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Energimyndighetens titel på projektet – svenska
SEAMLESS: Systematisk Utvärdering av Kombinerad Mobilitet – Färden mot Hållbara Lösningar

Energimyndighetens titel på projektet – engelska
SEAMLESS: Systematic Evaluations and Assessments of MaaS – Leading towards Sustainable Solutions

Universitet/högskola/företag	Avdelning/institution
RISE	

Adress
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Namn på projektledare
Steven Sarasini

Namn på ev övriga projektdeltagare
Jana Sochor (RISE/Chalmers), Göran Smith (RISE), Bijan Aryana (Chalmers), Mikael Johansson (Chalmers), MariAnne Karlsson (Chalmers), Helena Strömberg (Chalmers), Bhavana Vaddadi (KTH), Mia Xiaoyun Zhao (KTH), Anna Pernestål (KTH)

Nyckelord: 5-7 st
Mobility-as-a-Service, MaaS, Combined mobility, Sustainability assessment, Evaluation.

Foreword

The SEAMLESS project was funded by the Swedish Energy Agency, engaging a core team of researchers from Chalmers University of Technology, the Royal University of Technology (KTH) and RISE. The core research team was supported by an advisory group, comprising two university professors, Glenn Lyons (UK) and Susan Shaheen (USA) and an independent consultant, Susan Zielinski (CAN).

Contents

Energimyndigheten

Sammanfattning

SEAMLESS-projektet utformades för att adressera med en nyckelfråga som ställdes av bland annat statliga myndigheter och övriga offentliga aktörer och kommuner: Vilka är hållbarhetseffekterna av kombinerad mobilitet (MaaS)? Denna fråga blev allt vanligare efter intresset för MaaS-konceptet som växte mot slutet av 2010-talet. Inom transportbranschen hyllades MaaS som en silverkula som kunde lösa ekologiska problem, skapa innovationsmöjligheter samt lösa upp trängsel och förbättra tillgänglighet. Allt detta skulle kunna uppnås genom mobilitetstjänster som i kombination skulle bli ett relevant och prisvärt alternativ till privat bilägande och -användning. Mot slutet av 2010-talet positionerade Sverige sig för att följa Finlands exempel genom att lansera två ambitiösa FoI-program (KOMPIS och Challenge från Sverige) som skulle finansiera flera pilotprojekt av MaaS-konceptet. SEAMLESS utformades för att undersöka hållbarhetseffekterna av MaaS med hjälp av data som skulle genereras via dessa piloter. Datat skulle användas för att modellera effekter som klimatutsläpp, energieffektivitet och tillgänglighet inom städer, regioner och eventuellt för hela landet. Dock resulterade Covid-pandemin i stora utmaningar för pilotprogrammet. En majoritet av planerna avbröts och de få pilotprojekt som genomfördes resulterade i lågt intresse, vilket visar att det är svårt att locka ett större antal deltagare till piloter som bygger delade mobilitetstjänster under en pandemi. Pandemin påverkade också MaaS-marknaden, i och med att flera företag, både i Sverige och i omvärlden, gick i konkurs eller likviderades under denna period. Som en följd blev vår plan för att utvärdera hållbarhetseffekterna av MaaS i praktiken omöjlig att genomföra. Vi saknade nödvändigt data för att göra robusta analyser och var tvungna att ritka om projektet.

De få undersökningar som genomfördes baseras på piloter i Göteborg, Stockholm och Sydney (Australien). Resultaten av dessa sammanfattas i denna slutrapport. De övriga delarna av projektet fokuserade på att undersöka MaaS framtida utveckling. Vi behöll ett användarperspektiv som riktar sig till olika resenärer, ett organisatoriskt perspektiv vars fokus är MaaS-ekosystem, och ett makroperspektiv som riktar sig mot samhället i stort. Sammantaget kan man dra slutsatsen att MaaS har utvecklats längs en traditionell och typisk hypekurva och för närvarande står inför en oviss framtid. MaaS har dock fortfarande potential att spela en nyckelroll i ett mer hållbart transportsystem, särskilt med tanke på dess fokus på delad och aktiv mobilitet. Experter inom MaaS fältet är angelägna om att konstatera att MaaS inte är dött. Med tanke på de utmaningar som kommersiella MaaS-operatörer ställs inför avseende gångbara affärsmodeller kan man argumentera för starkare insatser från offentliga aktörer. Detta skulle kunna innefatta direktiv och lagstiftning som ger stöd till nya mobilitetstjänster. Projektet tyder också på att det är relevant att destabilisera delar av det befintliga transportsystemet som gör det svårt att leva utan den privata bilen. Utan sådana åtgärder är det svårt att åstadkomma riktig förändring och en omställning som är genuint hållbart.

Energimyndigheten

Summary

The SEAMLESS project was originally designed to address a pertinent question posed by governmental authorities, agencies and regional / local governments: What are the sustainability impacts of Mobility as a Service (MaaS)? This question became ever more prevalent following the hype that surrounded the MaaS concept in the latter half of the 2010s. That is, within and around the transport industry, MaaS was hailed as a silver bullet that could resolve ecological problems, provide innovation opportunities and reconcile transport-specific issues such as congestion and poor accessibility. All of this was achievable via mobility services that, when bundled, would provide a compelling and affordable alternative to private car ownership and use. Towards the end of the 2010s, Sweden was positioning itself to follow the example of Finland by launching two ambitious R&I programmes (KOMPIS and Challenge from Sweden) that would fund multiple pilots of the MaaS concept in differing contexts. SEAMLESS was designed to assess the sustainability impacts of MaaS using data that would be generated via pilots, which sought to engage a broad set of travellers ranging from households to employees and residential developments. This data would then be used to model impacts such as climatic emissions, energy efficiency and accessibility at the level of cities, regions and potentially the entire country of Sweden. However, the 2020 Covid pandemic resulted in major challenges for piloting activities. A majority of plans were cancelled and the few pilots that did run generated limited interest, demonstrating that attracting large numbers of participants to pilots that seek to trial shared mobility services during a pandemic is somewhat tricky. The pandemic also strongly impacted the MaaS market, with several companies filing for bankruptcy or liquidation during this period, both in Sweden and in other parts of Europe and the globe. As a consequence, our initial plan to evaluate the sustainability impacts of MaaS became virtually impossible. We lacked the requisite data to perform such assessments and were forced to reorient the project during its final year.

