

A Study to Determine Infrastructure Needs for Hybrid and Electric Vehicle Training in Vocational Education

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Abstract

In parallel with the widespread use of hybrid and electric vehicle production in the world and reaching a significant market share, the training needs of all relevant stakeholders, especially maintenance and service operations, are increasing rapidly, in addition to the routine vocational training of these vehicles. However, it is impossible to say that the vocational education infrastructure that can meet this increasing need is sufficient due to both costs and new technology. In this study, the infrastructure needs analysis findings were made to determine the Vocational Education and Training needs of employees in the hybrid field. Electric vehicle technologies were evaluated and aimed to provide infrastructure for training programs in line with these needs, thereby strengthening the existing education infrastructure.

Keywords

electric vehicles, hybrid vehicles, vocational training, infrastructure needs analysis

1. Introduction

Hybrid and Electric vehicle production and the number of users are increasing rapidly worldwide. This situation has significantly increased the service operations of these vehicles and the training needs of the personnel who will respond to the vehicles both in service and in cases such as accidents and fires. Therefore, people who work or will work in this field need more specific training and training infrastructures other than general vocational education. Such training focused on minimizing employee-related problems, and increasing productivity is called target-oriented training [1]. On the subject, Soydan et al. [2] within the scope of the EU-supported VEMEV project for Battery Electric Vehicle technologies education, an education platform that will be used in formal, non-formal, e-learning and mobile-learning tools has been created and pilot applications have been carried out.

The field of electric vehicles necessitates the sharing of infrastructure, practice, and experience in the field of education of these stakeholders, as mechanical, electrical, electronic, and computer engineers, physicists, chemists, industry, and investors need to work together.

Based on this requirement, in the study, a modular program has been proposed to understand, apply, research, and develop its basic knowledge to create a multidisciplinary "integrated" education-training program. Again, Fechtner H. et al. [3] present the study of developing a new e-learning platform for the competence to work on electric vehicles in Germany and the training evaluation results of 120 firefighters and students trained on the platform.

Many researchers and institutions are working to develop Virtual reality (VR) applications as a cheaper and more accessible solution to the high cost of physical workshop/laboratory setup and equipment supply for Hybrid and Electric (H/E) vehicle training.

For example, Perdikakis, A et al. [4] reported an Augmented Reality (AR) application they developed for electric vehicle training and the results of the application in pilot training. The evaluation results suggest that the AR application is reasonably successful by the users and trainees and that the scenarios they have developed should be expanded further with a systematic method. Another study, Luo H. [5], states that there are still some problems in the diagnostic system of purely electric vehicles and that the current diagnostic system needs to meet the needs of consumers. In order to overcome this problem, it focuses on the development of the electric vehicle diagnostic system with the use of VR fusion technology. The study discusses how the fault diagnosis and detection of the vehicle will be much easier by developing an integrated VR application with the existing engine management system software and how to develop the fault diagnosis system of the electric vehicle based on VR fusion technology.

In the present study, comprehensive training and infrastructure need analysis findings made to determine the Vocational Education and Training needs of those working in the field of H/E Vehicle Technologies were evaluated, and it was aimed to strengthen the existing education infrastructure by providing the infrastructure for teacher training and training programs to be developed in line with these needs. The "New generation Vehicle Technologies Sectoral Vocational Competence Training Centre" will be established within the scope of the EU project to establish new generation vehicle technologies excellence centre, where the study was carried out, focused on virtual reality applications and physical infrastructure.

2. Needs Analysis Methodology

In order to determine the infrastructure in need of H/E training, an infrastructure survey scale was prepared in order to determine the state of the equipment infrastructure of the enterprises providing training in new-generation vehicle technologies and the level of lack of training materials. A preliminary request for professional educators in the field of motorized vehicle technology was made for the target group, and the questionnaire was checked to ensure its conformity.

This study used the "differences approach," which compares what should be and the current situation, and "content analysis" methods for open-ended questions. In the infrastructure needs analysis of Hybrid and Electric Vehicles training prepared for Vocational High School Teachers and Managers, there are 17 questionnaires prepared on a 5-point Likert scale, which do not contain a sentence or judgment sentence and one open-ended question. The questionnaire used for the analysis was based on a Likert scale ranging from 1 (negative) to 5 (positive).

The results obtained were evaluated with a statistical method used to reveal whether the mean of the measurement results of the single-sample group was different from each other by using the Excel statistics program (95% confidence interval).

3. Findings and Evaluation

Within the scope of the study, a survey was conducted with 458 people in different education and management positions across the country. The obtained results were analysed with the Excel statistical program. The distribution of the respondents based on occupation and province is given in Figures 1 and 2.

When we look at the distribution of the respondents based on provinces, the highest rate is seen in Istanbul with 17%; however, participation was made from 56 provinces of our country, and the distribution rates on a regional and provincial basis are significant in terms of confirming the results.

