Human - Computer Interaction (HCI)

DRI.M.FE.C.S: An in-vehicle feedback system for investigating the motivation of drivers to optimize their driving behaviour

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SYNOPSIS

Excess fuel consumption is considered to be a common phenomenon among drivers. This could be avoided if an optimal driving strategy is at place, and the drivers are getting feedback about it via an in-vehicle feedback system. However, the circumstances under which drivers follow this strategy, and why they do so appears to be unclear.

The aim of this master thesis is to explore and evaluate the different factors that could persuade drivers to be more inclined to accept the feedback offered to them. Thus, DRIMFECS, an application that implements several motivational strategies has been developed and presented to drivers, in order to conduct a field evaluation. The emphasis was placed in evaluating the effectiveness of the different motivational strategies.

The results revealed that, drivers are more likely to adjust their behaviour when the motivational strategies of “Personalization”, “Goal Setting and Suggestion”, “Reward” and “Self-monitoring and Feedback” are at place, and also that the drivers’ preferences according to their personalities could well change while driving compared to other situations they may be in.

To sum up, it is demonstrated that it is possible to motivate drivers, regardless of their personality, by using those motivational strategies that are acceptable by the majority of the different personalities. However, there are indications that the preferences of each person towards motivational strategies may change, while the person is in a driving situation, in comparison with other situations of his/her daily life.

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ABSTRACT
Excess fuel consumption is considered to be a common phenomenon among drivers. This could be avoided if an optimal driving strategy is at place, and the drivers are informed about it via an in-vehicle feedback system. However, the circumstances under which drivers are motivated to follow this strategy, and why they do so appear to be unclear. The aim of this master thesis is to explore and evaluate the different factors that could motivate drivers to be more inclined towards accepting the feedback offered to them. Thus, DRIMFECS, an application that implements several motivational strategies has been developed and presented to drivers, in order to conduct a field study. The emphasis was placed in evaluating the effectiveness of the different motivational strategies and the drivers' preferences towards them, given their personality type. The results revealed that, drivers are more willing to adjust their behaviour when the motivational strategies of "Personalization", "Goal Setting and Suggestion", "Reward" and "Self-monitoring and Feedback" are at place, and also that the drivers' preferences according to their personalities could well change while driving, compared to other situations they may be in.

Author Keywords
Optimal Driving; Motivational Strategies and Personalities; Fuel Consumption; Driving Behaviour; In-Vehicle Feedback System

INTRODUCTION
Excess fuel consumption is a common phenomenon among car drivers that has several consequences not only to their economy, but also to the environment [27]. However it is not always an easy task to drive in an environmental and economical friendly way. There are several factors that can affect this. According to [24, 2, 29] this can be attributed to several factors like the lack of information or knowledge about how it is possible to drive in such a way, the power of habit, or the lack of understanding and motivation on the drivers' behalf.

In order to assist drivers in optimizing their fuel consumption, several feedback systems and applications have been developed by the car industry and by individual stakeholders as well [1, 11, 12, 30]. Typically, these feedback systems consist of "In-Vehicle Data Recorders" (IVDRs), whose purpose is to collect raw data from the car, for example its speed, acceleration, vehicle location, fuel consumption etc. Thus, it is possible to observe the drivers' behaviours, while they are driving, and the feedback system is capable of providing the drivers with live feedback about their driving performance. In addition, they have an interface via which a feedback is provided to the drivers via different modalities like visual or haptic.

In the literature a variety of feedback systems is described whose their primary aim is to inform the drivers about the different ways that they could improve their fuel consumption by adjusting their driving behaviour. Nonetheless, this is but one approach one can have to that matter. According to a bibliographic literature review conducted [18], there are some factors and questions that have not been neither evaluated nor answered yet. For instance, there is no guarantee that if one acquires the necessary feedback, this will also be put into practice. Furthermore, even if assumed that the feedback is actually being taken into consideration and used by the drivers, the reasons and the criteria that led the drivers into doing so remain uncharted. Additionally, one could set the question of, what is it that actually convinces the drivers to listen to the feedback provided to them. Is it somehow related to each driver's personality, thus, making it something individual? How can one ensure that the drivers will carry on using these systems and consider their feedback?

According to the research conducted [18], there is no previous study that explores this side of the domain described. Consequently, the main objective of this study is to explore the relationship between the feedback provided by an in-vehicle feedback system and the drivers' motivation to consider it. In order to achieve that,

DRI.M.FE.C.S (DRIving Motivational FEedback Consumption System) was developed, where a set of motivational strategies was implemented. DRIMFECS was afterwards evaluated via a field study, where real time data about the drivers' driving behaviours could be observed.

The research questions of this study are:

Will drivers be motivated and inspired to follow the feedback from DRIMFECS, and why?

Do the drivers' preferences towards the different motivational strategies change -according to their personalities-, in terms of what they found to be motivating for them while driving, and how?

RELATED WORK

Related work is separated in two parts. The first is about the different modalities for providing feedback to a driver according to their distraction level [4]. This is the criterion used, in order to determine the least distracting modality that DRIMFECS would employ, so as to provide feedback to the drivers. The second is about the different motivational strategies that motivate drivers to follow specific feedback; the main topic of this paper.

Different modalities of feedback

According to our previous research [18] there are many ways to provide feedback to a driver, which can be divided into four different categories: *Visual feedback, Audio feedback, Haptic feedback* and *Mix of them.*

Visual feedback

In general, visual feedback is not distractive, is usable and has been employed by several in-vehicle feedback systems in many forms [9, 16, 17, 25, 32, 34].

There are many studies that develop in-vehicle visual systems that provide feedback to drivers by examining the distraction of these systems in several aspects. The first aspect explored is the use of monitor and the positioning of these systems. Examples of these studies include monitor-placement on the radio [25] and monitor on the steering wheel [32].

The second aspect mentions smart devices that provide visual feedback to the driver. Examples of such feedback systems are the head mounted displays (smart glasses) [16], smart windshield [9] and touch screen tablets [34]. Lastly, there are studies that concentrated at the type of feedback such as colored lights on the steering wheel that use specific colors according to the driver's driving behavior [17]. Most of these papers mention that visual feedback is very attractive for the driver while it is not distractive since most of the times it is considered as secondary attention for the driver [4].

Audio feedback

Audio in-vehicle feedback systems are not distractive according to previous studies. However, they appear to be less usable compared to their visual counterparts [13, 20, 24].

Since audio feedback is considered as tertiary attention to the drivers [4] there are studies that develop systems, which provide audio feedback to them. The following studies did not focus to the volume of this audio feedback neither to the source of it. Their main purpose was to examine the context of the feedback.

There are mainly three practices for doing that. First, is by mentioning specific words in every situation [20]. Another is by stating predetermined sentences for helping the drivers "reach" the optimal behavior [13], while others are by producing alarm-sounds when the drivers deviate from their objective [24]. These studies demonstrate that, audio feedback while not distractive, is less usable than the visual feedback for the driver, according to the participants of their evaluations.

Haptic feedback

While haptic feedback is less distractive than audio and visual [11], there are not many studies that explore them, since they are very difficult to implement. However, one paper mentions a gas accelerator which informs the driver when the latter deviates from the objective [15].

A combination of them

Examples of in-vehicle feedback systems that use a combination of the three previously mentioned modalities are smartwatches [5] and smartphones [5, 10, 22, 30]. According to these studies while smartphones are very usable feedback systems, because they can provide any feedback via all the above-mentioned modalities in a familiar way to the drivers, they should be used with caution because they can become very distractive for them, if they require their primary attention.

The smartphones are considered to be feedback systems, which offer a combination of different modalities, because they use all three of them (visual/audio/haptic). There are several studies that develop an application on smartphone, in order to provide feedback to the driver. Examples of them are the DriveGain application [30], the IVIS system [10], the BCSS application [22] and a study that compares smartwatches vs smartphones while driving [5].

Motivational strategies

There are studies that categorize people to different personalities and combine their personalities with different motivational strategies. According to these studies [26, 21], a person can be named as: "Extraversionist", "Achiever", "Conscientious", "Hedonist", "Agreeable", "Neurotic" and "Follower" according to his/her personality (Appendix A, table A1).

Respectively, the different motivational factors for providing feedback are [21]: "Personalization", "Cooperation", "Simulation", "Self-Monitoring and

Feedback", "Comparison", "Punishment", "Goal Setting and Suggestion", "Customization, Competition", "Reward" and "Social Opinion" (Appendix A, table A2).

METHOD

For collecting the different requirements that are needed for creating DRIMFECS three steps were followed with the order they are mentioned.

The findings of [18] were taken into consideration, in order to explore the coupling of the different motivational strategies with the different personalities. Thus, the motivational strategies that DRIMFECS used could be determined, along with the personalities that it could target.

Afterwards, based on the feedback types from the "Related Work", sketches with different in-vehicle feedback systems were drawn, and were evaluated by using the SWOT analysis (Appendix B, table B1). The aim of the SWOT analysis was to determine which in-vehicle feedback system is the most usable to adopt, in terms of type of feedback, positioning and distraction for the drivers.

The last step was to create PowerPoint prototypes (PPps) based on the motivational strategies and the outcome of the SWOT analysis and conduct interviews, in order to decide the shape and size of the monitor, its exact positioning on the steering wheel, get ideas from the interviewees about design elements in DRIMFECS, that could motivate them, and also investigate whether the motivational strategies decided are capable of achieving their goal, namely motivate the drivers.

