Identifying indicators of driving in a hurry

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Elizabeth Rendon-Velez
Delft University of Technology
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Delft University of Technology
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Wilhelm Frederik van der Vegte
Delft University of Technology
61 PUBLICATIONS   140 CITATIONS
IDENTIFYING INDICATORS OF DRIVING IN A HURRY

Elizabeth Rendon-Velez  
Faculty of Industrial Design Engineering  
Delft University of Technology  
the Netherlands  
E.RendonVelez@tudelft.nl

Imre Horváth  
Faculty of Industrial Design Engineering  
Delft University of Technology  
the Netherlands  
i.horvath@tudelft.nl

Wilhelm “Wilfred” F. van der Vegte  
Faculty of Industrial Design Engineering  
Delft University of Technology  
the Netherlands  
w.f.vandervegte@tudelft.nl

ABSTRACT

Due to an increase in the use of cars and the growing complexity of driving situations, the number of people injured in traffic accidents has increased to 50 million. One of the most crucial factors contributing to accidents is driver’s behavior. A driver state which is known to provoke risky driver behavior is haste. Haste is defined as the state where the driver has feelings of urgency or pressure due to a lack of temporal resources. If it would be possible to automatically detect when a driver starts hurrying for being late for an appointment, this could be used to develop novel accident-prevention systems. The research reported on in this paper aims at exploring knowledge for the development and implementation of a car subsystem that can reliably detect driving in haste. Identification of indicators of haste has not received much attention in research so far. In this paper we present how we gathered the necessary knowledge and qualified indicators by contrasting the findings of a literature study with that of five focus group sessions, involving drivers and experts. These explorative studies have confirmed our assumption that haste not only manifests in changed human behavior, but it also influences human-car interaction, the state of the car and the car-environment interaction. Accordingly, we have sorted the proposed indicators into groups, and validated them from several aspects. This knowledge provides a good basis for the follow-up research cycles, in which we will test the strongest indicators, investigate the opportunities of detecting them within cars, and propose a technical solution for detecting driving in haste.

Nomenclature

| GN | All non-expert groups (G1+G2+G3+G4) |
| GE | Expert group |
| G  | All groups (Nexp + E) |
| L  | Literature |
| GN\GE | Intersection of Non-experts and Experts |
| G\L | Intersection of all groups and the literature |

1. INTRODUCTION

With the ever growing car usage and the more frequent occurrence of complex driving situations, the number of accidents leading to injuries and fatalities has increased dramatically. Traffic-related accidents are considered to be serious social and technological problems with global dimensions. A study made by the World Health Organization (WHO) revealed that annually as many as 50 million people are injured and over 1.2 million fatalities occur worldwide [1]. The most prominent factor contributing to the vast majority of traffic accidents is the behavior of drivers. According to various studies in Europe, USA and Africa, over 90% of car accidents can be traced back to some degree of driver misbehavior combined with equipment failure, improper roadway design, or poor roadway maintenance [2-5]. Misbehavior of drivers may take many forms (i.e. running red lights, tailgating, etc). Many of them appear when they are driving under haste or time pressure conditions. Actually, it was found in the European TRACE project that this was a primary factor contributing to traffic accidents in Europe [6]. A Japanese study also confirmed that this was the obvious cause of many accidents [7]. The risky nature of driving in haste was also proved by a study analyzing the driver characteristics in traffic accidents [8]. Also other studies, performed in the UK, showed that being in a hurry was quite often observed, and that drivers increased the risk of accidents when they were driving in this state [9].
Although several studies claim that the effects of being in haste state usually contribute to risky behaviors, most of the papers do not address the manifestations of haste. Instead they concentrate on (i) attaining a psychological understanding, (ii) identifying the type of people prone to show risky behaviors when in a hurry, or (iii) the context in which these behaviors most often occur. A different trend can be observed in the field of engineering-rooted studies, where system-oriented observations and investigations have been made, and various safety improvement-oriented solutions have been proposed. However, most of these studies suggest some sort of technical solutions for phenomena that have not been properly understood yet in the context of driving in rush or haste. Therefore, the suggested detection and control methods can not be fully validated. Our first impression and assumption has been that the affordances of these two major domains of interests (psychology and engineering) should most probably be combined somehow in order to get a comprehensive understanding and to explore optimal intervention possibilities, even if the current trends in the literature do not indicate efforts in this direction.

The ultimate goal of our research project is to aggregate the knowledge needed for conceptualization and implementation of a testable prototype of a smart driving assistance system. This system should detect if the driving happens in a haste state and should try to avoid driving hazard either by giving warnings to the driver, intervening the steering or brakes of the car, or both. The specific objective of the first phase of the research project reported in this paper is to synthesize an explanatory theory about recognizable behavioral indicators in the discussed context. This means to investigate which phenomena are strongly associated with the state of driving in haste, and how the various manifestations of these phenomena can be described by indicators, which can be detected and measured with some instrumentation. The findings will result in a theory, which explains which indicators are the most expressive and the most appropriate for instrumented measurement.

In order to fulfill this research objective we applied a two-cycle research framework. This framework helped us to maintain the coherence among the specific research activities. For this methodological framing, the theory proposed in [10] has been applied. Each research cycle is a logically ordered set of research actions, which have been supported by various methods (Figure 1). These two research cycles have been methodologically framed as research in design context (RDC). RDC supports getting insights about the phenomena studied and results in explanatory theories for knowing. Each RDC cycle involves six phases of activities, which have their specific objectives, namely (see Figure 1) (i) knowledge exploration and aggregation in context, (E), (ii) inductive statement of knowledge problems, research questions, and research hypothesis (I), (iii) deductive generation of descriptive/explanatory/predictive theories (D), (iv) rational and empirical justification of theories and models (J), (v) validation of the methods/conducts/findings (V), and (vi) generalization of the findings and the propositions (G). Starting out from the fact that fused knowledge is expected as an outcome, the objective of the first two research cycles has been defined to be practically the same. For this reason, the explorative parts (i.e. the exploration, induction, and deduction phases) were conducted separate, and with the support of different methods, but the confirmative parts (i.e. the justification, validation and generalization phases) have been merged into one stream of research actions, driven by the strategy of data and methodological triangulation. We explain this below.

In the first research cycle, internet-based literature study was used as a method for knowledge exploration. Information and data about indicators of driving in haste were aggregated by means of structured lists of keywords and cited references. In the second phase, the data carried by the written text have been interpreted and assumptions were made in an inductive way. Our main assumption has been that the behavior of the driver in a haste situation is different from his/her usual behavior in a normal driving situation and that the emerging changes in the behavior propagate from the driver through the car towards the environment. That is, the behavioral state of the driver is reflected not only on the parts of the human body, but it has observable influence also on the behavior of the car, the interaction of the driver with the car, and the interaction of the car with the environment. Based on this assumption a reasoning model was devised. This reasoning model was used as a support mean for a deductive generation of a theory that explains the nature, the relevance, strength and appearance of indicators, and allow us to classify them in a non-taxonomical way.

