



Delft University of Technology

Document Version

Final published version

Licence

CC BY

Citation (APA)

Vledder, G., & Van Nes, N. (2026). How to steer automated transport applications toward societal and traveler benefits: Fast Automated and Smart mobility impact Tool (FAST). In *AutomotiveUI Adjunct 2026 - 18th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 143-149). (AutomotiveUI Adjunct 2026 - 18th International Conference on Automotive User Interfaces and Interactive Vehicular Applications). Association for Computing Machinery (ACM). <https://doi.org/10.1145/3828158.3838243>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

In case the licence states "Dutch Copyright Act (Article 25fa)", this publication was made available Green Open Access via the TU Delft Institutional Repository pursuant to Dutch Copyright Act (Article 25fa, the Taverne amendment). This provision does not affect copyright ownership.
Unless copyright is transferred by contract or statute, it remains with the copyright holder.

Sharing and reuse

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

This work is downloaded from Delft University of Technology.

How to steer automated transport applications toward societal and traveler benefits: Fast Automated and Smart mobility impact Tool (FAST)

Gerbera Vledder*

Industrial Design Engineering
Delft University of Technology
Delft, Zuid-Holland, Netherlands
g.vledder@tudelft.nl

Nicole van Nes

Industrial Design Engineering
Delft University of Technology
Delft, Netherlands
c.n.vannes@tudelft.nl

Abstract

Automated mobility solutions are rapidly advancing globally, offering potential benefits in safety, sustainability, efficiency, and inclusivity. However, these benefits are not guaranteed and could decrease if improperly managed. This paper introduces the Fast Automated and Smart mobility impact Tool (FAST), a method to assess and visualize automated mobility's impact on travelers and society. Developed through an iterative design process involving literature review, tool design, and expert validation, FAST enables rapid initial assessments to stimulate discussion and inform decision-making. Preliminary validation shows potential but highlights the need for objective clarification, impact indicator refinement, and improved user group distinctions. Future work includes additional validation, framework elaboration, and interactive tool development to better support policy makers, researchers, and designers in evaluating automated mobility options. FAST can empower UI researchers to initiate dialogue with policy makers and industry, steering toward meaningful human-machine interactions, improving travel behavior, and facilitating acceptance of desired automated mobility futures.

CCS Concepts

• **Human-centered computing** → **Human computer interaction (HCI)**.

Keywords

Automated Vehicles, Social Value, Human Centered Design

ACM Reference Format:

Gerbera Vledder and Nicole van Nes. 2026. How to steer automated transport applications toward societal and traveler benefits: Fast Automated and Smart mobility impact Tool (FAST). In *18th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI Adjunct '26)*, September 20–23, 2026, Gothenburg, Sweden. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3828158.3838243>

1 Introduction

As automation technology is maturing, it is seeking its way to the global market, and we increasingly see full self-driving vehicle

applications in place around the world. Including well known examples in the United States such as the Waymo taxi service and the Full Self-driving Tesla, or the Baidu Apollo Go driverless taxi and WeRide robobus in China. Also in Europe, automated mobility solutions are entering our roads, Waymo is exploring the streets of London [4] and recently the Tesla Full Self-Driving (supervised) is allowed on the Dutch roads [19]. These examples show the current technologic advancement and status of implementation, and marks opportunities for automation to solve societal and individual needs.

The key question is: what can this technology offer our road transport system? There is a potential to improve the safety, sustainability, efficiency and inclusivity of our transport systems. For instance, people with disabilities could experience a 14% increase in travel distance with Automated Mobility solutions [11]. Also, it could help solve lack of professional drivers for freight and public transport. Despite this potential, it is important to realize these benefits are not automatically achieved with the introduction of the technology on the roads. In fact, the introduction of this technology could potentially also decrease the safety, sustainability, efficiency and inclusivity of our transport systems [15]. Automated vehicles could reduce the use of public transport, walking, and cycling [21]. The extend to which automatic mobility will contribute to societal mobility challenges will heavily depend on how we shape the technology and the proposition of the use cases. All together showing the relevance of the discussion around the potential impact of Automated Mobility on the user and society, and how this impact can be dealt with.

The development of automated vehicles (AVs) is largely driven by industry like original equipment manufacturers (OEMs)[22]. It is important that governments and policy makers take their role to steer these developments towards the societal needs. As an example, the Dutch minister of Infrastructure and Water management explicitly addressed the potential societal value of automated vehicles [2]. This increased interest in responsible automated mobility systems offer an opportunity to follow a more human-centred approach and to explore ideas deriving from the passenger or public sector perspective. Systemic assessment of the value around automated mobility is missing. Researchers can give a relevant contribution by developing tools to visualize and map possible futures and by facilitating informed debate.