Relationship between Motivational Strategies and Personalities

In order to reveal and understand the relationship between the different motivational strategies and the different personalities identified in the literature, in the context of receiving feedback while driving, the following process was followed:

The studies from [26, 21] describe the different personalities and motivational strategies in detail, as well as how they are related to each other (Appendix A, tables A1, A2). Given that, table A3 (Appendix A) [18] was created. It is mentioned however, that these studies, were not dealing with the context of conveying feedback to drivers in real time.

Afterwards, all papers found in the bibliographic research conducted [18], concerning different types of feedback systems, were evaluated and placed on the same table. This was done, by examining, which motivational strategies were employed by each feedback system. Thus, it could become apparent, which personalities were targeted, and how they were affected by the strategies, in terms of motivation.

Given the process described, there are some results that emerged and that consequently set the target group for DRIMFECS, by including or excluding some personality types, as well as motivational strategies:

The "Neurotics" are not motivated by any particular strategy, thus, no feedback system takes any action, in order to persuade and motivate this type of users.

The "Achievers", "Agreeable" and "Extraversionists" appear to be the most compatible type of users with most of the motivational strategies.

Most feedback systems employ the "Reward" and the "Self-Monitoring and Feedback" strategy in order to achieve their desirable results via their systems.

"Personalization" and "Goal Setting and Suggestion" are the second most often used strategies.

The factors that appear to have the biggest positive motivational influence on users are "Personalization" and "Goal Setting and Suggestion".

From the results mentioned, as well as the findings from the interviews conducted, which are described in the "Interviews" subsection of this chapter, it was decided that DRIMFECS should include a mixture of motivational strategies, described in the "DRIMFECS" chapter. This was decided due to the fact that by doing so; one can increase the chances of motivating all types of personalities at the same time, except for the "Neurotic" one.

SWOT Analysis

Several sketches were created and analyzed under a SWOT analysis, in order to compare them with the previous findings from the "Related Work". The sketches were created by following the Buxton funnels [3].

These sketches are our own ideas about DRIMFECS, and represent the following seven different in-vehicle feedback systems, in terms of positioning, modality of feedback and mean of feedback: monitor on the steering wheel, acceleration pedal combined with alarm audio system, use of a smartphone in different positions in the car, audio feedback system that emits sound from the radio system of the car, smart windshield, monitors that already have been installed in the car and use of a head mountain system (Appendix B, Figures B1-B12).

Taking into consideration the SWOT analysis (Appendix B, table B1) that has been done to each one of these cases; the outcome is that the optimal way for providing feedback to a driver is to have a visual in-vehicle feedback system, and to be more specific, by having a monitor on the steering wheel. This visual system it is not so distractive [32]. On the other hand, it is a system that could get complicated for the driver, if the feedback it provides him with is too complex, thus this is a limitation that needed to be taken into consideration, when DRIMFECS was developed.

Interviews

The purpose of the interviews was to evaluate the PPps that were created based on the findings from the "SWOT

Analysis" and the "Relationship between Motivational Strategies and Personalities" and consequently finalize the design and the functionality of DRIMFECS.

This means that design elements like colours, icons, as well as the type of feedback -e.g. optimal velocity, optimal torque etc.- were evaluated by the interviewees, in terms of motivation. In addition, the shape of the monitor and its position on the steering wheel was decided based on the results from the interviews. Finally, different motivational strategies were incorporated in the PPps, in order to explore their impact to the interviewees.

In order to prepare for the interviews, several mock-ups and 4 PPps were created in that order. The aim of the mock-ups was to put the different feedback systems found in the literature on paper and evaluate them via a SWOT analysis, in order to find out where DRIMFECS would be placed in the car, and also which type of modality would be used for relaying the feedback to the drivers. The SWOT analysis revealed that the idea of having a monitor on the steering wheel of the car, was the one with the most Strengths and least important Weaknesses and Threats, as table B1 in appendix B shows.

The 4 PPps were created after the mock-ups, in order to present the interviewees with more concrete ideas about how DRIMFECS would look like, and what it would be able to do, according to the findings from the research conducted [18]. The different features and design elements of the PPps were chosen after the criterion of implementing different motivational strategies like "Reward", "Self-monitoring and Feedback", "Personalization" etc.

After the PPps were created, it was decided to conduct some interviews

In total 11 persons (6 males and 5 females) from 6 different countries were interviewed in their cars, while they were seated on the driver's seat. The interviews' type was that of a semi-structured interview. This was deemed necessary, in order to allow the interviewees to provide their own perspectives and opinions on the matter. The interviewees were also requested to always justify their choices and the opinions they provided by either drawing, or telling their thoughts out loud.

In the beginning of the interview, the participants chose among different shapes of screens made of paper. This part was important for clarifying which monitor shape, they considered to be more useful to them, in order to retrieve the feedback. Afterwards, they placed it on a spot of the steering wheel of their car. This was done, in order to find out where they preferred the monitor to be positioned.

Then, they drew their thoughts about the type of information and the design-elements that would appear in the feedback screen of DRIMFECS, on the paper-screen that they chose. After that, they were presented with the 4 PPps and also asked to comment and rank them, as well as explain which elements of the design were motivating for them, whether they could understand them, and whether these elements served their purpose -convey the information desired, and motivate them-.

Lastly, they had the opportunity to make design recommendations and also change their initial sketches, after they had seen the PPps, if they deemed it to be necessary.

Results from interviews

More than half of the interviewees were in favour of having a cyclic monitor on the centre of their steering wheel for acquiring feedback (Figure 1). According to their justifications this is because they deemed it as more convenient and practical compared to other places.

As far as the information they wanted to be presented with on the monitor are concerned, these are the real and optimal: velocity and gear shaft. They would also like to see how much money they save per trip and how much they deviated from the optimal fuel consumption.

Figure 1: Round monitor on the center of the steering wheel

The motivational features that DRIMFECS should have according to their opinion are: personal hints for each driver, goal suggestion (e.g. achieve 15% deviation from the optimal fuel consumption in my next route), a map with coloured routes according to their performance, icons, motivational messages from DRIMFECS, the capability to personalize DRIMFECS and also gain levels according to the driver's performance.

DRIMFECS

In order to answer our research question, an application is developed that is called "DRIMFECS". It has been built by using Android Studio and by using sqlite for the creation of its database, while a specific API provided by Google has been used for the GPS access. The application is separated into two phases.

The first phase is about the real-time monitoring and feedback to the drivers, while the second phase is about the motivation of the drivers by giving feedback for their whole trip. DRIMFECS has a variety of different design elements (such as: icons and different colours), because according to the interviews of "Method" chapter, all the participants

would be motivated by having an application that it is simple oriented, in terms of the feedback it provides them with, while using simple images and not words, and separating the different driving behaviors with different colours.

First part: real-time recording and feedback

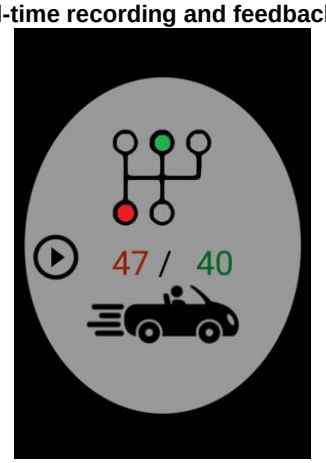

Figure 2: real-time screen

Real-time screen (Figure 2)

According to the results of the interviews, the drivers wanted to be able to see in real time the comparison between their velocity with the optimal way of driving, while giving them feedback about what is the best gear for them to use in order to have less fuel consumption. For achieving that, a database is made that stores and uses their velocities and torques values, which have been added manually, and in the same time, by using a mathematical model [31, 33] (Appendix E), DRIMFECS calculates the optimal speeds and compares them to the real ones. This can be shown in the Figure 2. There, two values can be shown. The one to the left is the driver's speed while the one to the right is the optimal one. The latter one is always green while the former one changes colors according to the driver's behaviour (black if it is below the optimal speed, green if it is the same and red if it is above that). These colours where chosen based on the findings from the interviews with the PPps.

The other design element, which is shown in the real-time screen in the Figure 2, shows the gear comparison. There, in red-filled circle is the gear that the drivers use while in a green-filled circle is the optimal gear that they could use according to their velocity. If these two values are the same then only one circle is filled with a green color. Both of these values are available after mathematical calculations that DRIMFECS does.

What the real-time screen achieves

The real-time screen has been decided after seeing from our research results that we need to use the motivational strategy that is called "Self-Monitoring and Feedback". Therefore, it uses the database that reads the velocity and the torque of the drivers (Self-Monitoring) and gives them in real time feedback about the optimal way of driving. With this motivational strategy most of the different personalities are being motivated, according to table A3 (Appendix A).

In the same time DRIMFECS suggests to the drivers to follow the optimal way of driving by showing them the optimal velocity according to their gear shaft they are actually using and also the optimal gear shaft according to their real velocity. With this addition the second part of the motivational strategy "Goal Setting and Suggestion" is used.

Second part: Motivation while giving feedback after the end of the driver's route.

After the driver has finished driving, then the application returns to the second phase that is the menu interface. This phase it is separated in three features, meaning the extra functions that DRIMFECS can perform: *Level*, *Consumption*, and *Map*.

