Finding the optimal route for car

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I. MOTIVATION

- 51 billion tons of greenhouse gases are produced globally on a vearly basis
- side effects are (excluding many) both global warming and *air* pollution
- 16% of emissions are produced by transportation only
- acting immediately to reach net-zero by 2050 is of utmost importance but e-mobility is not very accessible as of today
- improved driver behaviour has a significant potential for:
 - better drive safety
 - better fuel efficiency
 - lower emissions
- bad decisions can lead to a fuel efficiency worsened up to 48% but it is possible to teach and motivate an eco-friendly behaviour
- *gamification* motivates positive engagement and rewards can improve fuel efficiency up to 10%
- Günther et al. confirmed usefulness of aforementioned motivational strategies [DOI: 10.1016/j.erss.2019.101407] and it was suggested for further research to focus on measurement of their mutual effect

• **Research question:** Does strategy of giving rewards (extrinsic motivation) reduce the amount of driver's motivation that is caused by gamification (intrinsic motivation)?

II. SOLUTION DESIGN

- 4 types of feedback:
 - *in real time*
 - accumulated
 - offline
 - advice before a drive
- open-source enviroCar platform enables floating car data collection, sharing and analysis
- it is possible to use protocol for on-board diagnostics (OBD) for data collection
- the platform provides GPSbased and OBD-based models to calculate fuel consumption
- the choice to use *offline* feedback was made because of zero implications towards drive safety
- approach with more accurate OBD-based model was tested and was not successful because of technical limitations which resulted in a compromise
- the *enviroCar* platform was used for data collection and platform's GPS-based model to calculate fuel consumption

- participants divided into 2 groups in an experiment with between-subject design collected data during 6 weeks in 3 phases:
 - a. baseline data collection b. each group receives one motivational strategy
 - c. both groups receive both motivational strategies
- *fuel consumption* (dependent variable) was measured during the experiment in the natural field as strategies gamification and rewards (independent variables) were



- in place
- basic use case of a system for the experiment:
 - a. data collection with a smartphone
 - b. data upload to the enviroCar server
 - c. data synchronization in the system for the experiment
 - d. visualization of motivational feedback in the user interface based on the fuel consumption achieved in newly added tracks

- the system is a **containerized** application implemented based on principles of separation of concerns
- it consists of 4 main components:
 - web client (NextIS)
 - content management system (Strapi)
 - component for data synchronization and data processing (FastAPI)
 - monitoring tool (Grafana)

III. EVALUATION

- 10 participants collected data in 393 drives which are 5211 kilometers in length altogether
- the following *threats of validity* of results were identified:
 - a. small sample size due to the restrictions with regard to the situation around coronavirus which caused that there was a low chance of proving the observed change despite its potential existence
 - b. several confounding factors as collected data were not filtered based on track location together with direction of travel c. inaccurate method for data collection

- collected data are normally distributed and student's ttest resulted with **t-value** 0.6126 and p-value 0.5404
- statistically significant effect of the independent variable on the dependent variable was not found
- *system usability scale* (SUS) was evaluated at the end of the experiment and resulted in value of 79.25 which is considered to be above an average
- knowledge regarding ecodriving was **improved by** 49% in average

IV. SUMMARY

- contributions:
 - *framework* for implementation of the experiment
 - system for the experiment
 - equation for eco-
 - performance evaluation
 - *improved knowledge* regarding eco-driving
- suggestions:
 - re-implementation of the *experiment* with more participants after elimination of confounding factors and with OBD-based model for fuel consumption

SOLUTION BEAUTOFUEL WAS DEVELOPED USING MULTIPLE PROGRESSIVE STANDARDS AND TECHNOLOGIES

enviroCar

docker

React NEXT. ~ tailwindcss 🖄 GraphQL 🗱 J M T 🖪 strapi 🕐 FastAPI 🧔 Grafana

🖗 influxdb

mongoDB.