In the second research cycle, focus group studies were conducted. The goal was to complement the information found in the literature. The participants, in each focus group session conducted, were asked to express their opinions about the attitudes, behaviors, actions, etc. of drivers being in haste with
the help of open-ended, semi-structured discussion forums. Because our generic assumption was not falsified by the forerunners of the literature study, each phase of this research cycle was guided by the same objective and assumptions. In order to be able to derive relevant technically rooted indicators, we analyzed the obtained data from the focus group sessions in several steps. First, we grouped the sentences referring to the same possible observation of driving in haste. Then, we identified the background phenomenon for each group and derived some indicators. Afterwards, we sorted the indicators according to the reasoning model used for the literature and we made an assessment of them in order to derive the most relevant indicators.

In terms of the execution of the confirmative parts of research cycle one and two, we identified two objectives: (i) merge the bodies of knowledge generated in the explorative parts of research cycle one and two, and (ii) test and justify the resultant knowledge from multiple aspects. To achieve these goals, we brought together the knowledge obtained about the possible observations concerning driving in haste from the literature study with the knowledge obtained in the focus group studies. This research strategy is commonly referred to as ‘triangulation’ in the literature. Triangulation, allowed us to investigate the semantic relations and the relative contribution of the partial bodies of knowledge (i.e. the two sets of observations) to the consolidated theory about a set of dominantly relevant indicators. According to our reasoning, if there is high congruency between the two sets of observations it gives us evidence to believe that they are relevant, or even true.

We also investigated the correspondence of the two sets of observations, based on how frequently they were mentioned as relevant in the literature study and the focus group sessions, respectively. The frequency is expressed in terms of the number of people that agree that a possible observation is associated with the studied phenomenon. For the reason that the knowledge generation process is contextualized and influenced by human decisions, we need to consider the validation of the results of the research actions. Both internal and external validation plays an important role in testing if the obtained body of knowledge is proper and relevant. For testing internal validity, we considered source validity, and investigator validity. However, since the obtained knowledge will not be used outside the context of our research, we do not make effort to test its external validity. Otherwise in testing external validity aspects such as reliability, sensibility and usefulness of the data could be considered.

The next Sections present the findings of these two research cycles (Literature study, Focus group study). Section 2 discusses the findings of the literature study concerning the characteristic phenomena and indicators of being in haste state. Section 3 discusses the approach of exploring indicators and the set of possible observations (manifestations) related to driving in a hurry mentioned by drivers and experts in focus group sessions. The conduct of these sessions and the post-processing of the results are also presented in this section. Section 4 discusses the comparison and justification of the findings of the completed literature study and focus group sessions. Section 5 presents the outcomes of a multi-aspect validation of these findings. Finally section 6 offers some tangible conclusions.

2. LITERATURE STUDY

2.1. Objective and sources

Having the objective of exploring and synthesizing knowledge about the possible observations (manifestations) of driving in haste, the first research cycle concentrated on the works and results reported in the literature. The investigation covered journals, proceedings and academic reports. The literature study was carried out digitally, using Google Scholar, Scopus, IEEE Xplore Digital Library and Transport databases. As a first step, information about the proposed possible observations of driving in haste was collected by keyword-based searches and then this was complemented by the retrieval of the relevant articles included in the reference lists. The terms used in the search were constructed as combinations of the following words: ‘driver’, or ‘monitoring’, or ‘hurry’, or ‘driving’, or ‘symptoms’, or ‘aggressive’, or ‘time-pressure’, or ‘rushing’, or ‘state’ or ‘stress’, or ‘haste’, or ‘detection’, or ‘behavior’, or ‘assessment’ (e.g. ‘hurry driving’, ‘monitoring driver stress when in a hurry’, ‘stress assessment when in a hurry’). After gathering a large pool of literature items and interpreting their contents, we devised a reasoning model to support a structured further processing of the results. This reasoning model arranges the knowledge elements in a framework that helps finding facts and developing a theory for the research problem at hand. As pointed out in the previous section, the fundamental assumption behind the reasoning model is that the behavior of the driver in a haste state is different from his/her behavior in a normal driving state. Furthermore, this change propagates from the driver through the car to the environment. Our null hypothesis has been that this can be characterized by indicators.

2.2. Reasoning model

As shown in Figure 2, we have identified five potential source domains of indicators in the reasoning model. Namely they are: (i) the driver, (ii) the interaction of the driver with the car, (iii) the car, (iv) the interaction of the car with the environment and (v) the environment.

![Figure 2. Reasoning model](image-url)
The first source domain of indicators is related instantaneous human behavior. The indicators in this domain originates in the physiology of the driver (e.g. heart rate, muscle tension), or the body actions (e.g. hand movement, leg movement). The second source domain of indicators is the driver-car interaction. In this domain, we are looking for indicators that are associated with the way of driving and the car-related technical parameters (e.g. gas pedal pressure, steering angle, etc). The third domain provides indicators which are closely related to the operation and behavior of the car. These indicators can be detected and measured related to the state of the car (e.g. velocity, acceleration, engine rotational speed, etc). The fourth domain is the origin of indicators which are related to the interaction of the car with the surrounding environment. This domain provides indicators that can typically be observed in the car position in traffic flow (e.g. following distance, relative lane position, etc). The fifth possible source domain of indicators has not been considered in our investigation for the reason that, though there are detectable domain of indicators has not been considered in our investigation for the reason that, though there are detectable changes in the interaction of the driver with the car in a haste situation (such as increased CO₂ accumulation, damage in objects, etc), the recognition and measurement of these need to happen, or the best if happen, outside the car. On the other hand, detection of the indicators in the four domains is expected to provide sufficient information about all significant manifestations of driving in a hurry.

2.3. Findings of the literature study

Below we present the main findings of the literature study, clustered according to their source domain using the reasoning model.

### Possible observations related to human behavior

We have found reports and papers that discuss various forms of human behaviors, which can be associated with driving in a hurry or haste. However, these phenomena have not been extensively studied in the context of situation improvement. A number of studies report on relationships between driving in hurry and other psycho-physiological state of drivers such as stress and anger/aggression. However, these studies focus more on particular manifestations of stress and anger than on specific possible observations of driving in haste. Empirical research has shown that being in a hurry and having to keep a strict time schedule exacerbates the feeling of stress [11]. Drivers acting according to high urgency scenarios (running late) have shown higher stress level than drivers in low urgency scenarios (being on time) [12]. Additionally, it was found that time-urgency also increases frustration and irritation which result in negative moods, such as anger [13]. These findings reported in the context of driving, are also consistent with general studies on aggression and with the so-called frustration-aggression theory, which argues that “aggression is always a consequence of frustration” [14, 15].

