

# Improving Students' Vocational Training in the Field of Engineering and Infrastructure Design for Enterprises Relating to Car Service in the Arctic Zone

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In the modern world, society and the state put forward serious requirements for vocational education in terms of ensuring the quality of training of future teachers and strengthening their social role. Therefore, the aim of the article is to study the quality of vocational training of students in the field of training known as the "Operation of transport -technological machines and complexes " in the field of engineering and infrastructure design for enterprises relating to car service in the Arctic zone.

The study uses the following methods: the analysis of scientific, technical, methodological, domestic, and foreign literature. This includes production methods to ensure the quality and reliability of cars during their operation, studying the process of managing the resource-saving system of motor vehicles, the statistical processing of experimental data, and pedagogical experiment. This article identifies the problems of students' vocational training. The article presents organizational and methodological approaches to engineering and infrastructure design for enterprises relating to car service. It is assumed that scientific knowledge can be transformed into academic knowledge, and students' vocational training can be adapted to modern design requirements. The latter is possible when considering mechanical, technological, environmental and economic requirements of the climate zone and seasonality in areas of the Arctic zone.

**Key words:** *Vocational training, infrastructure design, engineering, Arctic zone, technical systems management.*

## Introduction

The purpose of vocational training is to prepare competent specialists. Therefore, the most attention is paid to it in the education system, because the future labor resource of the country depends on it. Effective vocational training should be oriented to the employer and the market, and training goals, objectives, and content should be constantly updated (Wise & Cui, 2019). There is an urgent need to search for new models of education so that specialists might develop universal professional skills that cannot be formed in the classical model of vocational education. Some researchers believe that the academic environment does not consider all changes taking place in the economic, social, technical, and political spheres, and therefore cannot achieve high results (Wells, 2006; Faleeva et al., 2017).

There is a need to study a multi-level transport strategy for resource-saving vehicles (including special equipment for the oil and gas industry and civil-industrial construction). The latter is in terms of enterprises in the Arctic zone of the Russian Federation. The need for such a study is due to the transition to the market economy, which is a catalyst for the decentralization of the technical systems management in transport (Ivanova & Klyukina, 2017). In conditions of decentralization, the role of quality and reliability of cars in the process of their operation has increased. Through the development of technical infrastructure of car services. In connection with the latter, there are global prerequisites for a quality and reliability increase, associated with the need to:

- Carry out technical and economic measures to improve the organizational and managerial structure of enterprises. The enterprises for the operation, storage, maintenance and repair of transport and transport-technological machinery and equipment. The said is in terms of the climatic conditions of the Arctic zone;
- Study rational forms of maintaining and restoring the working capacity of transport and transport-technological machines and equipment;
- Use assessment data (obtained using diagnostic equipment) on the technical condition of transport and transport-technological machines and equipment;
- Carry out quality control of fuel and lubricants and other consumables, adjusting the modes of their use in the Arctic zone.

Consequently, the problem of ensuring cars' quality and reliability during their operation is increasing at the present stage. In particular, under the decentralized technical systems management in transport and taking into account the climate zone and seasonality in the regions of the Arctic zone.

In modern conditions, the concept of traditional education is losing its relevance and is being transformed into a new system based on the interconnection of the categories of “knowledge-skills-competence” (Towey et al., 2018).

There have been researches on the following issues:

- Development of the theoretical foundations of the content of continuing professional education (Tkachenko, 2014);
- The theoretical foundations of intersubjective communications (Repko et al., 2019), their specifics in the vocational education system (Mishutina, 2013);
- The design of educational technologies for training specialists for high-tech industries (Frost et al., 2016; Levchenko et al., 2016);
- Integration of science, technology and production (Rusanov, 2014; Lyall, 2017).

Despite the availability of the above-mentioned research, it should be recognized that the modern stage of development of vocational education requires a deep analysis of experience and an examination of ways to improve the professional technical training.

Many scientific works are dedicated to the resource-saving issues in certain regions of the Russian Federation. They analyze the operation of cars in winter conditions, develop requirements for design features, and types of cars suited to southern and mountain performance (Bergström et al., 2017; Fu et al., 2018). The effect of low temperatures on the fuel efficiency of a car is investigated as well (Rusanov, 2014; Gómez et al., 2017). Fuel efficiency is assessed and vehicle driving modes are optimized (Tarakanov, 2014). The researches of V.N. Karnaukhov (2000), A.S. Gavaev (2007), A.G. Belov (2004) are devoted to the formation of transport strategies in the regions of Siberia and the Far North in which, certain aspects are disclosed of saving fuel and energy resources during the operation of automobile transport in low-temperature conditions. However, there are not many studies of vocational training in the field of engineering and infrastructure design of car service.

Based on the above, the aim of the article is to study the quality of students' professional training in the field of "Operation of transport-technological machines and complexes" in the field of engineering and infrastructure design for car service of enterprises in the Arctic zone.

