



Behavioural economics – finding a place in ATM

Prof Andrew Cook, University of Westminster

Engage thematic challenge 4, 2nd workshop
Madrid, 12NOV19



Founding Members



Behavioural economics – finding a place in ATM

Overview



- What we are trying to achieve
 - scope; pathways to tools
- Where we are now
 - brief recap from previous workshop; wider context
- Some challenges ahead
 - few examples: machine learning; metrics; trade-offs
- Next steps
 - selected heads-up for now; will present at end of day

What we are trying to achieve

What we are trying to achieve

Scope of thematic challenge 4

What TC4 includes

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Engage Thematic Challenges

At the core of the KTN is the definition of various thematic challenges: new ideas suggested by the research community, not already included within the scope of an existing SESAR project. They are developed along with the ATM concepts roadmap and complementarily with some of the network's PhDs and theses.



Forthcoming Engage workshops (scroll down to the thematic challenge for further information):

- 12 November 2019, Madrid, Spain – **TC4 Novel and more effective allocation markets in ATM**
- 02 December 2019, Athens, Greece (co-located with SIDs) – **TC2 Data-driven trajectory prediction**
- The cybersecurity workshop, **TC1 Vulnerabilities and global security of the CNS/ATM system**, will follow in 2020.

What we are trying to achieve

Scope of thematic challenge 4

What TC4 includes

Abstract

This research explores the design of new allocation markets in ATM, taking into account real stakeholder behaviours. It focuses on designs such as auctions and ‘smart’ contracts for slot and trajectory allocations. It seeks to better predict the actual behaviour of stakeholders, compared with behaviours predicted by normative models, taking into account that decisions are often made in the context of uncertainty. Which mechanisms are more robust against behavioural biases and likely to reach stable and efficient solutions, equitably building on existing SESAR practices? The research will address better modelling and measurement of these effects in ATM, taking account of ‘irrational’ agents such as airline ‘cultures’. A key objective is to contribute to the development of improved tools to better manage the allocation of resources such as slots and trajectories, and incentivising behaviour that benefits the network - for example by investigating the potential of centralised markets and ‘smart’ contract enablers.

What we are trying to achieve

Scope of thematic challenge 4



What TC4 does not include

- airport slots ✘
 - i.e. non-ATM, 'strategic' slots, coordinated airports
- cybersecurity (TC1) ✘
 - c.f. cryptoeconomic tools as *enablers* of new mechanisms ✓