Notwithstanding, some assessments were possible, based on pilots that ran in Gothenburg, Stockholm and Sydney (Australia). The results of these are summarised within this final report. The remainder of the project focused largely on addressing the prospects for future MaaS developments, highlighting user perspectives that target individual travellers; organisational perspectives that examine who may do what in future MaaS ecosystems; and a macro perspective that examines potential outcomes for society at large. Overall, one may conclude that MaaS has progressed along a traditional and typical hype curve and currently faces an uncertain future. However, MaaS does have the potential to play a key role in a more sustainable transport system, particularly given its focus on shared and active transport modes. Experts in the field are keen to proclaim that MaaS is not dead. Given the challenges faced by commercial MaaS operators in identifying viable business models, a case could now be made for stronger public sector action. This may include policies and legislation that provide support to new mobility services. However, our studies also suggest that it is pertinent to destabilise extant mobility systems based on private car ownership and use. We agree that MaaS is not dead, but fresh perspectives are required to rejuvenate the concept and make it fly.

Introduction and background

The SEAMLESS project was borne towards the end of the 2010s, during a period of heightened societal interest in the concept of Mobility as a Service (MaaS). MaaS is a service that integrates and bundles different types of individual mobility services (e.g. public transport, car- and ridesharing, taxis, bicycle pools, etc.) into a package that is made available to travellers via a single interface (typically a smartphone application). At the time, MaaS was billed as a means to facilitate radical gains in resource productivity and shifts towards non-fossil fuels such as renewable electricity. MaaS was seen by many as a silver bullet for transport systems problems, drawing its strength from new business models that promote sales of multi- and intermodal mobility. As such, MaaS was depicted as a viable and compelling alternative to private vehicle ownership that would encourage shifts towards more active and shared modes such as public transport, shared bicycles and car- and ridesharing. Modal shifts would (in principle) improve the energy efficiency of transport by reducing the number of vehicles required to fulfil travellers' needs.

Societal interest in MaaS had engaged important funding agencies such as Vinnova and the Swedish Energy Agency, who sponsored significant R&I activities and, importantly, pilots, demonstrations and field operational tests through initiatives such as Challenge from Sweden and the KOMPIS programme. MaaS pilots in different contexts would address several key questions, among them a critical issue regarding the sustainability impacts of combined mobility. At the time, there was a lack of research that systematically evaluates and assesses the sustainability impacts of MaaS, despite the fact that there was an overwhelming demand for such assessments among practitioners, public officials and within the research community. To respond to this demand, a framework for sustainability assessment was developed within the KOMPIS programme, and SEAMLESS was designed to perform such assessments. Knowledge on sustainability impacts was in high demand among public-sector organisations, to inform policymaking, and among practitioners in the field who required guidance in the development of sustainable MaaS business models and services. Hence SEAMLESS was set up to deliver a systematic evaluation and assessment of MaaS based on three levels of analysis, generating knowledge on the sustainability impacts of MaaS with regard to:

- A micro level that focuses on different types of individual travellers.
- A meso level that focuses on organisations who develop MaaS services.
- A macro level that focuses on cities, regions and nations.
- Syntheses between these levels.

The project would perform assessments using the KOMPIS framework, encompassing the environmental, economic and social dimensions of sustainability, examining indicators linked to transport emissions, energy efficiency, access to transport and accessibility, travel behaviour and modal shifts, business and innovation opportunities, and travellers' satisfaction with MaaS.

Energimyndigheten

When developing the proposal for the SEAMLESS project in 2019, we were confident that these types of analyses would be possible due to the level of interest in MaaS; the number of pilots that were ongoing or at the planning stages; and, most importantly, due to multiple statements of intent from Swedish pilot projects that committed to collaborations with us and use of the KOMPIS framework. However, in practice most of these commitments were not fulfilled. This was in large part due to the rise of the Covid pandemic in 2020, as a majority of Swedish pilots were either postponed or cancelled. During this period (and ever since) several MaaS operators, particularly those from the private sector, have discontinued their services following bankruptcy or liquidation. The more prominent MaaS actors that disappeared from the market include the Swedish company UbiGo, the Finnish company Kytti and, more recently, the Finnish market leader Whim. As such, we were unable to collect the requisite data to perform assessments that would fulfil our original goals and objectives, despite significant efforts to engage with MaaS initiatives across Europe.

As a consequence, we redesigned the SEAMLESS project in 2023 to focus on a modified set of aims and objectives. We maintained the analytical focus within the project (micro, meso and macro levels), focusing on the following:

- Potential users' willingness to use MaaS based on the notion of anticipated consequences (rather than attitudes) as a determining factor.
- How MaaS practitioners can apply service design principles in a manner that meets users' needs and supports sustainable behavioural changes.
- Who does what in MaaS ecosystems (i.e. roles and responsibilities), exploring the potential role for parking companies in the transition to servitised mobility and exploring the potential of future Park-and-Ride initiatives in this context.
- The systemic impacts of MaaS at macro levels, albeit derived from scenarios rather than the previous plan to generate models based on empirical data from the micro and meso levels.
- A podcast entitled MaaSterminds, which explores the history, present and proposed future of MaaS developments through dialogues with internationally renowned pioneers and experts within the field of MaaS innovation and research. The podcast focuses on how and why MaaS has developed along its particular innovation trajectory alongside expectations and predictions for future developments, given declining interest in MaaS its uncertain future.

Overall, the SEAMLESS project ran for four and a half years between 2019-2024, engaging a core team of researchers from Chalmers University of Technology, the Royal University of Technology (KTH) and RISE – the project coordinator.

Project setup

The SEAMLESS project centred on four work packages, outlined below.