Level

According to [18] results, most of the different personalities are being motivated by the "Reward" motivational strategy, as can be seen at table A3 (Appendix A). For achieving that, a level-up function (Appendix E) has been added to DRIMFECS that assigns a level to the drivers and the latter increases according to their driving behaviour.

Every driver starts with a level of zero. While the drivers are driving according to the optimal way, they gain "points" that are being stored by DRIMFECS. In the end of their route these points are added to their previous ones and the drivers gain levels according to their driving performance. The view of this feature can be seen in Figure 3.

With this feature, the "Reward" motivational strategy is followed, because the drivers feel the emotion of accomplishment when they increase their level.

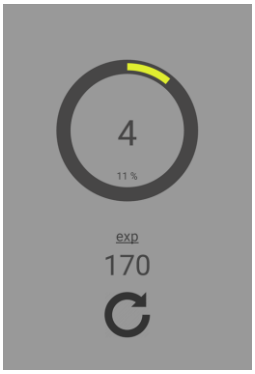

Figure 3: Level feature

Figure 4: Consumption feature

Consumption

According to the interviews the participants wanted to be able to see their complete performance after the end of their route. To be more specific they asked for their fuel

consumption average combined with the money that they have spent, in comparison to the optimal driving behaviour. For achieving that, a feature that is called "Consumption" has been added.

The application after using mathematical calculations (Appendix E) is able to show the average fuel consumption (lt/100km) of the driver's and compares that with the consumption of the optimal way of driving. After that, it shows the money that the driver has lost per 100 km by calculating and comparing the costs of these two different fuel consumptions. All of these values can be shown in Figure 4 that describes the "Consumption" feature.

With this feature two motivational strategies are followed. The first one is the "Self-Monitoring and Feedback" motivational strategy. This is due to the fact that the "Self-Monitoring" is accomplished by using the data of the drivers from the DRIMFECS's database, while the "Feedback" are the different comparisons between the fuel consumptions and the money the drivers spent extra, due to their deviation from the optimal driving behaviour. The second one is the first part of the "Goal Setting and Suggestion" since the drivers are able to see the money difference between their consumption and the optimal one, and set as goal to get this value to zero. Both of these strategies are accepted by most of the different personalities according to table A3 (Appendix A).

Map

While the drivers are driving, the database of DRIMFECS reads and uses not only velocity and torque data, but also the different locations that the car is located. These data have been added to the database manually. In the end of their trip, the drivers are able to see the whole route that they have done as it is shown in the Figure 5 below.

The lines of this route that are highlighted with red are the locations that the drivers deviated from the optimal driving while the rest that are highlighted with blue are the locations that they drive according to the optimal way.

Figure 5: Map feature

With this feature the "Self-Monitoring and Feedback" motivation strategy is followed. This is because the drivers can not only see their route ("Self-Monitoring"), but also get a "Feedback" about their performance, while they were driving. However, this time the feedback it is not in real time but it is after the end of the driver's trip.

EVALUATION

The next step of the process was to evaluate DRIMFECS, in terms of whether it could motivate different personalities to take into consideration its advices and suggestions, and thus improve their driving behaviour as far as their fuel consumption is concerned. To that end, a field study was conducted.

Setup

Participants

Eight participants (4 male and 4 female) took part in the field study conducted. For this study, 4 participants owned a car and decided to use it. For the ones that did not own a car, one was found for one day, and they drove in it, in order to participate in the field study conducted. All participants were obliged to have a driving licence, and drive according to the traffic rules of Denmark.

Process

The field study was designed to last around 40 minutes, and the total driving time with DRIMFECS was about 5.5 minutes. In the beginning, the participants drove a specific route that they were requested to, in order to familiarize themselves with the route and the car -if they did not use theirs-, without using DRIMFECS this time.

Then they were presented with a questionnaire called "IPIP Big Five-Factor Markers" [28] by one of the interviewers, that would reveal their personality, while the other one inserted in DRIMFECS's database data about their velocity and gears that were noted down during this driving session.

"IPIP Big Five-Factor Markers" was used, due to the fact that, it has been already used for a number of different studies such as [19, 8, 23] and it has been confirmed that it represents deservedly the specific personality of each participant [6].

This was done, in order to collect information about the participants' personality type that would be used later for the analysis of the results of the field studies, where the relationship between the personalities and motivational strategies would be evaluated.

Afterwards, they drove the same route again, only this time they were also using DRIMFECS, in order to get "live" feedback in regards to their driving performance. In reality however, they were receiving a feedback based on their previous driving performance, as explained in the next subsection, therefore it is called "live".

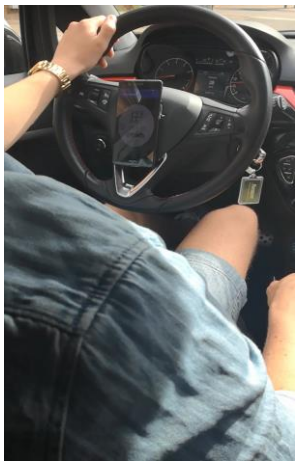

Figure 6: Participant during the evaluation process

During this session, one of the interviewers, who was sitting next to the driver, was writing down the amount of times that the participants glanced at DRIMFECS. After the second driving session was over, the participants navigated in DRIMFECS for exploring it and seeing what other features it had to offer to them.

Apparatus and Data Collection

The DRIMFECS application was running on a mobile phone that was placed on the steering wheel, as Figure 6 presents. Before DRIMFECS was used by each participant during their second driving session, it was updated by one of the interviewers via a laptop, with the velocity and gear shaft data that were noted during the first driving session that each participant had.

Throughout the evaluation study, given that DRIMFECS was using velocity and gear shaft data from the first time the participants drove the route, they received a "live" feedback every 8 seconds. The 8 second feedback period was decided based on the amount of times a participant who took part in a pilot-test, looked at DRIMFECS, while driving the same route as the other participants did for the field study.

Finally, the participants answered two more questionnaires. The first one -"Evaluation of DRIMFECS"- was related to evaluating DRIMFECS itself, in terms of how much it motivated the participants to follow its feedback, as well as to verify the effect of the different motivational strategies implemented in DRIMFECS to their personality types.

The second questionnaire -"Motivational strategies according to personalities"- consists of two parts, A and B, respectively.

Part A included features that were unveiled from the interviews with the 4 PPps, which were not implemented in DRIMFECS (e.g. motivational messages). These features could potentially add more motivational strategies in DRIMFECS, or strengthen the already existing ones. Thus, a relation between the motivational strategies of these features and the participants' personalities could be observed, and also add this relation, to the one that was the outcome of the "Evaluation of DRIMFECS" questionnaire, in order to get a better understanding and insight about how the different motivational strategies can be coupled with the different personalities.

Part B included questions about exploring whether, and how the drivers' preferences towards the motivational strategies, while in a driving mind-set, were altered, given their personality type and the latter's preferences as table A3 (Appendix A) shows.

The questionnaires in question used the 5-scale, in order to answer each question, and can be found at appendix C.

It is emphasized that these questionnaires were used as a mean for a further discussion with each participant, in order to justify their answers, where necessary, and get more qualitative knowledge about the findings of this study. The data acquired from this field study were processed by using the IDA [14] technique.

For two of the eight participants, who gave their consent, a camera was held by one of the interviewers who was sitting in the back seat, in order to monitor their hands, the dashboard, as well as the gear shaft.

EXPOSITION AND ANALYSIS OF FIELD STUDY'S RESULTS

The participant's personalities were relatively balanced, according to "IPIP Big Five-Factor Markers" [28]. Two of them were "Conscientious", two were "Achievers", three were "Agreeable" and one was "Extraversionist".

The first observation made, before handing the questionnaires to the participants, was the fact that on average the participants looked at DRIMFECS 29 times during their second driving session, meaning approximately every 11 seconds (SD = 9,84), which is a considerable amount of times given the 5,5 minutes they drove with DRIMFECS active. This observation indicates that the participants' attention was drawn to the feedback of DRIMFECS, without however distracting them from their primary task, namely driving carefully, as they stated after they drove the route for the second time.

"Evaluation of DRIMFECS"

From this questionnaire, based on which, the first part of the discussion with each participant after the two driving sessions was conducted, data were gathered about whether DRIMFECS served its purpose as a mean of motivation for the drivers.

Seven of the participants believed that they took into consideration DRIMFECS's feedback, with 4 declaring that they seriously took them into account. Furthermore, three of them obeyed to DRIMFECS's feedback, while 6 of them declared that felt motivated to follow it.

In addition, Figure 7 presents that the participants found DRIMFECS's implemented features to be inspiring and motivating for them, as far as following its feedback is concerned. Only one participant did not find the "Level" and "Real time screen" motivational. This is because according to him:

"Levelling up is not something that interests me, as I see driving as an important thing and not a game." (Participant 2)

"I feel like the real time screen is too complicated for me, and I don't have the time to decode the information, while I am driving." (Participant 2)

Furthermore, from the questionnaire it emerged that the two features that motivated the participants the least to follow DRIMFECS's advices were the "Real time screen" and the "Level", compared to the rest of the features, as Figure 7 presents.

As far as these features are concerned, even though this finding seems contradictory given the personalities of the participants and the motivational strategies that should positively affect them [18], one possible explanation is that, when the situation that people are in changes, then this change could well affect people's preferences, as far as the motivational strategies are concerned, given their personalities.

It is noted however that participants 2 and 8, who mentioned the "Real time screen" as not being motivational for them, added that if the information provided were easier to decode, for example *"only the advice for the optimal gear"* (participant 2), then they would have given a higher motivational score to that feature as well.