What we are trying to achieve

Scope of thematic challenge 4



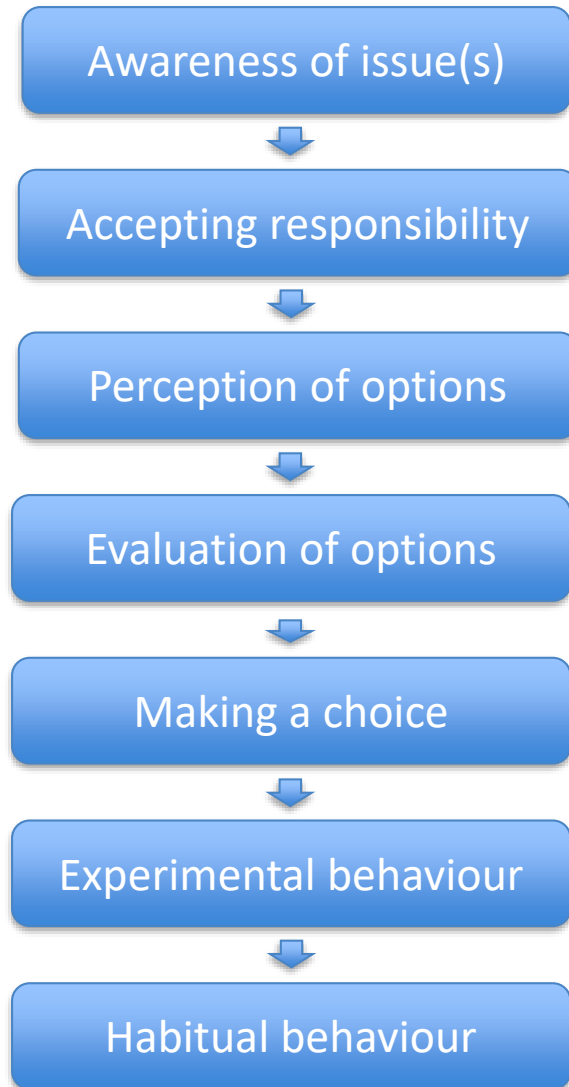
What TC4 may include in future

- we are open to new suggestions
- workshops such as today
- PhDs and CF project(s) developing ideas

- see 'next steps' for opportunities

What we are trying to achieve

Theory of Planned Behaviour



TPB dates from mid-1980s, used in health sector; three predictors of individual intention:

- **attitude** (favourable disposition towards the action);