When the possible negative or desired impact of an automated mobility system is defined, user interface (UI) design can have an important role in further development as we know UI can influence driver behavior or automated mobility acceptance. For instance,



This work is licensed under a Creative Commons Attribution 4.0 International License. *AutomotiveUI Adjunct '26*, Gothenburg, Sweden
© 2026 Copyright held by the owner/author(s).
ACM ISBN 979-8-4007-2815-0/26/09
<https://doi.org/10.1145/3828158.3838243>

Trust and perceived safety are essential to automated mobility adoption and internal advanced UI can enhance drivers' trust and acceptance [14]. Additionally, the Human-Machine Interface (HMI) is a critical component to guarantee safety to vehicle occupants and other road users [13]. Dong et al. [8] previously presented several scenarios how external and internal HMI design could improve safety. Showing the importance of early involvement of UI experts and HMI design in the development and choice process around automated mobility solutions.

In this paper, the aim is to formulate a method to cultivate and foster initial discussion about the impact of Automated Mobility (AM) on society and individuals. A method that transcends company interests, political color or individual preferences. A method that can be used to evaluate individual automated vehicles, and to compare solutions. And a method that can be used to formulate intended effects and future visions.

2 Method

Overall, this article follows an iterative design approach, starting with an analysis, definition of design criteria, creation of a tool design, evaluating the design and eventually suggesting improvements of the tool. Within this framework the approach will be as follows:

Chapter 3 contains a literature review, giving an overview of existing evaluation methods in the context of mobility, societal and individual impact, and through literature define relevant automated mobility indicators. The chapter will answer the question 'what evaluation indicators should be included in the quickscan?'

Within chapter 4 the formation of FAST will be described, based on the defined indicators from chapter 3, the formulation of the tool follows a designerly approach. Including the definition of design requirements, synthesis and visualization of the tool.

Chapter 5 contains a validation of the FAST quickscan through expert interviews. Answering the question 'Does FAST meet the design criteria?' Including questions such as 'Is the tool sufficiently facilitating the assessment of AM impact on the traveler and the society?', 'Does the tool spark discussion and directions of improvement?'

Chapter 6 presents an improved FAST quickscan, based on the interview findings.

Finally, the article is concluded with a conclusion and discussion, reflecting on further tool development and key takeaways for industry and academia on impact evaluation and debate (chapter 7).

3 Literature Review: Defining Automated Mobility Indicators

A range of transport evaluation frameworks exist and are in use. Including SUMI (based on the EU's Sustainable Urban Mobility Plans), which uses 13 indicators across four themes: global environment, quality of life, economic success, and mobility system performance [5], but focusses on sustainability. The LEVITATE Policy Support Tool (PST) serves as a one-stop-shop for CCAM decisions, offering extensive forecasting and back casting but requiring predefined scenarios with known input data [1].

Social Life Cycle Analysis (S-LCA), originally developed by the United Nations Environment Program, offers a holistic approach to assessing the impact of products and services throughout their lifetime [16], with a strong focus on measuring impact on stakeholders (employees, local community, society, consumers, actors in the value chain), but using the S-LCA framework is an extensive process that requires detailed data, which makes it less ideal for future applications that do not exist yet. Although, the principle of assessing the impact on different stakeholder groups is relevant, as Gompf et al. [12] demonstrated in a Berlin mobility setting where the scope was limited to the use phase of the services.

The principle of Broad welfare/prosperity includes looking at progress, not only in terms of economic growth or capacity problems alone [7]. Within this principle, progress and success is measured by looking at reachability of jobs, social contacts, or amenities, by checking the living environment's spatial quality, climate change, pollution, and barrier working [20]. Additionally, health (harmful emissions, stimulating physical exercise) and safety (social safety, traffic safety), are important determinants [20].

What previous methods or models have in common is that they are extensive and need elaborate data to complete the models. Alternatively, Andersson et al. [3] uses the Human-Tech Matrix to identify effects of an automated transport system. The matrix focuses on describing an individual influencing factor and maps out a particular chain of relations. A tool that can also be used during workshops or brainstorm sessions, the tool emphasizes the different stakeholders but not specifically mentioning impact areas or categories.

Following the example of Gompf et al. [12], the S-LCA was chosen as a basis for the tool in this article, focusing on the use phase of AM solutions and focusing on the impact on the consumer (the traveler), local community, and society. Where society and the local community are combined in 'society' in general. Using the above mentioned literature, a list of impact indicators was comprised (table 1). Additionally, to emphasize the focus on automated mobility solutions, potential large impact areas of AM are highlighted based on findings from [17]. To emphasize the human-centered and societal aim of the discussion, determinants influencing individuals travel behavior were added [18]. Table 1 shows three groups representing the stakeholder group that it influences. One group is a combination group, since for instance 'health' can have individual and societal impact. Eleven impact areas were selected with 37 indicators in total.

