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Using Phenomenology To Assess Risk Perception Of A New Technology In Public Transportation

The Case Of The Autonomous Vehicles As Mobility as a Service (MaaS) In Switzerland

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Abstract — In the mobility sector, a large number of new technologies such as autonomous vehicles (AVs) and services (e.g. carpooling) are emerging. AVs involve not only passengers, but also authorities, manufacturers, public transportation companies, law enforcement officials, drivers, pedestrians and shopkeepers. Applying phenomenology – the description of a phenomenon's live experience [1] – to this case of Mobility as a Service (MaaS) contributes to understanding its complexity and provides insights of users' perception of risk related to the AVs. This new technology brings many opportunities to improve our mobility system. Identified potential risks can affect the efficiency and the perception of the service. In this exploratory research, we have employed a technique called experimental phenomenology to identify these risks. The major advantage of this approach is to take into account the perception of passengers as a driver for design.

Keywords: autonomous vehicle, phenomenology, risk perception, Mobility as a Service (MaaS), public transportation, smart shuttle

I. CONTEXT

The field of mobility is changing rapidly. There are several trends, such as the connected car, advanced driver assistance systems and AVs. Indeed, a vehicle can be automated to different degrees, the autonomous driving representing its most advanced state. In order to study how users perceive these new autonomous driving modes, we have employed a field study approach called experimental phenomenology. The phenomenological method is generally adopted to explore individual variations in meaning regarding specific user experiences. Those descriptions are revealed from users personal accounts and experiences as they emerge in the moment. Phenomenology is a well- established method within interpretative consumer behavior studies and is presently gaining acceptance within risk perception research.

A. Autonomous Vehicles (AVs) – The Smart Shuttle in Sion

In Sion (Switzerland), for the first time in the world public AVs are being used to connect the train station to the city center on public roadways. The Smart Shuttle, fully electric motorized, runs at a speed of (maximum) 20 kilometers per hour and can transport a total of 11 passengers. During this pilot test, an attendant (the groom) is in charge of the safety and system monitoring. This project involves the transportation company (La Poste), public authorities (the City of Sion and the Canton of Valais) and universities (EPFL and HES-SO Valais-Wallis). The first phase of this pilot test ran through the old town district of Sion on a route of 1.5 kilometers (vehicle and pedestrian areas) [2]. After this successful test, the route was extended through a more dense traffic road with smart traffic lights able to communicate with the AVs and a roundabout.

At the heart of the traffic, AVs will be responsible for transporting passengers while respecting aspects such as pedestrian safety and traffic rules. The arrival of AVs raises the question of risk and responsibility. As demonstrated by a recent study (www.bertelsmann-stiftung.de, “Mobilität und Digitalisierung: Vier Zukunftsszenarien”), two-thirds of German people do not trust the AVs. There is thus a need to understand precisely this phenomenon.

B. Mobility as a Service

The introduction of Mobility as a Service (MaaS) to daily life is a major issue for companies, public authorities, academics, and citizens, especially concerning end-user acceptance such as usefulness, ease of use, and security perception [3]. Fragnière et al. [4] defined service as a problem resolution that simplifies the life of the user and at the same time adds value. Therefore, new services must be designed, pretested and validated by performance and perception measurements [5].

C. Developing R&D specifically adapted to mobility services

R&D for Services, in contrast to R&D for Products, is less formal and not attached to dedicated facilities. In general, its innovation goal combines the service process and customer services. Generated innovations are therefore more sociological than technological. In this development, prototyping becomes a staging and storytelling of the new concept of services. The involvement of all users is primordial in order for them to better perceive the value of the service. In this context, service design methodologies, especially phenomenology as the observation and immersion phase could improve the assessment of risk perception [4].

II. LITTERATURE REVIEW

A. Mobility challenges

By 2050, 68% of the world population will be living in urban areas [6]. According to Valerio [7], this expected increase in urban population will create a colossal mobility challenge so that the public transport infrastructure will encounter a great deal of pressure to cope with demand. The Vice-President of the European Commission, Commissioner for Transport and Energy already indicated in 2002 that the majority of European countries consider the negative consequences of traffic, in particular traffic congestion, air pollution and noise, predominantly in cities, no longer tolerable [8].

Indeed, many cities are already reducing road and parking space for cars [9]. As capitals and towns become, inevitably, less car-friendly while increasing their populations, people will gradually abandon the use of private vehicles. Already, many millennials are following that trend. There is a significant and rapid increase of young people postponing their driver's license, once considered a rite of passage [10] [11].

B. New technologies in the mobility system

According to Hannon et al. [12], the mobility systems will evolve from what exist today. The users are at the heart of this evolution and are open to adopting new technologies and services. Both the public and private sectors will have to join forces in paving the way for an effective and sustainable new mode of mobility.

