.695	0.087
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	26	6.6154	7	2.38457	-0.730	0.159
General charging behavior of Li-ion batteries	25	6.6000	7	2.16025	-0.728	0.745
Effects of cold weather into batteries and charging	28	7.3929	7.5	2.16606	-0.997	1.361
Effects of hot weather into batteries and charging	28	7.2857	7	2.08801	-1.067	1.641
Particularities of chassis or other support structures of electric vehicles	24	6.6250	7	2.41035	-0.696	0.104
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	25	8.0000	9	2.19848	-1.100	0.782
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	24	7.5000	8	2.67029	-0.994	0.230
Data processing and automation related to Driver Assistance Systems (ADAS)	23	7.3478	8	2.69020	-1.067	0.227
Vehicle communication technologies	22	7.5909	8	2.08530	-1.649	3.532
Regulation related to vehicle technologies and powertrains	21	6.6190	7	2.24669	-0.670	0.654

Results on the levels of professional skills needed in five years by vehicle and spare parts salespersons are summarised in Table 31. Respondents expected high skill levels to be needed especially in data processing and automation related to driver assistance systems (ADAS) (mean: 8.96, median: 10), sensor technologies and calibration of driver assistance systems (ADAS), (such as lane keeping, ACC, emergency braking) (mean: 8.92, median: 10) and vehicle communication technologies (mean: 8.8, median: 10). For some of the competences, the distributions of responses were highly skewed (had high absolute values of skewness) or had high values of excess kurtosis.

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Table 31. Future need for professional competencies – reported by vehicle and spare parts salespersons

How would you rate the needed level of skills in 5 years? (profession: Industry representative - sales/spare parts dealer, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Hybrid vehicle systems in general	28	8.3571	9	2.07658	-1.853	4.580
Maintenance of hybrid vehicle systems	25	8.1600	9	2.30362	-1.568	2.620
Hydrogen vehicle systems in general	21	6.9048	7	2.50808	-0.638	-0.187
Maintenance of Hydrogen systems	19	6.7368	7	2.64243	-0.489	-0.604
Electric vehicle systems in general	29	8.6207	9	2.04265	-2.199	5.981
Maintenance of HV Electric vehicle systems	25	8.4000	9	2.21736	-1.949	4.323
Hybrid LPG (liquified petroleum gas) systems in general	20	6.3000	7	2.73573	-0.436	-0.973
Maintenance of Hybrid LPG systems	19	6.3684	7	2.90995	-0.349	-1.189
Hybrid CNG (Compressed Natural Gas) systems in general	20	5.6000	5.5	2.79850	-0.134	-1.150
Maintenance of Hybrid CNG systems	19	5.8947	6	2.62244	-0.203	-0.982
Structure and function of lithium-ion batteries	25	8.0000	8	2.02073	-1.811	4.951
Task & function of a BMS (battery management system)	24	8.0417	9	2.17654	-1.714	3.756
Balancing of lithium-ion batteries (active/passive)	22	8.1364	9	2.25294	-1.780	3.890
Dealing with damaged batteries	25	8.4000	9	2.17945	-2.005	4.806
Hazards & Risks when Handling Li-Ion Batteries	25	8.4000	9	2.14087	-1.955	4.875
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	24	8.3333	9	2.11961	-2.033	5.307
Condition assessment of aged/obsolete batteries	24	8.4167	9	2.14510	-2.066	5.290
Battery assembly basics	23	8.2174	9	2.29538	-1.749	3.381
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	23	8.0435	9	2.38324	-1.446	2.076
Warranty claims for used BEVs and batteries	25	8.3200	9	2.51197	-1.904	3.039
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	24	8.2917	9	2.51049	-1.998	3.420
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	26	8.6154	9	2.04112	-2.458	7.239
General charging behavior of Li-ion batteries	27	8.6296	9	1.92450	-2.783	9.369
Effects of cold weather into batteries and charging	27	8.7037	9	2.01561	-2.574	7.797
Effects of hot weather into batteries and charging	27	8.7037	9	2.01561	-2.574	7.797
Particularities of chassis or other support structures of electric vehicles	25	8.1600	9	2.26716	-1.614	2.782
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	27	8.6667	9	2.14834	-2.421	6.075
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	26	8.9231	10	2.09615	-2.854	8.628
Data processing and automation related to Driver Assistance Systems (ADAS)	25	8.9600	10	2.13073	-2.893	8.668
Vehicle communication technologies	25	8.8000	10	2.12132	-2.704	7.874
Regulation related to vehicle technologies and powertrains	25	8.4800	9	2.38258	-2.012	3.704

Vehicle and spare parts salespersons' answers regarding the current level of professional skills and levels of skills needed in five years were tested for normality (Table 32 and Table 33). In case of current level of professional skills, answers related to some of the could be assumed to be normally distributed (p-values provided by Kolmogorov-Smirnov and Shapiro-Wilk tests 0.05 or more). However, this was not the case for all professional skills. This was the case also for answers on level of professional skills needed in five years.

Table 32. Current level of professional competencies – reported by vehicle and spare parts salespersons, tests of normality

How would you rate the current level of skills and competencies in your profession in general?							
(profession: Industry representative - sales/spare parts dealer, numeric answers only)							
Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.167	26	0.060	0.892	26	0.010	No
Maintenance of hybrid vehicle systems	0.208	21	0.018	0.888	21	0.021	No
Hydrogen vehicle systems in general	0.218	19	0.018	0.864	18	0.011	No
Maintenance of Hydrogen systems	0.204	16	0.075	0.846	16	0.012	No
Electric vehicle systems in general	0.215	26	0.003	0.817	26	<0.001	No
Maintenance of HV Electric vehicle systems	0.252	22	<0.001	0.874	22	0.009	No
Hybrid LPG (liquified petroleum gas) systems in general	0.155	18	0.200	0.973	18	0.859	Yes
Maintenance of Hybrid LPG systems	0.102	16	0.200	0.968	16	0.813	Yes
Hybrid CNG (Compressed Natural Gas) systems in general	0.206	19	0.033	0.9	19	0.048	No
Maintenance of Hybrid CNG systems	0.192	17	0.094	0.916	17	0.126	Yes
Structure and function of lithium-ion batteries	0.179	25	0.038	0.925	25	0.068	No
Task & function of a BMS (battery management system)	0.187	23	0.036	0.931	23	0.117	No
Balancing of lithium-ion batteries (active/passive)	0.180	21	0.073	0.919	21	0.084	Yes
Dealing with damaged batteries	0.117	22	0.200	0.953	22	0.367	Yes
Hazards & Risks when Handling Li-Ion Batteries	0.115	23	0.200	0.947	23	0.252	Yes
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.213	24	0.006	0.93	24	0.096	No