The state of anger has been associated with both overt behavior (observable actions), and physiological responses. Following from the overt behaviors, rude gestures, swearing or yelling at others, and facial expressions have been identified as manifestations of anger [16, 17]. These manifestations have already been used for the detection of anger in emotional recognition systems. Yelling or angriness of voice have been detected based on certain features of the voice, for instance, the pitch and sound pressure [18]. Although these two indicators were efficient for detecting angriness of the voice in controlled environments (e.g. driving simulators), according to some studies the heavy noise of real environments can significantly increase the difficulty of detecting these phenomena [19]. Angry facial expressions have been recognized based on extracting face features by evaluating their descriptive parameters. Although face features-based recognition has been effective, the existing methods are capable to handle only deliberate and exaggerated expressions of emotion [20]. As physiological characteristics, muscle activity, heart rate and skin temperature have been associated with anger. Researchers found that the activity of the corrugator supercilii (muscles above the brow, used in frowning) [21], the heart rate [22] and the skin temperature [23] increase when experiencing negative feelings. However, when anger was compared with neutral emotions in empirical research, there was no substantial difference in the pattern of heart rate. Similarly, in the study reported in [23] it was found that the changes in the skin temperature were not significantly different from those typical for neutral conditions.

A strong correlation has been found between stress and physiological responses. High levels of stress have been shown to result in a substantial increase in blood pressure. It was reported that drivers displayed greater systolic blood pressure in a hurry and under high stress than under normal conditions [24]. This was consistent with the results of the study in which high stress in offices was related to high blood pressure [25]. Also higher heart rate, skin conductivity (sweating) and skin temperature were found to be associated with stress [26, 27]. However, De Waard found that skin conductivity was affected by respiration, temperature, humidity, age, time of day and season [28]. He suggested that this indicator was not the most appropriate for detecting this state in cars. In some research, the increase of muscle tension and respiration rate were also correlated with high stress levels [28, 29]. However, according to other studies, the respiration rate had no clear correlation with stress levels due to the inter-individual differences [26, 30].

### Possible observations related to driver interaction with the car

According to several literature studies, there are observable changes in the interaction of the driver with the car in a haste situation. Researchers dealt with these changes from two perspectives: (i) psychological research focused on risky behaviors and their causes, and (ii) engineering research
concentrated on finding working principles for developing detection systems.

Psychology-rooted studies considered various forms of risky behaviors, such as horn honking and flashing headlights [16, 17, 31]. These studies typically used questionnaires. It was found that driving in a hurry was the most frequent cause of the two above-mentioned risky behaviors. Horn honking and flashing headlights were described as behaviors that help the driver to overcome frustrating obstacles formed by other drivers [16]. What is common in the findings of the above studies is that these behaviors do not happen without a cause. For the sake of completeness it has to be mentioned that these behaviors are also conditioned by gender [31] and/or culture [32]. Frequent horn honking both by men and women was reported, but it was found to be somewhat more pronounced among women and in countries with hot climate.

The studies conducted from an engineering perspective investigated phenomena such as manipulation of the pedals and the steering wheel [33-35]. It was found, in a naturalistic study, that when drivers were in a hurry, they changed from braking to pushing the gas pedal faster in order to accelerate the car [35]. It was also found that drivers have a tendency to delay activation of the brake, which result in heavier braking [33]. The findings in these studies were congruent with the findings of an experiment done in a driving simulator, where it was found that the driver made more intensive use of the brake pedal under frustrating conditions on roads than under normal conditions [36]. Canale and Malan also observed that, in addition to an intensive use of the pedals, drivers applied pressure more strongly and suddenly resulting in a large throttle opening and more fuel consumption [37]. Regarding the usage of the steering wheel, it was found that when drivers drove under high levels of anger and under irritating conditions in a driving simulator, they made bigger steering wheel movements [34]. These experiments indicated that drivers have poorer control abilities when in anger than in calm state. These findings are in line with studies on the effects of time pressure on using general device interfaces [38, 39]. In these studies it was found that time urgency tends to increase the stiffness of a person’s limbs, which explains why actions are performed with relatively high force.

**Possible observations related to car behavior**

Several psychological studies concluded that high speed is one of the most prominent possible observations of driving in a hurry [40-44]. In questionnaire-based studies, drivers agreed that the most prevalent reason for fast driving and speeding was time pressure, also referred by the people as ‘late for a meeting or appointment’ [45] [46]. In studies, where the drivers were caught speeding, they also indicated to be influenced by time pressure [47, 48]. Furthermore, in detailed descriptions of rollovers, field investigators also identified that being in a hurry was a factor that led to misjudgment of the speed at which a particular curve could be safely negotiated [49]. The above findings were in line with the results of a driving simulator-based study where participants who were instructed to drive under time constrains felt more activated and more aroused, and they drove faster than the drivers without the time constraints [50].

High speed driving was also observed in cases in which haste provoked anger in drivers [51, 52]. It was found, by questionnaire-based studies, that respondents drove faster when they were angry than when they were in any other emotional state [53, 54]. The intensity of angry/threatening expressions showed a significant correlation with this higher speed. The findings of these field studies were similar to the results of the studies made using driving simulators. Drivers with high anger maintained a higher average speed than drivers with low anger [55]. These conclusions were also confirmed by a naturalistic study where anger was continuously measured during driving [56]. In this study, participants who reported anger in certain parts of the route drove faster and exceeded the speed limit more often than participants who were not having anger. Complementing the above findings, Musselwhite found in a questionnaire-based study that speeding always occurs in combination with other behaviors such as accelerating and braking [41]. Therefore, he suggested that speeding should be addressed along with these other dangerous behaviors.

The majority of the reviewed engineering studies used acceleration as an indicator for detecting haste. It was found, in some naturalistic studies, that driver accelerated more when feeling hurried than in a normal mental state [35, 57]. Similarly, in a subsequent study, acceleration and deceleration were used to classify the driver’s style, specifically the aggressive style [58]. In this study aggressive maneuvers were identified through the rate of change in acceleration or deceleration.

**Possible observations related to car-environment interaction**

The majority of the studies found in this domain reported on psychology oriented rather than on system-development oriented investigations.

Psychology-rooted research mainly focused on understanding risky behaviors, such as running red lights and tailgating [31, 59, 60]. According to these studies, risky behaviors occur when drivers had to arrive timely but they were late. It was demonstrated by a survey study that a large number of drivers who were in a rush and wanted to save time were willing to speed up to run an upcoming red light [59]. These findings were also confirmed by a later study which found that drivers were more prone to show this behavior when they were driving alone [60]. Tailgating was also mentioned as a form of behavior that happens under time pressure, as well as under particular traffic conditions, such as heavy traffic on busy narrow roads during rush hour [31]. In a field study, the drivers who were stopped because of driving too close to the car in front, mentioned haste as a reason for their behavior [61].

