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Governance of automated vehicles in urban transport system: a case study of the Oslo region, Norway

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Abstract. Shared automated electric vehicles (SAEV) can increase safety, reduce congestion, and provide environmental benefits to the urban transport system. Nonetheless, SAEV's governance in the urban transport system is challenging. This paper proposes a novel interdisciplinary methodology and contributes to the governance debate from the 'policy' and 'polity' dimensions. We attempt to draw insight from the Norwegian cultural context and a willingness to use SAEV survey in Oslo, Norway. We analyse informal institutions from the cultural viewpoint using the Hofstede 6D model vis-à-vis a quantitative willingness to use SAEV survey. Then, we combine insight from the cultural indicators and survey to draw insight on the appropriate governance approaches from the 'policy' dimension of governance to promote SAEV deployment in Norway.

Keywords: SAEV, governance, urban transport system

1 Introduction

Autonomous vehicle (AV) represents a potentially disruptive yet beneficial change to the transportation system with the potential to improve vehicle safety, reduce emissions and congestion, facilitate efficient use of travel time and change travel behaviour [1][2][3][4]. The World Health Organization estimates 1.35 million road accident deaths and 50 million injuries annually, with human error responsible for around 95 percent of cases[5]. AVs' most revolutionary impact is integrating them into existing public transport systems to improve performance and fulfill current and latent mobility needs [6]. Shared autonomous electric vehicles (SAEV) are electric AVs in shared mode, such as robotaxis and automated shuttles. SAEV can provide different services, such as on-demand ride services within a fixed route with fixed stops, a fixed route with on-demand stops, or door-to-door on-demand services. SAEV can provide unimodal or multimodal door-to-door trips [7]. SAEV can also reduce vehicle ownership, fleet size requirements, parking demand, labour costs, and cold-start emissions [2]. Nonetheless, if not carefully managed, SAEV may have adverse environmental impacts such as sprawling land use, increased vehicle miles travelled associated with congestion, and increased travel time consequences [3][8][9]. Thus, appropriate governance frameworks to align public and private interests are required to capture the potential benefits, minimise costs, and support the integration of SAEV in the urban transport system [10].

This paper attempts to contribute to the governance of SAEV in the urban transport system debate. Governance can be in the 'political' dimension (the actor constellation - range of actors involved in the process of policymaking), 'policy' dimension (political steering - the nature and character of steering instruments in use) and 'polity' dimension (the institutional landscape - in which the actors operate based on a system of rules that shape their actions) [11]. Institutions are the humanly devised constraints that structure political, economic, and social interactions. Institutions consist of both informal constraints and formal rules in an interdependent manner and consequent political and economic organisations [12]. Informal institutions cannot be fully understood without considering culture, and understanding culture presumes insight into institutions. Culture is the collective mind programming that distinguishes the members of a group of people from others [13]. Culture matters because it affects attitude, behaviour, and choices, providing an indicative road map to distinguish between proper and improper behaviour in a society [14]. Culture is a primary factor influencing the adoption or acceptance of new technologies and innovation [15] [16].

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The willingness to use SAEV is the strength of people's intention to use SAEV [17]. Willingness to use is impacted by culture in a society and can be supported by a workable context-specific governance approach. We attempt to contribute to the governance debate to increase willingness to use SAEV from the 'polity' (focusing on informal institutions from the cultural viewpoint using the Hofstede 6D model) and the 'policy' dimension by adapting the framework developed in [18]. We attempt to answer the following questions:

- How does Norwegian culture impact the willingness to use SAEV in Norway?
- What is the workable governance approach to support SAEV deployment in Norway?

The original contribution of our paper is as follows:

- We propose a novel interdisciplinary methodology to analyse the governance of SAEV in the urban transport
- We provide insight into the appropriate governance approach to support SAEV deployment in Norway

This paper proceeds as follows: Section 2 is the literature review. Section 3 is the methodology. Section 4 presents our results. Section 5 is the conclusion.

2. Literature Review

This section presents three streams of related literature to our research: i. SAEV² integration in the urban transport system ii. Willingness to use SAEV iii. Governance of SAEV in the urban transport system.

2.1 SAEV in the urban transport system

Several recent studies have shown the impact of SAEV integration in the urban transport system. [19] found that SAEV fleet could lower negative externalities and generate cost benefits for commuters. [20] found that rapid reduction in technology costs, a rise in people's willingness to pay and supporting policies are required to promote AV adoption. [2] found that SAEV could pose additional challenges, such as increased waiting time and the associated inconvenience(s), increased vehicle miles travelled, and could increase congestion due to empty miles. A study in Oslo, Norway, to understand the impact of integrating SAEV in urban transport shows that in a scenario where all the existing ICEV users switch to SAEV, there will be drastic traffic reduction in Oslo as about 7% of the current vehicle fleet will be required to meet transport demand during the peak period [21]. Related studies show similar results, such as the OECD International Transport Forum's Lisbon study (3%), Helsinki (4%), Dublin (2%), Auckland (7%) and Stuttgart (7%) [22] [23] [24] [25] [26].