- **subjective norm** (perceived social pressure to act);
- **perceived behavioural control** (whether individual feels in control of process of action).

Developed & deployed to promote sustainable travel choices as 'Seven Stages of Change' model (early 2000s) (see figure LHS)

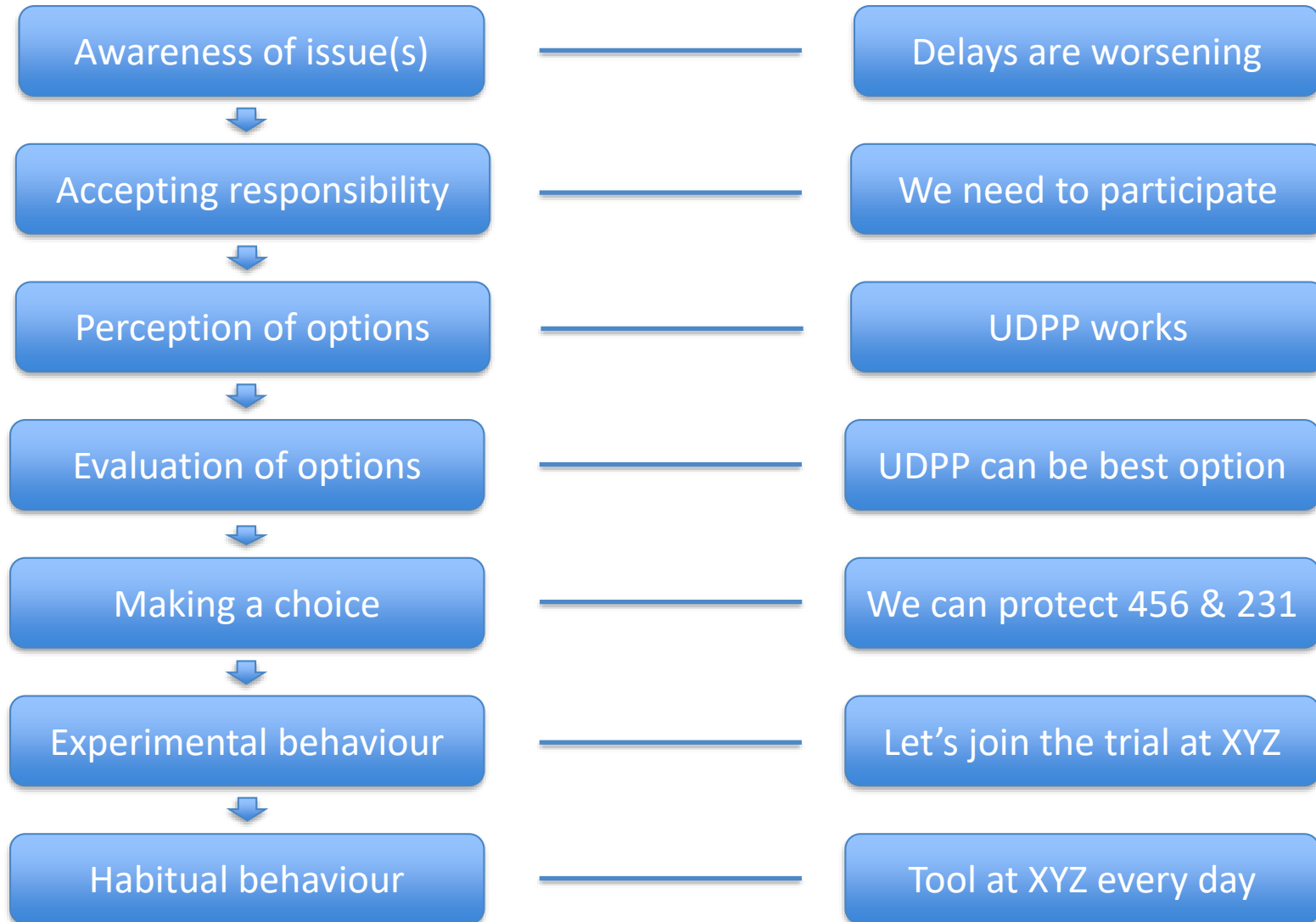
Useful framework, e.g. where to target campaign; not strictly sequential (e.g. feedback); some degree of **post-rationalisation**