4 Tool Development: Quickscan Creation (FAST)

To facilitate a healthy debate, it is important to know what societal and individual gains to steer towards, for instance by doing an initial quick impact assessment. With this in mind the Fast Automated and Smart mobility impact Tool (FAST) was created. A tool that separates itself by the explicit inclusion of areas in which it is expected AM will have a great impact, and by offering an easy and fast method. Additionally, FAST can be used for a broad range of applications where other tools might be limited to only automated vehicles, hence the use of the term automated mobility. The objective of FAST is twofold: Assessing the impact of automated

Table 1: Impact Categories for Automation in Mobility

Individual and Societal	
Living environment	Infrastructure space occupation (e.g., green space)*; Spatial quality; Air pollution/emissions (effect on the environment)*; Number of vehicles on the road*
Health	Noise pollution*; Community stimulation; Air pollution (effect on health); Physical exercise*
Safety	Data privacy; Traffic safety (traffic fatalities and injuries)*
Individual/Traveler	
Traveler accessibility	Easy reachable transport points/infrastructure; Inclusive design*; Access to social contacts, amenities, jobs, schools, healthcare
Travel costs	Ticket prices/gas prices*
Convenience and Satisfaction	Comfort; Service quality*; Other activities possible during travel*; Number of passengers in the vehicle*; Number of transfers; Possibilities for Luggage
Traveler Travel time and efficiency	Reliability; Travel speed*; Flexibility; Connectivity and frequency of service; Punctuality
Social Safety	Feeling of safety/perceived safety
Society	
Societal affordability	Tax income; Mobility costs (infrastructure, maintenance, number of employees necessary); Energy use (costs)
Society accessibility	Access to schools, jobs, hospitals; Community connection/cohesion
Infra efficiency and capacity	Infrastructure efficiency; Capacity; Congestion or traffic flow efficiency*

*Categories with potential high impact of automation [17]

transport on the traveler and society and visualizing this impact. With the final goal of stimulating and aiding the discussion or opinion forming process on whether certain solutions are desirable on a societal and individual level. And to uncover areas of improvement that can be changed to make AM better. The tool can be used for evaluation of a single AM solution but can also facilitate comparison between solutions in a decision-making process.

While developing the tool, the following design requirements were defined:

- The tool should assess the impact of automated transport on the traveler/individual and society.
- The tool should visualize this impact.
- The tool should spark discussion and directions for improvement.
- The tool can be used for a broad range of AM use cases (varying from small flying vehicles to autonomous taxis or automated electric wheelchairs).
- The tool should offer the possibility to generate quick initial results during a workshop or meeting with the goal of facilitating a debate. This means the tool can be used without elaborate research with basic knowledge of AM.
- The tool can be filled out alone or together with multiple people.
- The tool is focused on AM but can be used for other mobility solutions as well to facilitate comparison.
- The tool can be used by a broad range of professionals who are considering the implementation of AM (ranging from developers, researchers, policy makers).

Figure 1 shows the FAST design, with a fictional result comparing two AM options. The form of a radar graph was chosen for its visual comparison qualities, also following the example of Gompf et al. [12] and Claudelin et al. [6]. In addition to the visual presentation of the outcome, the tool includes a worksheet containing questions to facilitate subjective initial rating of the impact areas. The worksheet contains questions such as ‘how does the mobility solution influence individual and societal safety?’, and ‘how would you rate the impact on safety?’. To keep an overview, it is chosen to rate each impact area instead of each individual impact indicator.

For the scale used in the FAST tool a 5-point scale ranging from -2 to +2 was adopted. The scale used, is in line with the Social-LCA guidelines [16] and was further developed in the handbook for Product Social Impact Assessment [10]. The scale makes it possible to include positive and negative impacts. Gompf et al. [12] used the 5-point scale to assess mobility services in Berlin, showing the tool is suitable for qualitative evaluation of mobility systems. The scale as proposed by Goedkoop et al. [10] is defined as: +2 best in class, continuous improvement, +1 beyond generally acceptable situation, continuous improvement, 0 generally acceptable situation, -1 unacceptable situation but improving, -2 unacceptable situation no improvement.

5 Valitation Quickscan (FAST)

5.1 Interview Method

To answer the research questions and to evaluate if FAST fulfills the requirements of the tool, FAST is evaluated through semi-structured expert interviews.