As far as what would further motivate them to follow DRIMFECS's feedback, as well as to use it again, all participants wished to have the option to personalize DRIMFECS (e.g. choose which information will be displayed in the "Real time" screen), while 3 wished to be able to see the cause-effect link of their driving behaviour (e.g. tree that blossoms, or dies according to performance) and 4 wanted to have audio feedback as well in the form of either instructions or motivational messages.

Figure 8 presents how much each participant's answers were influenced by the fact that DRIMFECS was not using real-time data, in order to provide them with feedback. In total, five participants noticed that fact. Two of them replied that they were influenced a lot, by grading that question with 5 and 4 out of 5 respectively, while the rest grade it with 2 out of 5.

The three, who did not pay attention to it, claimed that it was because they were focused on DRIMFECS and not the dashboard, in order to get its feedback. This is an indication that the answers provided to the questionnaires and throughout the discussion after the driving sessions were not biased in their majority.

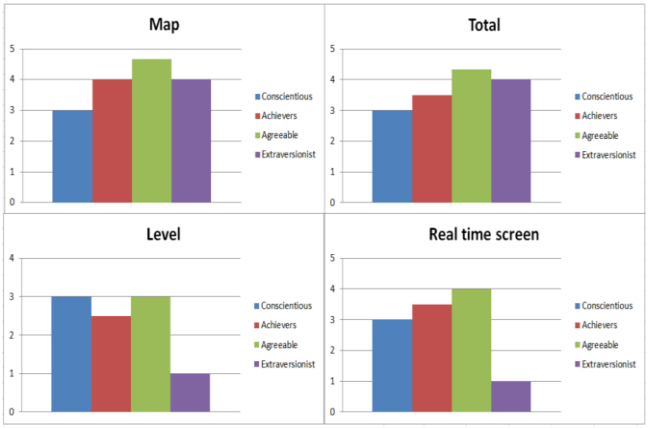

Figure 7: DRIMFECS's average scores per personality for each implemented feature

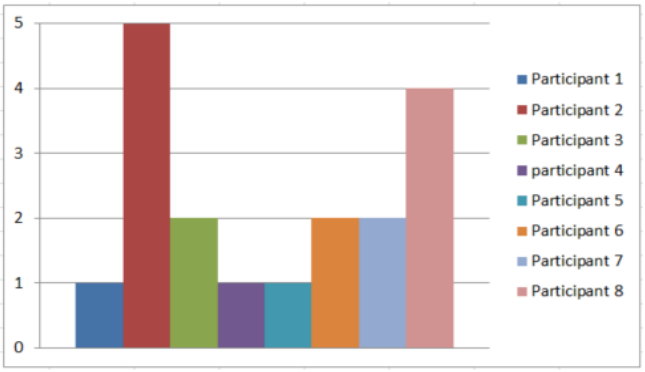

Figure 8: How much were participants' answers influenced by DRIMFECS not using real-time data from the car

"Motivational strategies according to personalities" (part B)

The aim of part B of this questionnaire was to find out, whether the participants' preferences towards the different motivational strategies according to their personality, would still follow the pattern of table A3 (Appendix A). This part was added, in order to investigate, whether driving is a situation that could affect their preferences or not, due to its importance and its responsibilities.

The first important finding was that the "Social Opinion" strategy was not neutral in terms of affection to the personalities, as table A3 (Appendix A) suggests, but in 5 out of 8 cases, it was negative. This well indicates that driving is perceived as a personal matter and drivers do not wish to listen to others' opinions about it.

The second one is that the participants, who had the "Conscinetious" personality, were against the "Cooperation" motivational strategy. This goes against table A3 (Appendix A), where this strategy is perceived as neutral from this type of personality.

The third one is that the motivational strategy of "Comparison" appeared to motivate one of the "Conscinetious" participants, even though they should be

neutral to it, according to table A3 (Appendix A). On the other hand, the "Extraversionist" participant stated that this strategy would demotivate him, even though it should be motivating for him according to table A3 (Appendix A).

The fourth finding is that the "Competition" strategy appeared to have a negative effect to the "Extraversionist" participant, instead of a positive one. This could be explained as this participant perceived driving as an important matter and did not like in this particular situation the idea of "gamifying" this matter.

Given the findings above, and combined with table A3 (Appendix A), the following conclusions can be extracted:

Overall, the participants who had the personality of "Conscinetious", appeared to resemble the "Hedonists", in terms of motivational strategy preferences, since they were demotivated by the strategies of "Cooperation", "Punishment", and "Social Opinion".

The participants who had the personalities of an "Achiever", or an "Agreeable" tended to follow the motivational patterns shown on table A3 (Appendix A).

Finally, the participant who had the "Extraversionist" personality, appeared, given his answers, to have the preferences, in terms of motivational strategies, of a "mixture" of a "Hedonist" with that of either an "Achiever" or an "Agreeable". This is because he felt demotivated with strategies like "Competition", "Comparison", "Cooperation" and "Social Opinion", but on the contrary he felt motivated with strategies like "Simulation" and "Customization".

"Motivational strategies according to personalities" (part A)

Part A of "Motivational strategies according to personalities" questionnaire served the purpose of examining the features that emerged as findings from the interviews with the 4 PPps and were not implemented in DRIMFECS, in terms of how motivational the participants deemed them to be.

It also assisted in relating the overall results with the relevant findings about motivational strategies and personalities from table A3 (Appendix A).

The first of the three features with 62,5% preference from the participants, was to be able to see the effect of the driving behaviour to the environment (e.g. a tree with different colours of leafs).

This feature can be categorized as the "Simulation" strategy, because it is the representation of the cause-link effect of the drivers' actions. This is in compliance with table A3 (Appendix A), even though one participant who had the personality of "Agreeable" did not want this feature and deemed it as "*Not important*".

The second feature of this group was to be able to set a goal about the real and optimal fuel consumption deviation and be able to check if it was achieved. This feature is a "Goal Setting and Suggestion" motivational strategy.

Interestingly, one of the two participants who had the "Conscientious" personality, the one who was "Extraversionist" and one of the three who had the "Agreeable" personality, were not fond of this idea, which is in contrast with table A3 (Appendix A). All of these participants deemed it as "*Not important*".

The last feature of this group was to get motivational messages from DRIMFECS. This feature is a combination of two motivational strategies. One is the "Reward", due to the fact that the drivers can have the feeling of accomplishment, depending on the context of the message. The other one is the "Self-Monitoring and Feedback", given that DRIMFECS will be monitoring the drivers' performance and providing them with feedback about it.

Even though according to table A3 (Appendix A), this combination of motivational strategies should motivate all eight participants, or at least they should be neutral towards it, this was not the case.

The "Extraversionist", one "Achiever", and one "Conscientious", were against this feature, as they stated that "*This has no meaning for me*".

On the other hand, the feature of DRIMFECS being able to set goals for the drivers before they start driving had 87.5% of acceptance. Only one participant who had the "Conscientious" personality was against it. However the same one agreed with the idea of being able to set a goal himself.

This could lead to the conclusion that it is not only important to implement one feature that supports one specific motivational strategy, but it is also about which one is implemented. This means that any personality could positively react to a strategy, as long as it is in a form that he/she would find motivating.

Finally, all participants agreed with the idea that they wanted to be able to choose for themselves, which information they are going to be presented with in the "Real time screen". This feature was a way to implement the "Personalization" strategy in DRIMFECS, and the result was expected according to table A3 (Appendix A).

LIMITATIONS

First of all, in order to have real conditions in the evaluation process, DRIMFECS should be connected with the car's "brain", in order to take the different information for the speed and the torque that the driver uses.

This connection should be done by using the OBDII [7] via Bluetooth as described at [18]. However, this connection has not been implemented in DRIMFECS. Instead, a database is used that stores and uses these two driver's

values and then passes them to DRIMFECS's functions, as it has already been described in the "DRIMFECS" and the "Evaluation" chapters of this paper respectively (Appendix E).

While this fact does not affect most of the participants' answers according to the Figure 8, it is admitted that this has a small impact to the evaluation's results and this is the reason why it is considered as a limitation of this paper, as far as the evaluation of DRIMFECS is concerned.

Furthermore, as already mentioned in the "Evaluation" chapter of this paper, 8 participants were used in order to be able to answer the research questions. It is clear that this sample size is a small one for generalizing the evaluation's results and this is the reason why this fact is considered as a limitation of the evaluation process.

Finally, the three main motivational strategies that were implemented in DRIMFECS are accepted by the majority of the different personalities according to the table A3 (Appendix A). However, there is another motivational strategy that fits the preferences of this majority according to this table and the interviews - the ones with the 4 PPps, and the ones from the field study- as well.

This motivational strategy is "Personalization" and it is about the ability of the drivers to change the application's characteristics according to their preferences and needs as table A2 (Appendix A). This strategy can be added via an extra feature to DRIMFECS, therefore this is considered as a limitation to DRIMFECS.

CONCLUSIONS

In this paper, the research has been broken down into two research questions, as stated in the introduction. The first is about whether the drivers would be motivated and inspired to follow DRIMFECS's feedback and why. The second one is about whether the preferences of the drivers towards the different motivational strategies, given their personality, are altered, and how.