WP1 - Micro level assessments and service design activities (Lead: Chalmers)

Originally, WP1 focused on gathering and assessing data at the level of individual travellers to examine attitudes, modal shifts, and changes in travel needs and preferences that result from MaaS services. Although this focus was retained, given limitations in our access to data, WP1 was reoriented to also focus on how to design Mobility-as-a-Services (MaaS) that enable a change in travel behaviour that can contribute to sustainable mobility goals. Overall, WP1 focused on the following activities:

Activity 1: Analysis of UbiGo travel diaries

UbiGo was one of the first MaaS services – a broker service for everyday urban travel and trialled by 195 participants for six months (Nov. 2013 – Apr. 2014). During the trial, a mixed methods approach was utilized to gather data on participants' attitudes and travel behaviour – e.g. questionnaires, interviews, focus groups, travel diaries, service use data – which resulted in one of the most comprehensive MaaS evaluations to date. However, the paper-based travel diaries – collected from 35 participants in 22 households, one week each 'before' and 'during' the pilot – had not been systematically analysed. Hence during the project, we performed analyses of user diaries to identify changes in travel patterns within the contexts particular to pilot participants.

Activity 2: Analysis of BRF Viva residents

BRF Viva constituted one of several MaaS pilots within Gothenburg following the UbiGo pilot. BRF Viva comprised a MaaS offer that targeted residents of a newly-built housing complex within minimal parking facilities, replaced by mobility services that were integrated by EC2B and Smartresenär. This activity examined user perspectives in relation to the novel service (available from 2017 onwards), utilizing methods such as interviews, focus groups and digital travel trackers.

Activity 3: Examining user perspectives within the Sydney MaaS pilot

The Sydney MaaS trial ran between 2019-20 and was funded by iMOVE Australia and planned, executed, and evaluated by a consortium consisting of the Institute of Transport and Logistics Studies at the University of Sydney Business School, the Insurance Australia Group and SkedGo. The trial set out to improve the understanding of how the design of subscription bundles affects MaaS uptake and travel behaviour. As such, this activity utilised a combination of questionnaires and interviews with trial participants to examine how the MaaS service influenced attitudes towards MaaS and key aspects of travel behaviour such as modal shifts. The evaluation and resultant conference / journal papers were partially financed by SEAMLESS.

Activity 4: Investigating future Park & Ride initiatives from a MaaS perspective

Göteborgs Stads Parkerings AB (Gothenburg parking) has developed a parking app where one can pay for parking and purchase tickets for onwards travel via public transport or bikeshare – a novel variant of MaaS. With this in mind, we conducted a survey (n=93) and two design workshops, one with experts and one with Park & Ride users. The main purpose was to generate service design ideas based on deep understandings of users' needs alongside the interests and perspectives of key stakeholder organisations.

The co-design workshop was supported by different 'mediating tools', such as a map of the city, a user journey template, and photos of different parking facilities.

Activity 5: National MaaS Survey

A majority of user studies on MaaS focus on attitudes, acceptance models, stated preferences. We conducted a national survey, but with a different approach than that of attitudinal or stated preference studies. Instead, we operated on the assumption that willingness to adopt MaaS is a matter of the positive or negative consequences users anticipate when using a MaaS service. The national survey was rolled out during spring 2024 and has generated 614 useful responses. Data was analysed using primarily descriptive analysis, i.e., frequencies, distributions, cross-tabulations and correlations.

WP2 – Meso level assessments (Lead: RISE)

Originally, WP2 was designed to assess and compare the economic sustainability of different types of MaaS business models, based on their financial viability and scalability, associated business and innovation opportunities, etc. Given limitations in our access to data, WP1 was redesigned to also focus on two new activities:

Activity 1: An unlikely case of combined mobility? Municipal companies' roles in the mobility ecosystem

Activity 1 comprised a traditional academic study that examines existing and potential roles of municipal parking companies within the mobility ecosystem, focusing on several initiatives within the field of sustainable mobility, including digitalisation, electrification, vehicle autonomy and MaaS. The study included analyses of key documents (such as ownership directives) and 11 interviews with individuals from municipal parking companies in Malmö, Gothenburg and Stockholm. The study explores the role of parking companies in destabilising existing transportation regimes and examines the possibility that municipal parking companies could act as the MaaS providers in the near future.

Activity 2: The MaaSterminds podcast

This activity focused on the production of a podcast that interviews key practitioners within the international MaaS field. Targeted interviewees include MaaS service providers, platform providers, key stakeholder organisations such as UITP and the MaaS Alliance and other mobility experts. The podcast focuses on a number of key questions that relate to the state-of the art in MaaS developments:

- What are the (actual and potential) sustainability impacts of MaaS?
- Are there viable business cases for MaaS?
- What types of innovation pathways could benefit MaaS developments?
- Which customer segments or applications constitute low-hanging fruit?
- How can MaaS scale geographically?
- What is the future for the MaaS concept?
- Given our experience so far, what roles can commercial and public actors take in future MaaS developments?

The full title of the podcast is "MaaSterminds – inside the heads of the pioneers and the practitioners. A podcast about flips, flops, plans, outcomes, learnings in the mythical field of Mobility-as-a-Service". In total, 5 episodes were published between 2023-24 and have generated over 500 listens to date.

WP3 Integrating assessments from the micro and meso levels (Lead: Chalmers)

Activity 1: Examining service design across MaaS pilots and projects

Originally, WP3 sought to synthesise results from WP1 and WP2 in order to assess how travel attitudes, behaviour and satisfaction vary according to the types of MaaS services developed within each pilot. WP3 aimed to examine the relationship between service design, emergent travel behaviour and user satisfaction, focusing specifically on how modal availability, pricing models, rewards and incentives that are embedded within MaaS services influence modal choices, potential reductions in travel, the utilisation of environment-friendly vehicles, willingness to rideshare, perceived accessibility and satisfaction, etc. This initial aim was to be facilitated

via comparative analyses of multiple pilots within different geographical settings and which target different customer segments (e.g. employees, commuters, household, tourists).

In practice, again due to limitations in access to date, this type of analysis has not been possible. Hence this WP focused on a study including a comparative case study of four MaaS pilots, all based in Gothenburg, to examine factors that influence success and failure. The study utilised participant observations, interviews, surveys and travel diaries to focus on the extent to which MaaS pilots and associated R&I projects utilised service design techniques that encompass some or other means to identify and examine users' needs, preferences, problems and perspectives when developing MaaS offers. The study offers a critique of the ways in which different R&I projects tackled these issues.