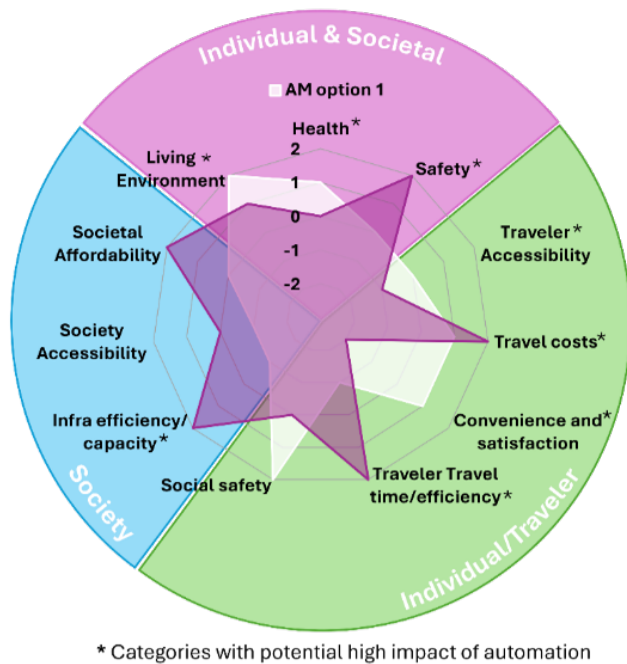


Figure 1: Fast Automated and Smart mobility impact Tool (FAST), showing a fictional example result.

Four expert interviews with five experts were performed to assess the quality, completeness and usability of FAST. Representing different levels of government, one expert is a ‘researcher sustainable mobility’ from a government advisory organization and two experts are ‘mobility innovation policy advisors’ at a provincial government. One expert is a senior academic researcher focusing on the design of future mobility systems, and one expert manages smart mobility projects within a knowledge institute. All participants are experts in the field of AM. On average the interviews lasted one hour.

The interviews followed a semi-structured approach. Starting with an introduction of the FAST tool, the objective of the tool, how and by whom the tool can be used, and what knowledge the tool was based on. Following the introduction, with the use of a case study, each criterion was scored and the tool was filled out by the expert. The case study used during the interview was the future introduction of the Waymo automated taxi service in London. This case study was chosen for the relative familiarity of the Waymo service. After the case study, the use of the FAST tool was discussed using questions regarding the completeness, quality and usefulness of the tool and the impact indicators used in the tool. Table 2 shows the questions asked and discussed. Additional to the questions shown in the table, the experts were also asked for their professional function and their experience concerning mobility and automated mobility.

All participants in the research filled out informed consent before the interview, following the ethical guidelines of Delft University of Technology.

Experts were contacted through the researcher’s professional network and through snowball sampling. The interviews took place either in an online or a physical face to face setting. In all cases the audio was recorded. The built in Microsoft Word transcription application was used to transcribe the audio files. The interviews were conducted in Dutch, and for this purpose FAST was translated to Dutch by a native Dutch speaker. Considering the limited number of participants, analysis was done using a qualitative open coding approach.

Since the development of the tool followed an iterative design process, in between the first two and the second two interviews three minor changes were made and directly tested in the last two interviews. ‘societal affordability’ was changed to ‘societal costs’, ‘traveler accessibility’ and ‘society accessibility’ were joined together and added to the ‘Individual and Societal’ group, and ‘societal safety’ was joined with ‘Safety’ to reduce differences in abstraction levels.

5.2 Interview Results

The following section described the outcomes of the expert interviews, first including the outcomes concerning the usefulness and use of the tool and second showing the quality and completeness outcomes.

5.2.1 Usefulness and use. Concerning the usefulness and use of the tool, the opinions between the participants were differed on some points.

Goal clarity and the catering to needs: The usefulness (from one of the governments perspective) wasn’t directly clear and the unclarity of the exact goal was mentioned. From the other three interviews, the stance was positive, a clear need would be met with the use of the tool, but it was also mentioned that the tool should fulfill the needs of other potential users. Specifically mentioning public transport operators.

Relevancy of showing an overview and uncovering blind spots: The relevance towards offering an overview or bigger picture of what could be improved and the relevance of facilitating discussions with stakeholders was emphasized. Including the option of having different stakeholders fill out the tool to uncover differences in perspective, also between colleagues. Finally, the potential of combining the tool with a workshop or a work meeting was emphasized.

Need for quantification: The relevance of using the tool at an early stage in a decision-making process was acknowledged, but all participants mentioned the importance of quantifying the impact areas in a follow-up stage. Necessary for measurability of the impact, but also to remove ‘emotions’ from the discussion process. Eventually, it was emphasized there is a necessity for having a discussion as a starting point before quantifying.