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Condition assessment of aged/obsolete batteries	0.132	22	0.200	0.949	22	0.303	Yes
Battery assembly basics	0.160	22	0.147	0.918	22	0.068	Yes
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.149	25	0.155	0.939	25	0.144	Yes
Warranty claims for used BEVs and batteries	0.158	24	0.127	0.937	24	0.139	Yes
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.186	24	0.031	0.918	24	0.052	No
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.181	26	0.028	0.92	26	0.045	No
General charging behavior of Li-ion batteries	0.151	25	0.147	0.944	25	0.183	Yes
Effects of cold weather into batteries and charging	0.142	28	0.153	0.911	28	0.020	No
Effects of hot weather into batteries and charging	0.160	28	0.065	0.906	28	0.016	No
Particularities of chassis or other support structures of electric vehicles	0.148	24	0.189	0.933	24	0.112	Yes
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	0.195	25	0.015	0.853	25	0.002	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.175	24	0.057	0.861	24	0.004	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.209	23	0.011	0.856	23	0.004	No
Vehicle communication technologies	0.260	22	<0.001	0.833	22	0.002	No
Regulation related to vehicle technologies and powertrains	0.153	21	0.200	0.952	21	0.379	Yes

Table 33. Future need for professional competencies – reported by vehicle and spare parts salespersons, tests of normality

How would you rate the needed level of skills in 5 years?							
(profession: Industry representative - sales/spare parts dealer, numeric answers only)							
Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.264	28	<0.001	0.761	28	<0.001	No
Maintenance of hybrid vehicle systems	0.242	25	<0.001	0.794	25	<0.001	No
Hydrogen vehicle systems in general	0.179	21	0.077	0.924	21	0.105	Yes
Maintenance of Hydrogen systems	0.173	19	0.139	0.931	19	0.178	Yes
Electric vehicle systems in general	0.263	29	<0.001	0.712	29	<0.001	No
Maintenance of HV Electric vehicle systems	0.247	25	<0.001	0.745	25	<0.001	No
Hybrid LPG (liquified petroleum gas) systems in general	0.201	20	0.033	0.932	20	0.171	No
Maintenance of Hybrid LPG systems	0.165	19	0.187	0.923	19	0.127	Yes
Hybrid CNG (Compressed Natural Gas) systems in general	0.142	20	0.200	0.947	20	0.318	Yes
Maintenance of Hybrid CNG systems	0.137	19	0.2	0.959	19	0.552	Yes
Structure and function of lithium-ion batteries	0.19	25	0.02	0.819	25	<0.001	No
Task & function of a BMS (battery management system)	0.212	24	0.007	0.807	24	<0.001	No
Balancing of lithium-ion batteries (active/passive)	0.216	22	0.009	0.778	22	<0.001	No
Dealing with damaged batteries	0.231	25	0.001	0.74	25	<0.001	No
Hazards & Risks when Handling Li-Ion Batteries	0.227	25	0.002	0.757	25	<0.001	No
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.216	24	0.005	0.768	24	<0.001	No
Condition assessment of aged/obsolete batteries	0.232	24	0.002	0.749	24	<0.001	No
Battery assembly basics	0.242	23	0.001	0.781	23	<0.001	No
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.221	23	0.005	0.814	23	<0.001	No
Warranty claims for used BEVs and batteries	0.287	25	<0.001	0.703	25	<0.001	No
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.287	24	<0.001	0.693	24	<0.001	No

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Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.267	26	<0.001	0.694	26	<0.001	No
General charging behavior of Li-ion batteries	0.317	27	<0.001	0.662	27	<0.001	No
Effects of cold weather into batteries and charging	0.299	27	<0.001	0.668	27	<0.001	No
Effects of hot weather into batteries and charging	0.299	27	<0.001	0.668	27	<0.001	No
Particularities of chassis or other support structures of electric vehicles	0.244	25	<0.001	0.793	25	<0.001	No
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	0.339	27	<0.001	0.649	27	<0.001	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.322	26	<0.001	0.574	26	<0.001	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.347	25	<0.001	0.551	25	<0.001	No
Vehicle communication technologies	0.298	25	<0.001	0.614	25	<0.001	No
Regulation related to vehicle technologies and powertrains	0.306	25	<0.001	0.692	25	<0.001	No

Differences between current levels of professional skills and level of professional skill needed in five years were analysed by calculating difference scores for each skill (difference of the level of the skill needed in five years reported by the respondent and current level of the skill reported by the respondent). These difference scores were calculated for each professional competence based on the responses given by vehicle and spare parts salespersons and aggregated by calculating the mean, standard deviation and standard error of the mean of the difference score (Table 34). All the observed difference scores were positive except skills related to hybrid CNG (Compressed Natural Gas) systems in general (mean: -0.22, standard deviation: 2.73, standard error of the mean: 0.64). For the professional skills covered by the study, the number of numeric answers received from vehicle and spare parts salespersons was relatively small (29 or less). For this reason, the impact of random variation on the results (e.g. the means of the difference scores) needs to be considered.