For answering the research questions, DRIMFECS, an in-vehicle feedback system that combines optimal driving behaviour and motivational strategies has been developed. This system is described in the "DRIMFECS" chapter of this paper. DRIMFECS tracks the drivers' behaviours, translates them into fuel consumption information and compares them with the optimal way of driving, according to the calculations it performs. Primarily, DRIMFECS aims to motivate the drivers to change their driving behaviour by using three motivational strategies: "Self-Monitoring and Feedback", "Goal Setting and Suggestion" and "Rewards".

For answering the first question, DRIMFECS has been used as a tool, along with the questionnaire "Evaluation of DRIMFECS" (Appendix C). According to the "Exposition and Analysis of Field Study's Results" chapter of this paper (Figure 7), the participants were motivated by the motivational strategies that DRIMFECS presented them with. Therefore, they were motivated to change their driving behavior and follow its feedback.

This was expected since DRIMFECS uses the motivational strategies that are acceptable by the majority of the different personalities according to the table A3 (Appendix A). The results of this analysis are described in detail in the "Exposition and Analysis of Field Study's Results" chapter.

For answering the second research question, the questionnaire of "Motivational Strategies According to Personalities" (Appendix C) was used. According to [18], different personalities have specific preferences in terms of motivational strategies that they are motivated by. However, from the findings in the "Exposition and Analysis of Field Study's Results" chapter, there are indications that drivers could potentially change these preferences, while they drive.

In other words, it is demonstrated that it is possible to motivate drivers, regardless of their personality, by using those motivational strategies that are acceptable by the majority of the different personalities. However, there are indications that the preferences of each person towards motivational strategies may change, while the person is in a driving situation, in comparison with other situations of his/her daily life.

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APPENDICES

Appendix A

Tables A1-A3 are taken from the corresponding reference in the paper

Table A1: Main different personalities of users [18]

Personality	Description
Extraversionist	Is outgoing, expressive, and ambitious and is looking for new opportunities.
Achiever	Is open to changes and self-enhancement, goal but not process oriented, likes to improve in front of others.
Conscientious	Is well organized, plans in advance, is dependable, is goal-oriented and has self-discipline.
Hedonist	Enjoy games, needs challenges to keep motivated, doesn't like pressure and anxiety, is imaginative, creative, curious and holds unconventional values.
Agreeable	Cooperates with others, tolerant, friendly and helpful, considerate.
Neurotic	Is sensitive, nervous, distrustful, unstable emotionally, fearful.
Follower	Is interested in others' opinions, wants to follow clear instructions, doesn't like changes and self-enhancement.

Table A2: Motivational strategies for users [18]

Motivational factor/strategy	Description
Competition	Users are able to compete with each other in order to display the desired behaviour.
Simulation	Users are capable of observing the cause-effect link due to their individual behaviour.
Self-monitoring and Feedback	People can track their behaviours, while having information about both their current and past states.
Goal Setting and Suggestion	Users need to set a crystal clear behavioural goal and be recommended with specific actions (in order to achieve the desired user's goal via the system usage).
Customization	Users are able to adapt the system's content and functionality according to their needs and choices.

Reward	Users get offered virtual rewards for performing the desired behaviour.
Comparison	Users are able to view and compare their performance with that of others.
Cooperation	Users need to cooperate for achieving a shared objective and they get rewards for achieving their desired targets collectively.
Personalization	Provides system-tailored contents and service to users, tailoring functionality and content according to a particular need, based on user's wishes and characteristics.
Punishment	Users get penalties for not reaching a set goal or performing the desired behaviour.
Social opinion	Users tend to be motivated by other users' opinions and get ethical rewards or punishment (disapproval) from others.

Table A3: Positive, neutral and negative impacts of each motivational factor to each user's personality respectively [18]

		User personality						
		Extraversionist	Achiever	Conscinetious	Hedonist	Agreeable	Neurotic	Follower
Motivational factors	Personalization	✓	✓	✓	✓	✓		
	Cooperation		✓		X	✓		✓
	Simulation		✓	✓		✓		
	Self-monitoring and Feedback	✓	✓	✓	X	✓		
	Comparison	✓	✓		X	✓		X
	Punishment	X	✓		X	✓		
	Goal Setting and Suggestion	✓	✓	✓				✓
	Customization		✓		X	✓		X
	Competition	✓	✓		X	✓		X
	Reward		✓		X	✓		✓
	Social opinion				X			✓

Appendix B

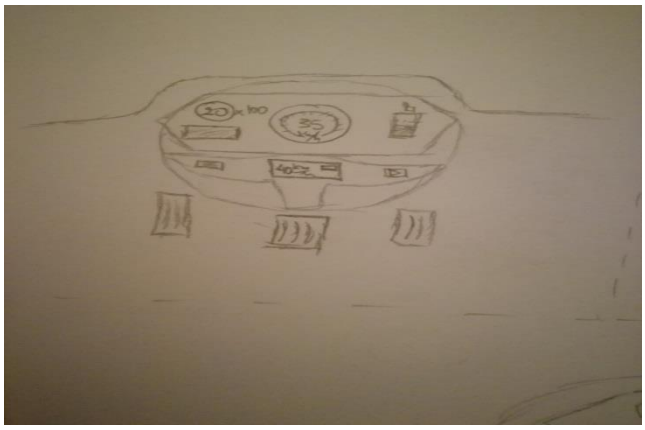

Figure B1: Monitor on steering wheel (case 1)

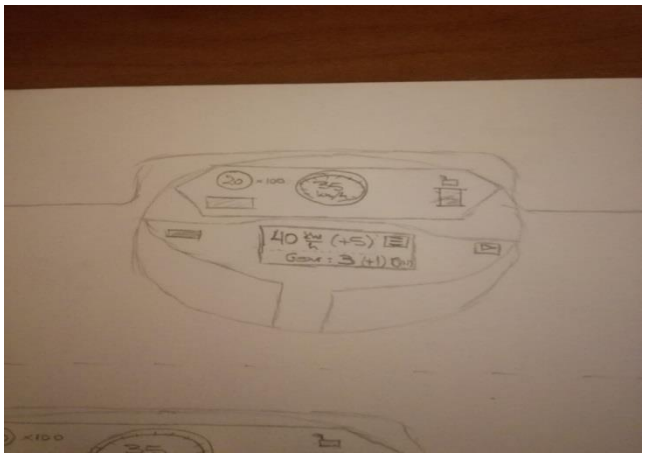

Figure B2: Monitor on steering wheel (case 2)

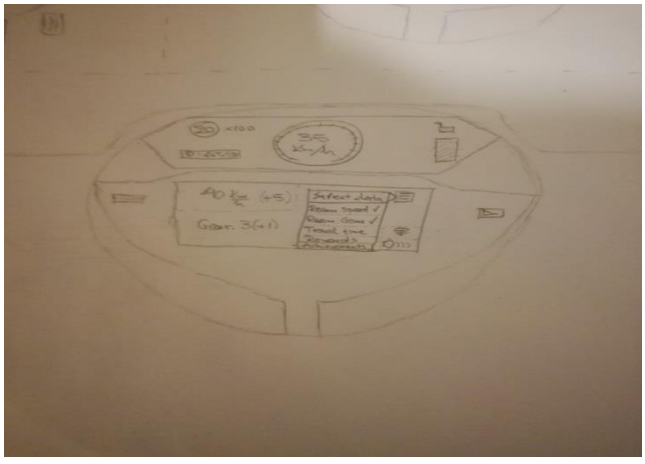

Figure B3: Monitor on steering wheel (case 3)

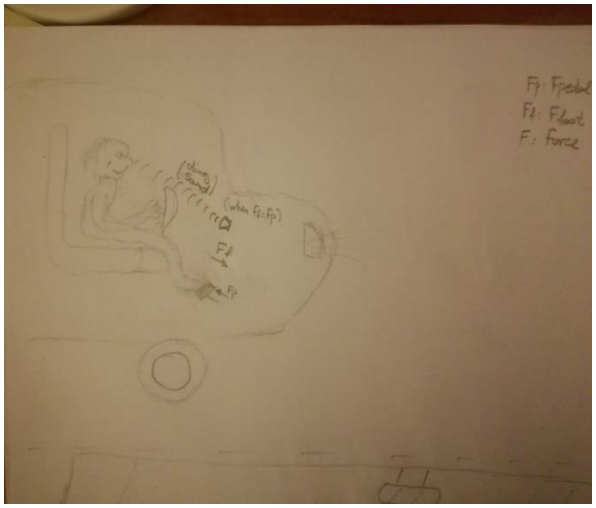

Figure B4: Acceleration pedal, that shows forces from system to driver's foot and vice versa, plus sound feedback