Application of the tool for a broad range of mobility solutions: The relevance of the tool for use cases in the direction of logistics (e.g. a package delivery drone) was debated in the first two interviews, as these systems might have completely different needs and for instance convenience and satisfaction would perhaps not be relevant. Using the tool for personal mobility was found useful (e.g. automated electric wheelchairs). Only the difference in scale

Table 2: Interview Questions

1	What do you think of the completeness of the tool? Is the tool complete? If not, what criteria (impact indicators) are missing?
2	Are the aspects that are relevant to address during developing and discussing ‘automated’ mobility solutions well enough represented? If yes/no, why?
3	Is the tool sufficiently facilitating the assessment of automated mobility impact on the traveler and the society?
4	What do you think of the formulation of the criteria considering for instance clarity, definition, or relevance?
5	Some societal and individual impact areas are similar (e.g., society accessibility, traveler accessibility) but looked at from a different perspective they might be interpreted differently and create different outcomes. What do you think about this?
6	What do you think of the usage of this tool?
7	What do you think of its usefulness? (Would you use this tool?)
8	Does the tool sufficiently visualize the impact on society and the individual?
9	Would the tool be fitting for a wide range of other use cases (e.g., delivery drones, autonomous wheelchairs, etc.)?
10	What do you think of the ease or speed with which the tool can be used?

and scope was questioned. As they noticed, from a systems perspective, implementation of automated electric wheelchairs might have limited societal impact and the impact might mainly be on a personal level, questioning the relevance of looking at a societal scale for certain AM scenarios.

5.2.2 Quality and Completeness. After the introduction of FAST, both participants mentioned they felt the tool was generally complete, and impact areas and indicators are formulated clearly and justly. During the follow up questions FAST was discussed in more detail. This resulted in the following feedback:

- 1 Affordability and accessibility are split up in a societal and individual impact area. During the first two interviews, both participants mentioned unclarity around this distinction and doubted its necessity. In the second two interviews, affordability was not mentioned, and the accessibility issue was resolved.
- 2 Additionally, for the first two interviews, the distinction between individual and societal overall groups wasn’t always clear. The relevance of having the separate categories ‘infrastructure efficiency/capacity’ and ‘traveler travel time/efficiency’ was acknowledged, but for some factors, it was not as clear why it specifically belonged to the overall groups. In the final two interviews, this distinction was not discussed in detail, while using FAST, the distinction seemed to be less relevant.
- 3 Visualization: Plotting the impact areas in a radar chart was found effective in creating an overview of the impact of the mobility solution discussed, and it was found sufficient in giving the option to compare between mobility solutions. The number of impact areas, however, was considered high, and the order unclear.
- 4 In all interviews, some unclarity was experienced around the scoring and the scale of the impact areas, as a clear reference was missed.
- 5 Representation of impact areas and indicators specifically relevant to the participants’ field of work were missed. From a government perspective specifically, it was mentioned that public acceptance or public opinion was missing. Additionally, impact on the business proposition was mentioned, as well as impact on employment.

- 6 A clear feedback point included differences in results that might occur when diverse user groups or individuals are considered. The same feedback applied to a use case in different locations. There was no consensus on the necessity to specify user and location better when first using the tool. It was mentioned this might add complexity where a quick process is required, and therefore it might be better to add this as a follow-up question.
- 7 Related but not the same, the impact of different scenarios specifying implementation rate or size and defining if it’s a supplement to the mobility system or a replacement was mentioned as an unclarity.
- 8 There is a large variety of indicators combined under the impact areas. Although the sentiment around this process was not necessarily negative (some are ‘justly combined’), this might cause factors to be overlooked or forgotten, and nuances might be lost compared to looking at one individual indicator. One participant wanted to assign different weights to indicators (together forming the impact area score), as this could better reflect the specifics of each situation and make the scoring process more transparent.
- 9 In the first two interviews, differences in abstraction levels between the impact areas were noted as a point of concern, as it might cause difficulty in comparability of the factors.

5.3 Interview Discussion

The reaction to the tool was positive. Although clarification of the tool objective and further research is necessary, all experts acknowledged the potential and relevance of FAST in facilitating discussion and evaluating automated mobility use cases.

Combinations of impact areas can be considered, particularly merging societal and traveller affordability (travel costs), and traveller and society accessibility. The initial separation was based on potential conflicts between individual and societal interests, such as governments prioritizing tax revenue over low public transport fares. However, participants questioned the necessity of this split. Other combinations of impact indicators should also be reviewed, potentially alongside **a reassessment of the three stakeholder groups**. Comments were made about energy use possibly belonging under societal affordability, but further research is required

to evaluate such indicator pairings. Additionally, future research should focus on ensuring no individual indicators are overlooked and on defining the appropriate level of nuance. If certain impact areas are split, this should be done while preserving or improving **the visual overview and clarity**, as these aspects are closely connected to the number of impact areas.