Vehicles are becoming increasingly computerized and intelligent and can already assist aspects of driving, such as pedestrian safety. Driven by many opportunities from those new technologies, manufacturers and other stakeholders are racing to develop autonomous vehicles. Benefits such as improved safety, reduced congestion, lower emissions, and higher productivity can therefore be expected. While the technological aspects must be addressed, it is similarly critical to analyse the integration of autonomous vehicles into the social aspects of traffic and car use [13].

C. Mobility as a Service

The digital revolution has unlocked new opportunities to improve customers' experience in public transportation. The role of smart technology is therefore to deliver services that are personalised, customising the needs and preferences of public transport users. This pioneering role of service delivering is known as mobility as a service (MaaS). While MaaS models provide great opportunities to meet customer expectations, they are also responsible for the disruption of current practices involving mode-specific contracts, protected service areas and often under-utilised bus capacity [14].

D. Autonomous Vehicles (AVs) for public transport

Mobility services are rapidly evolving on a global scale. Major breakthroughs in autonomous public transport could potentially be a turning point in urban mobility. Consumer behaviours and needs are constantly evolving from ownership towards usership. Passengers are the real consumers of mobility services and their perceptions of safety and security have a significant influence on

acceptance of public transport. While their subjective perceptions are fundamental to assessing service performance, there is a lack of empirical data on user experience. More than ever, a positive user experience is at the heart of customer engagement, which is based on internal cognition and emotion [15].

Koopman et al. [16] argue that a more methodical testing approach is needed to ensure quality of such service, where the software is tested primarily on the basis of system failure.

For the authors, testing at the vehicle level will not be sufficient to ensure safety. The most apparent challenge in an entirely autonomous vehicle is the absence of a driver on whom safety engineers can no longer rely to assess the safety and security whilst the vehicle is in operation.

E. Phenomenology

While users rely on these new autonomous vehicle technologies, they actually do not have any control over the technical elements, particularly as they also do not have much understanding of how they operate. To deal with the anxiety and helplessness resulting from this lack of control, users have no choice but to trust the technology and by extension both the engineers and regulators responsible for their implementation. Consequently, the concept of trust becomes a central theme in the examination of risk perception and communication in contemporary society: trust being a very complex process interrelated with notions of individual, social freedom and responsibility [17].

As new social relationships between the vehicle and users emerge while transport automation becomes more prevalent, the emphasis placed on interactions with the driver rather than with all passengers will be questioned. When the co-experience of AVs becomes a constitutive aspect of vehicle use, it is essential to understand how people socially interact with autonomous vehicles for future use and adoption, but little is known at present [13].

In this paper, phenomenology is adopted as an interpretive approach for risk perception assessment. This approach was used by Sanderg [18] to describe qualitatively different ways in which aspects of reality are experienced and refer to people ways of experiencing or making sense of their world. Marton [19] argued that this kind of research aims at description, analysis and understanding of experience directed toward experiential description.

F. Risk perception

Perceived risk has a part to play in consumer behaviour [20]. In this context, risk is defined as the "effect of uncertainty on objective" [21]. According to Bauer, perceived risk is "a combination of uncertainty plus seriousness of outcome involved" [22]. This concept posits that consumers' choices are classified as risk-increasing or risk-decreasing behaviour [23]. In the Perceived Risk Theory, several categories of risk composed the overall perceived risk [24] [25] [26]:

- Financial, the probability of losing money;
- Performance, the probability that something does not work properly;
- Physical, the probability that something is not safe, is harmful or injurious;
- Psychological, the probability that something affects the way you think about yourself;

- Social, the probability that something affects the way others think of you;
- Time, the likelihood of wasting time.

Mediating factors affect the perception of risk: inadequate information, immediacy of events, bounded rationality, personal traits (such as the degree of risk averseness) and a predisposition towards the innovation [27].

III. METHODOLOGY

A. Selecting participants and collecting data

In April 2018, 21 risk management students from a university in Switzerland (Master's students) used the smart shuttle for the first time. Participants were required to complete a qualitative survey on their perceptions before, during and after this experience. Two questionnaires were given to them before and after.

The first questionnaire was created to collect the passengers' perceptions before the experience:

- You will take an autonomous vehicle without a driver; is this the first time? If not, tell about your previous experiences.
- What are your concerns about such a means of transportation?
- Do you see any advantages to this mode of transportation?
- Use three words to describe the transportation experience you are about to have.

The second questionnaire was created to collect the passengers' perceptions during and after the experience:

- Can you describe in a chronological and simplified way, from beginning to end, your journey by shuttle?
- What did you particularly like and why?
- What did you particularly dislike and why?
- If you had a magic wand, what would you change in this experience?
- Have any of the apprehensions you had before taking the shuttle changed since then?
- Would you consider, in the future, taking a vehicle without a driver, in a more systematic way (public or private transport)? Why?
- To conclude, would you like to add a few additional remarks?