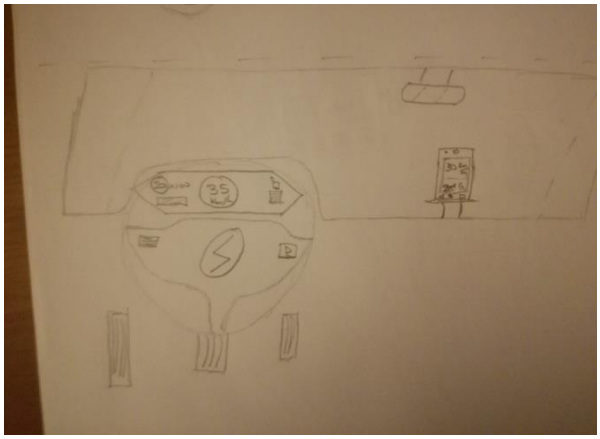

Figure B5: Mobile phone placed on a case in the middle

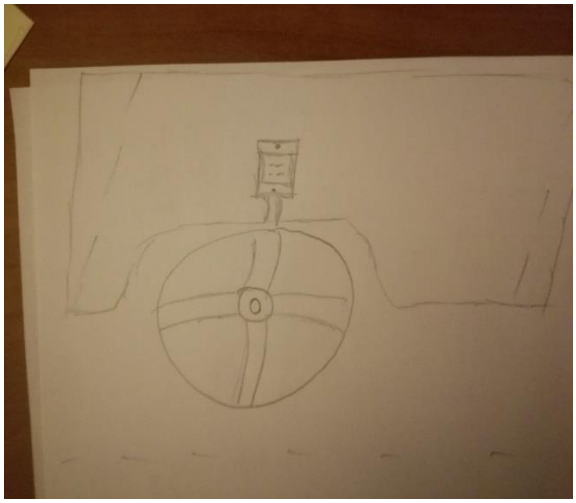

Figure B6: Mobile phone placed on a case above the dashboard

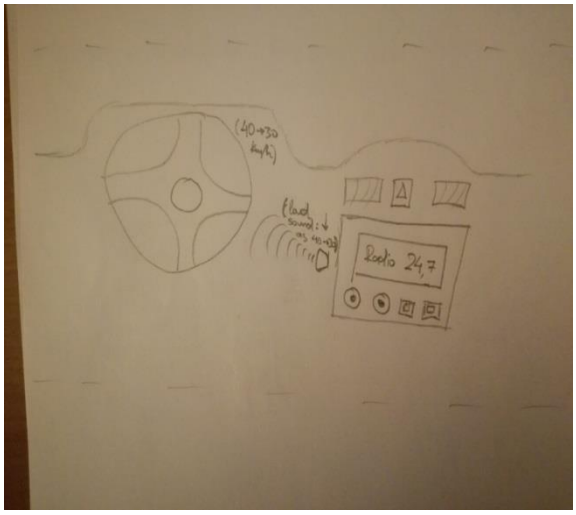

Figure B7: System connected with the radio, that changes the sound volume of the radio, according to how close to the optimal velocity the driver is

Figure B8: Smart windshield and smart-glasses (as the driver sees through his eyes)

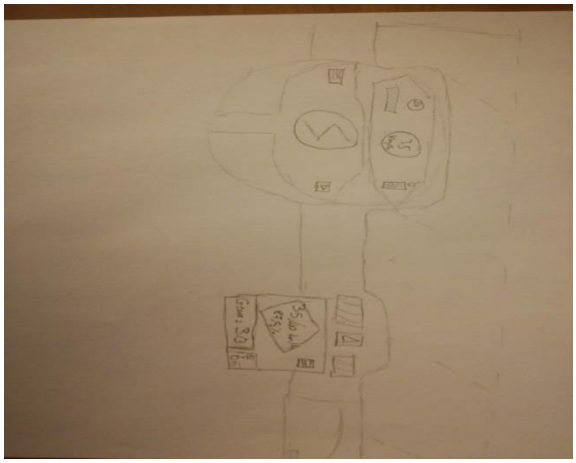

Figure B9: System implemented in the central screen that the car has

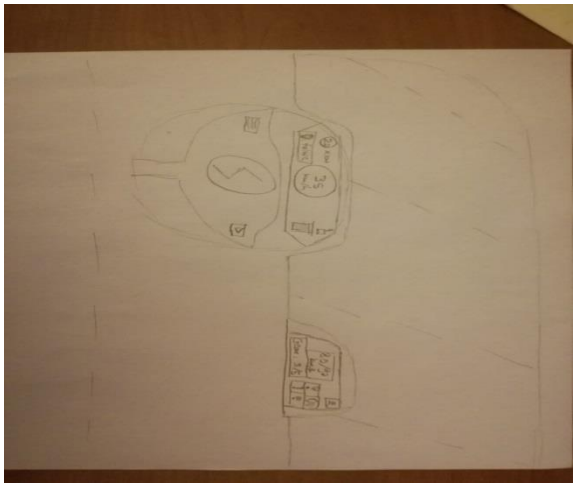

Figure B10: System implemented in a monitor that the car has (e.g. https://www.chceauto.pl/toyota-yaris-10-68km-2010-39760/foto2/)

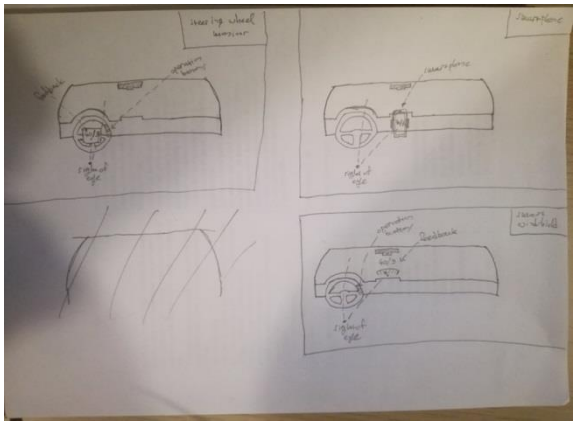

Figure B11: Steering wheel monitor (top left), smartphone (top, right), smart windshield (bottom left)

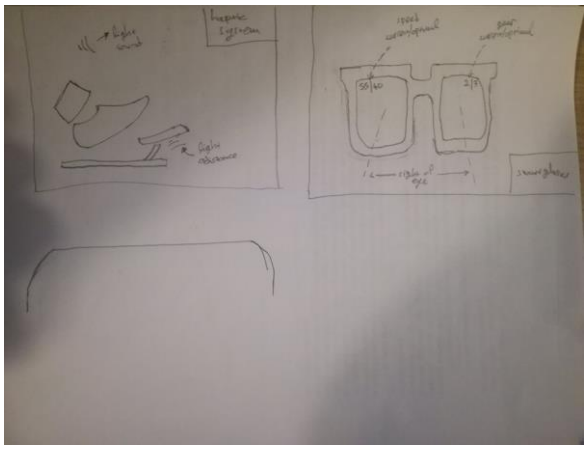

Figure B12: Acceleration pedal/haptic system (top left), smart-glasses (top right)

Table B1: SWOT Analysis for each case

Fig.B1-B3 (screen on wheel):

Strengths	Weaknesses	Opportunities	Threats
1. Not distractive 2. Can display all info 3. Can convey info via multiple modalities 4. Easy for user to see 5. Can apply various strategies 6. Can be “faked” by using a cellphone 7. Direct visual update with easy operation system	1. Doesn’t exist as technology 2. Could bother him when wanting to honk	1. It’s the first feedback system that introduces this mean of feedback 2. There is a lack of reliable applications in this field	1. Similar feedback systems in terms of functionality are already introduced 2. Could get too complicated and distractive if many functions are integrated and requires complex navigation while driving 3. Could get too complicated and distractive if infos presented are complicated

Fig.B4 (acceleration pedal + sound):

Strengths	Weaknesses	Opportunities	Threats
1. The least distractive system as it requires the haptic modality 2. Sound can alleviate any doubt on the drivers’ parts	1. It requires the development of a mental model for using it 2. Could lead to the development of problematic behavioural patterns 3. Difficult to implement and evaluate 4. Not many motivational strategies can be implemented	1. The first system of this kind that combines audio and haptic modalities 2. Sound helps driver react fast	1. Similar feedback systems in terms of functionality are already introduced 2. Critical safety issues for driver

Fig.B5-B6 (mobile phone placed in the middle of the windshield + above the steering wheel):

Strengths	Weaknesses	Opportunities	Threats
1. Can display all info 2. Can convey info via multiple modalities 3. Easy for user to see 4. Can apply various strategies 5. Ease to implement and evaluate	1. Could get too complicated and distractive if many functions are integrated and requires complex navigation while driving 2. Could be proven to be very distractive for the driver, depending on factors like the type of modalities it will use for conveying info 3. Could be illegal to use	1. Could be attractive for drivers 2. There is a lack of reliable applications in this field	1. Similar feedback systems in terms of functionality are already introduced 2. Critical safety issues for driver if he uses his hands for navigating and not holding steering wheel

Fig.B7 (sound volume from radio):

Strengths	Weaknesses	Opportunities	Threats
1. Not distractive system since it requires the audio modality 2. User will not need to deal with the system more than just activating it	1. It requires the development of a mental model for using it 2. Could lead to the development of problematic behavioural patterns 3. Difficult to implement 4. Not that many motivational strategies can be implemented 5. Could turn out to be annoying for the drivers 6. Could cause problems to the drivers by not allowing them to listen to other sounds (e.g. from their engine) 7. Would need to deal with the car's software and possibly hardware in order to implement it → no insurance	1. Could be proven a good alternative for conveying info to the drivers	1. Could be annoying for the driver

Fig.B8 (windshield):

Strengths	Weaknesses	Opportunities	Threats
1. Can display all info 2. Can convey info via multiple modalities 3. Easy for user to see 4. Can apply various strategies	1. Potentially expensive 2. Not all drivers can obtain them 3. Could be proven distractive for the drivers, if info block their road-view 4. Could turn out to be annoying for the drivers 5. Difficult to simulate/implement	1. It's the first feedback system that introduces these means of feedback	1. Big development costs

Fig.B9 (use of the monitor already installed in the car):