Specification of the individual user group and use location can be added as a **follow up step in the discussion process**, in this way acknowledging their relevance. Although further testing of the tool is necessary to specify impact of individual groups and location, retaining the simple profile of FAST is relevant. As was mentioned by the participants, adding too many details might not be favorable. The same is suggested for quantification. Quantifying the criteria is important, but the relevance of having a discussion before quantifying was also emphasized. Using the tool in a subjective way was a conscious decision, and as previously said, it does not replace the need for a more elaborate assessment. Perhaps the tool can be placed in a **larger framework or decision-making process**. Where the framework describes a step-by-step process with FAST at the start and other methods such as the LEVITATE model [1] as a follow-up step.

Define a reference for the evaluated use case as a starting activity when using the tool. Uncertainty about what the future automated mobility product/system should be compared to can lead to incomparable results. Helping the user to define what the future mobility system should be compared with, and what the zero point ‘general acceptable situation’ stands for before filling out the tool could help to create clarity and better results. Additionally, the wording in the scale could be reconsidered and evaluated to see if it best fits the context of this test.

There is a strong need to have a **clear objective** of the tool. For one participant the initial goal was too abstract. Therefore, the objectives should be specified further and when explaining the tool, the description should be improved. The other participants understood the goal of the tool better, perhaps because of better explanation of the goal by the researcher. Additionally, **field-specific impact areas** to improve the usefulness could be considered, perhaps by leaving room for a few personalized impact areas. Also, the inclusion of business and employment indicators should be considered in order to increase relevance. Additional interviews should be conducted, as opinions on the tool’s usefulness and field-specific indicators varied according to participants’ backgrounds.

Further research is necessary for evaluating the application of the tool for a broad range of mobility solutions as there was no consensus and it was based on a single use case. A suggestion would be to set up an additional test, testing different use cases, considering level of impact (systemic or personal), and the specific needs of applications (e.g. logistics).

As comparability between the impact areas is one of the main goals of the tool streamlining abstraction levels between impact areas is necessary. As a follow up step, the impact areas and indicators could be further compared to existing frameworks such as the EU-CEM handbook for CCAM [9] to streamline vocabulary and definitions.

The main limitations of the tool evaluation include the limited number of participants. More experts need to be invited, representing diverse backgrounds, especially the industry perspective is now underrepresented.

Additionally, the open coding approach of the analysis makes it difficult to define importance of certain feedback. For further analysis, when more interviews are included, a more structured thematic analysis could be applied.

As described in the methodology, after the first two interviews minor changes were already made to the tool design, making it possible to directly test the improvements, but this also means the comparability between the interviews is reduced. When interpreting the results, this should be considered.

Additionally, due to time constraints in some interviews it wasn’t possible to ask all the prepared interview questions. When this happened, a focus was made on discussing the usefulness and completeness. This might have led to less rich outcomes concerning answers about the tool’s application to other use cases, or clarity of objectives. Again, this should be resolved by conducting additional interviews.

6 Presentation Of The Improved FAST Quickscan

Following the interview outcomes described in chapter 5, and following an iterative design approach, a re-design of the tool was made (fig. 2). Changes made are: three stakeholder groups were brought back to two, simplifying the distinctions; ‘Living environment’ and ‘Safety’ were added to the Society group; ‘Health’ and ‘Accessibility’ were added to the Individual/Traveler group; the impact areas ‘Economic activity & employment’ and ‘User acceptance’ were added; wording of some indicator were changed based on the EU-CEM handbook for CCAM (FAME, 2025); and in the process the option will be added to make the impact areas a combined score of the indicators, giving the option to weigh indicators differently. Besides the impact areas and indicators shown in figure 2, the tool will consist of a larger FAST framework. Including; before filling out the FAST quickscan, guidelines for clarification of the AM proposition, and definition of the scoring reference. And after filling out the FAST quickscan, guidelines for defining improvement points, defining unknowns, and considering different implementation areas, user groups, or non-users.

7 Conclusion & Discussion

Initial steps have been taken towards a method to facilitate discussion about the impact and of automated mobility on society and individuals. The FAST quickscan was composed, initial reactions are positive, and concrete improvements have been made. Including, the clarification of the objective, the optimization of impact indicator combinations, and the formulation of a larger FAST decision-making framework.