Activity 2: Compilation and analysis of literature on national and international MaaS pilots and projects

Throughout the project, we have continuously monitored newly published academic and grey literature on MaaS. Analyses of the emergent field of literature has underpinned several outputs and deliverables. A particular focus has been papers reporting assessments and/or evaluations of MaaS pilots and trials as a basis for a cross-case analysis of if and how the design of the MaaS impacted the outcome of pilots and trials in terms of users' use of the service, attitudes, behavioural changes etc.

WP4 – Macro level assessments (Lead: KTH)

Initially, WP4 was designed with the goal of evaluating the accumulated effects of MaaS pilots on emissions, transport efficiency and wellbeing. To achieve this goal, our idea was to integrate data from the micro- and meso-levels through selecting and modifying existing models that can be applied on macro level for impacts evaluation. Specifically, WP4 aimed to examine the extent to which MaaS can deliver towards societal goals and to explore the unanticipated societal implications of integrating MaaS in the whole transport system. As part of the reorientation of the project, WP4 was focused on future MaaS developments and impacts through the co-creation and valorisation of future scenarios rather than actual data, following stakeholder consultations. That is, WP4 proposes a systematic framework to facilitate the evaluation of MaaS impacts under different pathway evolutions at the macro & system-level. WP4 centres on two main activities:

Activity 1: To identify methods that can be adapted to assess the system-level impacts of MaaS.

The purpose of this activity was to identify and adapt suitable methods for assessing the system-level impacts of Mobility as a Service (MaaS). This involved determining effective evaluation techniques that can provide insights into how MaaS, once fully implemented, could affect the overall transport system. Given the current scarcity of comprehensive data from existing MaaS pilots, the objective was

to find methodologies that can still deliver reliable impact assessments. These include system dynamics, multi-level perspective, scenario analysis, agent-based models, or hybrids of these approaches. WP4 performed a state-of-the-art analysis based on current studies that have focused on impacts evaluation of innovative mobility services.

Activity 2: Investigating MaaS development trajectories under various uncertainties and the potential impacts that it may bring.

Parallel to investigating potential methods for evaluating MaaS impacts, WP4 also sought to understand the possible development trajectory of MaaS, moving beyond pilot studies and posing the question: where is MaaS likely to end up in the coming years? WP4 investigated the trajectories between now and 2035, considering various uncertainties that could influence developments. This involved identifying and validating key uncertainties through expert surveys and interviews and using these insights to explore different future scenarios. The goal was to understand how these uncertainties might shape MaaS development and to assess the potential impacts on the mobility ecosystem. By doing so, this objective sought to provide a strategic framework for evaluating the future of MaaS, helping stakeholders navigate the complexities and develop sustainable, informed strategies despite limited data availability.

Results

WP1 - Micro level assessments and service design activities (Lead: Chalmers)

In this section, we report on the main results from each respective work package and activity. The main deliverables for each activity are noted and appear in **Error! Reference source not found.**.

Activity 1: Analysis of UbiGo travel diaries (Deliverable D8)

In total, travel diary participants had travelled around 5500 km in both the 'before' and 'during' weeks, with a reduction of 5% from the 'before' to 'during' weeks. Although the size of this reduction can be debated, it is important to remember that UbiGo was used in daily travel, i.e. participants still needed to go to work and school, etc., so it is unclear if any reduction in km travelled should even be expected. However, interview results had previously revealed that participants had tried to pool their trips in new ways while using UbiGo, e.g. hiring a shared car only once per week to cover all errands/trips that had previously been undertaken in multiple trips by private car throughout the week. This could be a potential explanation as to a reduction.

Regarding modal shift, the first stage analysis revealed differences in km travelled of: walk -15%, bike +36%, private car -34%, shared car +22%, local bus +34%, express bus +53%, tram -13%, train -51%, other +6%. Although one may react at a 15% reduction in km travelled by walking, this is only a -0.6% reduction in the share of km travelled by walking, illustrating the importance of using both indicators. The difference in share of km travelled by bike and private and shared cars was +2.1%, -11.1% and +3.7% respectively. The second stage analysis revealed an overall modal shift away from all car modes and towards public transport and bike. Total car use (i.e. both private and shared) fell by -19% in km travelled and -7.5% in share of km travelled, while total public transport use (i.e. bus, tram, train) increased by +9% in km travelled and +5.6% in share of km travelled. In other words, travel diary participants reduced their use of private car in favour of shared car, but also reduced their total car use in favour of public transport and biking. This reflects the questionnaire results from the majority of all the participants, in which 48% of respondents reported less private car use (and 4% more car use), 57% reported more carsharing use, and 50% reported more bus/tram use. Thus, as confirmed by the travel diary analysis (which is also supported by the questionnaire results), a well-designed, attractive MaaS service can support a shift towards more sustainable transport, in this case by shifting travel away from private car and towards shared modes including public transport.

Activity 2: Analysis of BRF Viva residents (Deliverable D11)

Abstract from journal paper:

"Despite widespread interest, empirical research on how end-users perceive and use Mobility-as-a-Service (MaaS) is scarce. To address this knowledge gap, this article analyzes the end-user process of adopting a MaaS service entitled EC2B, which was launched in Gothenburg, Sweden, in the spring of 2019. The contribution to the MaaS literature is three-fold. Firstly, the article provides insight into potential

end-users by describing the characteristics and motives of the studied group of adopters. Secondly, it improves the understanding of the potential effects of MaaS by outlining how the EC2B service was used and how it influenced travel behavior. Thirdly, the article informs strategies for facilitating MaaS adoption by outlining what types of drivers and barriers the end-users faced during different stages of the adoption process. The reported findings underscore previous assertions that MaaS is much more than just an app and a subscription plan and highlight a mutually reinforcing relationship between the introduction of MaaS and the implementation of policies aimed at reducing car use".