Strengths	Weaknesses	Opportunities	Threats
1. Can display all info 2. Can convey info via multiple modalities 3. Easy for user to see 4. Can apply various strategies	1. Not all drivers can obtain them 2. Could be proven distractive for the drivers 3. Could turn out to be annoying for the drivers (e.g. if they want to use the radio, gps etc) 4. Difficult to implement 5. Would need to deal with the car's software and possibly hardware in order to implement it → no insurance	1. Could be attractive for drivers	1. Could get too complicated and distractive if many functions are integrated and requires complex navigation while driving 2. Could get too complicated and distractive if infos presented are complicated

Fig.B10 (install one more monitor like toyota yaris):

Strengths	Weaknesses	Opportunities	Threats
1. Can display all info 2. Can convey info via multiple modalities 3. Easy for user to see	1. Could be proven very distractive for the drivers, given all the monitors already existing in a car 2. Not enough space for displaying all necessary infos	1. Could be attractive for drivers	1. Could get too complicated and distractive if many functions are integrated and requires complex navigation while driving 2. Could get too complicated and distractive if infos presented are complicated

4. Can apply various strategies			

Fig.B11 (smartglasses):

Strengths	Weaknesses	Opportunities	Threats
1. Direct visual update 2. Easy adaption to user's direction 3. Easy for user to see	1. More distraction than other visual systems 2. Potentially expensive 3. Not all drivers can obtain them 4. Difficult to simulate/implement	1. Upcoming technology 2. It's the first feedback system that introduces these means of feedback	1. Big development costs 2. Could be proven distractive for the drivers, if info block their road-view 3. Could turn out to be annoying for the drivers

Appendix C

Questionnaire 1:

Evaluation of DRIMFECS

1. Overall, how would you rate the application?

   1 2 3 4 5

2. How satisfied are you with the application?

   1 2 3 4 5

3. Would you use the application again?

   1 2 3 4 5

4. If not, why not?

_____

5. Would you recommend the application to others?

   1 2 3 4 5

6. Why?

_____

7. How many times did you pay attention to the application's instructions while driving?

   1 - 2 3 - 5 6 - 8 9 - 12 over 12

8. How much do you believe that you took into consideration the application's instructions?

   1 2 3 4 5

9. How much do you believe that you obeyed the application's instructions?

   1 2 3 4 5

10. How motivated were you to follow the application's instructions?

1 2 3 4 5

11. Which features would motivate you to use the application again?

_____

12. How would you rate, motivation-wise, the map feature?

1 2 3 4 5

13. How would you rate, motivation-wise, the level feature?

1 2 3 4 5

14. How would you rate, motivation-wise, the fact that you could see your deviation from the "optimal" driving behaviour (average fuel consumption and average money deviation)?

1 2 3 4 5

15. How would you rate, motivation-wise, the feedback screen that you could see while driving?

1 2 3 4 5

16. Which features of the application did not motivate you?

_____

17. Why?

_____

18. What else would you like the application to have as extra features in order to motivate it you even more to use it and follow its advices?

_____

19. Did you notice that the real velocity that the application was providing you with had some deviation from the one you could see on your dashboard?

    - ○ Yes
    - ○ No

20. If yes, how much did this affect your previous answers?

    1 2 3 4 5

Questionnaire 2:

Motivational strategies according to personalities

(Part A)

1. Which of the following features would further motivate you to use the application and follow its instructions?

    - ○ Estimated time of arrival for optimal driving.
      Why?_____
    - ○ Fuel in deposit Why?_____
    - ○ Animation features (e.g. tree with brown or green leafs)
      Why?_____
    - ○ The effect of your driving behavior to the environment
      Why?_____
    - ○ Set goal about real and optimal fuel consumption deviation and check if achieved
      Why?_____
    - ○ The application provides you with a goal suggestion before you start driving
      Why?_____
    - ○ To be able to share your result in social media
      Why?_____
    - ○ To get motivational messages from the application
      Why?_____

- To be able to have your personal profile
  Why?_____
- To be able to decide which information you are going to be represented with while driving Why?_____
- To be able to personalize other features of the application
  Which one(s)? Why?_____
  _____
  _____
  _____

(Part B)

2. Would you like to compete with other drivers (e.g. in social media) in order to display the desired behaviour?

   1 2 3 4 5

3. Would like to be able to observe the cause – effect link due to your individual driving behavior (e.g. fuel consumption rate, to the environment, etc.)?

   1 2 3 4 5

4. Would you like to track your behaviour while having information about both your current and past driving performance?

   1 2 3 4 5

5. Would you like to set a crystal clear goal and be recommended with specific actions from the application in order to achieve it?

   1 2 3 4 5

6. Would you like to be able to adapt the application content according to your needs and choices?

   1 2 3 4 5

7. Would you like to get virtual rewards for following the application's advices?

   1 2 3 4 5

8. Would you like to be able to view and compare your performance with that of other drivers?

   1 2 3 4 5

9. Would you like to cooperate with other drivers for achieving a shared goal and afterwards if you achieve the goal, to get the rewards collectively?

   1 2 3 4 5

10. Would you like the application to be able to provide you with contents and services which are according to your characteristics?

    1 2 3 4 5

11. Would you like to the application to give you penalties for not reaching a set goal or not performing desired driving behaviour?

    1 2 3 4 5

12. Do you tend to be motivated by other drivers' opinions and get ethical rewards or be motivated if other drivers disapprove your driving behaviour?

    1 2 3 4 5

Appendix D

Questions for the interviews with the 4 PowerPoint prototypes:

1. Choose among different shapes and sizes of monitors and justify choice
2. Choose where to position the monitor chosen in the previous question on the steering wheel
3. Use one side of the paper prototype monitor to draw the information the interviewees would like to be presented with, and also how they would like them to appear on the monitor
4. Present the interviewees with the 4 PowerPoint prototypes (separate PowerPoint files)
5. Ask them to explain to us what they understand, while navigating the prototypes
6. Ask the interviewees while using the 4 prototypes what they like and what they don't like about them
7. Ask the interviewees to rank the 4 prototypes
8. Ask the interviewees if they would like a mixture of 4 prototypes and if yes, what elements should the mixture have from each one
9. Ask the interviewees if they have changed their minds about the information they want to be displayed in the monitor, while they are driving
10. Ask the interviewees the information they would like to be able to see from the application, after they have reached their destination

11. Ask the interviewees what other features the application could have, that would motivate them to use it, and take into consideration its feedback
12. Ask the interviewees more specifically, if they wish to have features like login, menu button, to be able to personalize the application, to share their performance via the social media, to have a gamification aspect (e.g. level up, competition with friends)
13. Ask the interviewees if they would like to redraw the screen with the information they are going to be presented with while they are driving (from the other side of the paper prototype screen that they used to draw in the beginning of the interview)

Appendix E

Flow diagrams of the three main features of DRIMFECS.