IV. DATA ANALYSIS

The components of the Perceived Risk Theory (PRT) are used to analyse the collected data with the RQDA software. This analysis is divided in three stages: prior to, during and after the experiment. The data were classified according to the components of the PRT.

Prior to the experiment, the participants perceived the following risk elements:

- Financial: AVs can reduce the cost or the public transport. Indeed, “no need to pay a driver”.

- Performance: For our participants, AVs will “always respect the rules”, “be on time”, avoid traffic jams, and reduce or avoid errors due to the driving.

However, they mention many apprehensions: “don’t stop when I have to go out”, “don’t brake”, “don’t know where to go”, “too hot”, “no driver” or “don’t open the door” are cited.

- Physical: For the participants, AVs can reduce the risk of having an accident. However having an accident is also one of the main apprehensions cited.

- Psychological: Participants will use an AV on a public road for the first time. For them, “it's hard to imagine how it [the experience] will take place and how it will feel inside.” Especially, they would like to know if “we feel safe?” Furthermore, the absence of the driver makes them feel insecure; “I’m not confident”. Some of the participants are sensitive to the idea that some jobs will be eliminated.

- Social: AVs could replace the personal vehicle. One other advantage is that AVs allow passengers to be more social and engage in conversation.

- Time: For participants, AVs are more punctual and can save time. However, a participant mentioned that “some routes are faster on foot”.

During the experiment, the participants perceived the following risk elements:

- Performance: Participants remarked that the Smart Shuttle is able to run into narrow streets, that it is aware of the traffic and that it stops to avoid the pedestrians. However, the groom often needs to drive the Smart Shuttle. The manner in which the Smart Shuttle brakes is brutal and scares some participants.

- Physical: One participant was not able to enjoy the scenery. Indeed, he was concerned with “potential bumps”.

- Psychological: The presence of the groom calms the participants. One participant became “claustrophobic”.

- Time: At the bus stop, participants had to wait a long time for the Smart Shuttle. They did not appreciate this waiting. They remarked that the shuttle rides slowly and stops frequently.

After the experiment, the participants perceived the following risk elements:

- Financial: The actual solution with a groom on board “is very expensive” and does not reduce the cost of public transport.

- Performance: Participants enjoyed how the Smart Shuttles brakes, detects physical obstacles and pedestrians. They observed the capacity of the Smart Shuttle and its agility to circulate better through narrow streets compared to human drivers. They appreciate that the groom has "an Xbox joystick for a potential control". However, some participants were disappointed that there was a groom inside. They would like to remove the driver. Furthermore, they do not appreciate the braking of the Smart Shuttle and would like to soften it.

- Physical: The presence of the groom was appreciated in case of a potential crash and participants enjoyed that "security is a priority". However, the braking is hard and dangerous for the physical safety of passengers.

- Psychological: The panoramic windows allow participants to enjoy the scenery. They can discover the city.

- Social: Participants enjoyed the layout of the Smart Shuttle as it facilitates discussions with other passengers.

- Time: For participants, the speed of the Smart Shuttle is too slow. Participants would like to augment the speed "without increasing the accident risk".

During the three stages, innovation and information were mediating factors that influenced the perceived risk (reduction or increase).

V. DISCUSSION

With this new technological disruption, autonomous transport presents its new concepts and applications that can be, at first, unfamiliar and daunting. While it brings plenty of opportunities to better our mobility system, it also carries potential risks that can lead to more complications, rather than relieving the public transportation systems from existing inefficiencies. Furthermore, the introduction of AVs in the public transportation systems raise similar questions such as other new automation technologies such as replacement of human by machine or loss of control over decisions and responsibilities.

For all participants this was the first time they rode in a motor vehicle on open roads without the intervention of a driver. They appreciated the novelty of the experience and enjoyed participating in this experimental phenomenology experience as part of a course. The participants felt that the autonomous shuttle experience is well adapted to a sightseeing tour as the vehicle can easily face the challenges of the narrow and winding roads of the old town.

The data shows that the level of risk perception with the new technology of AVs varies. With a fully autonomous vehicle, drivers cannot be counted on to cope with exceptional situations. According to our analysis, the presence of a human being such as a driver seems to be a key element in the perception of risk by users. However, these results are based on participants' preconceptions. They had no real AV experience and their preconceptions were influenced by recent media-related events on some rare AV accidents. Their anxiety is certainly due to the loss of human control over the vehicle and the lack of confidence in a vehicle-driving algorithm, which calls into question the machine's ability to handle the unexpected. As a result, participants were very attentive to details that are typically no longer observed when a human is driving (first turn, first braking, driving

correction details or handling of the groom to avoid obstacles). Moreover, participants tend to personify the AV. This leads them to compare the AV's driving performance to the human ability to operate a vehicle in complex situations.