These findings were also confirmed in driving simulators under experimental conditions [55]. The general observation was that, in traffic congestion, a high-anger driver drove faster
and had a shorter time and distance to other cars. Evidently, many other forms of misbehaviors can happen under time pressure, for example, weaving in and out of traffic, neglecting stop signs, failing to yield pedestrians, and “cutting” in front of other drivers [16, 17]. Apparently, these behaviors do not sometimes happen alone, they are accompanied by other dangerous behaviors. For example, Musselwhite reported that frequent switching of lanes and a series of forced overtaking are accompanied by intense speeding [41]. However, we could not find enough studies reporting on empirical evidence.

The engineering-oriented studies concerning the real-time detection of hurried driving mainly focused on tailgating [35, 57]. As an indicator of this behavior, the headway has been considered. This is expressed as a distance or time between cars following each other. Although time-headway was reported to differ among different drivers and road sections when driving in a hurry, the average value and the standard deviation over all drivers tended to be smaller than for normal driving.

3. FOCUS GROUPS

3.1. Objective and general outline of the focus group sessions

As mentioned earlier, the objective of the second research cycle was to extend the relatively limited set of observations that were found in the literature with the knowledge that drivers and experts had or assumed about manifestations of driving in haste. Their opinions were gathered in focus group sessions and later converted into indicators.

In all conducted sessions, a questionnaire and visual material were used to stimulate discussions, and to maximize the amount of the elicited knowledge. Additionally, a specific procedure was elaborated for conducting the sessions. Four days before a focus group session took place, the participants received a visual dictionary to familiarize themselves with the (driving-related) terminology that was used in the session.

Five focus group sessions were conducted in Colombia, South America. The first four sessions were organized with people who used cars for professional purposes. The fifth session was conducted with experts who had different backgrounds and were active in different fields. These sessions were spread over five weeks. Each session was structured as follows: At the start, each participant received the socio-demographic data form and the image-based questionnaire. Actually, the first half hour was spent for preparation. All participants were asked to complete the above data form, which requested the participants to provide information about age, gender, driving experience, and education. Then the participants were asked to watch a video with traffic situations with the aim of bringing them into the context of the session. After this, they were asked to provide answers to the questions of the image-based questionnaire concerning possible manifestations of haste. In the following hour a female moderator (M.Sc.-level researcher) moderated a group discussion on the specific questions. The same moderator was present in all sessions. All sessions were video and audio recorded, and later transcribed. The data from the transcriptions was pruned and analyzed in order to arrive at a descriptive theory about the most important indicators of being in a hurry.

3.2. Sampling of groups and subjects

Four of the five Colombian focus groups were composed of participants who used cars for professional purposes at different companies (n =12, n=10, n=9 and n=8). The fifth group (n=8) was composed of experts with backgrounds in medicine (n=3), transportation (n=3) and psychology (n=4). In the stage of data analysis, the outcomes of the former sessions were compared with those of the latter sessions.

The number of participants in each of the groups was based on Krueger recommendation [62]. He proposed that groups consisting of 8-10 participants per session are most efficient. Anticipating cancellations and no-show ups, we over-recruited each group by inviting 12 persons. The number of focus groups was decided based on Nyamathi and Shuler recommendations [63]. They proposed that four focus groups are adequate to reach sufficient saturation, which is the point where no new information emerges from additional groups.

To select the non-experts, purposive sampling was applied. This allowed us to obtain a diverse sample of about 48 individuals (n=48) who drive a car on a daily basis (i.e. who were experienced at driving a car). Purposive sampling was entirely based on the researcher’s judgment. To select the participants, the following set of criteria was applied: (i) being at least 20 years of age, (ii) having a valid driving license, (iii) having minimum 3 years of drive experience, and (iv) traveling at least 150 km per week for professional purposes. Based on this set of criteria, a list of eligible persons (n=118) was compiled. The proposals for the possible participants were made by the Human Resource Management departments of five companies. There were twenty people (n=20) on this list who worked for a taxicab company. Due to the fact that they had a different socioeconomic status than the other subjects, and in order to maintain homogeneity inside the groups, these people were considered as possible participants of one focus group session. Each of them received our invitation and the group was actually formed from the first twelve volunteers.

From the other people whose names remained on the list (n=98), a total of seventy eligible persons (n=70) were randomly chosen for the other focus group sessions. They received invitation to participate and were randomly sorted into three focus group sessions. Each of these sessions involved twelve participants, who were selected from the first 36 volunteers. For setting up the expert group, we specifically used snowball sampling by contacting three doctors (one psychiatrist, and two internists), four psychologists (three behavioral psychologists, one neuropsychologist) and three traffic policeman (minimum three years of experience). These

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2 All developed contents can be requested from the main author by email.
3.4. General workflow of processing the gathered data

After each focus group session, the recordings were transcribed and the notes taken by the moderator on paper were typed. Data analysis involved the following main actions (i) arranging the gathered raw data (verbal expressions) in groups according to their meaning (semantic groups) and characterizing each group by an expressive textual descriptor, (ii) sorting the descriptors (possible observations regarding the haste state) according to the reasoning model presented in section 2.2 in order to compare it with the literature (iii) identifying the background phenomena based on the consideration of the descriptors, (iv) deriving indicators from each phenomenon, and (v) sorting these indicators according to the different domains of the reasoning model presented in section 2.2, and making an assessment of these indicators.

3.5. Filtering the data and sorting them into semantic groups and into the different knowledge domains

After completing all the five focus group sessions and transcribing the outcomes into text, the transcripts of the recordings were analyzed by two members of the research team and the irrelevant textual parts were removed. The resulting processed text was actually the basis for sorting the data into groups that referred to the same possible observation (semantic groups). The criterion used in sorting into semantic groups was whether the transcribed data element was related to the same possible observation mentioned by the participants or not. Each semantic group referred to one particular observation mentioned by the participants. The semantic groups were created by the researchers in an inductive way. While they were browsing through the transcripts, a group was created every time a new observation of driving in a hurry was found. For creating each group, the researchers started with one data element (sentence or phrase) mentioned by a participant that referred to one possible observation. Then they looked for textually and/or semantically congruent, or similar, data elements in the transcript and they gathered them in a group (the first semantic group). The search was done using synonyms or similar expressions.

