CASE STUDIES ON SUSTAINABLE TRANSPORT

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Plan for today

- Sustainable transport in rural transport
  - KPIs as tool for sustainable design
- Sustainable Air Traffic Management
  - Personas for Modeling Artificial Intelligence
  - User involvement in the design of ML-infused systems

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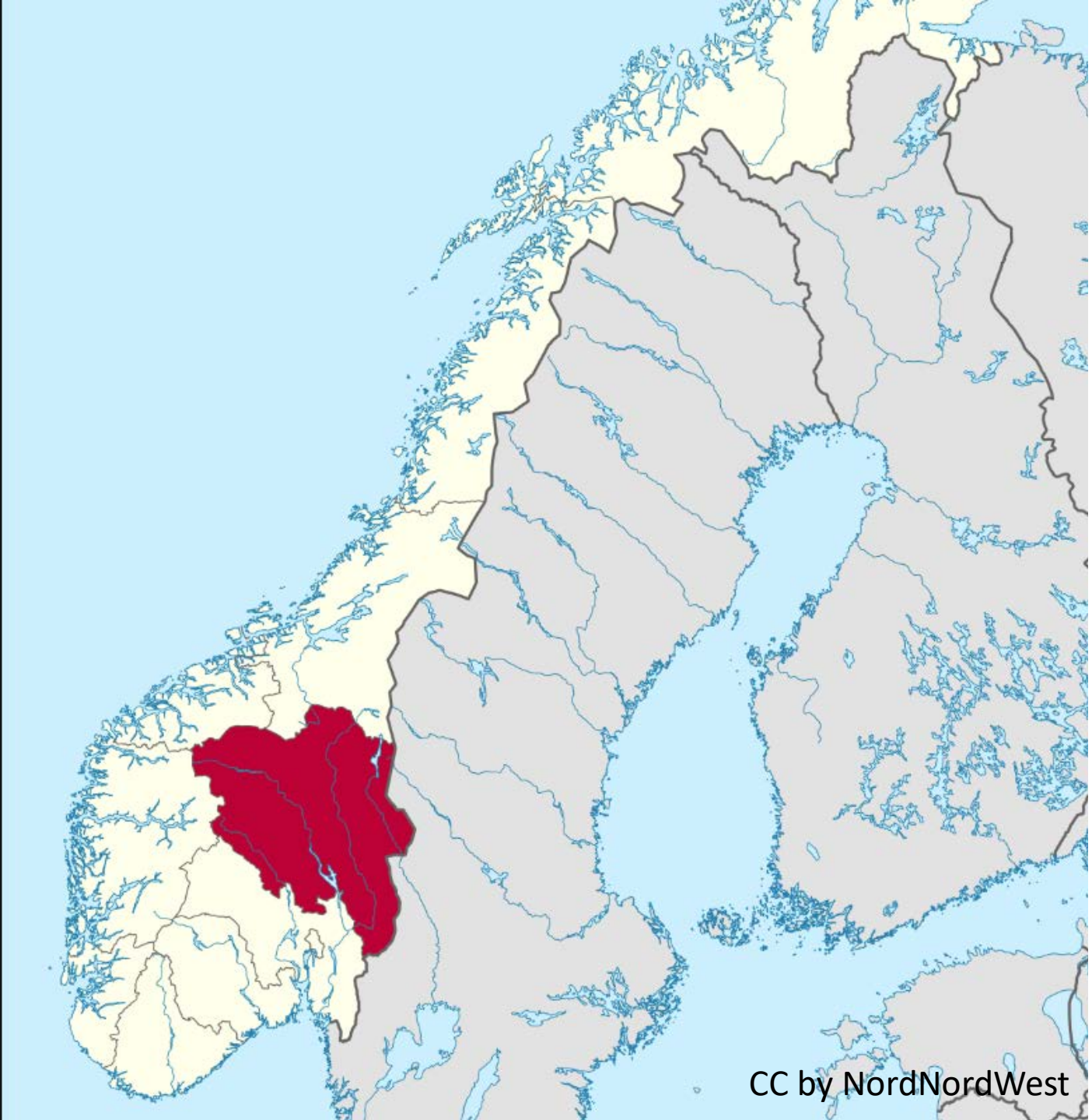
SUSTAINABLE TRANSPORT IN RURAL AREAS



Innlandet County
Area 52 072.44 km^2
Population 371 385 (4th quarter 2019)
Population density 7.1 innhabitants per km^2

Wikipedia.org

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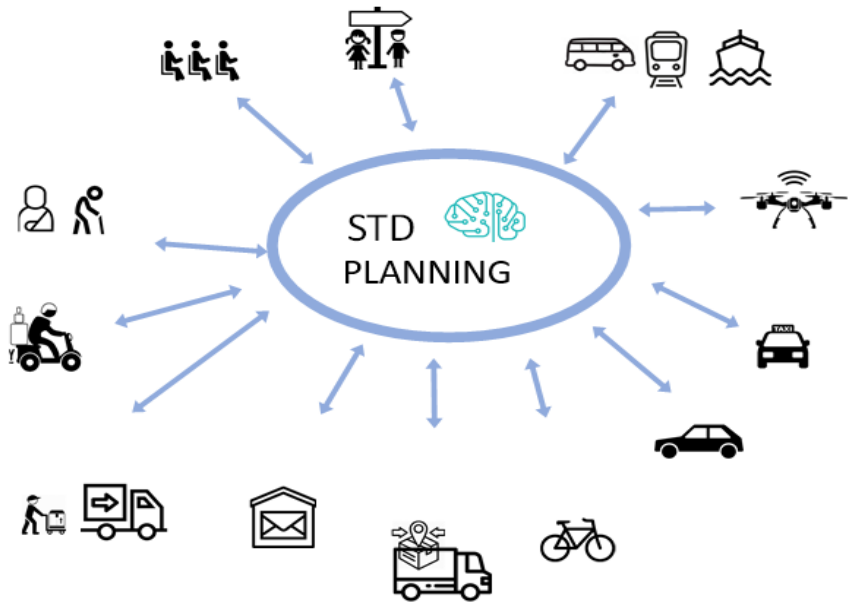
HOW TO PROVIDE GOOD TRANSPORT KEEPING FINANCIAL AND ENVIRONMENTAL COSTS LOW?