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Table 34. Differences between needed level of professional skills in 5 years and current levels of the skills, vehicle and spare parts salespersons

Differences between the need for each skill in 5 years and the current level of the skill (profession: Industry representative - sales/spare parts dealer, numeric answers only) Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" – "How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	**Mean**	**Std.deviation**	**Standard error of the mean**	**Lower CI**	**Upper CI**	**t**	**df**	**two-sided p-value**
Hybrid vehicle systems in general	1.34615	1.91713	0.37598	0.57181	2.12050	3.580	25	0.001
Maintenance of hybrid vehicle systems	1.76190	2.70009	0.58921	0.53284	2.99097	2.990	20	0.007
Hydrogen vehicle systems in general	3.22222	2.21108	0.52116	2.12268	4.32177	6.183	17	<0.001
Maintenance of Hydrogen systems	3.60000	2.29285	0.59201	2.33026	4.86974	6.081	14	<0.001
Electric vehicle systems in general	0.96154	1.90748	0.37409	0.19109	1.73198	2.570	25	0.017
Maintenance of HV Electric vehicle systems	0.85000	1.69442	0.37888	0.05699	1.64301	2.243	19	0.037
Hybrid LPG (liquified petroleum gas) systems in general	0.66667	2.19625	0.51766	-0.42550	1.75884	1.288	17	0.108
Maintenance of Hybrid LPG systems	1.00000	2.68328	0.67082	-0.42982	2.42982	1.491	15	0.157
Hybrid CNG (Compressed Natural Gas) systems in general	-0.22222	2.73443	0.64451	-1.58202	1.13758	-0.345	17	0.734
Maintenance of Hybrid CNG systems	0.05882	2.90410	0.70435	-1.43433	1.55198	0.084	16	0.934
Structure and function of lithium-ion batteries	1.63636	2.03646	0.43418	0.73345	2.53928	3.769	21	0.001
Task & function of a BMS (battery management system)	1.57143	2.01424	0.43954	0.65456	2.48830	3.575	20	0.002
Balancing of lithiumion batteries (active/passive)	2.40000	2.47939	0.55441	1.23961	3.56039	4.329	19	<0.001
Dealing with damaged batteries	2.09524	2.56719	0.56021	0.92667	3.26381	3.740	20	0.001
Hazards & Risks when Handling Li-Ion Batteries	2.00000	2.30940	0.49237	0.97607	3.02393	4.062	21	<0.001
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	2.00000	2.26779	0.48349	0.99452	3.00548	4.137	21	<0.001
Condition assessment of aged/obsolete batteries	1.95238	2.74729	0.59951	0.70183	3.20293	3.257	20	0.004
Battery assembly basics	1.52381	2.80391	0.61186	0.24749	2.80013	2.490	20	0.022
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation).	1.81818	2.30189	0.49076	0.79758	2.83878	3.705	21	0.001
Warranty claims for used BEVs and batteries	1.65217	2.01379	0.41990	0.78135	2.52300	3.935	22	<0.001
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	1.38095	1.88351	0.41102	0.52359	2.23832	3.360	20	0.003
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	1.87500	1.91816	0.39154	1.06503	2.68497	4.789	23	<0.001
General charging behavior of Li-ion batteries	2.04000	1.76730	0.35346	1.31050	2.76950	5.772	24	<0.001
Effects of cold weather into batteries and charging	1.30769	1.59422	0.31265	0.66377	1.95161	4.183	25	<0.001
Effects of hot weather into batteries and charging	1.42308	1.57919	0.30970	0.78523	2.06093	4.595	25	<0.001
Particularities of chassis or other support structures of electric vehicles	1.58333	2.28257	0.46593	0.61949	2.54718	3.398	23	0.002
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	1.04167	2.07426	0.42341	0.16579	1.91755	2.460	23	0.022
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	1.30435	2.24489	0.46809	0.33359	2.27511	2.787	22	0.011
Data processing and automation related to Driver Assistance Systems (ADAS)	1.65217	2.32787	0.48539	0.64553	2.65882	3.404	22	0.003
Vehicle communication technologies	1.23810	2.38547	0.52055	0.15224	2.32395	2.378	20	0.027
Regulation related to vehicle technologies and powertrains	1.95000	1.93241	0.43210	1.04560	2.85440	4.513	19	<0.001

Vehicle maintenance personal

Vehicle maintenance personnel participating in the study were requested to rate the current level of professional skills and competences in their profession. Basic statistical figures (mean, median, standard deviation, skewness and kurtosis) were calculated for the responses regarding each professional competence (Table 35). There was considerable variation in skill levels across various professional competencies. Moderate levels of skills and competence were reported for some areas related to batteries of electric vehicles (such as effects of cold weather into batteries and charging, mean: 6.57, median: 7; effects of hot weather into batteries and charging, mean: 6.42, median: 7, hazards and risks when handling Li-ion batteries, mean: 5.96, median: 7) and driver information systems and ADAS (driver information systems, such as driver drowsiness monitoring/warning, speed alert etc., mean: 6.38, median: 7; sensor technologies and calibration of driver assistance systems (ADAS), mean: 6.32, median: 7). Meanwhile, the level of skills and knowledge related to hydrogen vehicles and maintenance of hydrogen systems were considered to be low (maintenance of hydrogen systems, mean: 2.64, median: 2; hydrogen vehicle systems in general, mean: 2.85, median: 2). The results also indicated that there was considerable variation in the current skills levels among the respondents of the study (standard deviation was more than 2 for all the professional competences covered by the study).

Table 35. Current level of professional competencies – reported by vehicle maintenance personnel