Activity 3: Examining user perspectives within the Sydney MaaS pilot (Deliverables D6 and D12)

Abstract from the journal paper:

"The positive effects that Mobility-as-a-Service (MaaS) is envisioned to have on transport can only be reaped if people are using MaaS. Yet, the understanding of the user perspective on MaaS is incomplete and primarily based on experiments with non-users. To address this shortcoming, this paper reports user experiences from a trial of a high-level MaaS service in Sydney, Australia. Based on questionnaires and interviews, it analyses who participated in the trial and why, and whether the trial experience satisfied their motives. The contribution to the literature on MaaS is three-fold. Firstly, most of the people that participated in the trial were frequent users of both public transport and private cars. This supports the notion that multi-modal travellers are likely early adopters of MaaS and contradicts the fear that MaaS does not appeal to private car users. Secondly, a desire to contribute to innovation and curiosity about MaaS were the main motives for signing up for the trial, which highlights the important role an inviting setting for experimentation, such as a trial, can play in stimulating MaaS adoption. Thirdly, many participants struggled with making the trialled service work for them and on average they seemed to value the support and feedback functions higher than other service features. This underscores the novelty of MaaS, compared to existing service models, and reiterates the notion that more than an app and a few subscription plans is needed to make MaaS useful for users".

Activity 4: Investigating future Park & Ride from a MaaS perspective (Deliverable D4)

The study examined Park & Ride (P&R) from a commuter perspective to identify key factors influencing commuters and to suggest improvements to attract new commuters in the future. In summary, the findings indicate that P&R plays a role in reducing the length of the journey by car, where the parking facility itself (capacity, etc.) is one important aspect but as important is interactions with other modes of transport. Fundamental expectations concerned capacity (number of and availability of parking), location, and whether the parking was free of charge. Increased commuter satisfaction was linked to the seamless integration between the P&R and public transport (PT) which involved factors such as walking distance to PT stops and the PT service available (number of departures, routes, etc.) and safety and security issues. The way such factors influenced commuter behaviour became

Energimyndigheten

evident in the workshops—introducing a parking fee when an employer offers free parking or relocating a bus stop to a less convenient or a more expensive fare zone can easily shift a commuter from a 'park-and-rider' to a '100% car commuter'.

One suggestion for the future was to provide real-time information about free parking available both on signs en-route (as today) as well as a mobile phone application to enhance the predictability of the trip and make it easier to plan the commute. More radical suggestions concerned transforming P&R facilities into service hubs with, e.g. temporary services in terms of, e.g., tyre changes in autumn and spring. Such features would mitigate the perception of P&R as desolate spaces and promote them as travel hubs rather than an 'abandoned' parking lots.

The study also found that the future development of attractive P&R relies upon cooperation between relevant stakeholders–strategic mobility planners, parking companies, public transport, digital/IT solution providers, and commuters–emphasising mutual benefits and shared responsibility.
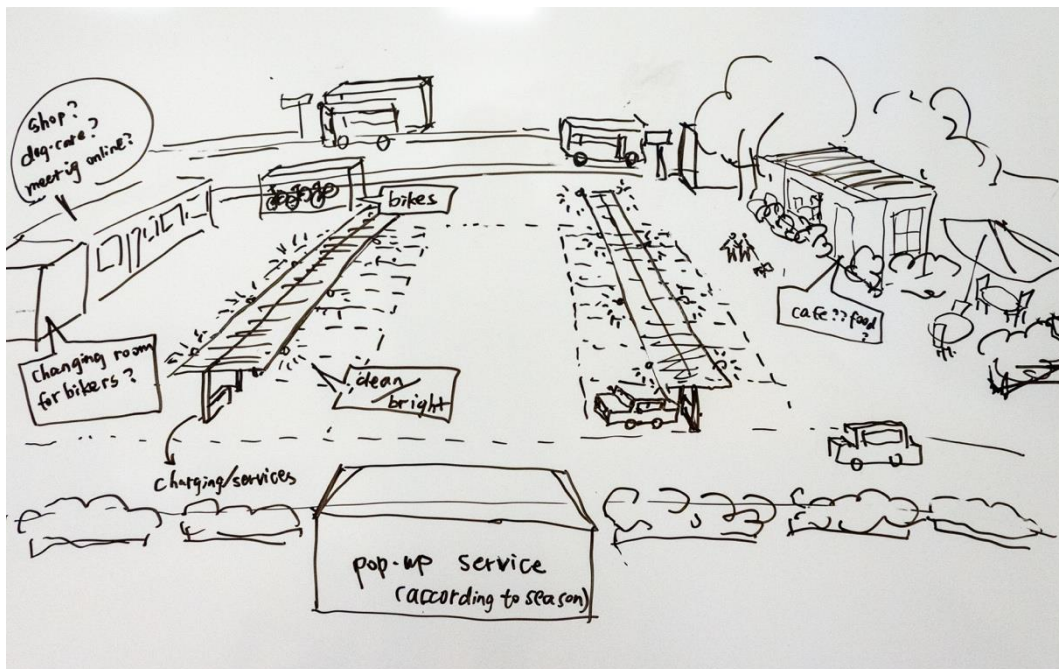
Workshop results. An illustration of Park &Ride of the future.

Activity 5: National MaaS Survey (Deliverable D9)

All in all, 761 responses were obtained of which 617 were complete. A majority (80%) of these was <u>not</u> familiar with the term Mobility-as-a-Service or MaaS. Based on the description of MaaS provided in the survey, approximately 30% indicated a willing to use MaaS for everyday travel.