Afterwards, they took another data element that referred to another possible observation and that has not been grouped yet and they did the same procedure in order to form a new semantic group. They repeated the procedure until they have grouped all the data elements. This mean, until all semantic groups have been formed. Then, researchers assigned expressive descriptors to each group. In several cases, the most characteristic (transcribed) verbal expression was used as the descriptor in each group. For example, in the transcripts people mentioned statements like “The driver is waving his hands quickly”, “The driver is making movements of the hands faster”, “The driver moves his arms aggressively”. All these statements were gathered in one group and the descriptor used was “The driver is moving hands and arms abruptly”. The list of some examples of the semantic groups that refer to possible observations of driving in a hurry can be seen in Table 1. In this list, we also recorded the frequency with which the participants mentioned each statement about possible observations related to driving in a hurry in the focus group sessions.

3.6. Identifying background phenomena to derive indicators

After completing the list of semantic groups, the researchers came together and compiled the lists in one file. Afterwards, for each semantic group, the researchers inductively derived the background phenomenon using a rational reasoning. The phenomenon was a generalization of the possible observation mentioned by the participants. The goal of this generalization was to find other possible indicators that were not mentioned by the participants in the focus group sessions. So, the researcher taking each of the phenomena applied a deductive reasoning in order to derive all possible indicators of the phenomenon. By indicator we mean a testable research variable that is related to one aspect of the phenomenon. This derivation was done by searching for different implications of the phenomenon in the driving system: Driver-Car-Environment. For example, the background phenomenon derived for: “the driver is moving the hands and arms abruptly” was “Tendency to have a dynamic interaction with the car”. For this phenomenon the following indicators were derived: (i) force
exerted on the pedals (brake, clutch, gas), (ii) force exerted on the steering wheel, (iii) force exerted on the gearstick, (iv) speed switching between pedals, (v) acceleration of the body of the car, etc. All of these indicators are implied by this general phenomenon. The list of the background phenomena and indicators can be seen in Table 1.

3.7. Categorization and a rational assessment of indicators

Having derived the list of relevant indicators, we categorized them according to the different knowledge domains they semantically belong to (the reasoning model was presented in Section 2.2). Each of the indicators were allocated to one domain were they can be dominantly observed and measured. In order to assign the indicators to these knowledge domains consistently, we provided unambiguous definitions for each domain. This assured that each researcher over time or multiple researchers independently will arrive at the same results when sorting the indicators. For example, “heart rate” was allocated to the driver related knowledge domain, “force exerted on pedals (brake, gas, and clutch)” was allocated to the driver-car interaction related knowledge domain, “longitudinal acceleration” was allocated to the car related knowledge domain and “time headway” was allocated to the car-environment interaction knowledge domain. The list of all sorted indicators can be seen in Table 1.

After sorting the indicators into the different knowledge domains, we did a preliminary filter of the indicators choosing the domains where the change induced by driving in a hurry appears first. Assuming that (i) the driver behavior under the condition of driving in a hurry define everything which is observable (physiological, motor, perception, cognition changes), (ii) the behavior is transferred to the car through the driver interaction, (iii) the behavior of the car is already a reaction to the driver behavior, and (iv) the car-environment interaction is a “distant” (indirect) reflection of the driver behavior; then the indicators that were selected were the ones that belonged to the driver and driver-car related domains because they are the first domains where the change induced by driving in a hurry occur. The rest of the indicators were filtered out because they were just propagations of the human behavior (indirect driving behaviors) which occurred later in time. Besides, using indirect indicators like the ones coming from the car behavior and car-environment interaction needs a system that can cope with larger changes in the characteristics of the roadway, road quality and lighting. Additionally, some of the indicators highly depend on the vehicle type, driving experience and age. Indirect measures from driving behavior are much more difficult to interpret and seem partly not very suitable to infer from them the driver’s state. They may not be specific to only driving in a hurry but also to other states of the driver (i.e. fatigue, distraction, etc.). The collection and the correct interpretation of indirect measures require knowledge about the surrounding environment. For example, for calculating the frequency changing lanes, lane markings have to be assessed by sensors. Also steering activities can only be interpreted correctly if influencing factors from the environment (e.g. driving through curves) or driving maneuvers (e.g. turning, lane changing) are considered. Besides, the methods relying on these indicators are not attempting to detect driver state per se, but the effect of changes in the driver’s state that are significant for road safety. It is our belief that indirect driving parameters will never be suitable to be used as single measures alone for the detection of driving in a hurry as it was proved to be for other states such drowsiness and distraction [64]. They always have to be combined with direct driver-related measures (i.e. indicators related to the driver and driver-car interaction knowledge domains). Indicators coming from the driver and from his/her interaction with the car are inevitable and are expected to explain the highest amount of variance within a combined algorithm. We think that a system based on driver related measurement will achieve the best accuracy in terms of driver state detection due to the fact that they measure directly on the human which is the source.

After selecting the indicators related to the driver and driver-car interaction domain, we selected from these domains the most viable indicators for measuring. The selection was carried out by considering criteria that were also contemplated in other research projects about detection of driver’s state. These criteria were the recognizability, specificity and measurability of the indicator for this state [65]. Recognizability refers to how dominant the indicator for driving in haste is. Specificity refers to how indicative of driving in haste and not of other states is the indicator. Measurability refers to how easy to measure is the indicator. After evaluating the compliance of the indicators with the proposed criteria, we hypothesized that in the context of our research measuring the heart rate, the intensity of the body movements (e.g. turning, lane changing) are considered. Besides, the methods relying on these indicators are not attempting to detect driver state per se, but the effect of changes in the driver’s state that are significant for road safety. It is our belief that indirect driving parameters will never be suitable to be used as single measures alone for the detection of driving in a hurry as it was proved to be for other states such drowsiness and distraction [64]. They always have to be combined with direct driver-related measures (i.e. indicators related to the driver and driver-car interaction knowledge domains). Indicators coming from the driver and from his/her interaction with the car are inevitable and are expected to explain the highest amount of variance within a combined algorithm. We think that a system based on driver related measurement will achieve the best accuracy in terms of driver state detection due to the fact that they measure directly on the human which is the source.

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4. JUSTIFICATION OF THE THEORY ABOUT RELEVANT INDICATORS

In order to provide evidence that justifies the properness of the theory about deriving the relevant indicators of being in haste (presented in subsections 3.5 – 3.7) we carried out two logic-based analyses, namely, (i) congruency analysis, and (ii) correspondence analysis.