2.2 Willingness to use SAEV

The results of the willingness to use SAEV survey in the literature seem heterogeneous. The results are demographically diverse, context-specific, and a function of the researchers' data and adopted methodology. [27] found that people willing to use AV are most likely early adopters. [28] found that around half of their survey respondents in different cities are willing to use self-driving vehicles. [29] found that nearly two-thirds of their survey respondents consider they will be late adopters of AV technology. [30] found reduced willingness to use AV due to extreme concern about AV technology. [31] found that users with lower anxiety and increased self-confidence were more open toward AVs. [32] found that privacy concerns and perceived safety significantly affect general concerns about the willingness to use AV. [18] found that the more positive the attitude toward AV, the higher the willingness to use AV.

2.3 Governance of SAEV in the urban transport system

This sub-section reviews the literature on the governance of SAEV in the two dimensions applied in this paper: i. steering instruments (policy) and ii. institutional properties (polity) [33].

'Policy' dimension of the governance of SAEV

[34] proposed 'a no-response strategy, prevention-oriented (avert)', 'control-oriented (regulation)', 'tolerance-oriented (reform)', and 'adaptation-oriented (manage policy uncertainty)' approach for SAEV governance. Building upon and combining the works of [35] and the multi-level perspective [36], [20] proposed five governance frameworks (governing by doing, governing by enabling, laissez-faire, self-governing and governing by authority) for SAEV integrated in Mobility-as-a-Service (MaaS) in the urban transport system. [37] proposed a comparative analysis framework for governance based on the assumed roles of the technology, identified domains and mechanisms of governance, and the assumed actors responsible for steering the development process.

² AV, SAEV and self-driving vehicles are used interchangeably in this paper.

‘Polity’ dimension of the governance of SAEV

[38] found that existing regulatory standards and industry self-regulation shape AV regulatory governance, and international policies and conventions co-exist simultaneously in Sweden and Norway. [39] argue that existing regulatory institutions affect the regulatory response to emerging technologies and are responsible for different trajectories of regulatory development across countries. [40][41] found that informal institutions can complement formal institutions to facilitate coordination and achieve effective governance in the European public transport context. [42] argue that governance strategies that aim to tap the potential of AVs in supporting sustainable urban mobility should explicitly consider institutional dynamics.

3. Methodology

We discuss in this section the adopted methodology in this paper.

3.1 Willingness to use survey.

We conduct a willingness-to-use survey in the Oslo region, Norway. The questionnaires were designed based on the following determinants: (i) personal technology innovativeness³, (ii) perceived usefulness/benefit, (iii) safety perception (perceived safety and perceived risk) and (iv) price perception. The determinants are among the empirically proven significant determinants of willingness to use SAEV in the literature [19]. The respondents were asked questions on their attitude to technology adoption, willingness to share a vehicle with strangers if it results in a lower price for the journey, perception of self-driving vehicles as a solution to meet their future transport needs, and perception of safety and security of self-driving vehicles to gain insight into their willingness to use SAEV. The 5-point Likert scale was used from ‘totally disagree’ to ‘totally agree’. The respondents were contacted on their mobile phone numbers for the interview. The survey was conducted for all citizens over 15 years old in the Oslo region (old Akershus county (Viken), Groruddalen and Oving) from Tuesday to Saturday every week in September 2022. There were 1,738 respondents: Groruddalen (615), Viken County (604), and Oving (519).

3.2 Informal Institution (Norwegian cultural dimension)

We draw insight from Hofstede’s 6-D model to discuss Norwegian culture. In Hofstede’s 6-D model, culture is described in six dimensions: Power Distance, Individualism, Tough/Tender, Uncertainty Avoidance, Long-Term/Short Term Orientation, and Indulgence. Hofstede’s model has been used extensively during recent decades in the theoretical and empirical literature in different social science fields. Hofstede’s model can be regarded as a grounded approach for describing culture [16].