In the course of the study, the following tasks have been posed and solved:

- An analysis of vehicles' operating conditions and the climatic conditions of vehicles' operation;
- An analysis of the existing integrated indicators of weather severity, which consider the combined influence of various climatic factors;
- An investigation of the impact of vehicle operating conditions on fuel efficiency in the Arctic zone;

- Search for the organizational and methodological approaches to the design of production programs, taking into account types of maintenance, technical repair and the adopted operating regime of enterprise zones;
- Reviewing knowledge and skills of students of the specialty: “Operation of transport-technological machines and complexes”.

The scientific originality of the research is in the development of scientific and pedagogical foundations and technological support for the system of professional competence formation in students. Namely, the students of the specialty: "Operation of transport-technological machines and complexes". The following is substantiated:

- Design activities;
- Operation of technological equipment, devices, units, systems and parts of transport and transport-technological machines;
- Mechanical, technological, environmental, and economic requirements of climate zone and seasonality in the regions of the Arctic zone.

### **Methods and Materials**

The research applies the following methods, namely:

- Methods for studying and analyzing scientific, technical, methodological domestic, and foreign literature in the field of infrastructure design and engineering for car service of enterprises in the Arctic zone;
- Production methods to ensure the quality and reliability of vehicles during their operation, considering the climatic zone and seasonality;
- Methods of managing the resource-saving system of motor vehicles (including special equipment for the oil and gas industry and civil-industrial construction) in the Arctic zone of the Russian Federation. Taking into account real conditions and the impact of various random factors of the external and internal environment;
- Methods of statistical processing of experimental data;
- Pedagogical experiment.

The results of a pedagogical experiment have been processed with the help of mathematical and statistical methods and applied software. Thus, data has been obtained on the level of students' professional readiness. The November Institute of Oil and Gas of the Yamalo-Nenets Autonomous Okrug has served as an experimental base. At the first stage of the pedagogical experiment, the level of practical skills and knowledge of 200 students of the specialty "Operation of transport and technological machines and complexes" has been tested. The audit has included tasks (refueling transport and technological machines, their repair, etc.) and theoretical questions on the same topics. The experimental results are expressed as a

percentage. Based on the results, the problematic points of vocational training have been identified. Approaches to improving the vocational training of students have been developed. The students in the field of infrastructure design and engineering for enterprises' car service.

The reliability and scientific validity of the results of the work are due to the following:

- Methodologically justified theoretical positions;
- Development of diagnostic methods that are adequate to the tasks, subject and object of the study;
- Representativeness of the sample;
- Quantitative and qualitative analysis of experimental data.

### Research Results

The analysis of the experiment results (Table 1) has revealed the problems of students' professional training. The future specialists will work with transport and technological machines on enterprises and organizations of the Arctic zone. Namely, they will deal with machines' operation, storage, refueling, maintenance and repair, along with material and technical support for operating enterprises and vehicle owners.

**Table 1:** The results of the experiment to verify the level of training

Skills	Indicator, %
Refueling transport and technological machines	81%
Maintenance of transport and technological machines	77%
Vehicle operation	53%
Installation and commissioning of equipment for maintenance	68%

Students in the field of training "Operation of transport and technological machines and complexes" are preparing for the following types of professional activity:

- Design;
- Experimental research;
- Organization and management;
- Service and maintenance.

These types of activities (aside from the installation and commissioning of equipment for maintenance and repair of transport and transport-technological machinery and equipment)

involve the infrastructure design and engineering for enterprises' car service in the Arctic zone. In addition, the level of professional competencies are not sufficiently formed in the field of design when it comes to operation of technological equipment, devices, units, systems and parts of machines. This is especially relevant considering the mechanical, technological, environmental and economic requirements of the climate zone and seasonality in areas of the Arctic zone.

It is worth noting that the operation of technological equipment, transport and transport-technological machines includes analytical skills. The results show that students have unsatisfactory level of these skills, which is slightly above average (53%). To increase this indicator, one should focus on the following skills:

- Calculation of the annual production program;
- Selection of input data for technological calculations for car service station;
- Calculation of the annual volume of work on maintenance of vehicles;
- Calculation of the annual volume of cleaning and washing works;
- Calculation of the annual volume of work on corrosion protection;
- Calculation of the annual volume of work on the pre-sale preparation of cars;
- Calculation of capacity of the production and technical base of the car service station;
- Selection and adjustment of the normative frequency of maintenance and mileage;
- Calculation of the number of write-offs and maintenance for one car;
- Calculating the frequency of maintenance per group of cars per year;
- Calculating the diagnostic program for the entire car park per year;
- Calculating the daily maintenance and diagnostic program per year;
- Calculating the number of workers and auxiliary posts of car service stations;
- Calculating the number of posts for cleaning and washing at the car service stations;
- Calculating the number of full-time and technologically necessary workers;
- Calculating the number of managers;
- Calculating the area of industrial premises and warehouses;
- Calculating the area of production sites;
- Calculating the area of warehouse and administrative premises;
- Calculating the area of car storage and parking;
- Calculating the total area of the car service station.