Smart transport in rural areas

- Develop Mobility as a Service (MaaS) tools and services specifically tailored for sparsely populated rural areas
- **MaaS services – services offering passengers the transport that suits their needs by combining transport services from different providers through unique platform**
- Create a holistic system for transport planning that dynamically coordinates the transport of people and goods to make the most of transport resources



What is sustainable future?

United Nations Sustainable Goals

- SDG 9 - *Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation*
  - Importance of efficient transport systems and services as the key drivers of economic development.
  - Targets – develop reliable, sustainable, and resilient infrastructures
  - Indicators - proportion of the rural population lives within 2 km of an all-season road, number of passengers and freight volumes by mode of transport

Transition design

- Approach to lead transitions towards more sustainable futures
- Calls for more holistic approach
- Takes a long-term perspective
- Rethinks solution beyond financial and commercial interests

Transition Design in practice

Phases

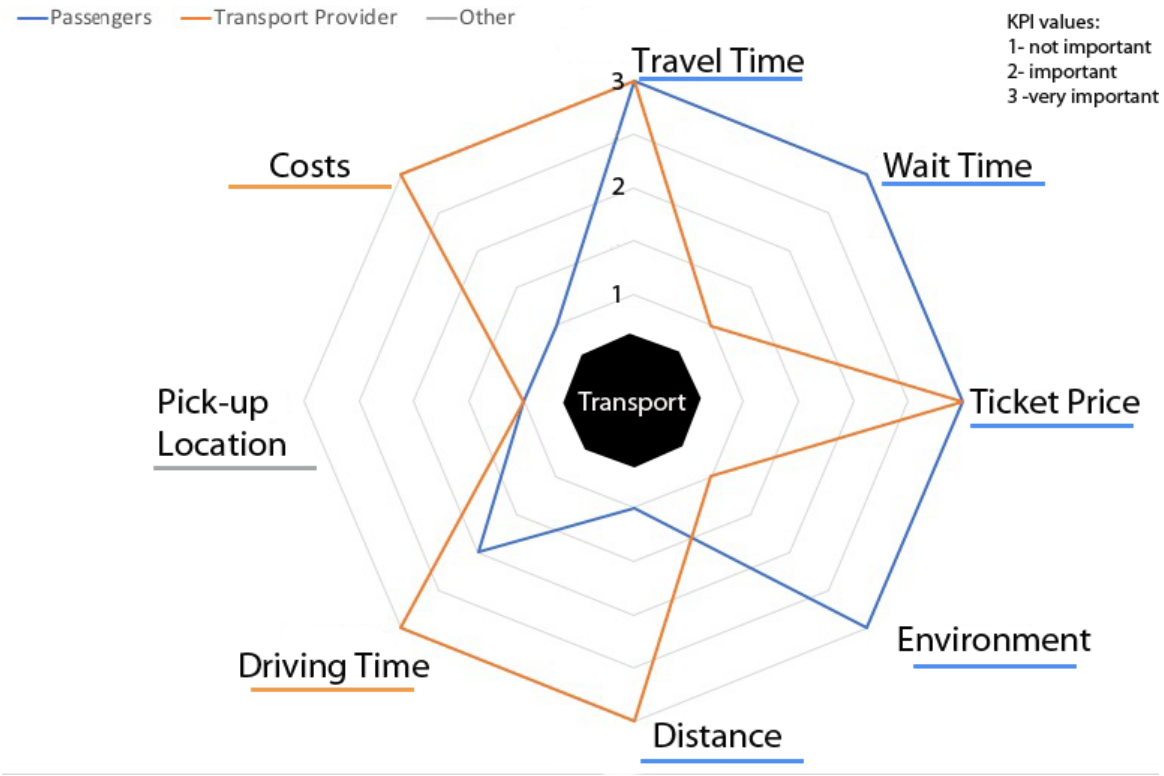
- Reframing the present and future – mapping the problem, mapping stakeholders concerns and relations, future visioning
- Designing intervention – discovering intervention points, intervention design, multiple interventions
- Waiting and observing

Few case studies reported, the lack of actionable components and methods

How to get from high level sustainable goals to design prototypes?

KEY PERFORMANCE INDICATORS IN SUSTAINABLE TRANSPORT

KPIs



Initial list of KPIs – during the project idea development

- Workshops and meetings - problem owner, researchers
- UN and national goals, input from experts

KPIs in the projects

- 2 workshops with 8 experts
- Radar chart
- Two perspectives
- *Drivers workload, operating costs,*
- *utilisation of resources, reduces use of private cars,*
- *costs (passengers, municipalities, transport providers)*
- *Increased income, open category*

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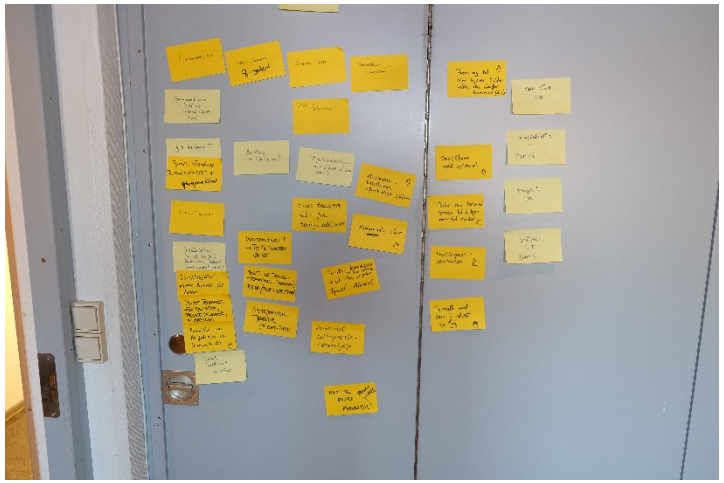
KPIs IN USE

Phase 1 - Reframing present and future

- Map the current problems, creating a map of stakeholder concerns, and the relation between these and the visions for transition
- Workshop with project partners (6 domain experts)
- The most important KPIs were:
  - passenger and freight volume
  - monetary and environmental costs
  - utilization of transport resources
  - travel time and waiting time



How were KPIs useful?