Energimyndigheten

Willingness to use MaaS for everyday travel
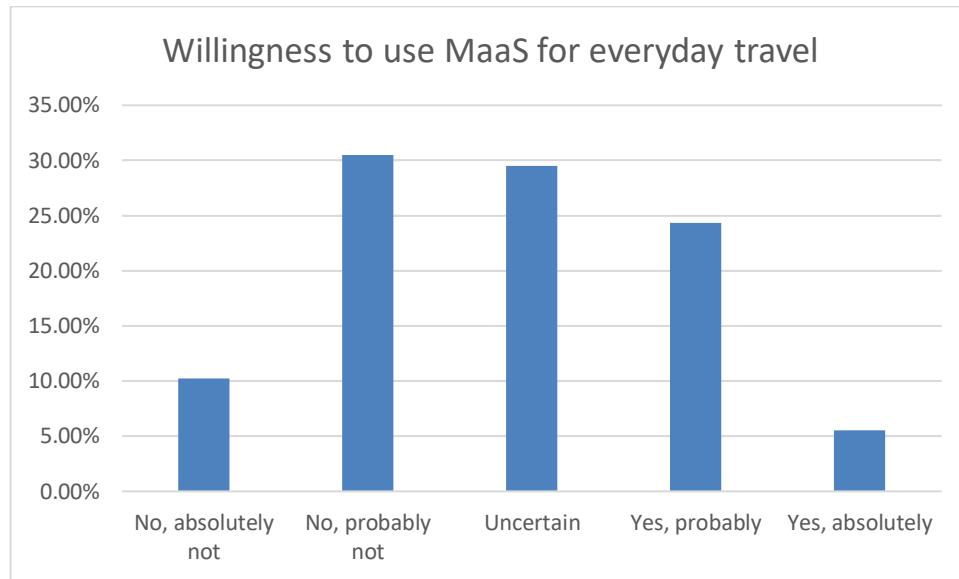
Respondents' reported willingness to use MaaS for their everyday travel (n=617).

The results show that there are correlations between willingness to use MaaS and the anticipated consequences–positive or negative) but results are contradictive. For example, 39% anticipated negative consequences for the degree of flexibility, 28% for travel times and 31% for costs associated with travelling but a share of these respondents still indicated a willingness to use MaaS. At the same time there were those who anticipated positive consequence, but nevertheless responded that they were not willing to use MaaS for everyday travel. Furthermore, approximately 1/3 of the respondents consistently reported having difficulties anticipating the consequences of using MaaS and some of the consequences appeared more difficult than others to assess, e.g. travel times and travel costs. This illustrates the difficulty associated with the non-tangible aspects of service development and evaluation.

Respondents were also asked to indicate if their willingness to use a MaaS would increase given certain features. Several service elements appeared to increase respondents' willingness to use MaaS, primarily those already willing. Service elements that increased the willingness of non-willing respondents were if travel costs did not increase, if they could choose which modes of transport were included in the service they used, and if shared cars and bicycles offered by car- or bicycle pooling were available when needed. However, the respondents' comments indicated that their assessment of the feasibility was coloured by contextual factors – their actual need for transport, their present access to different modes of transport, their earlier experiences of transport services, etc.

Activity 6: Analysis of literature on national and international MaaS pilots and projects (Deliverable D3)

The main part of studies with a user perspective are studies focusing on different potential user groups' attitudes towards MaaS, their willingness to pay or studies investigating people's preferences for different service elements in MaaS. However, even though long lists are provided of MaaS services, pilot and project in Europe, the US, China, and Japan, there are very few providing any empirically based results

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describing effects in terms of changes in, e.g. attitudes, modes used or travel behaviour.

Based on an initial analysis of a limited number of studies, two main user categories emerge. One is 'modal-mixers', i.e. those travellers who already use different modes of transport (including public transport) which suggests a MaaS which offers multimodal integration facilitates and reinforces an already established behaviour rather than requires radical behavioural changes. A second category includes users who experience a need for access to a car, or to a second car, but who do not necessarily need to own the car. In these cases, a MaaS service that offers access to various modes of transport, including cars, can be an alternative to becoming a car owner and thus the lock-in effects and perceived problems that this entails.

Regarding effects, there are reported reductions in private car use and increases in the use of car sharing, (e)-bicycle, and public transport even though the degree of reported changes varies. Furthermore, no evidence has been found regarding long-term effects of users access to MaaS. However, the studies report from different types of MaaS in terms of the actors involved (e.g. B2C, B2B(T) and B2B(E), and/or terms of the service elements. A first comparison of MaaS with different service contents indicate differences in terms of impact. An app based, on-demand MaaS with no integration of different travel modes appeared to have changed users' choice of means of transport, but the changes were limited to specific situations and types of trips–hence–one mode of transport merely replaced by another. In comparison, an app based MaaS, offering integration of several modes appeared to have had an impact on everyday travel as a whole. Tentative conclusions are that a MaaS must include more than one modality for travellers to have access to the alternatives that are perceived best suited for the specific situation and for different types of travel and must offer a higher level of integration for the service to result in noticeable changes in users' travel behaviours.

WP2 – Meso level assessments (Lead: RISE)

Activity 1: An unlikely case of combined mobility? Municipal companies' roles in the mobility ecosystem (Deliverables D7 and D13)

Abstract from conference paper:

"Regime destabilization is an integral part of sustainability transitions. Yet, the question of how governance activities can be explicitly oriented towards destabilizing 'unsustainable' regimes is surprisingly novel. This paper investigates the roles taken by municipally owned companies in regime destabilization and discusses how these roles influence local governance capabilities and capacities. Specifically, the paper focuses on the contributions of three municipal parking companies in Sweden towards municipal goals of reducing urban automobility. Our analysis, which builds on thematic coding of policy documents and interviews with employees within the municipal parking companies, shows that these companies play enabling, promoting, and partnering roles with regard to nurturing shared mobility niches, but act more passively and indirectly with regard to destabilizing urban automobility regimes. The analysis also illustrates that the mix of political

and market logics that characterizes municipally owned companies enables experimentation with niches in ways that would supposedly be difficult for municipal administrations and privately owned companies. However, this mix also makes it challenging for them to divest from prevalent regimes if the available niches cannot offer relatively sizeable and certain short-term profits. Drawing on these results, we conclude that municipalities must implement measures to decrease niche investment risks for municipal companies if they are to play more active roles in regime destabilization".

Activity 2: The MaaSterminds podcast (Deliverable D17)

The MaaSterminds podcast consists of five episodes with internationally renowned experts (see D17 in **Error! Reference source not found.**). The podcast has been successful in the sense that pioneers of the field have openly shared their personal stories and their opinions regarding the history, present and future of the MaaS concept. The general sentiment is that MaaS has progressed along its own hype curve, with a high level of societal interest in the concept during the pre-pandemic period. Following the pandemic, interest has waned and several prominent actors have disappeared from the scene. This does not mean, however that MaaS is dead. Rather, the guests to our podcast were adamant that MaaS has a future and that it is a necessity for a sustainable reorientation of the transport system.