Need to evaluate institutional and individual behaviour; used for CDA evaluations*

* Cook and Tanner, 2008. *Managing the Acceptance of Change in ATM* Air Traffic Control Quarterly, 16 (3), 235-254

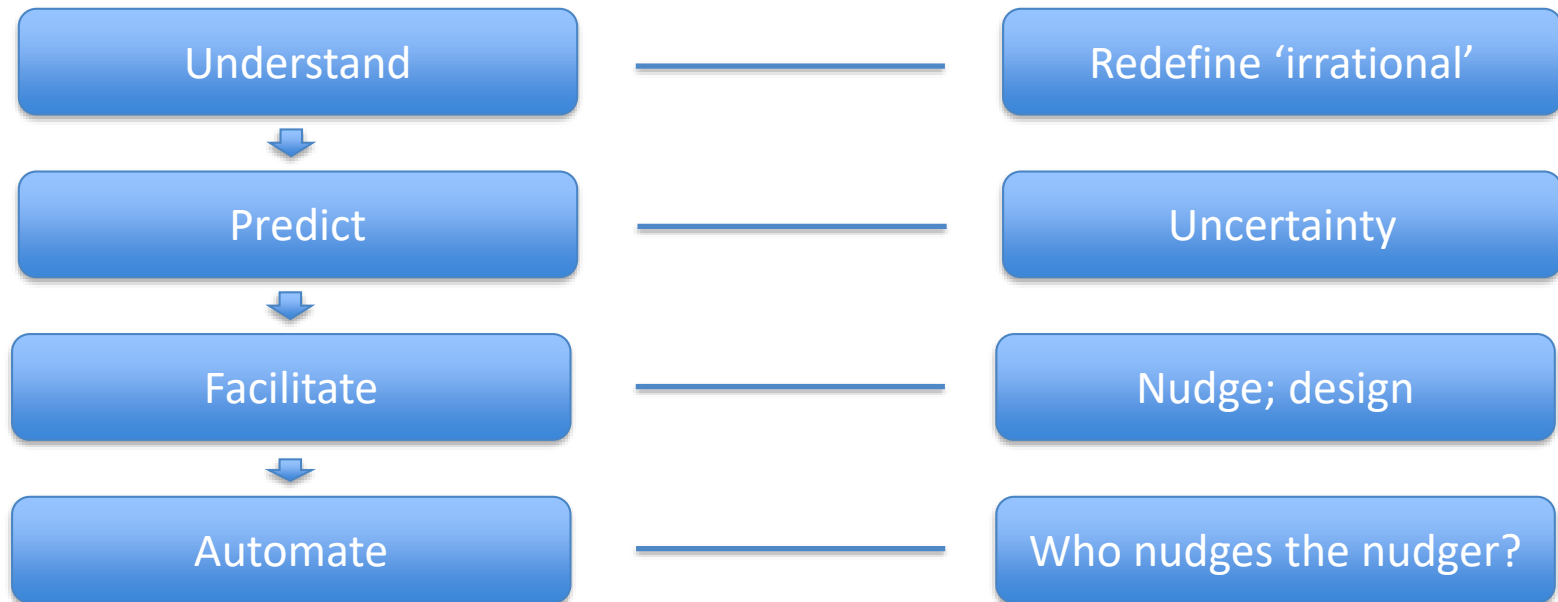
What we are trying to achieve

Theory of Planned Behaviour



What we are trying to achieve

Behavioural science pathway in ATM



What we are trying to achieve

Behavioural science pathway in ATM

Understand



Human perspective

‘Irrational’ \neq ‘wrong’

Stated/understood goals c.f. actions

Better decisions – more time, more information

Post-rationalisation (cognition and choice)

- thousands of inputs competing for our attention, also as we make significant decisions
- only some voluntary actions leave a trace in short-term memory (= motivation?)
- which inputs/thoughts were ‘causes’ of an action?

What we are trying to achieve

Behavioural science pathway in ATM

Model perspective

Two types of uncertainty:

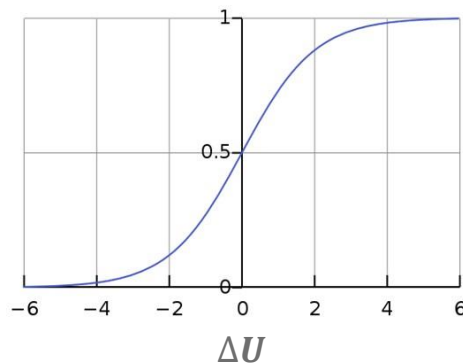
- **epistemic**: model deficiency, lack of information
- **aleatory**: stochastic, inherent
 - capture such effects in agents?
 - very close utilities/prospects

Wider modelling, challenge to capture:

- causality (technical workshop?)
- emergence (positive and negative)
- gaming
- 'irrationality'

} control in mechanisms?

Predict



softmax function
(normalised exponential)

All contribute to model robustness

What we are trying to achieve

Behavioural science pathway in ATM

HM perspective

Behavioural economics – ‘nudge’ to make ‘right’ choice easier, whilst leaving all choices available

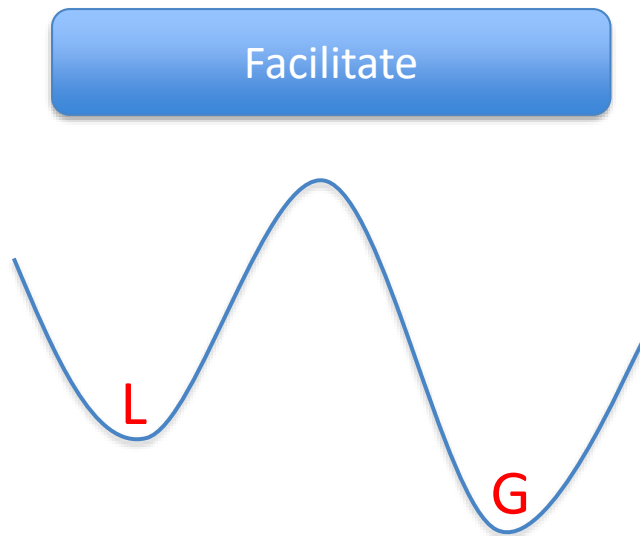
KPAs to measure ‘right’ (e.g. equity and flexibility)

Complex KPA trade-offs; who decides:

- market?
- consensus?
- regulation?