Defining goals

- Utilization of resources -> local entrepreneurs with vans and minibuses
- Passenger and freight volume -> low volumes
- G1 – to work actively on extending the list of the stakeholders
- Travel/waiting time -> motivation
- G2 – to engage citizens in more environmental behavior

"We transport people from the place they don't want to start their travel to the place they don't want to end it at a time which is not convenient for them. People simply want to go from A to B when they want. And there is already a perfect solution. It is called a private car. The question is how to compete with it. How do we motivate people to use public transport?"

How were KPIs useful?

Envisioning future

- Structuring discussions about expectations
- Defining measurable goals
- Showing expected benefits

Example: Two persons use public transportation from Folldal to Alvdal/Tynset (two small Norwegian municipalities) instead of private cars 250 days a year

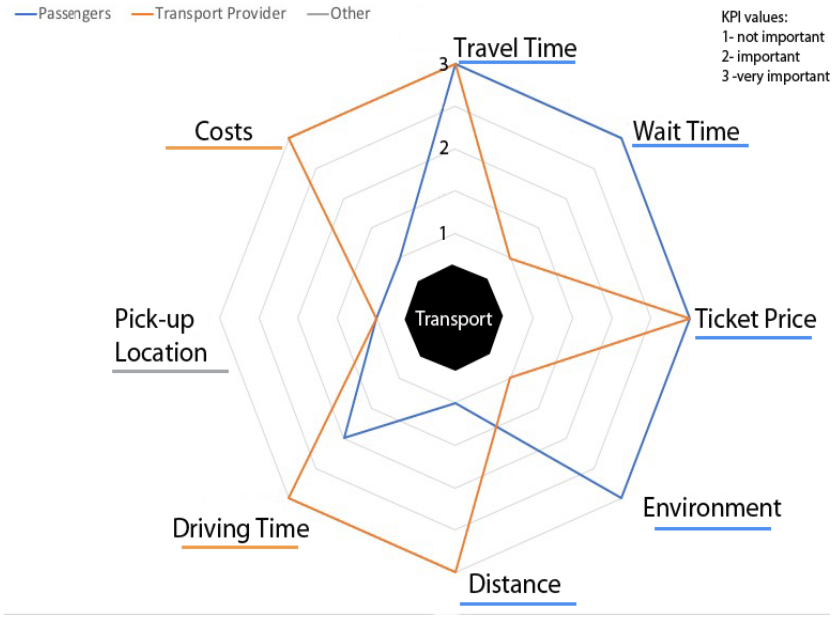
- Reduction in driving distance 200 km per day
- CO_2 emissions reduction 6 kg
- Fuel consumption reduction 3 000 L
- Income from public transportation tickets €5,000

Phase 2 – Designing interventions

Understanding how the problems and concerns are amplified or mitigated at different system levels and seen from different time perspectives.

User insight – interviews with 13 participants

- Transport planning, decision makers
- Radar chart, reflection on KPIs, transport of their dreams
- Two perspectives: passengers and their work position



How were KPIs useful?

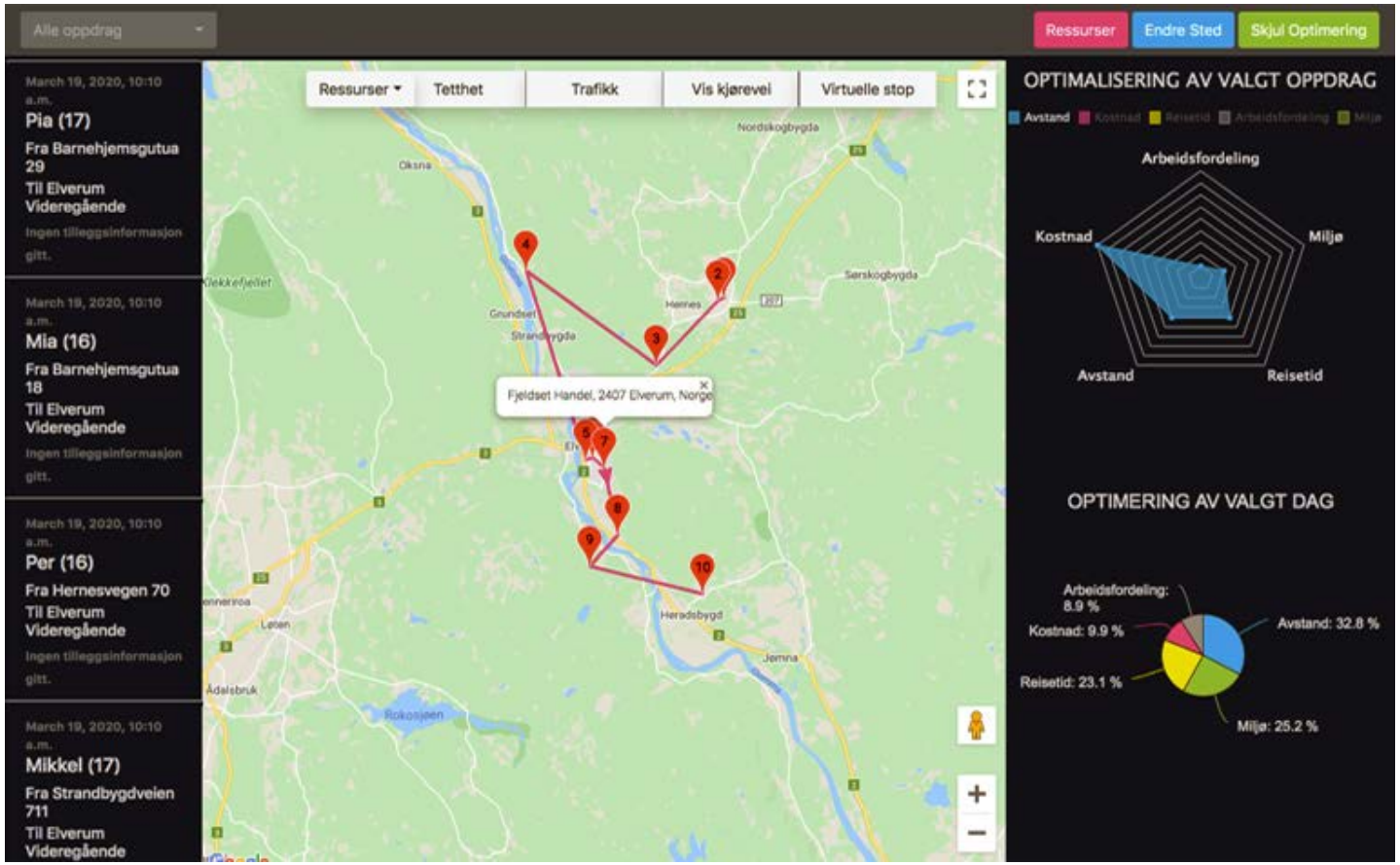
Environmental KPIs help getting broader picture of transport planning