3.3 Governance (policy dimension)

Building upon the framework proposed by [37] on public authorities’ approaches for governing cities and climate change, [20] proposed five governance approaches for governing the development of MaaS in public transport: i. Governing by authority (employing traditional top-down mechanisms to govern) ii. governing by enabling (facilitating and encouraging actions with non-public actors through partnerships and incentives development) iii. governing by doing (public authorities take care of the entire service production and delivery and avoid collaborating with private actors) iv. Self-governing: governing by ‘showing the way’, and v. laissez-faire (public authorities allow the network of actors to reach a stable state without getting involved). We adopt the framework of [20] to develop the corresponding actions in developing SAEV for the five governance approaches.

Figure 1 shows the schematic representation of our methodology discussed in sections 3.1 to 3.3. We focus on informal institutions and culture from the ‘polity’ dimension of governance. Then, we analyse informal institutions from the cultural viewpoint vis-à-vis the quantitative willingness to use SAEV survey. Then, we draw insight on the appropriate governance approach from the ‘policy’ dimension of governance.

³ Personal technology innovativeness is the willingness of a person to try out a new technology.

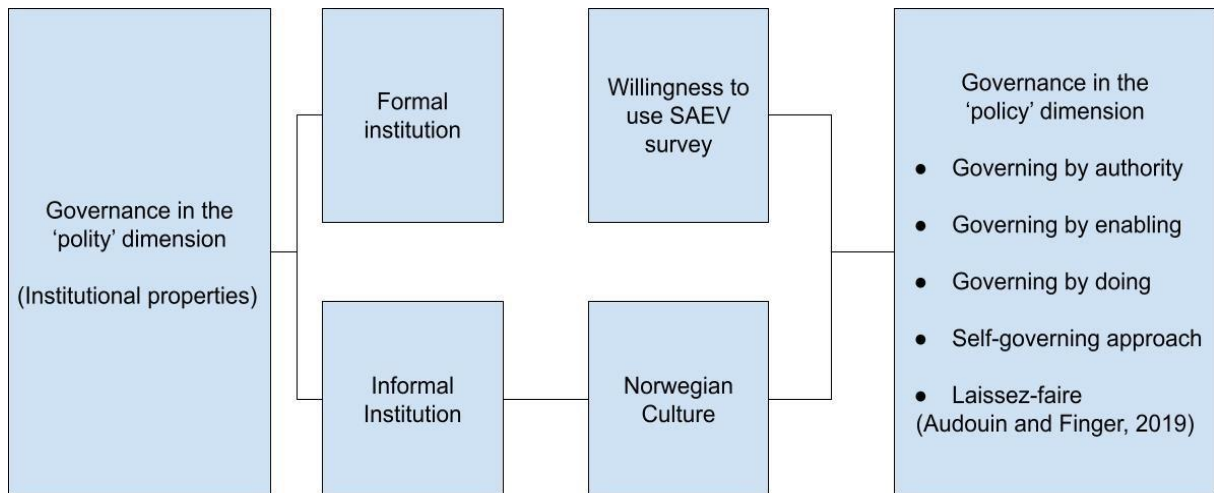


Figure 1: Schematic diagram of the methodological framework

4. Results

4.1 Willingness to use SAEV.

We discuss the results of our questions for the willingness-to-use SAEV survey in the Oslo region, Norway: i. Attitude to new technology ii. Willingness to share a vehicle with strangers if it results in a lower price for the journey iii. Believe that self-driving vehicles can solve many of the transport needs of the future. iv. Believe that self-driving vehicle is safe and secure. We found that 27 out of every 100 respondents partly or totally believe SAEV is safe and secure, 41 out of every 100 believe that SAEV can meet their future transport needs, 30 out of every 100 respondents partially or completely agree to share SAEV and 46 out of every 100 respondents like new technology and are willing to be among the early adopters. We infer that, on average, 36 out of every 100 are partly or totally willing to use SAEV.

We summarise the insights from the Norwegian cultural indicators vis-à-vis the willingness to use SAEV survey and workable governance framework in Table 1.