Better decisions – more time, more information

- wider context: peers; network (evidence-led)
- timing of decision; local v. global optimum



What we are trying to achieve

Behavioural science pathway in ATM



Automate

In parallel to the watching of this balance and to the improvements of the current algorithm, that both EEC and CFMU are doing, a longer term project was initiated. It is ISA (Innovative Slot Allocation); its objective is the study of other systems of priorities : feasibility study and quantification of the possible renunciation of the rules currently applied by CFMU.

HM perspective

CASA (FPFS) – notwithstanding acceptability, “Innovative Slot Allocation” report (EATCHIP, 1997) explores prioritising flights by pax numbers, issues of equity ... ISA as a “longer term project”

Scale, stakeholder perspective, mechanisms:

- hub / AU, airport backbone / AU alliances, ... whole network
- rules-based, market-based (monetary/credits)

Data science is a “concept to unify statistics, data analysis, machine learning and their related methods” (*Wikipedia*) – broad church, so is TC4

- AlphaGo, ‘move 37’ – locally ‘bad’, globally ‘good’
- new motifs, new styles of play

What we are trying to achieve

Behavioural science pathway in ATM

Nudging behaviour, all around us



Pay your bills

Utility bills, insurance bills, speeding and parking fines... No need to enter the references, the amount and the beneficiary anymore.



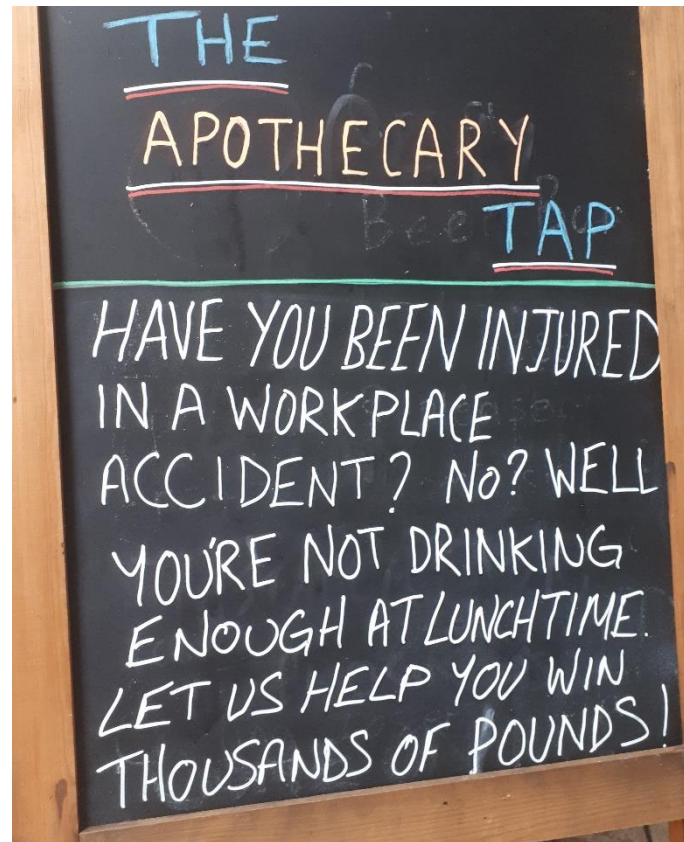
Nos partenaires



What we are trying to achieve

Behavioural science pathway in ATM

Nudging behaviour, all around us



Where we are now

Where we are now

Simple timeline



Where we are now

Recap from TC4 workshop 1 (details in website briefing doc)

The following have been identified as *example* ideas for potential further exploration:

1. Incorporating behavioural science methods into improved traffic demand and distribution predictor tools for ANSPs and UDPP;
2. Assessing if incentives or penalties work as better drivers of behaviour: whether social norms can be used to improve collaboration;
3. Predicting and avoiding undesirable behaviour, such as gaming, in ATM allocation mechanisms;
4. Building a better understanding of 'equity' and 'fairness', plus trade-offs across different stakeholders, and with 'flexibility';
5. Improving the assessment of uncertainty and disturbance, and of new mechanism implications for policy recommendations;
6. Running models and tools in shadow-mode, with practical user interfaces and value in output metrics (e.g. costs, overloads).