How would you rate the current level of skills and competencies in your profession in general? (profession: industry representative - vehicle maintenance, numeric answers only) 1 = low, 10 = high	**N**	**Mean**	**Median**	**Std. Deviation**	**Skewness**	**Kurtosis**
Hybrid vehicle systems in general	135	5.8444	6	2.54179	-0.227	-0.725
Maintenance of hybrid vehicle systems	128	5.7031	6	2.7418	-0.065	-1.018
Hydrogen vehicle systems in general	102	2.8529	2	2.13132	1.36	1.695
Maintenance of Hydrogen systems	96	2.6354	2	2.28551	1.661	2.334
Electric vehicle systems in general	135	5.8444	6	2.59122	-0.208	-0.851
Maintenance of HV Electric vehicle systems	129	5.5194	6	2.82318	-0.014	-1.122
Hybrid LPG (liquified petroleum gas) systems in general	114	4.3947	4	2.66945	0.243	-1.083
Maintenance of Hybrid LPG systems	111	4.2613	4	2.73267	0.341	-1.064
Hybrid CNG (Compressed Natural Gas) systems in general	113	4.1416	4	2.71197	0.444	-0.974
Maintenance of Hybrid CNG systems	110	4.1364	4	2.80065	0.447	-1.056
Structure and function of lithium-ion batteries	135	5.4	5	2.64913	-0.102	-0.941
Task & function of a BMS (battery management system)	136	5.6471	6	2.77697	-0.159	-1.074
Balancing of lithium-ion batteries (active/passive)	132	4.6894	5	2.86365	0.249	-1.137
Dealing with damaged batteries	136	5.1471	5	3.10443	0.066	-1.395
Hazards & Risks when Handling Li-Ion Batteries	137	5.9635	7	2.96898	-0.345	-1.148
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	137	5.4088	6	2.85831	-0.148	-1.143
Condition assessment of aged/obsolete batteries	133	5.5188	5	2.87255	0.027	-1.141
Battery assembly basics	133	5.9624	6	2.81878	-0.085	-1.171
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	133	5.7744	6	2.92227	-0.166	-1.16

Warranty claims for used BEVs and batteries	135	5.2815	5	3.10909	0.033	-1.263
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	130	5.2923	6	2.83786	0.025	-0.991
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	133	5.0677	5	2.82091	0.175	-1.007
General charging behavior of Li-ion batteries	137	5.4088	6	2.82467	-0.014	-1.016
Effects of cold weather into batteries and charging	136	6.5735	7	2.517	-0.522	-0.64
Effects of hot weather into batteries and charging	138	6.4203	7	2.52234	-0.449	-0.714
Particularities of chassis or other support structures of electric vehicles	138	5.5507	6	2.74745	-0.338	-0.954
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	136	6.3824	7	2.59075	-0.604	-0.469
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	134	6.3209	7	2.69949	-0.419	-0.811
Data processing and automation related to Driver Assistance Systems (ADAS)	131	5.5038	6	2.73826	-0.117	-1.032
Vehicle communication technologies	140	5.9429	6	2.41331	-0.365	-0.521
Regulation related to vehicle technologies and powertrains	138	5.7464	6	2.54611	-0.215	-0.805

Vehicle maintenance persons participating in the study were also asked to rate the needed level of various professional skills in five years in future. The results were summarised by calculating the basic statistical figures (mean, median, standard deviation, skewness and kurtosis) (Table 36). In general, the professional skills covered by the study were considered as relevant in future by participants. For almost all of the professional skills covered by the study, the mean of the rated importance in five years was between 7 and 8. Exceptions to this were technologies related to hydrogen vehicles and technologies related to LPG and CNG vehicles which were considered slightly less important in future on average. The results also indicate that there were differences between respondents in the perceived importance of various professional competencies in future. For all the professional competencies covered by the study, the standard deviation of the perceived importance of the competence in future was around 2.5 (more than 2 but less than 3).

Table 36. Future need for professional competencies – reported by vehicle maintenance personnel

How would you rate the needed level of skills in 5 years? (profession: industry representative - vehicle maintenance, numeric answers only) 1 = low, 10 = high	N	Mean	Median	Std. Deviation	Skewness	Kurtosis
Hybrid vehicle systems in general	140	7.3429	8	2.45175	-0.925	-0.027
Maintenance of hybrid vehicle systems	137	7.1825	8	2.56452	-0.846	-0.169
Hydrogen vehicle systems in general	123	6.1626	6	2.61576	-0.312	-0.758
Maintenance of Hydrogen systems	122	6.0246	6	2.72261	-0.249	-0.936
Electric vehicle systems in general	140	7.4071	8	2.70331	-1.042	0.1
Maintenance of HV Electric vehicle systems	134	7.2463	8	2.62274	-0.882	-0.14
Hybrid LPG (liquified petroleum gas) systems in general	123	5.6179	6	2.60366	-0.115	-0.816
Maintenance of Hybrid LPG systems	121	5.5124	5	2.60485	-0.075	-0.815
Hybrid CNG (Compressed Natural Gas) systems in general	123	5.6911	6	2.62438	-0.221	-0.829
Maintenance of Hybrid CNG systems	121	5.6612	6	2.65692	-0.188	-0.898
Structure and function of lithium-ion batteries	138	7.1739	8	2.68794	-0.897	-0.223
Task & function of a BMS (battery management system)	137	7.4964	8	2.59843	-1.091	0.298
Balancing of lithium-ion batteries (active/passive)	137	7.1752	8	2.67037	-0.896	-0.199
Dealing with damaged batteries	139	7.4245	8	2.58754	-1.003	0.151
Hazards & Risks when Handling Li-Ion Batteries	139	7.6331	8	2.47932	-1.122	0.492
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	137	7.4088	8	2.48985	-0.994	0.3
Condition assessment of aged/obsolete batteries	139	7.3094	8	2.60948	-0.948	-0.023
Battery assembly basics	135	7.5481	8	2.62797	-1.019	0.098
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	137	7.4453	8	2.54639	-1.044	0.376
Warranty claims for used BEVs and batteries	137	7.4526	8	2.52916	-1.026	0.374
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	135	7.2593	8	2.52735	-0.84	-0.068
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	135	7.237	8	2.58644	-0.796	-0.323
General charging behavior of Li-ion batteries	135	7.3556	8	2.62442	-1.049	0.218
Effects of cold weather into batteries and charging	139	7.4892	8	2.52054	-1.011	0.089
Effects of hot weather into batteries and charging	139	7.6043	8	2.47778	-1.134	0.378
Particularities of chassis or other support structures of electric vehicles	140	7.4214	8	2.53626	-1.034	0.277
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	141	7.4894	8	2.32876	-0.881	0.166

Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	135	7.5556	8	2.5176	-1.029	0.301
Data processing and automation related to Driver Assistance Systems (ADAS)	136	7.4706	8	2.42194	-0.924	0.214
Vehicle communication technologies	138	7.6377	8	2.33645	-1.1	0.703
Regulation related to vehicle technologies and powertrains	140	7.4786	8	2.36421	-0.929	0.255

Vehicle maintenance persons' answers regarding the current level of professional competencies and the needed level of professional competencies in five years in future were tested for normality (Table 37 and Table 38). The results of Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that the answers were not normally distributed (all p-values less than 0.05 and most less than 0.001).