WP3 Integrating assessments from the micro and meso levels (Lead: Chalmers)

Activity 1: Examining service design across MaaS pilots and projects (Deliverables D1, D5 and D10)

The retrospective analysis of one of the MaaS cases showed that the design and implementation of the service were more complex than anticipated, involving multiple stakeholders with different goals, policies, etc. In addition, many steps in the service design process were found to be missing or completed in an incorrect order. Customer and/or user requirements were not thoroughly enough investigated at the beginning of the process; there were misfits between service offer and user needs, e.g. users' actual travel patterns differed from those designed for; and not all interaction points between traveller and service in the user journey were considered.

Abstract from journal submission (D10):

"The term service design refers to a collection of techniques, methods and activities that, among other things, aim to ensure that services are developed according to a clear understanding of what users need and want. Mobility as a Service (MaaS) has been pitched as a user-centric approach to resolving problems related to passenger transportation, and yet the extent to which user perspectives feature in development activities is an unresearched topic within the MaaS field. This paper seeks to address this gap by exploring ways in which user-centred service design methodologies were deployed in association with four field operational tests (pilots) of MaaS, all of which took place in Gothenburg during the last decade. In addition to describing

the varying focal areas for service design activities, the study examines the reasons for variance across cases and deliberates on the ways in which shortcomings may influence MaaS developments more generally".

WP4 – Macro level assessments (Lead: KTH)

Activity 1: To identify methods that can be adapted to assess the system-level impacts of MaaS (Deliverables D2 and D15)

A state-of-the-art analysis was conducted based on the review of current studies that have focused on impacts evaluation of innovative mobility services (single shared mobility service, new energy driven mobility, and bundled mobility as a service). One gap that has been found is that, currently, the investigation on what and how much impacts MaaS will have on the transport system when it comes to a full-scale implementation is still lacking. However, it is acknowledged that it is necessary to assess the impacts of different types of MaaS services, and to elucidate the means on how MaaS can be governed and developed on a macro & system level. Particularly, this is regarded vital not only for public-sector organizations that require knowledge and guidelines in policy making, but also for private-sector practitioners that require guidance to help developing successful business models related to MaaS.

When evaluating the potential impacts of MaaS on a macro and system level, the availability of data is crucial. The limited number of existing pilots has resulted in a scarcity of data, making comprehensive impact evaluations challenging. Furthermore, full-scale MaaS operations are not yet a reality. Despite these challenges, certain methods have been identified that can facilitate impact evaluation even with limited data. These methods include system dynamics, multi-level perspective, scenario analysis, agent-based models, or a hybrid of these approaches. The work conducted in this thread has been presented on the IcoMaaS conference, Tampere, Finland, November 29-30th, 2022 (D2). The paper was then submitted to the European Transport Research Review and received comments & feedback which are currently being addressed (D15).

Activity 2: Investigating MaaS development trajectories under various uncertainties and the potential impacts that it may bring (Deliverable D14)

Findings from activity 1 indicate that the reliance on standard travel survey data and logical assumptions may not provide a comprehensive view of the macro and system-level impacts of MaaS. Numerous uncertainties could lead to various future pathways for MaaS. Methods from the state-of-the-art review offer insights into conducting macro-level evaluations without solely depending on data. Scenario building and co-creation strategies are recommended for future studies to analyse MaaS evolution in uncertain contexts, involving stakeholders from academia, local and regional authorities, and industry in both the Nordic region and France.

A survey conducted in June 2022, with 29 responses from Nordic and French experts, identified key uncertainties such as policy transversality, enabling policies, MaaS ownership, user adoption, and public transport operators' willingness to integrate services into MaaS. Interviews with 18 experts provided further insights,

revealing a belief in the continued existence of MaaS, potential transformations through AI, and challenges related to integrating transportation services and achieving profitability. Despite these challenges, there is optimism for a sustainable and economically viable future for MaaS, with potential journal paper submissions to Transportation Research Part A: Policy and Practice or Sustainable Cities and Society.

Table 1: Deliverables from the SEAMLESS project.

#	Conference papers and presentations
D1	Aryana, B., Karlsson, M., Sprei, F., Wallgren, P., Strömberg, H. (2022). Designing the S in MaaS: Behind the scenes and beyond the screens. Poster presentation at the 3rd ICo MaaS International Conference on Mobility as a Service in Tampere, Finland, 29-30 November 2022.
D2	Zhao, X., Reyes, M. & Vaddadi, B. (2022). A conceptual approach towards assessing the system-level impacts of Mobility as a Service (MaaS) – Paper presented at at the 3rd ICo MaaS International Conference on Mobility as a Service in Tampere, Finland, 29-30 November 2022.
D3	Karlsson, M. (2020). Mobility-as-a-Service: Tentative on users, Use and Effects. International Conference on Human Computer Interaction, HCII 2020. Lecture Notes in Computer Science. Vol. 12213, p. 228-237.
D4	Johansson, M. and Karlsson, M. (2024). Park & Rise Revisited. Exploring insights of today and pacing the way for future solutions. Abstract submitted to the Annual Swedish Transport Research Conference 2024.
D5	Sarasini, S., Karlsson, M., Smith, G., Sochor, J., Strömberg, H. (2022). From vision to reality: How service design processes shape Mobility as a Service offerings. Presented at the 3rd ICo MaaS International Conference on Mobility as a Service in Tampere, Finland, 29-30 November 2022.
D6	Smith, G., Hensher, D., Ho, C., Balbontin, C. (2022). Mobility-as-a-Service users: Insights from a trial in Sydney. Presented at the 3rd ICo MaaS International Conference on Mobility as a Service in Tampere, Finland, 29-30 November 2022.

