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SUBSTANTIATION OF THE APPROACH TO THE CREATION OF AN INFORMATION SYSTEM FOR CALCULATING FUEL CONSUMPTION AND CARBON DIOXIDE EMISSIONS BY MOTOR VEHICLES

Abstract. This introduced work presents the rationale for the need to develop information systems that make it possible to calculate fuel consumption based on vehicle characteristics, distance traveled, and average speed for enhanced control, primarily over the impact of CO_2 emissions on the environment, as well as to track user costs.

Keywords: transportation costs, map of the area, route, mobile web application, ecology, emissions, cars.

Today it is hard to imagine our world without cars. Every day, more than 1 billion cars drive around the world [1], performing both complex logistics tasks and simple passenger transportation from point A to point B. But not everyone understands the cost to the planet of these incredibly complex machines. Among all vehicles, motor vehicles remain one of the main sources of air pollution and ecological disruption. Vehicles use fuel made from various types of oil products and lubricants, the volatile fractions of which, as part of the exhaust gases of diesel and gasoline internal combustion engines, pollute almost all environmental objects. During fuel combustion, carbon emissions are generated by the release of carbon dioxide during fuel combustion and depend on the carbon monoxide content. The carbon saturation of a fuel is a characteristic inherent in a particular type of fuel and does not depend on the process or conditions of fuel combustion. In particular, motor vehicles have a negative impact on acoustic (noise) pollution on central highways [2].

Just one passenger car emits 4.6 tons of CO_2 per year [3]. Multiplying the estimated number of active cars worldwide by the average amount of CO_2 emissions, we get 6,440 billion tons of carbon emissions per year. Now imagine that in addition to cars, there are space programs, heavy industry plants, etc. It should be noted that before the global crisis of COVID-2019, car production in the period from 2000 to 2018 increased from 58 million units per year to 97 million units per year, after a decline in the second half of 2020 to 78 million units and a sharp increase to 85 million cars annually in 2022, indicating a strong global demand for cars [7, 8].

According to researches, human activity produces about 50 billion tons of CO_2 emissions annually [4]. Therefore, it is now imperative to explore ways and methods to reduce and control emissions.

There are many online applications that allow drivers to plot the fastest route in conditions of varying traffic congestion, get an estimated time of arrival in relation to the speed and the route taken. There are even apps that show the current location of speed cameras, roadway repairs, obstacles, etc. However, not many applications are

able to calculate online transportation costs and analyze how much CO_2 was emitted into the atmosphere after the trip.

Before developing a project, it is imperative to first formulate its basic description, namely, its features, goals, stakeholders, etc. Thus, the main objectives of this project are:

- promoting emission control and reduction;
- control over the material costs of drivers who will use the application.
- to help users of the application monitor environmental changes.

From which we can identify the project stakeholders:

- drivers-users;
- global environmental associations;
- logistics and transportation companies.

The basis for such an application can be the development of an online map using the Open Street Map API or the Google Maps API, where the collection of user location data, geocoding of addresses into coordinates, collection of map and road network data, route optimization, route alternatives, and, most importantly, the interface are already implemented in the libraries of the above APIs and can facilitate the creation of an application by focusing on the implementation of fuel consumption and emissions calculation algorithms.

The complexity of implementing such an application lies in the variety of cars, their engines, exhaust systems, and engineering solutions to reduce harmful emissions. And as noted earlier, carbon dioxide emissions also depend on the physical and chemical properties of the fuel used by the vehicle.

However, it should be noted that there is a formula for calculating annual carbon emissions by fuel type, engine [5, 6]:

$$E = M \times K_1 \times TNZ \times K_2 \times \frac{44}{12}, \quad (1)$$

where, E – annual carbon emissions (tons/year); M – actual fuel consumption per year (tons/year); K_1 – carbon oxidation factor in fuel (share of carbon that was burned); TNZ – net heat value (tons/J); K_2 – carbon emission factor (tons/J); 44/12 – carbon to carbon dioxide conversion factor.

Data on the actual fuel consumption of a car is taken from the vehicle's technical passport, engine model, and average speed.

For a better understanding of the application's operation, we present a contextual diagram of the "AS IT WILL BE" application (Fig. 1):

As you can see, the input is data on the characteristics of the car whose emissions will be calculated, namely: car model, engine type, fuel type, weight, etc.; information about the route the user will take, traffic congestion, and average car speed. The elements of regulation are the Resolution of the Cabinet of Ministers of Ukraine "On Road Traffic Rules", as well as the Law of Ukraine "On Transport" and the Law of Ukraine "On Road Traffic". Emission calculation and route planning systems allow our application to receive the following information as output: a ready-made route, information on fuel consumption, and information on harmful emissions, including CO_2 emissions.