"It is also about how we plan municipality development, where to place the kindergarten in relation to residential areas."

"We would like to be involved much earlier in the development of new residential areas and roads. When they build an area without a space for the bus to turn, it is too late."

"It does not help to plan being in front of school A at 8:15 a.m. and in front of school B at 8:30 a.m. if school B starts at 8 a.m. We have to negotiate with them or drive one bus to school A and another to school B, which is bad for the environment."

Prototyping solutions



The goal to engage citizens in more environmental behavior generated some design ides

- Presenting impact of a proposed solution on KPIs
- KPIs as an input to the tool

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LESSONS LEARNED

KPIs in Transition Design

- Useful for mapping the problem, mapping stakeholder concerns, envisioning the future, obtaining user insights, identifying the current situations that contribute to the problem, and designing interventions
- Helped keeping the focus on sustainability
- KPIs and radar charts worked well in workshops and interviews
- Potentially useful in other domains

Your tourn! 5 minutes

A new tourist resort will be build in a mountain village. You should design a transport system.

Which United Nations Sustainable Goals are relevant?

Which KPIs are relevant?

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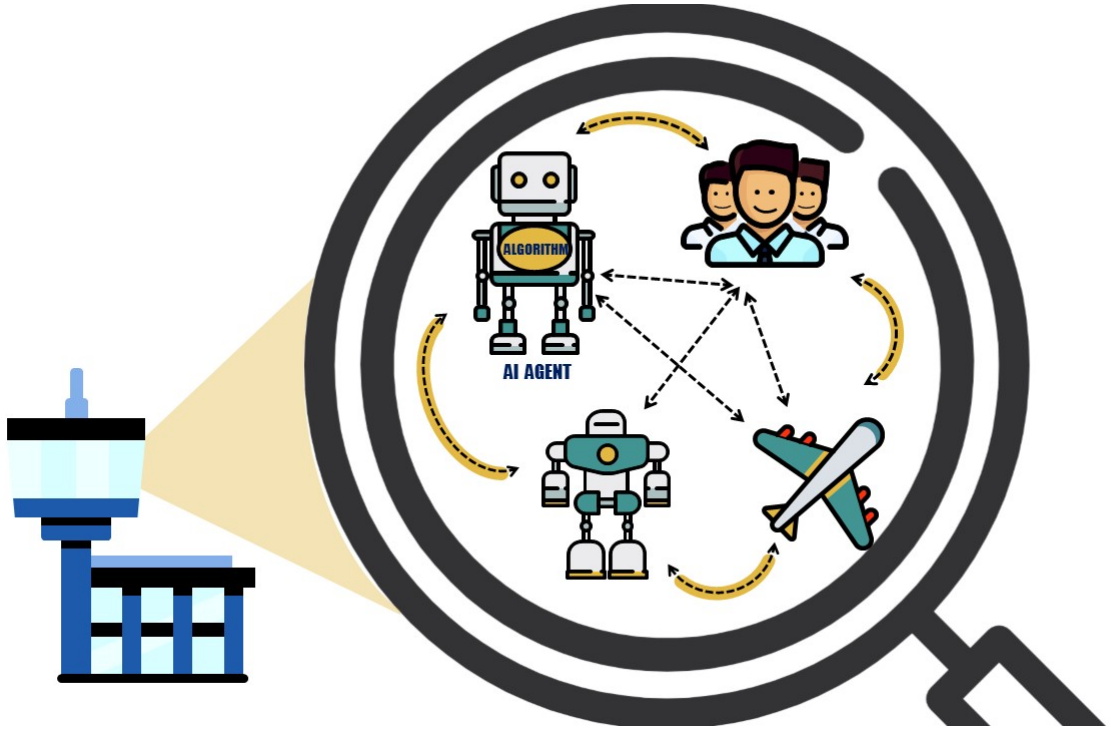
SUSTAINABLE AIR TRAFFIC MANAGEMENT



Air Traffic Management

- Highly automated decision support tool for air traffic controllers
- Airt traffic controllers (ATCOs) job: directing aircrafts on the ground and through controlled airspace, organising end expediting the flow of the traffic, preventing collisions
- AI agents – planning agents – consider future situations caused by their actions to choose the best

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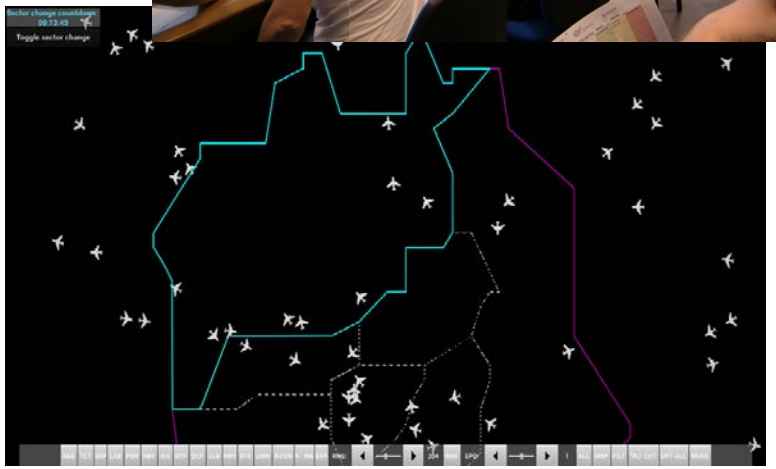
Characteristics of the domain