Where we are now

Behavioural economics in ER4

2.4.3 SESAR-ER4-08-2019: Behavioural Economics in ATM

Specific challenge:

The application of economic models supports well targeted policy making. However, current economic models applied in ATM are often normative, thus making a number of assumptions about agent rationality that have been demonstrated not to work in practice in several cases. This is because real decision are often not fully rational. An assessment of novel ATM concepts using behavioural economics in ATM at an early design stage could help to predict the actual behaviour of ATM stakeholders and inform decisions about the specific design of the concepts and policy decision making related to their introduction.

Technical Specification
2020 Exploration
H2020-SESAR

Edition date:
Edition:
Status:
Classification:

Abstract

This document constitutes the
Call H2020-SESAR-2019-1 (SESAR
awarded under the call). It specifies
the research activities addressed

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European Union


SESAR
JOINT UNDERTAKING

Where we are now

Two Engage PhDs and catalyst fund project



SESSION 2 Behavioural economics and the Engage PhDs

1120-1150 ***Investigation into 'irrational' airline strategies***
Exploring ground operations as crucial control elements in airline networks
Hartmut Fricke (TU Dresden)

Airline; schedule recovery, market mechanisms, HITL

1150-1220 ***The bridge between optimisation and simulation: application to APOC***
The benefit of coupling optimisation and simulation in order to enhance decisions in a multi-agent environment
Daniel Delahaye (ENAC)

Airport; ABM, stakeholder motivation, HITL

SESSION 3 The Engage catalyst fund & industry perspectives

1330-1400 ***What UDPP hopes to deliver to the airspace users***
The importance of designing the right mechanism and understanding the drivers of the user
Nadine Pilon (EUROCONTROL)

Flight prioritisation; ABM, 'rationality', new metrics

1400-1430 ***Exploring future UDPP concepts through computational behavioural economics***
Insights into the Nommon Engage catalyst fund project, with a focus on flight prioritisation
David Mocholí (Nommon)

Where we are now

Next version of this workshop



November 2020?

- results from the catalyst fund project (Nommon)
- progress from / support to the PhDs (candidates?)
- further activities from 2nd Engage catalyst fund Call
- focus on progress towards tools

- suggestions from you

Some challenges ahead

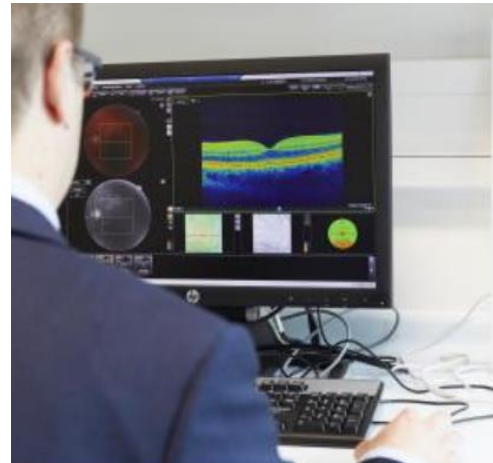
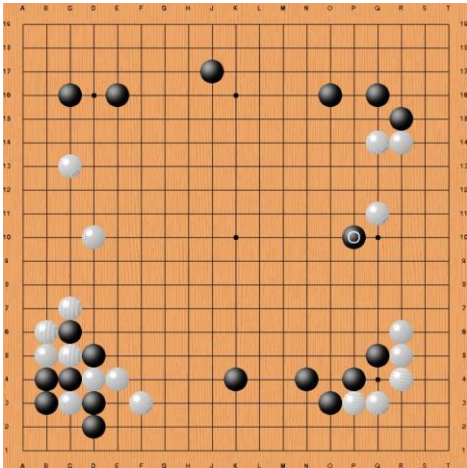
Some challenges ahead (1/3)