The tool can be used in a fast way to create a global view of impact for policy makers, researchers, and designers. But to fully answer one of the research questions ‘Does the tool spark discussion and directions of improvement?’ further research is necessary. To explicitly answer this question a more elaborate discussion and evaluation of a real AM proposition is necessary next to finishing

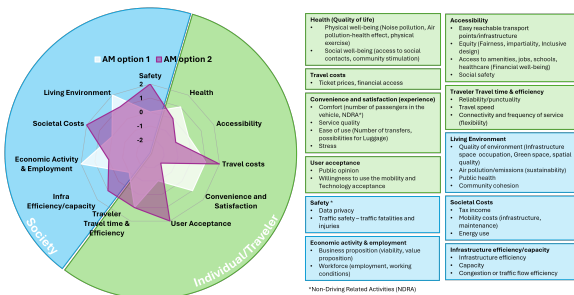


Figure 2: Updated Fast Automated and Smart mobility impact Tool

the current interview study. Organizing a group discussion during a workshop or a focus group could be a concrete next step. Also, the tool should be tested during a pilot in a real-world scenario, applying the tool during a decision-making process of AM options.

Further development of the tool should contain a clear description and definition of the impact areas and indicators, to guide users and sensitizing them to different nuances. And finally, the intention is to update the tool design and develop into an interactive toolkit, giving the option to try out different scores, directly see the impact in the chart, and working out the worksheets into specific discussion guiding cards.

When FAST is fully developed, it can be used as a starting point for discussion, offering practical handles for creating a first impact assessment, considering the values and needs of society and the AM users. FAST has the potential of creating consciousness around the potential positive and negative impacts, offering a tool kit to people who otherwise might not be aware of these effects, and which otherwise might be overlooked. Presenting this tool to user interaction researchers, can empower them to start a dialogue with policy makers or industry developers and gives them the opportunity to steer towards meaningful human machine interactions, positively impact travel behavior, and help facilitate acceptance of desired automated mobility futures.