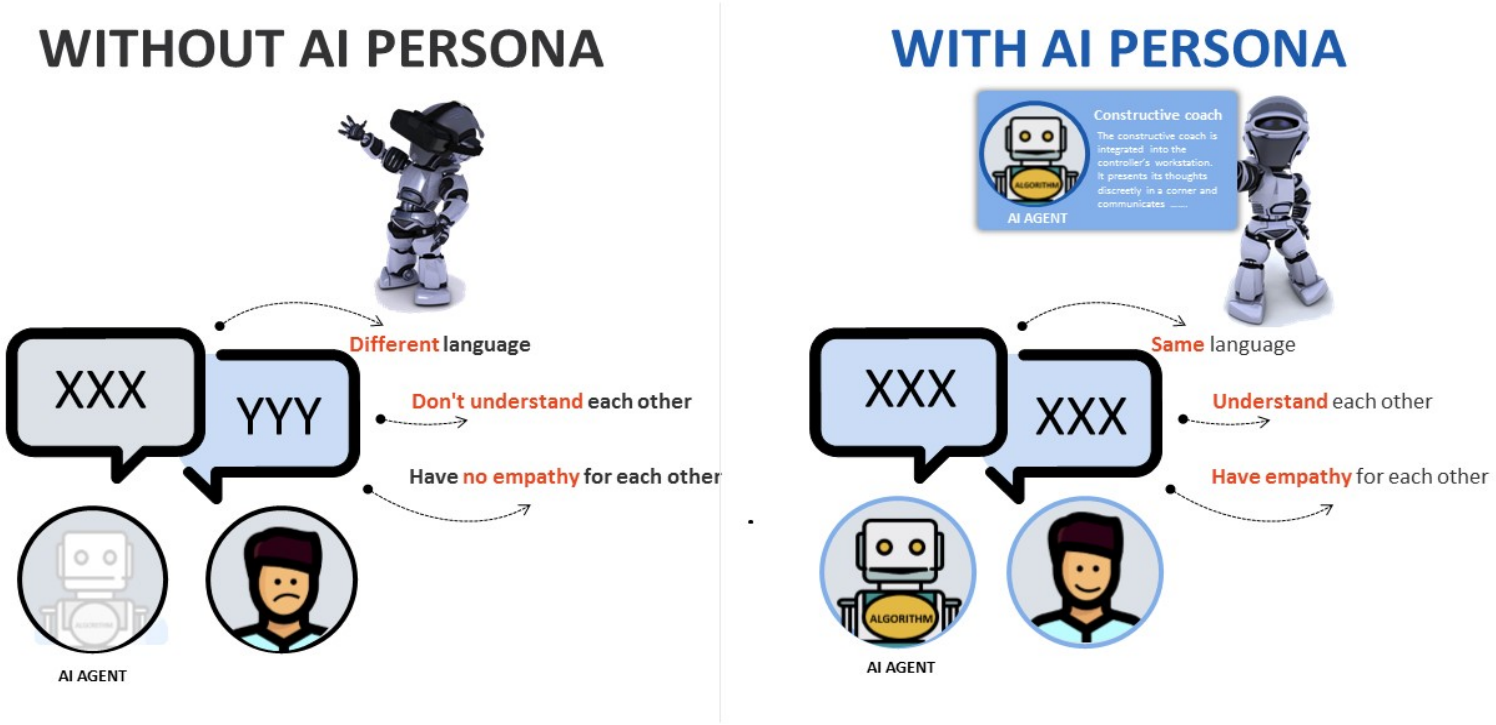
- Decisions – time- and safety-critical
- A decision of one agent (human or AI) impacts the whole system
- Optimisation can improve performance by 20-50%, but introducing it in ATCOs working environment is non-trivial



AI agent needs to adapt to ATCOs behaviour

AI agent needs to explain its decisions

How to work with AI as a design material?



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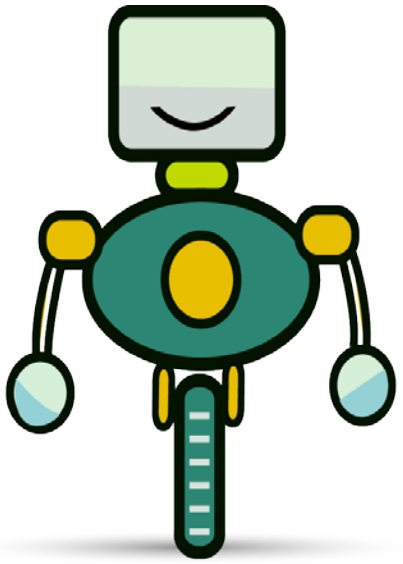
The process we used

- Identify preliminary behavioural variables
- Select relevant behavioural variables (redundancies, completeness)
- Expand the descriptions of variables and behaviours
- Designate types of AI personas



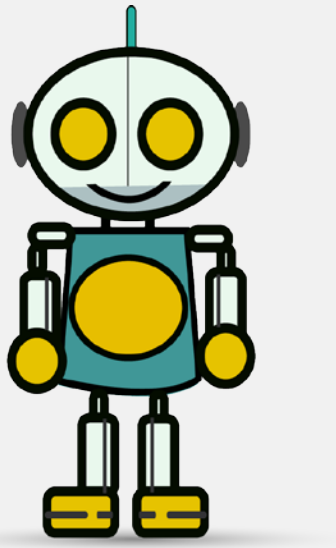
Properties of AI Personas

Appearance	The agent's look/size/layout/interaction forms, such as a pop-up window at the controller's working station or a small robot siting on the desk. Specification of how it interacts with the controller, such as through speech or visual communication.
Type of communication	The high-level or simple dialogue used with the controller, such as brief instructions or longer sentences. Whether the agent will take over communication with the pilot to reduce the workload of the controller.
Social relationship and trust	Ability to establish a social relationship with the controller and build trust over time.
Controller's state	Recognizing the state of the controller

Properties of AI Personas cont.