Examples for discussion

From ML perspective

- difficult to train nets (esp. deep learning)
- new styles of play c.f. lack of ‘general’ intelligence (so far)
- interpretability
- don’t replace ‘irrationality’ with opaqueness

supervision,
HILT,
interviews

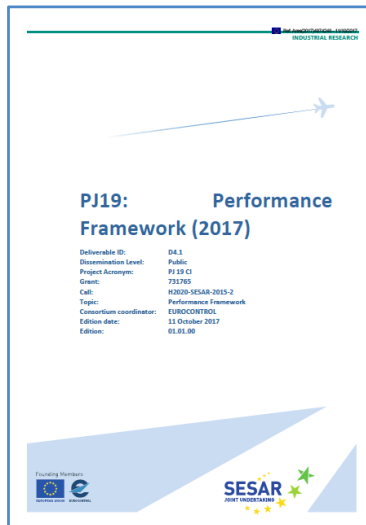


Some challenges ahead (2/3)

Examples for discussion

Metrics (let's be ambitious!)

- no KPIs yet for **flexibility** KPA (UDPP examples) or access & **equity** KPA
(buffer, re-sector, rebook)
- **resilience** (capacity KPA, various PIs); need: absorptive, adaptive, restorative
- can we measure mechanism susceptibility to 'irrational' behaviour?
- pax delay c.f. flight delay (e.g. POEM, SESAR WP-E) ...

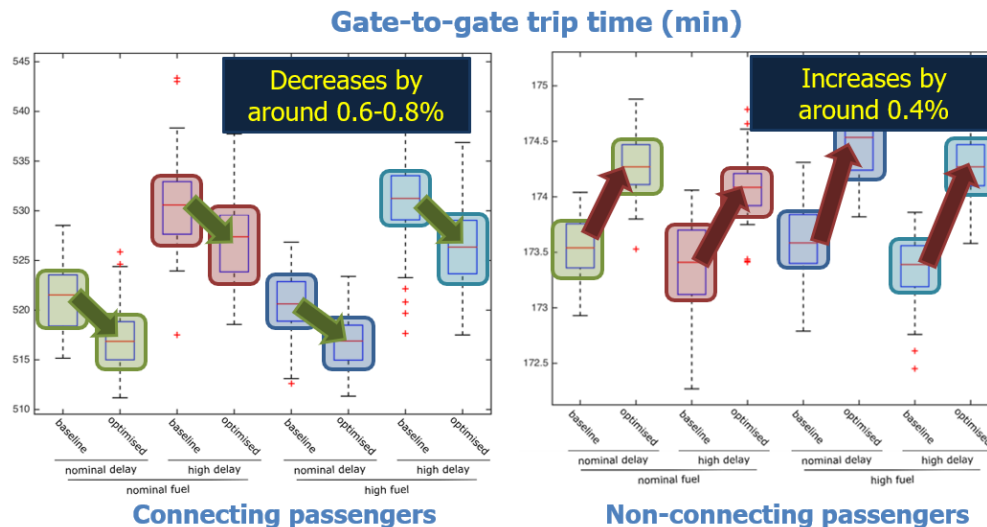


Some challenges ahead (3/3)

Examples for discussion

Trade-offs

- ... and pax types (CASSIOPEIA, SESAR WP-E, *et seq.* ...)
- capacity offered c.f. punctuality (older); **equity c.f. flexibility**
- delay cost supralinear function of duration: all delay mins not equal
- particular challenges re. quality of cost data and itineraries (& crew)



Next steps

Next steps

Selected heads-up – will present at end of day

To bear in mind for now

- Engage technical workshops (industry / academia)
- updates from today, before 2nd Engage catalyst fund Call



Thank you



Behavioural economics – finding a place in ATM

Thank you



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