Cultural dimension	Norwegian Cultural Indicators [43]	Impact of cultural indicators on the willingness to use SAEV	Proposed workable governance approach to mitigate willingness to use barriers based on the Norwegian cultural context
High individualism	<ul style="list-style-type: none"> The right to privacy is important and respected. 	Privacy loss concerns could reflect the low perception of the safety and security of SAEV and the willingness to share SAEV with strangers in public transport → Reduce willingness to use SAEV.	<p>‘Governing by doing’ could help increase the perception of safety and security and increase willingness to use SAEV:</p> <ul style="list-style-type: none"> Developing SAEV projects in-house in a closed manner could increase the perception that the government is thorough to ensure that all safety and security concerns are addressed. Minimising collaboration with third parties could help allay the fear of unnecessary private data exposure to many third parties (such as private sector institutions) or corporate entities.
High short-term orientation	<ul style="list-style-type: none"> Strong concern for establishing the truth. Normative thinking with great respect for traditions. Preference to maintain time-honoured traditions and norms. Viewing societal change with suspicion. 	Lack of full understanding of SAEV, disruption of traditional public transport paradigm, and suspicion of societal change could reflect a relatively low interest in new technology, willingness to be early adopters, and believe that SAEV can meet future transport needs → Reduce willingness to use SAEV.	<p>‘Governing by doing’ could help address the challenges with the traditional Norwegian culture and pessimistic view of societal change:</p> <p>Developing SAEV projects in-house in a closed manner with minimum collaboration with third parties could help address the perception of change in tradition, societal norms and public transport disruption.</p>
Moderate uncertainty avoidance Moderate restraint	<ul style="list-style-type: none"> Moderate structure and planning are required. Moderate perception that social norms restrain actions 	Due to uncertainty concerns, citizens should be assured that SAEV is carefully planned and structured. The perception that social norms restrain actions could affect the willingness to use SAEV since the innovation is new and its impact is not fully understood. The indicators could also reflect on the willingness to share SAEV with strangers in public transport. → Reduce willingness to use SAEV.	Combining governing by doing and self-governing by: Developing solutions in-house in a closed manner, minimising collaboration with third parties, and providing all government employees with a SAEV solution could allay uncertainty fears and ‘restraint’ constraints. Combining the governance approaches could serve as a springboard to promote SAEV, increase awareness, encourage sharing with strangers, and integrating SAEV in the public transport system.
Tender Culture Power Distance	<ul style="list-style-type: none"> Levelling with others, consensus, cooperation Taking care of the environment and societal solidarity. Incentivisation Dialogue. Decision-making is achieved by involving people. consensus-oriented communication Management facilitates and empowers. Decentralised power 	These indicators could serve as enablers to increase awareness and willingness to use SAEV.	<p>‘Governing by enabling’ actions appear to align with the ‘tender’ and ‘power distance’ Norwegian cultural indicators:</p> <ul style="list-style-type: none"> Initiating public-private partnerships → Levelling with others, consensus, cooperation, dialogue, consensus-oriented communication, and decision-making. Providing funding → Incentivisation. Influencing negotiations in favour of SAEV → Incentivisation, societal solidarity. Leveraging SAEV opponents using horizontal network governance → decentralised power, dialogue, management facilitates and empowers and consensus-oriented communication.

Table 1: Summary of Norwegian cultural dimensions, indicators, and proposed governance framework

Based on the short-term orientation, privacy loss and the combination of moderate uncertainty avoidance and restraint concerns that appear influential on the survey results, we suggest combining governing by doing, self-governing and features of governing by enabling (Table 2).

<p>Governance approaches for SAEV deployment in Norway</p>	<p>‘Governing by doing’, ‘self-governing’ and ‘governing by enabling’.</p> <ul style="list-style-type: none"> • Develop a SAEV solution in-house in a closed manner. • Minimise collaboration with third parties. • Provide government employees with a SAEV solution to show citizens examples to follow. • Provide funding. • Initiate public-private interactions. • Define vision with strong quantitative objectives. • Influence negotiations in favour of SAEV • Leverage SAEV opponents using horizontal network governance.
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Table 2: Proposed governance approaches to support SAEV deployment in Norway

As the willingness to use SAEV increases, a ‘governing by enabling’ approach could be fully adopted in relation to Norway’s tender, power distance and individualism cultural indicators. ‘Governing by enabling’ could promote end-user acceptance and awareness of the environmental benefits of SAEV based on the tender cultural indicator of Norway.

5. Conclusions

This paper attempts to provide insight into the governance of SAEV integrated in the Norwegian urban transport system using insight from the Norwegian cultural context and willingness-to-use survey. The survey result suggests that less than half of Norwegians are willing to use SAEV in the Oslo region. We then suggest that a workable governance approach for SAEV integration in the Norwegian public transport system should allay fears of privacy concerns (high individualism) while making people feel safe and secure, allay uncertainty fears, manage pessimism to technological innovation (high short-term orientation), regard time-honoured traditions and address the moderate ‘uncertainty avoidance’ and ‘restraint’ indicators. Also, the cultural indicators should align with the Norwegian culture’s ‘tender’ and ‘power distance’ indicators, such as consensus, cooperation, societal solidarity, incentivisation, dialogue, facilitating management and decentralised power. Therefore, we argue that ‘governing by doing’, ‘self-governing’ and ‘governing by enabling’ should be combined to increase the willingness to use and promote SAEV deployment in Norway.

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