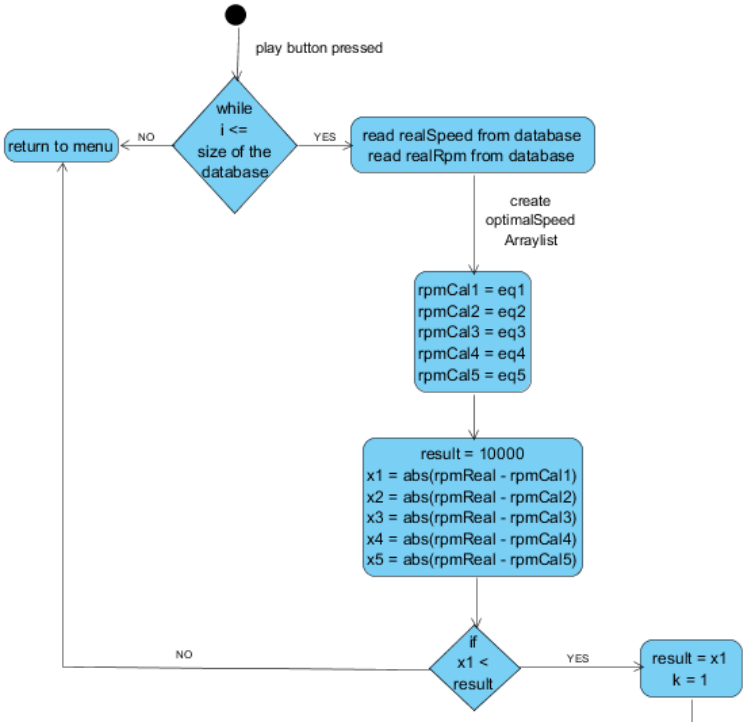

Figure E1: real – screen (feature) part 1

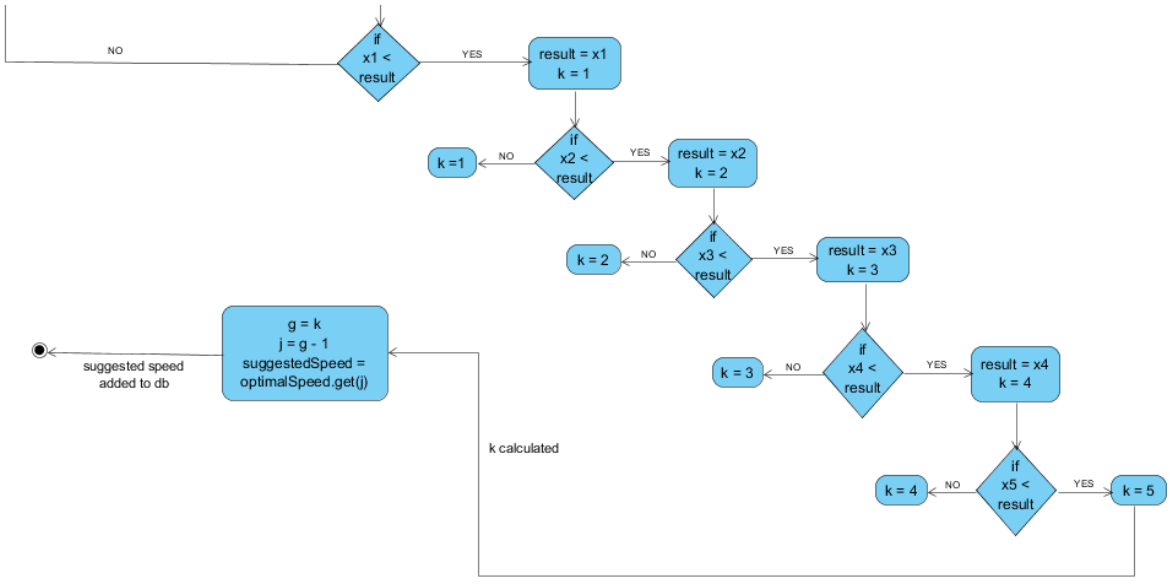

Figure E2 : real – screen (feature) part 2

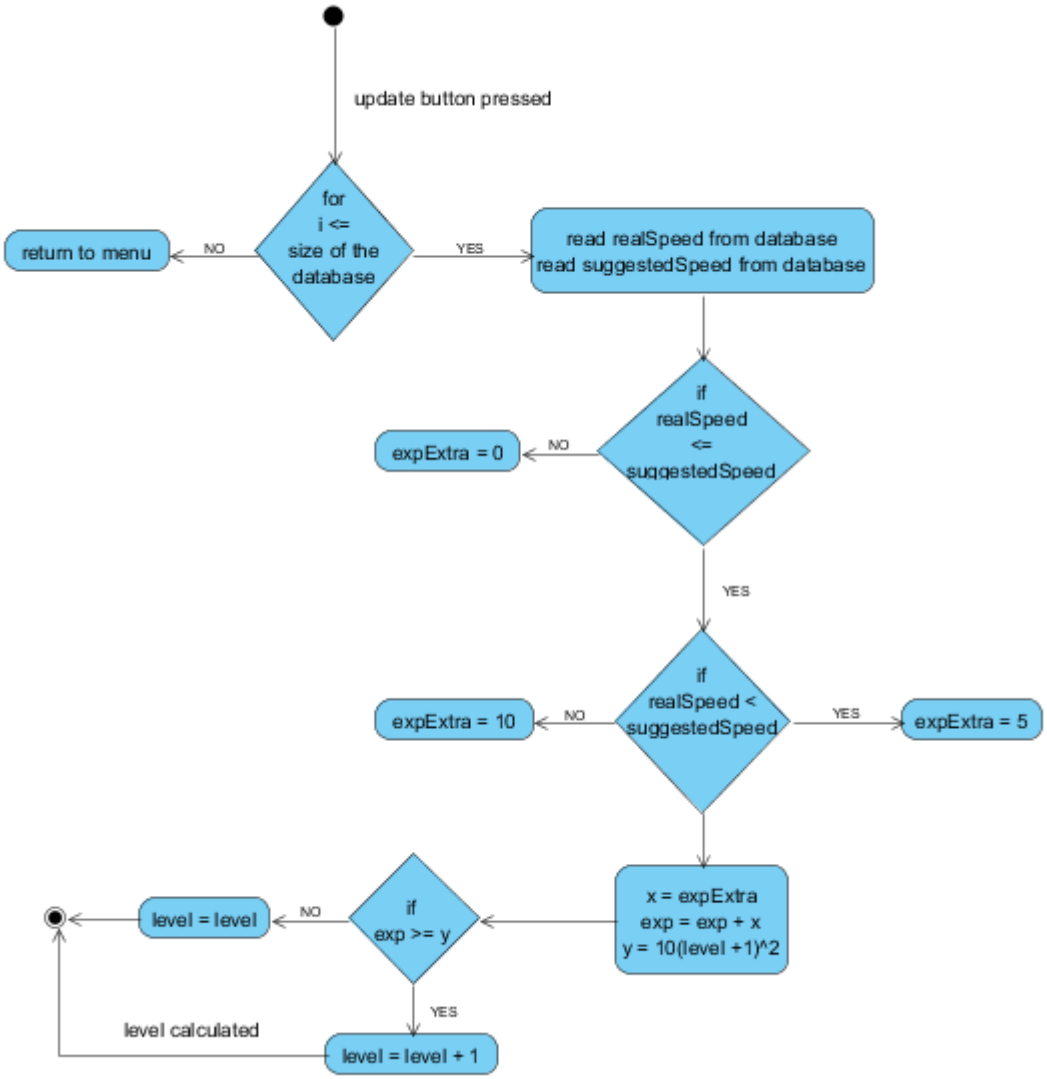

Figure E3: level feature

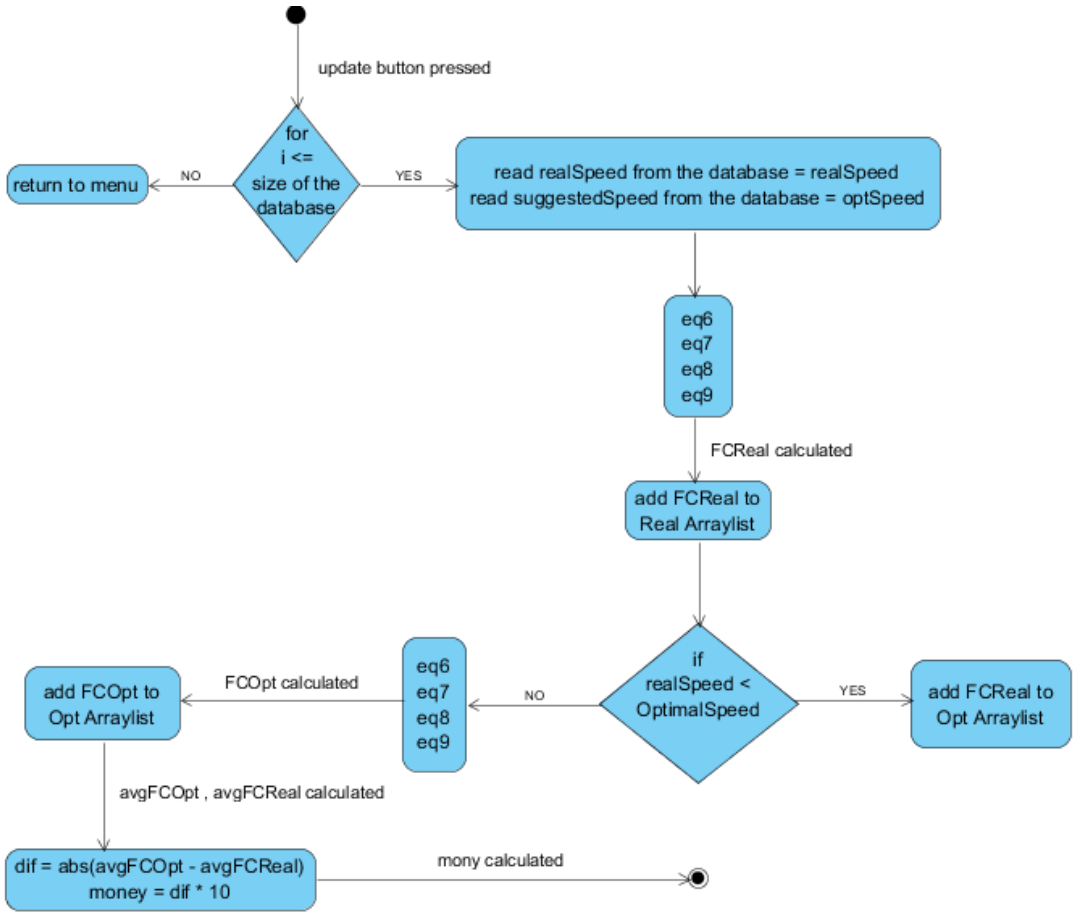

Figure E4: total feature

Table E1 uses the references mentioned next to each equation from the paper.

Table E1: Equations used in flow diagrams (Fig. E1-E4)

Equations		
eq 1 [31]	rpmC1 = 1000 (realSpeed - 0.266) / 7.4	where: a = - 0.67944 e = 0.029665 g = 1.49 * 10^(-6) f = - 0.00028
eq 2 [31]	rpmC2 = 1000 (realSpeed + 1.466) / 14.51	
eq 3 [31]	rpmC3 = 1000 (realSpeed) / 20	
eq 4 [31]	rpmC4 = 1000 (realSpeed - 5.333) / 25.14	
eq 5 [31]	rpmC5 = 1000 (realSpeed - 0.4) / 34.6	
eq 6 [33]	FC = exp[a + e * 0.9113 * speed + f * (0.9113 * speed)^2 + g * (0.9113 * speed)^3]	
eq 7	FCUnit1 = FC * 3.7854	
eq 8	FCUnit2 = speed / FCUnit1	
eq 9	FCUnit = 100 / FCUnit2	