Table 37. Current level of professional competencies – reported by vehicle maintenance personnel, tests of normality

How would you rate the current level of skills and competencies in your profession in general? (profession: industry representative - vehicle maintenance, numeric answers only) Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.127	135	<0.001	0.954	135	<0.001	No
Maintenance of hybrid vehicle systems	0.112	128	<0.001	0.945	128	<0.001	No
Hydrogen vehicle systems in general	0.224	102	<0.001	0.818	102	<0.001	No
systems	0.245	96	<0.001	0.743	96	<0.001	No
Electric vehicle systems in general	0.109	135	<0.001	0.954	135	<0.001	No
Maintenance of HV Electric vehicle systems	0.095	129	0.006	0.942	129	<0.001	No
Hybrid LPG (liquified petroleum gas) systems in general	0.129	114	<0.001	0.923	114	<0.001	No
Maintenance of Hybrid LPG systems	0.147	111	<0.001	0.911	111	<0.001	No
Hybrid CNG (Compressed Natural Gas) systems in general	0.157	113	<0.001	0.907	113	<0.001	No
Maintenance of Hybrid CNG systems	0.168	110	<0.001	0.895	110	<0.001	No
Structure and function of lithium-ion batteries	0.105	135	<0.001	0.951	135	<0.001	No
Task & function of a BMS (battery management system)	0.121	136	<0.001	0.941	136	<0.001	No
Balancing of lithium-ion batteries (active/passive)	0.131	132	<0.001	0.922	132	<0.001	No
Dealing with damaged batteries	0.152	136	<0.001	0.905	136	<0.001	No
Hazards & Risks when Handling Li-Ion Batteries	0.155	137	<0.001	0.914	137	<0.001	No

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Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.117	137	<0.001	0.93	137	<0.001	No
Condition assessment of aged/obsolete batteries	0.115	133	<0.001	0.936	133	<0.001	No
Battery assembly basics	0.126	133	<0.001	0.935	133	<0.001	No
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.115	133	<0.001	0.93	133	<0.001	No
Warranty claims for used BEVs and batteries	0.116	135	<0.001	0.912	135	<0.001	No
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.114	130	<0.001	0.934	130	<0.001	No
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.087	133	0.015	0.937	133	<0.001	No
General charging behavior of Li-ion batteries	0.095	137	0.004	0.94	137	<0.001	No
Effects of cold weather into batteries and charging	0.156	136	<0.001	0.933	136	<0.001	No
Effects of hot weather into batteries and charging	0.134	138	<0.001	0.941	138	<0.001	No
Particularities of chassis or other support structures of electric vehicles	0.152	138	<0.001	0.925	138	<0.001	No
Driver information systems, such as driver drowsiness monitoring/warning, speed alert…	0.138	136	<0.001	0.922	136	<0.001	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.151	134	<0.001	0.933	134	<0.001	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.094	131	0.007	0.944	131	<0.001	No
Vehicle communication technologies	0.119	140	<0.001	0.955	140	<0.001	No
Regulation related to vehicle technologies and powertrains	0.109	138	<0.001	0.956	138	<0.001	No

Table 38. Future need for professional competencies – reported by vehicle maintenance personnel, tests of normality

How would you rate the needed level of skills in 5 years? (profession: industry representative - vehicle maintenance, numeric answers only) Tests of normality							
	Results of Kolmogorov-Smirnov test			Results of Shapiro-Wilk test			Data normally distributed
	Test statistic	df	p-value	Test statistic	df	p-value	
Hybrid vehicle systems in general	0.191	140	<0.001	0.878	140	<0.001	No
Maintenance of hybrid vehicle systems	0.172	137	<0.001	0.89	137	<0.001	No
Hydrogen vehicle systems in general	0.125	123	<0.001	0.944	123	<0.001	No
Maintenance of Hydrogen systems	0.118	122	<0.001	0.942	122	<0.001	No
Electric vehicle systems in general	0.215	140	<0.001	0.844	140	<0.001	No
Maintenance of HV Electric vehicle systems	0.203	134	<0.001	0.876	134	<0.001	No
Hybrid LPG (liquified petroleum gas) systems in general	0.101	123	0.004	0.955	123	<0.001	No
Maintenance of Hybrid LPG systems	0.1	121	0.005	0.954	121	<0.001	No
Hybrid CNG (Compressed Natural Gas) systems in general	0.111	123	<0.001	0.948	123	<0.001	No
Maintenance of Hybrid CNG systems	0.125	121	<0.001	0.947	121	<0.001	No
Structure and function of lithium-ion batteries	0.208	138	<0.001	0.871	138	<0.001	No
Task & function of a BMS (battery management system)	0.205	137	<0.001	0.847	137	<0.001	No
Balancing of lithium-ion batteries (active/passive)	0.191	137	<0.001	0.874	137	<0.001	No
Dealing with damaged batteries	0.192	139	<0.001	0.861	139	<0.001	No
Hazards & Risks when Handling Li-Ion Batteries	0.199	139	<0.001	0.848	139	<0.001	No
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	0.163	137	<0.001	0.875	137	<0.001	No
Condition assessment of aged/obsolete batteries	0.187	139	<0.001	0.868	139	<0.001	No
Battery assembly basics	0.19	135	<0.001	0.844	135	<0.001	No
Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation)	0.177	137	<0.001	0.862	137	<0.001	No