The graphic in Figure 3 shows the answers given to 17 questions of "Education Infrastructure Needs" directed to teachers and administrators. In the Training Infrastructure Needs Analysis, the participants reported a need between 88% and 92% for the questions directed to them, which is a very serious rate and means that the expectations regarding the infrastructure requirements in the relevant field are high. It is clear that the details of the infrastructure in the questions are also an indication of the centre of new generation vehicle technologies expected in the project.

Table 1 shows the answers to the "Education Infrastructure Needs Analysis" questions directed to teachers and administrators, sorted by need percentage/priorities. In the table, with a high rate of 94%, "He needs at least one Electric Vehicle in working condition to be used in on-vehicle training," and the

second rank is again, "Needs at least one Hybrid Vehicle in working condition to be used in on-vehicle training" with 93%. As emphasized in the introduction, these answers overlap with the active learning method "seeing/explaining and applying", which requires high investment but provides students with a high level of permanent knowledge and skills.

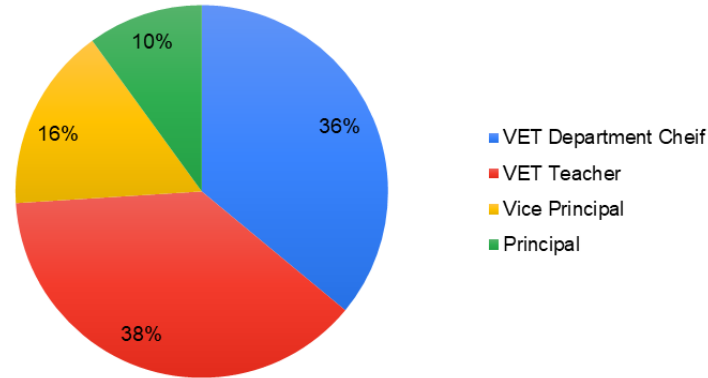


Fig. 1. Occupations of Education Infrastructure Needs Analysis participants

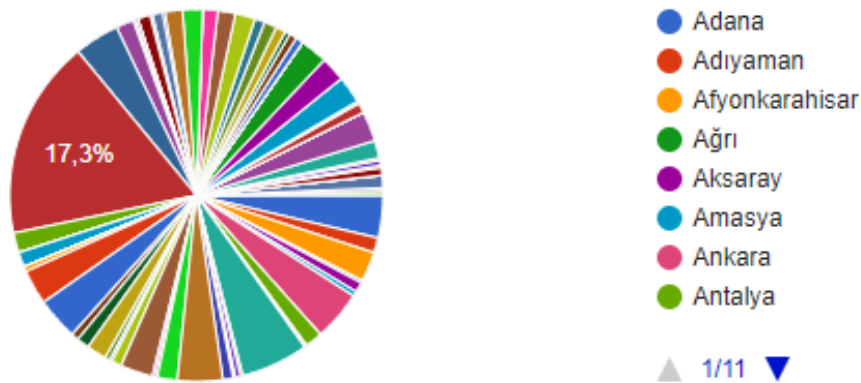


Fig. 2. Distribution of Education Infrastructure Needs Analysis participants by province

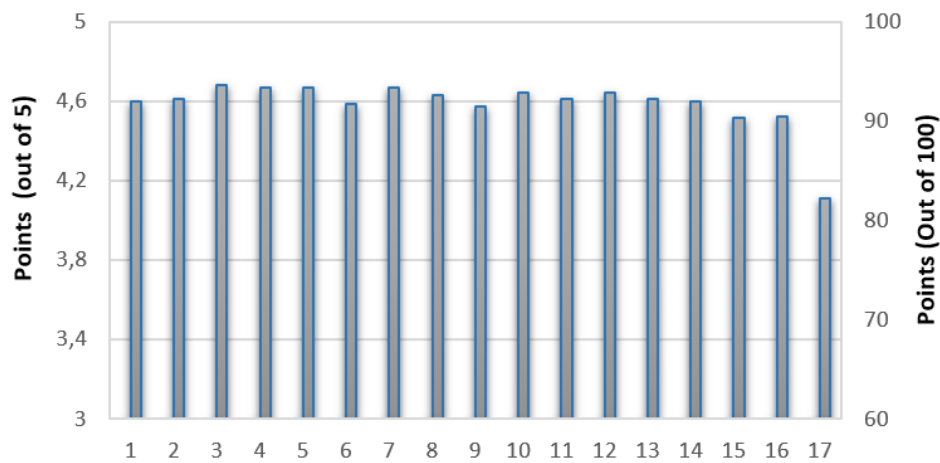


Fig. 3. Results of Education Infrastructure Needs Analysis

Although there was a very high expectation in this study, the only question that differed from the general trend was the question of "Needs Online or Distance Education Applications," with 82%.

The fact that the expectation is 82% at this point indicates the demand for digital education material in a very serious sense, which is also considered an essential data for the VR applications envisaged in the project.