4.1. Congruency analysis

In general, a congruency analysis concentrates on how much various bodies of knowledge from different sources overlap semantically (logically) and/or how much they complement each other. The main considerations of our congruency analysis are discussed below:
Table 1. Derived indicators related to driving in haste

<table>
<thead>
<tr>
<th>Example of some semantic group</th>
<th>Freq</th>
<th>Background Phenomena</th>
<th>Derived indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>The driver argues with other drivers and self-complain a lot</td>
<td>28</td>
<td>Intense drive for immediate aggressive verbal communication</td>
<td>Pressure of voice - Pitch of the voice - Number of aggressive words - Number of moan.</td>
</tr>
<tr>
<td>The driver swears at others or yell (verbal aggression)</td>
<td>15</td>
<td></td>
<td>Presence of change in the facial expression - Presence of frowning (activity in the corrugator supercilli) - Presence of aggressive gesture with the hand - Presence of mouth movement - Making gestures indicating other people to move.</td>
</tr>
<tr>
<td>The driver makes gestures with the hand or mouth</td>
<td>13</td>
<td>Intense drive for immediate non-verbal (gestural) communication</td>
<td>Frequency of hand / arm motion - Frequency of leg / feet motion - Frequency of head motion - Frequency of eye movements - Frequency of moving the trunk of the body - Number of changes of pressure distribution on the seat - Frequency of the driver checking the time - Presence of frowning (activity in the corrugator supercilli) - Frequency of touching the head.</td>
</tr>
<tr>
<td>The driver frowns</td>
<td>23</td>
<td></td>
<td>Frequency of hand / arm motion - Frequency of leg / feet motion - Frequency of head motion - Frequency of eye movements - Frequency of moving the trunk of the body - Speed of head movement - Speed of eyes movement - Time the hands remains on the gearstick - Time the foot remains depressing the clutch - Frequency stepping on the lane line - Frequency of failing to yield a pedestrian - Tailgating (Distance between cars) - Frequency of horn honking - Frequency of moving the steering wheel - Inclination of the tires from the road.</td>
</tr>
<tr>
<td>The driver moves the hands - arms frequently (conscious to operate controls of the car or unconscious like nervous movements)</td>
<td>21</td>
<td>Intense drive for unconscious body part motion (nervous movements)</td>
<td>Speed of hands / arms movement - Speed of feet / legs movement - Acceleration of hands / arms movement - Acceleration of feet / legs movement - Acceleration of head / neck movement - Frequency of hand / arm motion - Frequency of leg / feet motion - Frequency of head motion - Frequency of eye movements - Frequency of moving the trunk of the body - Speed of head movement - Speed of eyes movement - Time the hands remains on the gearstick - Time the foot remains depressing the clutch - Frequency stepping on the lane line - Frequency of failing to yield a pedestrian - Tailgating (Distance between cars) - Frequency of horn honking - Frequency of moving the steering wheel - Inclination of the tires from the road.</td>
</tr>
<tr>
<td>The driver makes mistakes often</td>
<td>26</td>
<td></td>
<td>Frequency of errors when operating the gearstick - Frequency of not pressing the clutch properly - Frequency of accidentally pressing the horn - Frequency of riding the clutch - Frequency of releasing the clutch too soon.</td>
</tr>
<tr>
<td>The driver drives the wrong way</td>
<td>5</td>
<td>Tendency to commit errors</td>
<td></td>
</tr>
<tr>
<td>The driver presses the pedals harder</td>
<td>22</td>
<td>Tendency to make dynamic interaction with the vehicle</td>
<td>Force exerted on the pedals - Force exerted on the gas pedal - Force exerted on the brake pedal - Force exerted on the clutch pedal - Force exerted on the steering wheel - Speed of switching between pedals - Speed of moving the steering wheel - Speed of moving the gearstick - Force exerted on the gearstick - Force exerted on the steering wheel - Force exerted on the horn - Pressure exerted on the steering wheel - Acceleration of the body of the car.</td>
</tr>
<tr>
<td>The driver makes sudden movements of the steering wheel (turning the steering wheel harder)</td>
<td>9</td>
<td>Tendency to operate frequently the vehicle.</td>
<td>Frequency of using clutch pedal - Frequency of pressing brakes - Frequency using the steering wheel - Frequency of pressing gas pedal - Frequency of shifting gears - Frequency of horn honking.</td>
</tr>
<tr>
<td>The driver uses the horn frequently (horn honking a lot)</td>
<td>46</td>
<td></td>
<td>Position of accelerator pedal (displacement of the accelerator pedal to the max position) - Engine rpm - Acceleration of the body of the car - Tire wear - Speed of the wheels - Rate of fuel consumption - Rate of change of the fuel level gauge - Rate of deceleration - Sound level of the engine - Rate of temperature change in the engine - Acceleration of the car - Speed of the car - Tire wear rate - Level of speedometer - Level of RPM - Rate of change of the odometer - Amount of emissions - Temperature on the brakes disk - Temperature on the engine - Vibrations of engine (Cyclic amplitude of the vibration) - Position of the brake pedal (displacement of the brake pedal to the max position) - Frequency of turning the lights on and off - Presence of screeching of the wheels.</td>
</tr>
<tr>
<td>The gas pedal is pressed up to the maximum position</td>
<td>12</td>
<td>Tendency to overuse the capabilities of the vehicle.</td>
<td></td>
</tr>
<tr>
<td>The speed average is higher than normal</td>
<td>34</td>
<td></td>
<td>Frequency running red lights - Frequency running stop signs - Speed near a stop sign - Speed on the speed bumps - Frequency and duration driver goes the wrong way - Frequency disobeying traffic signs - Frequency of dangerous overtaking - Distance between cars - Speed on curves.</td>
</tr>
<tr>
<td>The car runs the red lights or drives through the yellow lights</td>
<td>35</td>
<td>Tendency to underestimate the risk</td>
<td></td>
</tr>
<tr>
<td>The speed average is higher than normal</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Due to the limited resources and time, it was not realistic to strive for an exhaustive collection of statements about possible observations concerning being in a haste. Obviously this meant that the obtained set of statements mentioned by the participants of the different focus group sessions and the literature could give us just a limited approximation of the ideal knowledge. Under ideal knowledge we mean the exhaustive collection of statements that hint all indicators of being in haste and that would guarantee the strongest basis for deriving indicators. The sets of statements about possible observations collected from the different focus group sessions and literature represent just a part of this ideal knowledge. However, it can be considered as a proper assumption that the aggregation of the different set of statements obtained in various focus group sessions and literature can provide us with a good approximation of this ideal knowledge.

Obviously, if the set of statements coming from the different sources (i.e. different focus group session or literature) would define completely disjoint (i.e. non-overlapping) sets of statements, the ideal knowledge formed by these set of statements would be questionable. This implies the need for a congruency analysis with the objective to show how much the statements from the different sources overlap with each other semantically, and how much they complement each other towards the sought for ideal knowledge. We started the congruency analysis with a saturation test. In our case, saturation means, and is reached, when no significant new statements emerge from the subsequent focus group sessions. It should be seen that saturation can not be considered without taking into consideration the minimal number of focus groups that are needed for a successful experimentation. The larger the number of focus groups, the larger is the chance to have differing statements.