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Warranty claims for used BEVs and batteries	0.174	137	<0.001	0.863	137	<0.001	No
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	0.155	135	<0.001	0.89	135	<0.001	No
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	0.179	135	<0.001	0.887	135	<0.001	No
General charging behavior of Li-ion batteries	0.19	135	<0.001	0.854	135	<0.001	No
Effects of cold weather into batteries and charging	0.192	139	<0.001	0.858	139	<0.001	No
Effects of hot weather into batteries and charging	0.218	139	<0.001	0.84	139	<0.001	No
Particularities of chassis or other support structures of electric vehicles	0.205	140	<0.001	0.863	140	<0.001	No
Driver information systems, such as driver drowsiness monitoring/warning, speed alert...	0.161	141	<0.001	0.892	141	<0.001	No
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	0.192	135	<0.001	0.857	135	<0.001	No
Data processing and automation related to Driver Assistance Systems (ADAS)	0.153	136	<0.001	0.882	136	<0.001	No
Vehicle communication technologies	0.192	138	<0.001	0.865	138	<0.001	No
Regulation related to vehicle technologies and powertrains	0.18	140	<0.001	0.885	140	<0.001	No

The differences between the level of the professional competence needed in five years and the current level of the professional competence was analysed by calculating the difference between the rated level of the competence needed in five years and the current level of the competence assessed by the respondent. Based on the responses from vehicle maintenance persons, difference scores were calculated for all professional skills covered by the study. The difference scores were summarised by calculating the mean, standard deviation and standard error of the mean for all the professional competencies covered by the study (Table 39). In addition, paired T-test was carried out for the paired differences to evaluate whether the differences of the means of current competence levels and means of competence levels needed in five years were different from each other in a statistically significant manner. The paired T-test procedure of SPSS provided also confidence intervals for the difference of the means.

Relatively high difference scores were obtained especially for technology related to hydrogen vehicles (hydrogen vehicle systems in general, mean: 3.18, standard deviation: 2.50, lower confidence interval: 2.67, upper confidence interval: 3.68; maintenance of hydrogen systems, mean: 3.18, standard deviation: 2.76, lower confidence interval: 2.61, upper confidence interval: 3.76). On the other hand, these competences had a lower number of numeric answers than other competences. This may indicate polarisation among the respondents of the study. Respondents who did not consider these competences relevant possibly provided a non-numeric answers (not relevant for me) or did not provide an answer regarding these competences. On the other hand, respondents who considered hydrogen technology relevant, have likely provided numeric answers with high difference between current skill levels and the levels needed in five years.

The standard deviation of the difference score was between 2 and 3.1 for all of the competences covered by the study. This result suggests that the most pressing needs for development of professional competencies may be different for different participants of the study. Further analyses can potentially provide more information on the differences among respondents (e.g. differences between member states, respondents with different levels of education and differences between respondents working at independent or brand-affiliated vehicle repair and maintenance shops).

Table 39. Differences between needed level of professional skills in 5 years and current levels of the skills, vehicle maintenance personnel

Differences between the need for each skill in 5 years and the current level of the skill								
(profession: industry representative - vehicle maintenance, numeric answers only)								
Results of paired T-test for the paired difference: "How would you rate the needed level of skills in 5 years?" –								
"How would you rate the current level of skills and competencies in your profession in general?"								
	Figures for the difference			95% confidence interval for the difference		Results of paired T-test		
Skill	Mean	Std.deviation	Standard error of the mean	Lower CI	Upper CI	t	df	two-sided p-value
Hybrid vehicle systems in general	1.51515	2.34922	0.20447	1.11065	1.91965	7.41	131	<0.001
Maintenance of hybrid vehicle systems	1.54400	2.32970	0.20837	1.13157	1.95643	7.41	124	<0.001
Hydrogen vehicle systems in general	3.17526	2.50004	0.25384	2.67139	3.67913	12.509	96	<0.001
Maintenance of Hydrogen systems	3.18478	2.76131	0.28789	2.61293	3.75663	11.063	91	<0.001
Electric vehicle systems in general	1.62595	2.36102	0.20628	1.21785	2.03406	7.882	130	<0.001
Maintenance of HV Electric vehicle systems	1.84426	2.57778	0.23338	1.38222	2.30630	7.902	121	<0.001
Hybrid LPG (liquified petroleum gas) systems in general	1.11111	2.92375	0.28134	0.55339	1.66883	3.949	107	<0.001
Maintenance of Hybrid LPG systems	1.12381	2.92435	0.28539	0.55788	1.68974	3.938	104	<0.001
Hybrid CNG (Compressed Natural Gas) systems in general	1.37037	2.69854	0.25967	0.85561	1.88513	5.277	107	<0.001
Maintenance of Hybrid CNG systems	1.38095	2.84328	0.27748	0.83071	1.93120	4.977	104	<0.001
Structure and function of lithium-ion batteries	1.75385	2.55804	0.22436	1.30995	2.19774	7.817	129	<0.001
Task & function of a BMS (battery management system)	1.81818	2.60305	0.22657	1.36998	2.26638	8.025	131	<0.001
Balancing of lithiumion batteries (active/passive)	2.55469	2.71133	0.23965	2.08046	3.02891	10.66	127	<0.001
Dealing with damaged batteries	2.25954	2.79447	0.24415	1.77651	2.74257	9.255	130	<0.001
Hazards & Risks when Handling Li-Ion Batteries	1.53788	2.75572	0.23985	1.06339	2.01237	6.412	131	<0.001
Ageing mechanisms of Li-ion batteries, i.e. decreased battery capacity	1.87692	2.73370	0.23976	1.40255	2.35130	7.828	129	<0.001
Condition assessment of aged/obsolete batteries	1.94574	2.58393	0.22750	1.49558	2.39589	8.553	128	<0.001
Battery assembly basics	1.56349	2.77271	0.24701	1.07462	2.05236	6.33	125	<0.001