Table 1. The answers given to the “Education Infrastructure Needs Analysis” questions directed to teachers and administrators, sorted by need percentage/priorities

Question	What kind of infrastructure and equipment are primarily needed for a quality H/E Vehicles training in your opinion as a person who gives/receives the training?	%
3	Needs at least one Electric Vehicle in working condition to be used in on-board training	94
4	Needs at least one Hybrid Vehicle in working order to be used in on-board training	93
5	Battery simulator and insulation hand tools need insulation testers	93
7	Vehicle Electronics; Vehicle comfort systems needs visual training materials	93
12	Electric vehicle engine change and modification technologies systems training kits	93
10	Needs fuel cell battery and charging systems training kits.	93
8	Vehicle communication technologies workshop / Needs CAN BUS experiment set	93
11	Power transmission and motion control systems in Hybrid Vehicles need cross- section and training sets.	92
13	It needs training sets (ABS/ESP/Engine Management, etc.) for the systems used in Vehicle Automotive Electronics.	92
2	Vehicle lifting. lift, work bench, insulated hand tools, Personal Protection Equipment etc. needs an Electric Vehicles workshop with equipment	92
1	Vehicle lifting. lift, work bench, insulated hand tools, Personal Protection Equipment etc. needs a Hybrid Vehicles workshop with equipment	92
14	Automotive Electronics needs measuring and diagnostic devices for maintenance, troubleshooting, and troubleshooting training.	92
6	Needs a fully equipped service infrastructure and vehicle conversion kit	92
9	High voltage lines and battery systems need training sets	91
16	Needs autonomous and advanced driving assistance systems training materials	90
15	H/E Vehicles training needs VR apps	90
17	Needs online or distance education applications	82

Content Analysis: Very comprehensive and specific answers were given to the open-ended evaluation of "Please write down the topics/equipment/educational material or your suggestions that are most lacking in Hybrid and Electric Vehicles training and that you think should definitely be improved." All answers were subjected to content analysis and combined under five main headings, and the results are shown in Figure 4.

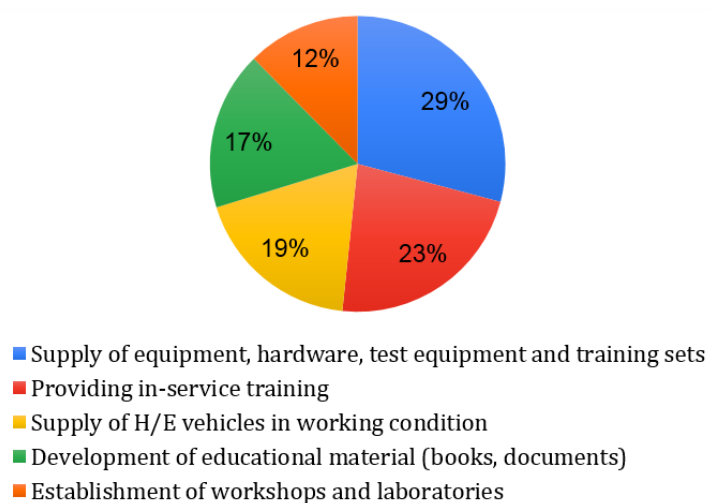


Fig. 4. Education Infrastructure Needs Analysis Content evaluation results of the suggestions from the teachers regarding the open-ended question

"Procurement of equipment, hardware, test devices, and training sets" took the first place in the evaluations with 29%, followed by "Provision of in-service training" with a percentage of 23%, as expected. Again, while 19% of the participants answered "Provision of real H/E vehicles in working condition in the workshops for training", 17% answered "books or other training materials the demand for development of training material" followed. And again, 12% answered, "Creating workshops and laboratories". Although this rate seems low, it would not be wrong to predict that those who gave this answer also included the 1st and 3rd order demands. All these results directly overlap with the content of the ongoing project. They show that the project will be a pioneer by closing a serious gap in meeting the related demands.

4. Conclusion

In this study, the infrastructure needs analysis findings made to determine the Vocational Education and Training needs of the employees in the field of H/E Vehicle Technologies were evaluated, and it was aimed to provide the infrastructure for the training programs in line with these needs, thus strengthening the existing education infrastructure.

In the study, it is possible to perform many sub-analyses that are not listed one by one in the above findings. It is expected that the results will be a resource for H/E vehicles training, which is still in the research phase, planning for vocational education programs and program development worldwide. Within the scope of the "New Generation Vehicle Technologies Sectoral Vocational Competence Training Centre" project of the BTO Education Foundation funded by the EU, efforts to establish a centre that will meet the above expectations are ongoing. When the project is completed, it is anticipated that the centre will serve as a model for our country's H/E vehicles training.

Acknowledgements

This work; It was carried out within the scope of the European Union TREEP2.1.IQVETIII/P-03/38 "New generation Vehicle Technologies Sectoral Vocational Competence Training Centre" project carried out jointly by BTO and BTO Education Foundation.

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