References

- [1] [n. d.]. Levitate Connected and Automated Transport Systems Policy Support Tool. <https://www.ccam-impacts.eu/>
- [2] 2026. Voortgang voertuigautomatisering. https://www.tweedekamer.nl/kamerstukken/brieven_regering/detail?id=2026D22591&did=2026D22591
- [3] Jonas Andersson, Tor Skoglund, and Niklas Strand. 2019. The Human-Tech Matrix: A Socio-Technical Approach to Evaluation of Automated Transport Systems. *Advances in Intelligent Systems and Computing* 876 (2019), 375–380. doi:10.1007/978-3-030-02053-8_57/SAVE-RESEARCH
- [4] Mickey Carroll. 2026. Autonomous robo-taxis now driving themselves on British streets | Science, Climate & Tech News | Sky News. *Sky news* (4 2026). <https://news.sky.com/story/autonomous-robo-taxis-now-driving-themselves-on-british-streets-13531630>
- [5] Ioannis Chatzioannou, Alexandros Nikitas, Panagiotis G. Tzouras, Efthimios Bakogiannis, Luis Alvarez-Icaza, Luis Chias-Becerril, Christos Karolemeas, Stefanos Tsigdinos, Pontus Wallgren, and Oskar Rexfelt. 2023. Ranking sustainable urban mobility indicators and their matching transport policies to support liveable city Futures: A MICMAC approach. *Transportation Research Interdisciplinary Perspectives* 18 (3 2023), 100788. doi:10.1016/j.trip.2023.100788
- [6] Anna Claudelin, Fatemeh Jouzi, Laura Lakanen, Jarkko Levänen, and Risto Soukka. 2025. Social life cycle assessment of the use phase in mobility: case study of a Finnish region considering consumers. *Journal of Cleaner Production* 525 (9 2025), 146647. doi:10.1016/j.jclepro.2025.146647
- [7] Lauri de Boer, Niek Mouter, and Martijn de Vries. 2022. Brede welvaart heeft ethische blik nodig. In *Colloquium Vervoersplanologisch Speurwerk* (Utrecht).
- [8] Haoyu Dong, Tram Thi Minh Tran, Rutger Versteegen, Silvia Cazacu, Ruolin Gao, Marius Hoggemüller, Debargha Dey, Mervyn Franssen, Markus Sasalovici, Pavlo Bazilinskyy, and Marieke Martens. 2024. Exploring Holistic HMI Design for Automated Vehicles: Insights from a Participatory Workshop to Bridge In-Vehicle and External Communication. *Conference on Human Factors in Computing Systems - Proceedings* 1 (5 2024). doi:10.1145/3613905.3651086/JOURNAL:JOURNAL:ACMCONFERENCES:PAGEGROUP:STRING:PUBLICATION
- [9] FAME. 2025. *European Common Evaluation Methodology Handbook for Connected Cooperative and Automated Mobility (EU-CEM Handbook for CCAM)* (1.0 ed.). <https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/>
- [10] M.J. Goedkoop, I.M. de Beer, R. Harmens, P. Saling, D. Morris, A. Florea, A.L. Hettinger, D. Indrane, D. Visser, A. Morao, E. Musoke-Flores, C. Alvarado, I. Rawat, U. Schenker, M. Head, M. Collotta, T. Andro, J.F. Viot, and A. Whatelet. 2020. *Product Social Impact Assessment Handbook* (5 ed.). www.product-social-impact-assessment.com
- [11] Fahimeh Golbabaei, James Dwyer, Rafael Gomez, Andrew Peterson, Kevin Cocks, Alexander Bubke, and Alexander Paz. 2024. Enabling mobility and inclusion: Designing accessible autonomous vehicles for people with disabilities. *Cities* 154 (11 2024), 105333. doi:10.1016/j.cities.2024.105333
- [12] Katharina Gompf, Marzia Traverso, and Jörg Hetterich. 2022. Applying social life cycle assessment to evaluate the use phase of mobility services: a case study in Berlin. *The International Journal of Life Cycle Assessment* 2022 27:4 27 (4 2022), 603–622. Issue 4. doi:10.1007/s11367-022-02051-y
- [13] Iwona Grobelna, David Mailland, and Mikolaj Horwat. 2025. Design of Automotive HMI: New Challenges in Enhancing User Experience, Safety, and Security. *Applied Sciences* 2025, Vol. 15, Page 5572 15 (5 2025), 5572. Issue 10. doi:10.3390/AP15105572
- [14] Soyeon Kim, Xiaolin He, René van Egmond, and Riender Happee. 2024. Designing user interfaces for partially automated Vehicles: Effects of information and modality on trust and acceptance. *Transportation Research Part F: Traffic Psychology and Behaviour* 103 (5 2024), 404–419. doi:10.1016/j.trf.2024.02.009
- [15] Mobilizers. 2025. *Mobility Futures Four scenarios for the Dutch mobility system in 2050 system in 2050*. Technical Report. Delft University of Technology. www.tudelft.nl/mobility-futures
- [16] C. Benoît Norris, M. Traverso, S. Neugebauer, E. Ekener, T. Schaubroeck, S. Russo Garrido, M. Berger, S. Valdivia, A. Lehmann, M. Finkbeiner, and G. Arcese. 2020. *Guidelines for Social Life Cycle Assessment of Products and Organizations 2020*. Technical Report. United Nations Environment Programme (UNEP). <https://www.lifecycleinitiative.org/library/richtlijnen-voor-sociale-levenscyclusanalyse-van-producten-en-organisaties-2020/>
- [17] Kareem Othman. 2022. Exploring the implications of autonomous vehicles: a comprehensive review. *Innovative Infrastructure Solutions* 7 (4 2022), 165. Issue 2. doi:10.1007/s41062-022-00763-6
- [18] Rajesh Ranjan and Sanjeev Sinha. 2025. A systematic review of mode choice behavior in urban transportation with emphasis on individual preferences and influencing factor. *Discover Cities* 2025 2:12 (10 2025), 98–. Issue 1. doi:10.1007/S44327-025-00138-3
- [19] RDW. 2026. RDW explanation of European type approval Tesla with provisional validity in the Netherlands. <https://www.rdw.nl/en/news/2026/rdw-explanation-of-european-type-approval-tesla-with-provisional-validity-in-the-netherlands>
- [20] Danielle Snellen, Jeroen Bastiaanssen, and Maarten 't Hoen. 2021. *Brede welvaart en mobiliteit*. Technical Report. Planbureau voor de Leefomgeving. <https://www.pbl.nl/publicaties/brede-welvaart-en-mobiliteit>
- [21] Aggelos Soteropoulos, Paul Pfaffenbichler, Martin Berger, Günter Emberger, Andrea Stickler, and Jens S. Dangschat. 2021. Scenarios of Automated Mobility in Austria: Implications for Future Transport Policy. *Future Transportation* 2021, Vol. 1, Pages 747-764 1 (12 2021), 747–764. Issue 3. doi:10.3390/FUTURETRANSP1030041
- [22] Qidi Zhang, Tingru Zhang, and Liang Ma. 2023. Human acceptance of autonomous vehicles: Research status and prospects. *International Journal of Industrial Ergonomics* 95 (5 2023), 103458. doi:10.1016/j.ergon.2023.103458