Handling of obsolete batteries for further assessment (hazard warnings, storage, visual inspection, tools, transportation).	1.69767	2.86030	0.25184	1.19937	2.19597	6.741	128	<0.001
Warranty claims for used BEVs and batteries	2.13178	3.04236	0.26786	1.60177	2.66180	7.958	128	<0.001
Types of authentications at public charging infrastructure (different between AC/DC charging, autocharge, plug-in charge)	2.00000	2.66120	0.23995	1.52499	2.47501	8.335	122	<0.001
Risks and possibilities of charging in the private sector (smart charging, statistical and dynamic load management, PV surplus charging, bidirectional charging)	2.17000	2.46905	0.21824	1.74003	2.60372	9.952	127	<0.001
General charging behavior of Li-ion batteries	1.96154	2.38342	0.20904	1.54795	2.37513	9.384	129	<0.001
Effects of cold weather into batteries and charging	0.93233	2.49604	0.21643	0.50420	1.36046	4.308	132	<0.001
Effects of hot weather into batteries and charging	1.22963	2.45235	0.21107	0.81218	1.64708	5.826	134	<0.001
Particularities of chassis or other support structures of electric vehicles	1.83582	2.50771	0.21663	1.40733	2.26431	8.474	133	<0.001
Driver information systems, such as driver drowsiness monitoring/warning, speed alert...	1.04478	2.25404	0.19472	0.65963	1.42992	5.366	133	<0.001
Sensor technologies and calibration of Driver Assistance Systems (ADAS), (such as lane keeping, ACC, automatic emergency braking)	1.28125	2.23409	0.19747	0.89050	1.67200	6.488	127	<0.001
Data processing and automation related to Driver Assistance Systems (ADAS)	1.96825	2.57352	0.22927	1.51451	2.42200	8.585	125	<0.001
Vehicle communication technologies	1.72593	2.12810	0.18316	1.36367	2.08818	9.423	134	<0.001
Regulation related to vehicle technologies and powertrains	1.67407	2.51512	0.21647	1.24594	2.10221	7.734	134	<0.001

The difference scores listed in Table 39 and their confidence intervals are presented in Figures 11–14.

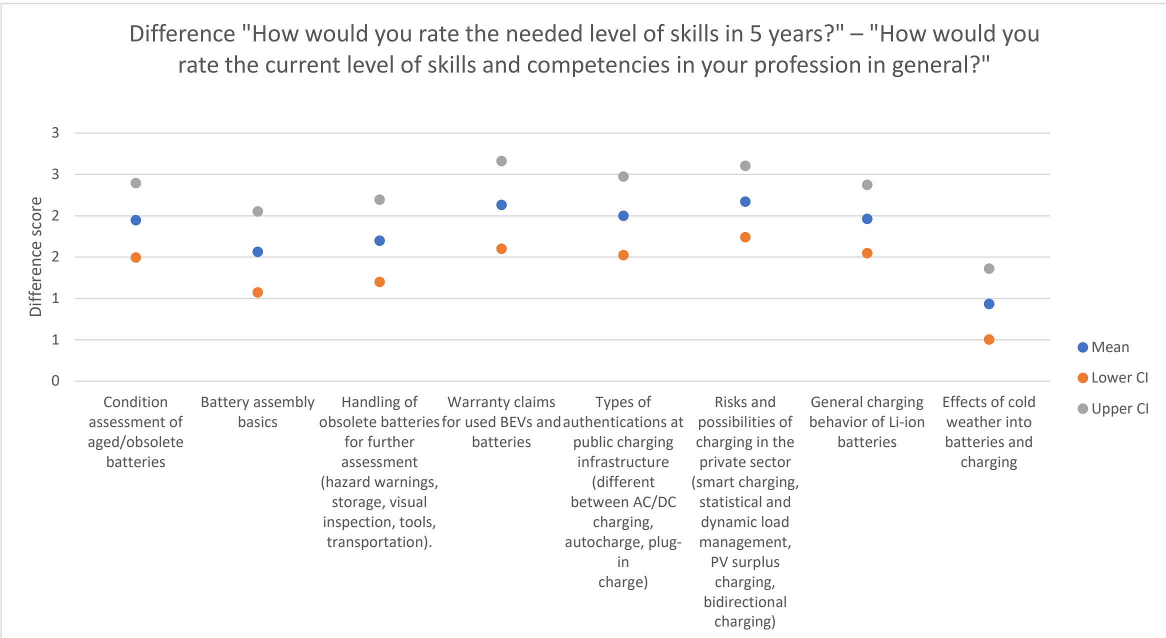

Figure 11. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, vehicle maintenance personnel (1).

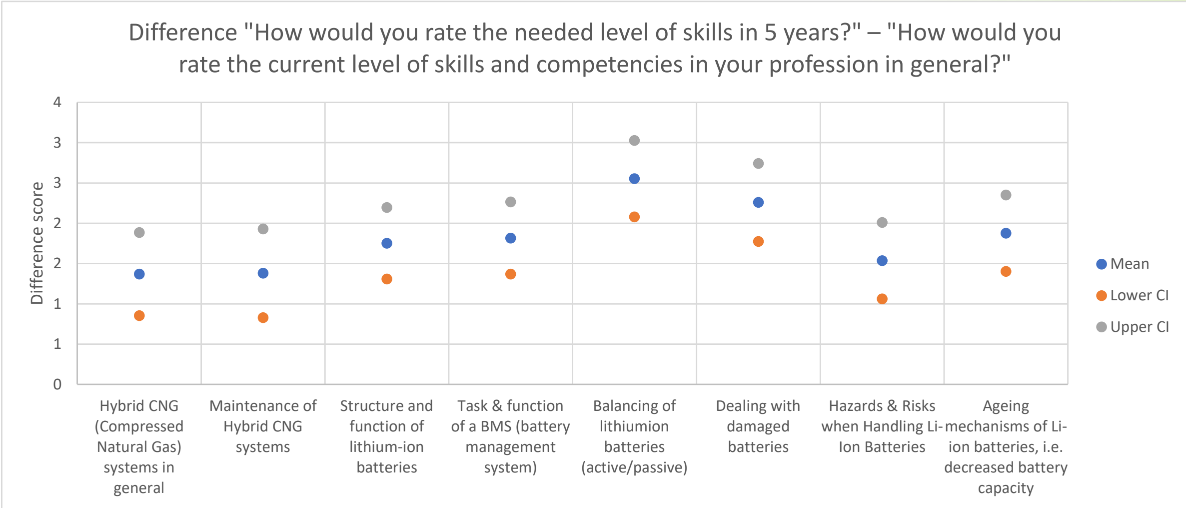

Figure 12. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, vehicle maintenance personnel (2).