Due to the legislation in force, the pilot test demands the presence of a human operator. Furthermore, the AV's technology was not fully operationally compelling; at certain times, the operator had to regain control of the vehicle by using an "Xbox controller". The use of such a control led the participants to consider the autonomous shuttle as a gadget.

Such conditions did not contribute to giving a "Wow effect" to the experience, resulting in no particular enthusiasm for taking this type of vehicle again. There is no come back taste, meaning no recurrence of the service.

The results of this experiment show that the participants were not aware of their new role. Are they users or testers of a new technology? To our opinion, and in this particular case, the transportation company has to put more emphasis on the crucial role of tester, which means that these first users are here to give their opinion about this new mobility mode. Based on their perception, they can typically contribute to improve the overall experience of being passengers in an AV. For adequately shaping and designing futuristic mobility modes, transportation companies should include such "perception test benches" in their R&D

function and "tangibilize" their effort to the public (e.g. create a flyer to explain such testing and related conditions for all passengers, collect data about their perception and ask for recommendation). This approach would lead to relevant "co-creation" in order to better serve the cause of public transportation. In our view, passengers are not solely travelling, but also testing and contributing to new kinds of mobility. Public transportation R&Ds must absolutely understand this so that future passengers of AVs will have a good perception of the phenomenon they are experiencing.

VI. CONCLUSION

While the use of phenomenology to study risk perception associated with new technologies is not very common in typically very engineering-orientated fields like systems reliability, this approach may lead to new appreciations and understandings of such disruptive phenomena. Indeed, the use of phenomenology shows great potential in terms of understanding risk perceptions related to a new technology, such as AVs. Those findings can be used in the future to define scenarios for the use of the Smart Shuttle of Sion. These scenarios will then be "staged" in real size and evaluated in order to design new "operating modes" of Mobility as a Service in the case of public transport based on autonomous shuttles.

The introduction of new technologies into everyday life is a major challenge for businesses, public authorities, academics, citizens, etc., in particular its acceptance by the end user as the utility, ease of use and risk perception.

R&D for services, unlike R&D for products, is less formal and is not linked to dedicated facilities. In general, its innovation objective combines the service process and customer service. The innovations generated are therefore more sociological than technological. In this development, prototyping becomes a staging and narration of the new service concept. Consequently, new services could be pre- tested and validated by performance and risk perception measures.

REFERENCES

[1] H. Starks and S. Brown Trinidad, "Choose your method: A comparison of phenomenology, discourse analysis, and grounded theory," in Qualitative health research, 17(10), 2007, pp.1372-1380.

[2] G. Eden, B. Nanchen, R. Ramseyer and F. Evéquoz, "Expectation and experience: Passenger acceptance of autonomous public transportation vehicles," in IFIP Conference on Human-Computer Interaction, 2017, pp. 360-363.

[3] P. Jittrapirom, V. A. W. J. Marchau, R. van der Heijden and H. Meurs, "Future implementation of Mobility as a Service (MaaS): Results of an international Delphi study," 2018.

[4] E. Fragnière, R. Ramseyer, V. Grèzes, P. Kuonen, B. Nanchen and J.M. Sahut, "Service Design and Educational Challenges to Foster Innovation in Tourism: the case of the Swiss Matterhorn Region," in Gestion 2000, 34(1), 2017, pp. 203-213.

[5] E. Fragnière, F. Cimmino, L. Emery, M. Héritier, M. Kambly, B. Nanchen and R. Ramseyer, "An ethological experiment to improve airport security gate process reliability: Understanding time perception and personal awareness of older adult travelers," in 2nd International Conference on System Reliability and Safety (ICSRS), 2017, pp. 68-73.

[6] "68% of the world population projected to live in urban areas by 2050, says UN," May 2018. Retrieved July 26, 2018, from https://www.un.org/development/desa/en/news/population/2018- revision-of-world-urbanization-prospects.html.

[7] P. Valerio, "Autonomous Car Mobility Shifts Electronics Industry," October 2016. Retrieved July 26, 2018 from https://www.ebnonline.com/author.asp?section_id=3560&doc_id=28 1835.

[8] L. de Pacio, "The new challenges for urban transport - Europa EU", europa.eu/rapid/press-release_SPEECH-02-519_en.pdf, 2002

[9] M. J. Nieuwenhuijsen and H. Khreis, "Car free cities: pathway to healthy urban living," in Environment international, 94, 2016, pp. 251-262.

[10] A. Delbosc, "Delay or forgo? A closer look at youth driver licensing trends in the United States and Australia," in Transportation, 44(5), 2017, pp. 919-926.