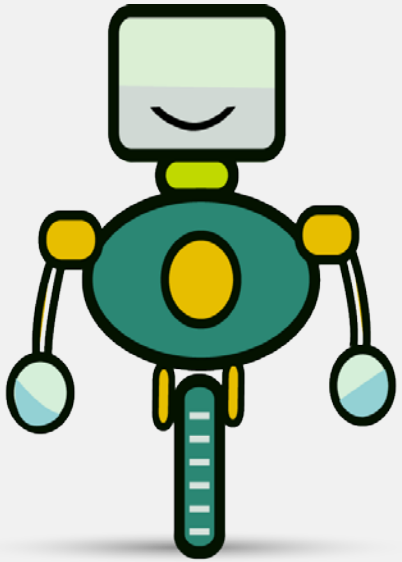
Personality	Individual personal characteristics of the agent, such as extraversion (outgoing/reserved) and agreeableness (friendly/challenging) as well as the interpersonal behaviour of the agent, such as dominance/submissiveness and affiliation (warmth/hostility).
Social competence	Ability of the agent to learn and develop social competence
Algorithm's job-related properties /limitations	Ability of the agent to perform its job
Adaptiveness	Ability of the agent to receive input and adapt
Transparency	Ability of the agent to explain its actions, including the reasons for and impact of those actions
Role	The agent's role such as being supervisor or a colleague.

Self-aware ATM robot



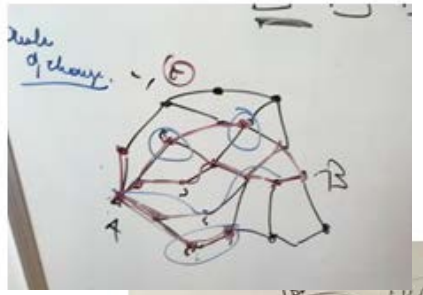
This agent is not human and has no gender. Its voice is male 50% of the time and female 50% of the time. It communicates via speech and text. If everything is normal, it always starts with the same message, perhaps with some variations in tone. If there is some form of negotiation, it will use high-level dialogue, including commands/instructions, and it should support small talk. More high-level talk will be used in the feedback session. The robot explains its decisions. It is not arrogant or patronising; its tone engenders trust. It accepts criticism. It is not passive aggressive. It responds to insults, but it is friendly. It shows some empathy to controllers, but it is not servile or too humble. It communicates sadness if the controller does not follow its advice. It does not use humour very often as it is difficult to echo the culture of the country and of the workplace. If the controller is stressed and does not ask for help, the agent is quiet and says nothing.

Constructive coach



The constructive coach is integrated into the controller's workstation. It presents its thoughts discreetly in a corner and communicates through text, pictures and speech. If the controller clicks on the coach's thoughts, they are related to a map. The coach is easy going and lets the controller try what the controller wants. Afterwards, the coach can offer feedback. During feedback sessions, it would give advice, such as, "If this happens again, you can try doing this". The controller can ask the coach for such feedback, and it is a two-way communication. The feedback is about recurrent issues. If the controller is very busy, the controller can ask the coach, "Hey, can you help me here?" The coach is medium extraverted and agreeable. It would normally say, "Yes. Let's try this," and in the feedback session, shortly after the work session, it could explain more and propose other solutions. The coach would need to know not only the actions of the controller, but also the controller's intentions. The controller can also ask the coach its opinion on the different solutions by asking, "What if I do this?".