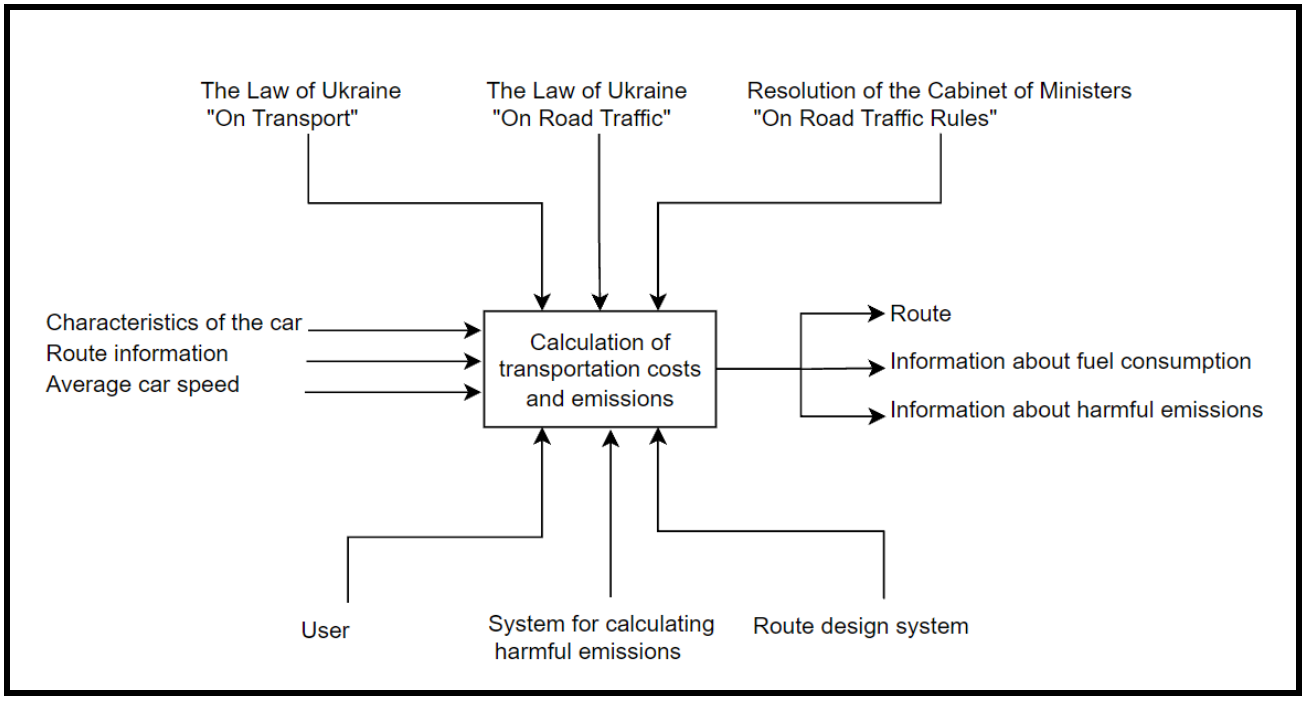

Figure 1 – A context diagram of the "AS IT WILL BE" application.

When calculating CO_2 emissions, it should also be remembered that even with two identical cars, the same model, engine type, and distance traveled, the value of E (1) may differ, because another important factor in calculating carbon is the wear and tear of the engine and exhaust system, road conditions and traffic, using of climate control system and even a drive style of the driver can lead to increased emissions.

A necessary component of the application implementation is to create databases for users, available cars, their possible configurations, and to use such technologies as JavaScript, HTML, CSS, Node.js, and AtlasBD in the development.

For greater visibility of the application, we will develop layouts of the main interface components, namely: the main page with a map, the page with filling in the characteristics of the car (Fig. 2):

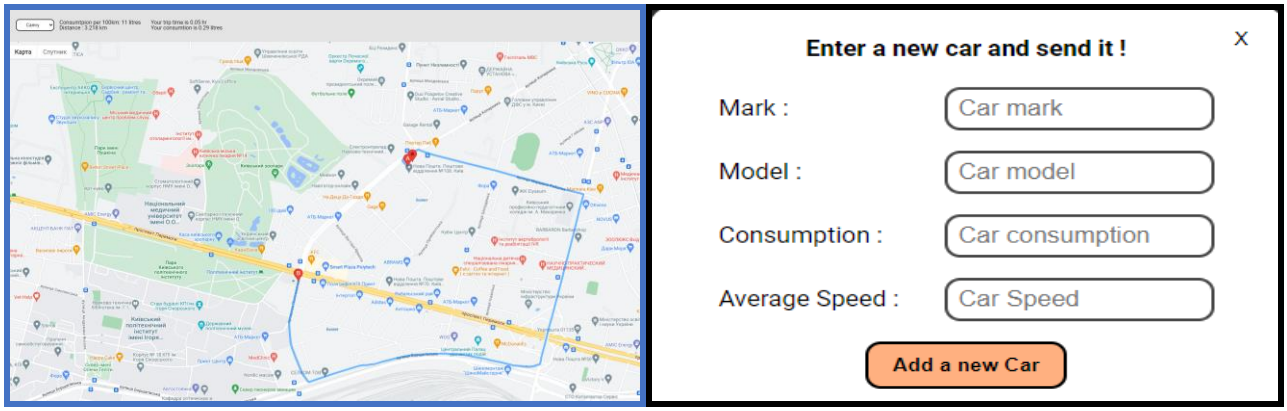

Figure 2 – A layout of the application for calculating costs and emissions

The products of this project will include an online application for calculating fuel consumption and emissions, a database of cars and their emissions, and environmental campaigning.

Conclusion. Automobiles are one of the main sources of air pollution and ecological disruption. Carbon dioxide emissions from motor vehicles account for a significant portion of total greenhouse gas emissions in the world. The development of an information system for calculating fuel consumption and carbon dioxide emissions from motor vehicles is an important step towards reducing the negative impact of motor vehicles on the environment, as it will allow monitoring at the level of an ordinary vehicle user.

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This book includes abstracts of the 10th International Conference "Information Technology and Implementation (Satellite) – 2023". Philosophical, theoretical and applied aspects which describe the results, problems and prospects of the creation and use of intelligent computing methods and creating of information systems and technology on their basis are reviewing.

Main tracks of the conference are: Artificial Intelligence Technologies, Cyberspace Protection Technologies, Data Analytics, Digital Project Management Technologies, E-commerce, E-government and E-learning Technologies, Mathematical Foundations of Information Technology, Network and Internet Technologies, Smart Technologies.

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