D7	Smith, G. & Sarasini, S. (2024) Local governance of regime destabilization: The roles and action spaces of municipal parking companies in reducing urban car traffic. Paper presented at the 15th International Sustainability Transitions Conference in Oslo, Norway, June 16th-19th 2024.
D8	Sochor, J. (2022). Can MaaS contribute to sustainability goals? Empirical evidence from the UbiGo pilot. Lectern presentation, TRB conference on Sustainability and Emerging Transportation Technology (SETT) (Irvine, California, May 31 - June 2, 2022).
	Journal papers and submissions
D9	Karlsson, M, and Johansson, M. (2024). Users' willingness to use Mobility-as-a-Service. Investigating the Impact of Anticipated Positive and Negative Consequences. To be submitted to Travel Behaviour and Society.
D10	Sarasini, S., Karlsson, M., Smith, G., Sochor, J., Strömberg, H. (2024). Is MaaS user centric? Evidence from Swedish piloting activities. Under review at Research in Transportation Business & Management.
D11	Smith, G., Sochor, J., Karlsson, I.C.M. (2022). Adopting Mobility-as-a-Service: An empirical analysis of end-users' experiences. Travel Behaviour and Society, 28, 237-248.
D12	Smith, G., Hensher, D., Ho, C., Balbontin, C. (2023). Mobility-as-a-Service users: Insights from a trial in Sydney. European Transport Research Review 15 (1), 40, 2-11.
D13	Smith, G. & Sarasini, S. (2024). Local governance of regime destabilization: The roles and action spaces of municipal parking companies in reducing urban car traffic. To be submitted to Environmental Innovation and Societal Transitions.
D14	Vaddadi, B., Zhao, X. & Reyes, M. (2024). Potential pathways towards Mobility as a Service futures" To be submitted to Transportation Research Part A: Policy and Practice OR Sustainable Cities and Society

D15	Zhao, X., Reyes, M. & Vaddadi, B. (2024). Identifying potential methods for evaluating the impacts of Mobility as a Service (MaaS) Currently under review at European Transport Research Review
	PhD dissertations
D17	Vaddadi, B. "Understanding the system-level for Mobility as a Service: A framework to evaluate full-scale impacts of MaaS," Doctoral thesis Stockholm: KTH Royal Institute of Technology, TRITA-ITM-AVL, 2022:30, 2022.
	Other deliverables
D18	*The MaaSterminds Podcast*
	Episode 1: The world's first Mobility as a Service experiment: How it all started, featuring Hans Arby (UbiGo, RISE) and Steven Sarasini (RISE).
	Episode 2: Who's your Daddy? Introducing the father of MaaS, featuring Sampo Heitenen (MaaS Global/Whim).
	Episode 3: The first MaaS platform provider, featuring Michael Kiesslinger (Fluidtime).
	Episode 4: The very first MaaS service, featuring Martin Rörhleef (Hannover Mobile).
	Episode 5: Another side of the Finnish MaaS scene, featuring Krista Huhltala-Jenks, (The Finnish Ministry of Transport, MaaS Global/Whim, MaaS Alliance).
	Listens to date: 560.
D19	*Governance of future MaaS developments*
	During 2023-24, we provided several inputs for a consultation activity performed by Sweco (funded by Trafikverket), which focused on future MaaS developments, and which resulted in the report entitled "*Fördjupad kartläggning av modellverktyg föreffektberäkning inom kombinerad mobilitet: Behovskartläggning och utvärdering*", authored by Mats Johansson (Sweco) and Clas Roberg (Trafikverket)[1].

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[1] This replaces our previously planned outreach activity that would generate a white paper on the governance of future MaaS developments.

D20	*Keynote speech at MaaS Scotland's annual conference*
	On 6th June 2024, MaaS Scotland held their annual conference in Glasgow, UK. Hans Arby represented SEAMLESS as a keynote speaker at the conference, discussing the potential future of the MaaS concept.

Energimyndigheten

Discussion

As noted in previous sections of this report, our initial intention within the project was to conduct systematic assessments of the sustainability impacts of MaaS using data from multiple piloting activities across Sweden and beyond. Our original plan was to utilise pilot data at the micro and meso levels specified within the KOMPIS framework to develop macro level models that would allow us to draw conclusions regarding the implications of MaaS for the Swedish energy system and for society more generally. To date, MaaS uptake is incredibly limited, and it is therefore difficult to draw any meaningful conclusions regarding sustainability impacts. Notwithstanding, we draw the following conclusions from the project:

1. Pilots that succeeded in recruiting large numbers of participants tend to show positive results in terms of user satisfaction with MaaS, modal shifts towards shared and active modes of transportation and willingness to diverge from private car ownership and usage.

2. Results from other types of studies, including stated preferences and our anticipated consequences study indicate a divergence among users in terms of their willingness to adopt MaaS.

3. This perhaps explains some of the difficulties faced by commercial MaaS operators within the B2C segments, since market demand for MaaS among private consumers may not be as high as previously expected.

4. Other challenges faced by commercial MaaS operators include the need to focus simultaneously on inter- and intraorganisational changes and behavioural change among travellers. That is, in addition to changes in travel behaviour based on the use of services in place of private cars, MaaS also requires a novel business ecosystem with new roles and responsibilities for existing actors and relationships between them. Taken together, these requirements pose huge leadership challenges for commercial startups, particularly given their limited resources.

5. A further challenge is related to the need for service design activities that ensure that MaaS offers are truly user centric following development processes that iterate between users' needs and preferences and service content. Our studies indicate that service design plays a critical function, and yet has been overlooked in some cases.

6. Aside from these challenges, our project has uncovered some promising future trajectories. The B2B segment appears to be more fruitful than the B2C segment, as evidenced by the relative health of companies with corporate customers and given significant pivots made by some market players. Also, municipal parking companies have emerged as a potential actor that can play a key role in the future mobility ecosystem with relation to MaaS, park and ride initiatives and other activities that fit under the sustainable mobility rubric. However, their ability to deconstruct and destabilise existing mobility practices appears to be limited.

Energimyndigheten

Overall, one may conclude that MaaS has progressed along a traditional Gartner hype curve and currently faces an uncertain future. However, MaaS does have the potential to play a key role in a more sustainable transport system, particularly given its focus on shared and active transport modes. Given the challenges faced by commercial MaaS operators in identifying viable business models, bringing about the requisite changes in transport behaviour and in facilitating the development of novel business ecosystems, a case could now be made for stronger public sector commitments. This may include policies and legislation that provide support to new mobility services. However, it is perhaps more pertinent to consider ways to destabilise extant mobility systems and patterns based on private car ownership and use, and to mobilise public sector organisations such as regions, municipalities and public transport agencies in a more coherent and assertive fashion.

List of publications

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Appendices

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