Improved dialogue between designers and AI experts

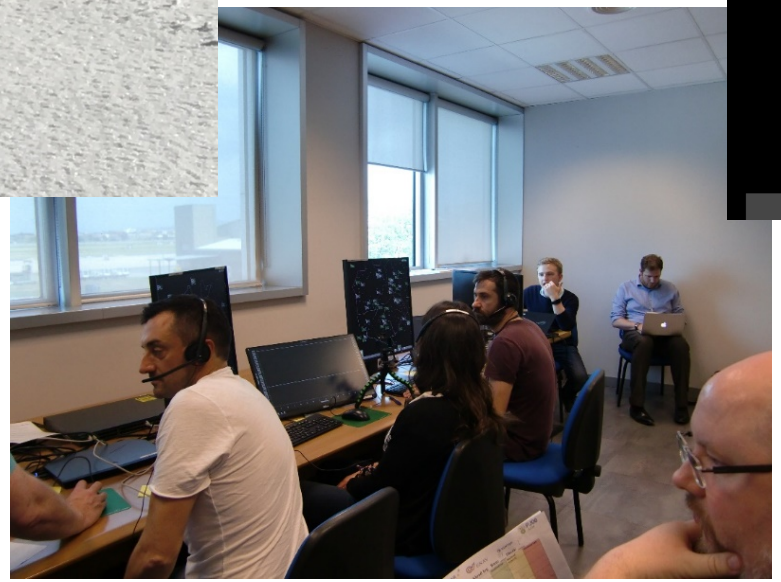


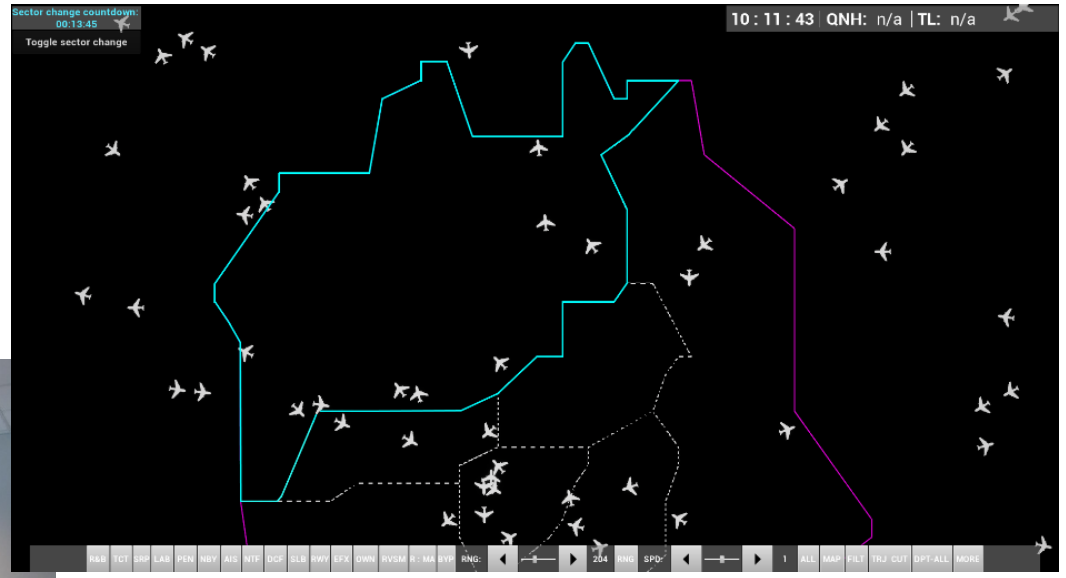
- Finishing each other's sentences, interrupting each other and giving their own examples
- All team members empathized with the (human) end-user and the AI agent
- Giving their own examples
- *'If I often travel to one place for business meetings, it [the algorithm thinks that it] means that I want to travel there all the time and offers me amazing holidays there'*
- *'If we [the algorithms] are keeping track of what a controller can do, we can update the objectives of the model, and you would not suggest some solutions if you know that the controller has only two minutes or something and cannot do it anyway.'*
- *'If it is a black box, I don't care how you do it, but I see that you [the algorithm] remember that I usually travel'.*

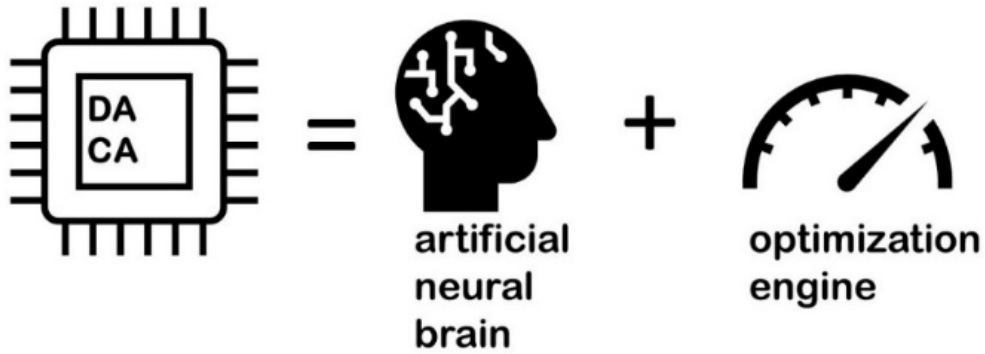
Your tourn! 5 minutes

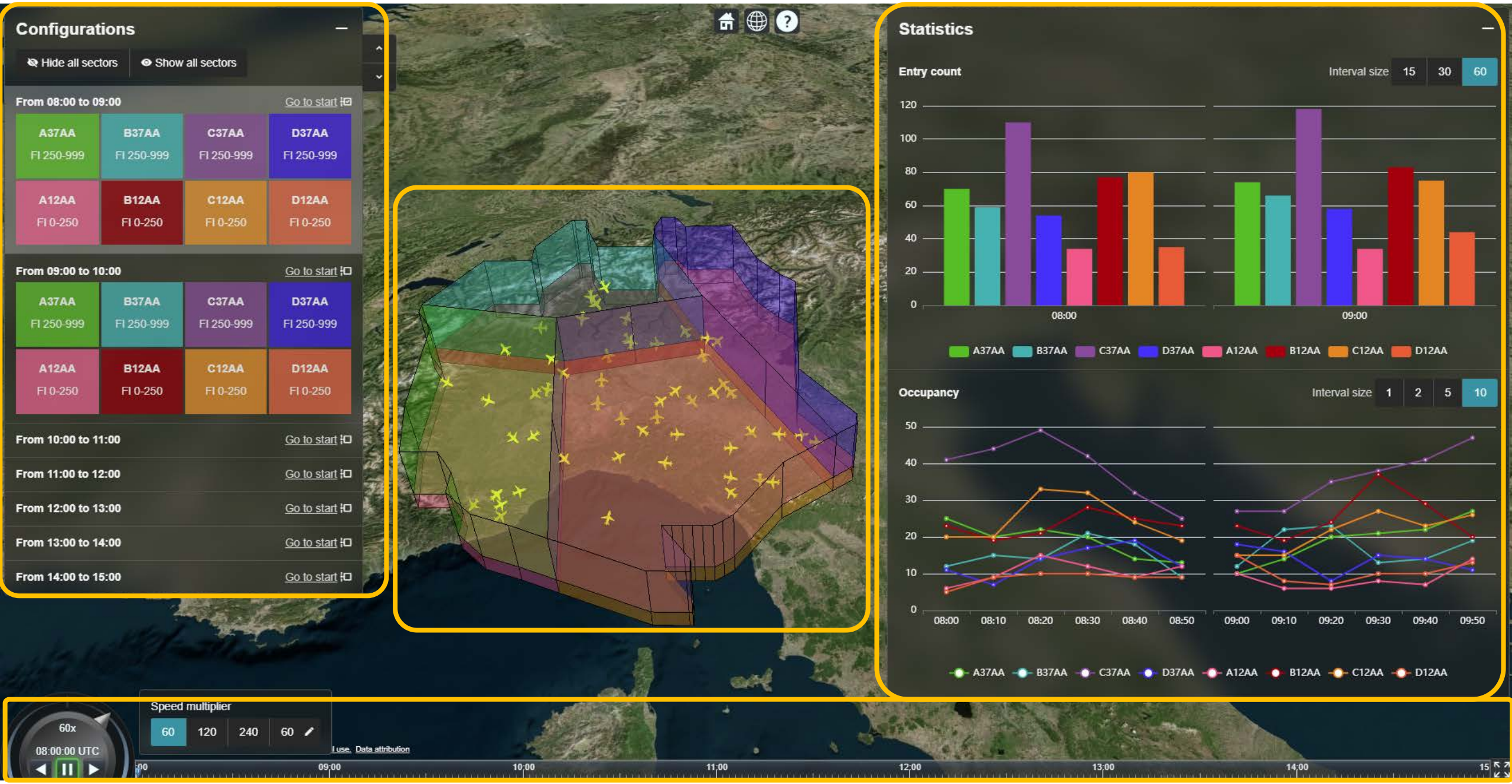
Make personas of a chatbot helping you to plan your trips.