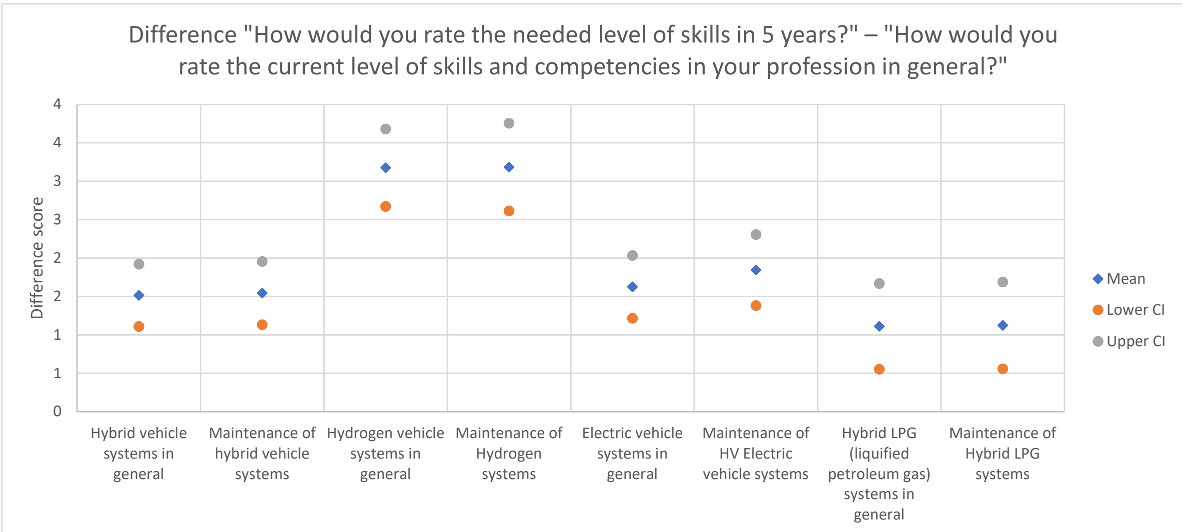

Figure 13. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, vehicle maintenance personnel (3).

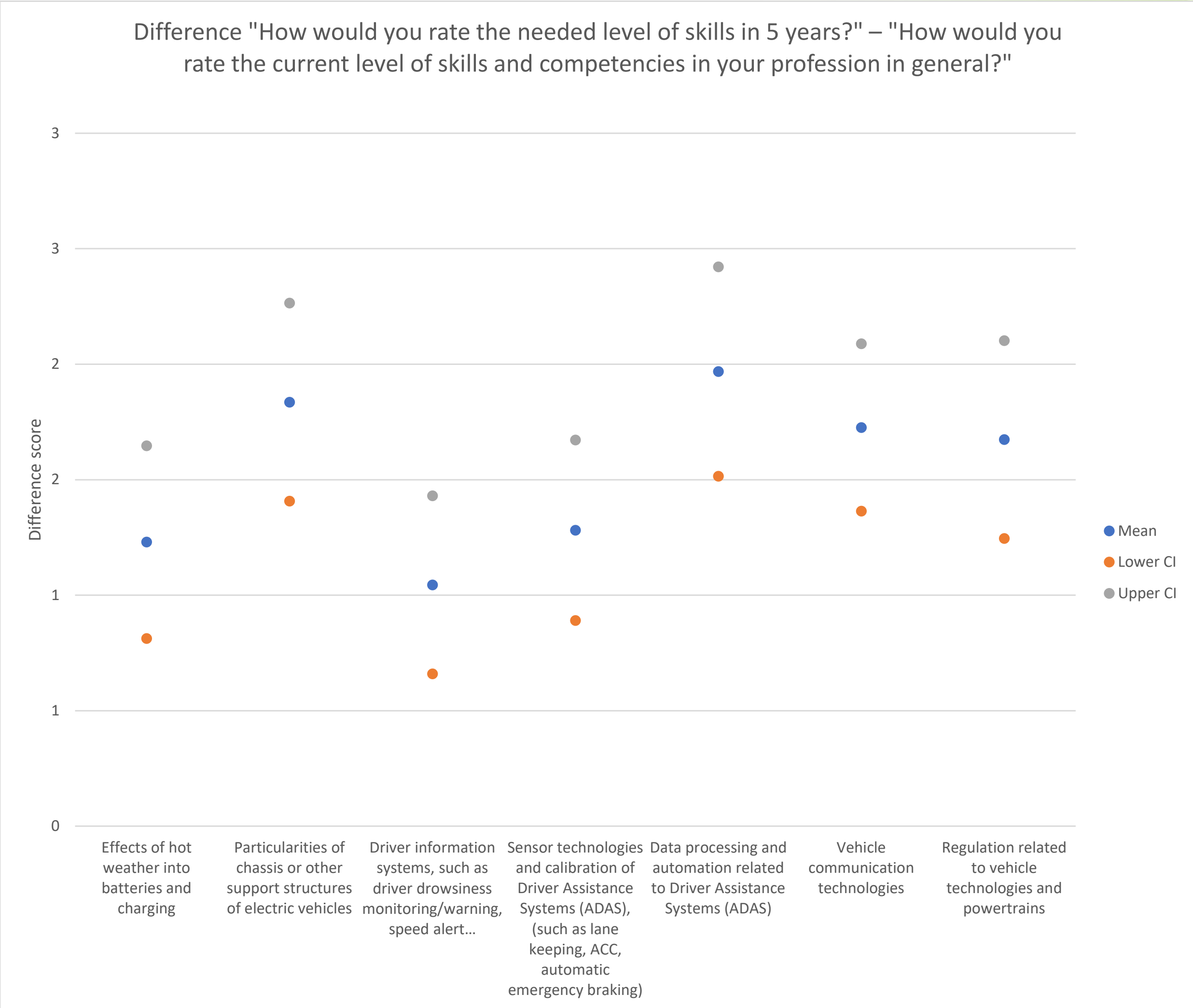

Figure 14. Difference in the needed levels of professional competencies in 5 years and the current levels of the competencies, vehicle maintenance personnel (4).

AUTOCOVE 2.0

Automotive Engineering Education