The technological design of the maintenance and repair zones be should based on the production program according to maintenance types, taking into account the adopted operating mode of zones. The design tasks are as follows:

- Determining the number of posts and service lines;
- Distributing workers by posts;

- Calculating and selecting equipment;
- Distributing areas (e.g. for storage rooms etc.);
- Planning maintenance and repair zones, as well as the production building as a whole.

Technological design of maintenance and repair areas should include:

- A brief description of the object of study;
- Structural diagram of car service station's management system;
- Functional diagram and functions of structural units of the car service station;
- Work process of the structural unit of the object under study;
- Selecting organization method and operation mode of car maintenance zones;
- Distribution of the scope of work on car maintenance.

When designing maintenance areas, the following research objects have been considered:

- The warranty department;
- The mechanical section;
- The area for cleaning and washing operations.

The percentage of comprehensively serviced cars by classes: extra small, small, medium. During design process, it is necessary to consider the aspects of quality and reliability of a vehicles' operation. Design should also include reconstruction of diagnostic and repair zones for technological machines and equipment.

Therefore, the training program should include the calculation of technical and economic indicators. Indicators characterize the economic efficiency of the project for the reconstruction of the diagnostic and repair zones of technological machines and equipment. In addition, students should have the knowledge and skills to select the lacking equipment, and upgrade old equipment to more modern in order to improve the quality of the work of diagnostics and repair zones of electrical equipment.

Based on the experiment results and analysis of the methodological literature, the authors have come to the following conclusion. Namely, the professional education of students in the field of training "Operation of transport and technological machines and complexes" will be effective if implemented taking into account the following:

- Organizational and methodological approaches while developing production programs, according to maintenance types and taking into account the adopted operation mode of enterprise zones;

- Rational forms of maintaining and restoring the working capacity of transport and transport-technological machines and equipment in specific climatic conditions of the region.

It is worth noting that quality management is an important aspect of the vocational training process. It should include a phased assessment of the level of professional competence using various existing methods and means of control. Such methods and means give quantitative and qualitative ideas of the level of professional competence of students. Namely, whether the students can:

- Apply organizational and methodological approaches to ensure the quality and reliability of cars during their operation;
- Design production and technical infrastructure of Arctic enterprises' car service.

Such an approach will help to quickly and accurately identify gaps in students' knowledge, evaluate the effectiveness of the selected programs and methods, and adjust the learning process in the direction of increasing efficiency.

A popular direction in the development of education in many countries (the UK, the USA, Germany, Spain, etc.) is the development of special vocational-technical training programs for students with intellectual disabilities and development (Frank, 2016; Ray, 2020). Another important task in the development of education is the creation of close ties between the university providing vocational education and potential employers. For example, Poland and the Czech Republic are now actively working in this direction (Ferrandez-Berruenco et al., 2016).

The conducted studies cannot be referred to as an exhaustive scientific description of all aspects of such a complex process as improving the quality of students' professional training. Especially in the field of training "Operation of transport-technological machines and complexes." Among the issues in need of further research are as follows:

- Conducting qualitative and quantitative multiple-criteria analysis to optimize the management of the resource-saving system of motor vehicles in the Arctic zone of the Russian Federation;
- Development of algorithmic and software for managing the resource saving system of vehicles;
- Development of guidelines for managing the resource-saving system of vehicles (including special equipment for the oil and gas industry and civil engineering). While such a system might allow reducing the cost of fuel, lubricants, maintenance and repair costs of rolling stock, depreciation charges on rolling stock at enterprises.

## Conclusions

The choice and relevance of the study are determined by the following:

- Objective requirements for improving the professional training of students in terms of design activities;
- Insufficient development of organizational and methodological approaches to the design of industrial and technical infrastructures for Arctic enterprises' car service.

An innovative didactic system is developed in the target, substantive, procedural and organizational aspects to ensure the quality and reliability of cars during their operation, taking into account the climate zone and seasonality in the regions of the Arctic zone.

The analysis was conducted on the functioning and design of production and technical infrastructures, while studying professional training of technical students. The core elements are determined of the design, experimental, research, organizational, managerial, service and operational activities necessary for the study.

The development of complex didactic systems for designing and operating transport and technological machines and complexes might be based on the following:

- Identifying training process problems;
- developing training content;
- Developing work programs for the design of production and technical infrastructures of enterprises' car service.

The contribution of this research to world pedagogical science in the direction of “Theory and Methodology of Vocational Education” is in the following. Namely, the system has been developed for improving the professional training of students in the direction: “Operation of transport-technological machines and complexes”. The latter allows one to transform scientific knowledge into academic and adapt students' professional training to modern design requirements, especially considering the mechanical, technological, environmental and economic requirements of the climatic zone and seasonality in the Arctic zone.

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