On the other hand, it is a clear indication that saturation was achieved with the involved sample of population if no new statements are obtained from the subsequent focus group sessions (i.e. the participants of the subsequent focus group are just repeating what was mentioned by the participants of the preceding focus group sessions). Involving the outcome of each of the focus group sessions, the saturation test showed that even the group of experts has not significantly extended the results obtained from the four non-experts groups. Though five groups may sound few, the decision on the requested number of focus groups sessions was based on the work of Nyamathi and Shuler, which suggested that four sessions should be sufficient to reach saturation [63]. The research design of our focus group sessions seems to reconfirm this theory.

Since the focus group sessions represent “one-time actions”, their outcome also represents “one-time results”. This in principle could be applied to the related professional literature but just over a much longer time (perhaps decades). Consequently, extending the saturation test to the literature publications did not seem to be meaningful. In the congruency analysis we used that set of statements about the possible observations concerning driving in haste, which were available in the time period of conducting the literature study. This means that a below-saturation set of statements has been used in the congruency study.

In order to operationalize the mentioned strategy of congruency study, we introduced a measure called congruency index, $C_i$. The congruency index $C_i$ is a measure of how much the statements gathered from the focus group sessions and the literature study semantically overlap and/or complement each other. Eventually, this index also informs about the proportional contribution of the focus group sessions and the literature study to the aggregate knowledge. The congruency index has been formally defined as:

$$C_i = \frac{I_i}{T}, \text{ where,}$$

$$I_i = \{G1,G2,G3,G4, GN, GE, L, GN\cap GE, G\cap L\}$$

$T$ = total number of statements mentioned by all sources

$T$ can be considered as an approximation of the ideal knowledge or, in other words, the “relative truth”. In the rest of this paper it will be called “aggregated knowledge”. This congruency indexes were calculated for each of the four knowledge domains by considering the actual aggregated knowledge.

In the driver-related knowledge domain, the non-expert groups approached up to 80% the aggregated knowledge, while the experts up to 95% and the literature up to 45%. To our surprise, the literature did not contributed a large number of possible observations, and with a view to the aggregated knowledge, most of the possible observations were mentioned by the experts and the non-experts. All possible observations mentioned by non-experts were also indicated by the experts. Even more, the experts contributed with additional possible observations not mentioned at all by the non-experts. The literature offered only one more new observation, but mentioned up to 40% of the possible observations brought up by the groups together.

In the car-related knowledge domain, the non-experts brought about 100% of the possible observations, while the experts mentioned 80%, and the literature dealt with only 14%. All the observations related to this domain were mentioned by the non-experts. To our surprise, some of the possible observations in this domain were not mentioned at all by the experts. An explanation for this can be that we did not have experts in this field and we only conducted one expert session. The literature did not contribute to any new possible observations but mentioned 14% of those mentioned by all the groups together.

In the driver-car related knowledge domain the non-experts and the experts brought up 100% of the possible observations while in the literature we could find only 40% of

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4 Please refer to the nomenclature
5 The table that present the calculations of the correspondence indices can be requested to the main author
the aggregated knowledge. This means that all the statements of the non-experts were confirmed by the experts. To our surprise, the literature did not offer any new possible observation that would have not been mentioned by the participants of the focus group sessions, but confirmed 40% of the statements of all the groups together.

Related to the car-environment knowledge domain, the non-experts again mentioned 100% of the aggregated knowledge while the experts mentioned 93% of it, and the literature only 53%. 93% of the possible observations mentioned by the non-expert groups were confirmed by the non-experts. The literature, however, did not contribute to any new possible observation concerning the interaction of the car with the traffic environment during driving in haste, but discussed 53% of the statements made by all the groups together.

In general, the contribution of the particular focus group sessions to the aggregated knowledge was high for each knowledge domain. The majority of the possible observations were mentioned in the focus group sessions with non-experts. The literature only contributed one new statement in the driver related knowledge domain and this can be considered as a good mirror of the advancements in, and the maturity of this field of interest. For the driver-car and car-environment related knowledge domains, the saturation was reached in the non-expert focus group sessions. No information about other possible significant observations emerged in the follow up expert session. For the driver and car related knowledge domains, the saturation is not so dominant. There were some differences in the amount of possible observations mentioned by the various groups. For example, in the session conducted with cab drivers (G4) only 32% of the possible observations were mentioned with respect to the car related knowledge domain. An explanation of this may be the lower level of specialized education among the participants.

4.2. Correspondence analysis

In general, a correspondence analysis intends to make visible how much and what kind of bodies of knowledge underpins the aggregated knowledge. It is claimed that if a given piece of knowledge was mentioned by multiple sources (participants in the focus group sessions and publications), it gives a stronger underpinning of the aggregated knowledge than a piece of knowledge (possible observation) mentioned by one or just a very few people. Actually, a larger number of mentions indicate that people agree on the content and significance of a given possible observation. In other words, more frequent mention informs about how relevant the statement about the possible observation is to describe driving in haste. If correspondence is expressed in terms of a measure, then its higher value can indicate higher relevance. To express the measure of correspondence, we introduced a correspondence index $CO_i$. This can be applied to quantify the correspondence of the statements about possible observations, so as:

$$CO_i = \frac{F_i}{Ti}$$ where

$I = \{G, L\}$,

$F_i = \text{Frequency with which a statement is mentioned by a source}$

$T_i = \text{Total number of people taking part in the focus group sessions or conducted studies in the literature}$

We calculated this correspondence index for the outcome of the focus group sessions and the literature study in each of the four domains.

Regarding the driver related knowledge domain, the possible observations that have the highest correspondence to aggregated knowledge about the haste state in all the focus group sessions are swearing at others (57%), sweating (53%), frowning (47%), moving the eyes frequently (45%), turning the head and moving the hands frequently (43%), and inclining the body forward (43%). In the literature study, the highest correspondences showed for heart rate (45%), arterial blood pressure (25%), body temperature (25%), sweating at others (20%), sweating, changes in facial expression (15%) and breathing rate (15%). Both the group sessions and the literature study agree that swearing and sweating are the possible observations that mostly correspond to being in the haste state.

In the driver-car knowledge domain, the possible observations with the highest correspondence index in all the focus group sessions are horn honking (94%), checking the mirrors frequently (76%), flashing headlights (57%), and pressing pedals hard (45%). In the literature study, the highest correspondences showed for horn honking (36%), flashing headlights (18%), pressing pedals hard (18%), switching between pedals faster (9%), gripping hard the steering wheel and turning the steering wheel harder (9%). Both focus group sessions and the literature study agree on that horn honking, flashing headlights and pressing pedals hard are the most frequently observable manifestation of driving in haste.