How to involve end-users in the design of Machine Learning-infused systems in ATM?





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Show all sectors
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Statistics
Entry count
Interval size 15 30 60
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Online study

- Three iterations
- Three domain experts
  - One male and two females
  - Experienced supervisors and/or flow managers working for the Italian national air navigation service provider (ENAV)
  - Common training sessions in advance
  - Separate experiment sessions for each expert
- Facilitator, secretary and silent observers
- Sessions were recorded
- Scores, notes and recording summarized after each session
- Findings used to enhance the DACA algorithm and the DAC-P tool

Experience

End-user involvement enabled us to

- determine if some optimisation objectives were missing
- Identify the relative importance of each optimisation objective
- estimate if the workload caused by a proposed sector configuration and a change is acceptable by ATCOs

"the closeness of the traffic to sector boarders"

But - it takes time and resources both in the development and evaluation

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Experience

- End-user involvement enabled us to
  - determine if some optimisation objectives were missing
  - Identify the relative importance of each optimisation objective
- The importance of explaining the role of ML and how it works
- The clear communication of the goal of user involvement
- Difficulties to find the appropriate maturity level of the prototype

THANK YOU FOR YOUR ATTENTION!!!

Contact: amela@sintef.no

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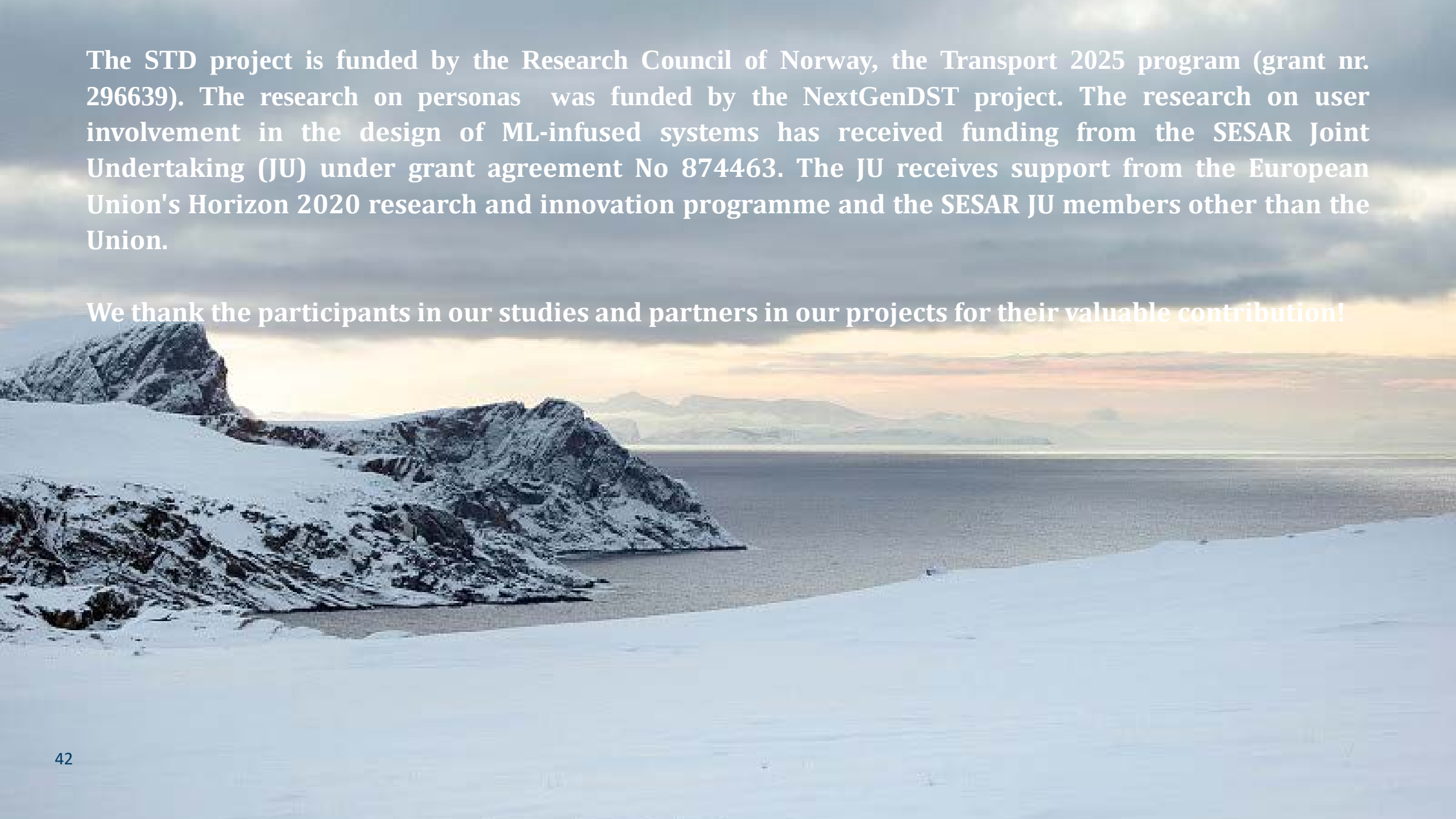
We thank the participants in our studies and partners in our projects for their valuable contribution!



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