In the car related knowledge domain, the high speed (69%), revving up the engine (65%) and hard acceleration (63%) were claimed to be the most frequent manifestations of being in haste. In the literature study, the higher correspondence indexes were for the high speed (79%), high acceleration (21%) and high deceleration (13%). Both the focus group sessions and the literature study agree that speed and acceleration are the most significant possible observations of change of normal behavior.

Regarding the car-environment related knowledge domain, changing lanes frequently (90%), running red/yellow lights (71%), disobeying traffic signals (57%), failing to yield pedestrians (51%) and tailgating (49%) showed the highest correspondence index values in the results of focus group.

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6 Please refer to the nomenclature

7 The table that present the calculations of the correspondence indices can be requested to the main author
sessions. In the literature study, the highest correspondences indices were for tailgating (64%), running red/yellow lights (29%), changing lanes frequently (14%), disobeying traffic signals (14%), failing to yield pedestrians (14%) and cutting others off (14%). Both, the focus group sessions and the literature study agree that in this domain, tailgating, changing lanes frequently and running red/yellow lights are the most important possible observations for driving in haste. Since driving in a hurry correlates with the physiological state of the drivers, it is not a real surprise that a large number of possible observations were mentioned related to the human body and to its bio-physiological operation. As in other similar states such being in stress, the most often mentioned driver-related possible observations were for example, sweating, muscle tension and heart rate variability. Overt behaviors, such as the change in facial expression and the intensity and frequency of body movements when operating the controls of the car, were also frequently mentioned as observable facts of driving in a hurry. This suggests that our hypothesis is valid for testing in the following research cycle.

5. VALIDATION OF THE FINDINGS

For the purpose of this confirmative study, two targets of validation were considered: (i) source validity, and (ii) investigator validity

5.1. Source validity

In this subsection we will discuss the validity of our sources, i.e., participants in the focus groups and papers collected for the literature study, and their possible influences on the findings. As major issues, we will consider the characteristics and randomness of sampling and, for the focus groups, the cultural background of the participants.

It is well known that social behaviors, cognitive processes, and attitudes are influenced by cultural background and the related values and norms [66]. Similarly, driver behavior is influenced by the local road infrastructure and road situation, particularities of typical cars and how they have been engineered as well as factors related to road users and traffic culture [67]. The focus group sessions were conducted in Colombia. Compared to the US and European countries, Colombia has less strict requirements for obtaining a driving license and the infrastructure and road traffic regulations, which affect driver behavior, are different. In Colombia, the road signs tend to resemble United States signage conventions more than the European and Asian conventions. In addition, Latin-American countries rank among the most collectivistic cultures while European countries such as Great Britain and the Netherlands have very high scores in individualism [68]. According to some researchers, drivers in individualistic cultures show a more conscious involvement in traffic, which leads to a safer driving compared to drivers in collectivistic cultures [69]. In this sense the driving style in Colombia may have large variation compared to the US and European countries, which may question the relevance of the data to other contexts and make generalization of this study to a larger population problematic.

Focus group participants were gathered through a process of non-probability sampling, which does not provide the proper degree of representativeness of a larger population that may be achieved in, for example, e-mail surveys. Besides, it has to be noted that focus group data are firmly contextualized within a specific social situation. Therefore they produce ‘situated’ accounts, tied to a particular context of interaction. Although this empirical generalization may be difficult to achieve, theoretical generalization may be possible [70]. The data gained from this study provided theoretical insights which possess a sufficient degree of generality to allow their projection to other contexts or situations which are comparable to that of the original study. In addition, it has to be considered that the findings of the focus group sessions were compared with other studies conducted in other countries (literature study). In this literature study, only scholarly journals, traffic reports issued by governmental agencies of different countries and peer-reviewed conference papers were considered. This increases the validity of the findings. However, whether we can extend the study into a more general context is still an issue for further research.

5.2. Investigator validity

According to the conventions, as a test, investigator validity evaluates the influence of the researcher on the findings. In this research project, the main researcher has a background in mechanical engineering and not in psychology. For minimizing the effect of the experimenter we used a “blind” data collection procedure. This means that the main researcher did actually not collect data or make observations but instead a “naive” observer was trained to do so. The person collecting the data and making the observations was unaware of the purpose of the study. This person was a design engineer master level student with good communication skills.

As suggested by Rubin & Rubin [71], we also established a detailed procedure for another investigator to know and check what we have done. Toward this goal a data collection protocol was produced, in which the conditions under which each of the focus groups was carried out, had been standardized. This guaranteed that no information was left out and that the procedure was stable over time and across researchers. In the same way, the researcher presented a detailed data analysis procedure in this paper in order for other researchers to reproduce similar results.

6. CONCLUSIONS

The applied general methodological framework allowed us to define a proper approach for the low level strategy for the literature study and the focus groups. The applied research methods proved to be appropriate for gathering information about the haste state. The use of focus groups for this knowledge exploration provided insights into the perceptions and opinions of participants about the haste state. This
approach proved to be well suited for generating preliminary hypothesis in a domain where little research has been carried out. In the same way, the literature study complemented the information found in the sessions and at the same time acted as a check or confirmation of the possible observations mentioned by the non-experts and experts in the sessions. However, the reported study faced some limitations.

The available literature was not centered around the topic of our study and did not reflect our objective. In a sense, it was more a general literature. The majority of the studies only focused on psychological understanding of this state. Just few of them presented limited information regarding system oriented solutions. Although we conducted four focus groups with regular drivers and one with experts, generalization of the findings to a larger population may be problematic. If this generalization is desired, focus group sessions or surveys in different countries have to be performed. The reasoning model provided sufficient guidance to the exploration of the possible observations related to driving in haste. In the literature and in all the focus group sessions, people mentioned facts in each domain confirming our null hypothesis: when driving in a hurry, people manifest symptoms not only in the body, but also in the relation with the car, the car behavior and in the interaction of the car with the environment.

The wide range of possible observations described in the literature study and in the focus group sessions had different descriptive power. They were not equally significant. Focus groups sessions conducted with professional drivers contributed more to the knowledge exploration, but they were confirmed only by some experts as it was shown in the congruency analysis. The studies described in the literature were few but their proposals were confirmed by peer reviewers. In this sense, the research question about the possible observations in the haste state was partially answered. We could verify some of the statements mentioned by the groups with the statements found in the literature but there is still uncertainty about some observations that were only verified by some experts. For this reason, in the following research cycle, we will test observations that had high correspondence to the haste state according to the focus group sessions and the literature study. This means we will test heart rate, the intensity of the body movements and the frequency operating the controls of the car. However, it is clear that further research is imperative in order to justify whether other characteristics can also be observed and to see if they should be considered from an instrumentation point of view.

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7. REFERENCES


