D6.2 Stakeholder Consultation on Business and Regulatory Scenarios

Deliverable 6.2

Vista

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Vista

MARKET FORCES TRADE-OFFS IMPACTING EUROPEAN ATM PERFORMANCE

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Abstract

The results from the consultation with stakeholders on business and regulatory factors, scenarios and metrics are presented in this deliverable. Vista examines the effect of factors on the current and future (2035, 2050) framework. This consultation will help to identify which factors and scenarios should be prioritised and to ensure we are capturing all relevant parameters within the model.

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Executive summary

Vista examines the effects of conflicting market forces on European performance in ATM, through the evaluation of impact metrics on four key stakeholders, and the environment. The project comprises a systematic impact trade-off analysis using classical and complexity metrics, encompassing both fully monetised and quasi-cost impact measures. To achieve these objectives, Vista models the current, 2035 and 2050 timeframes based on various factors and their potential evolution. These factors influence the choices of the actors in the ATM system: prices of commodities and services, regulations from national and supranational entities, and new technologies are all part of a complex socio-economic system that results in evolving business models, passenger choices, etc. Previous deliverables have defined the modelling framework and metrics estimated per stakeholder (D4.1), the literature review of regulatory and business factors considered (D2.1) and the definition of foreground and background factors and of background scenarios to be modelled in Vista (D3.1).

These concepts have been the subject of a consultation with experts and stakeholders, and the results are summarised in this document, Deliverable 6.2. The objectives of the consultation are to:

- ensure that all the relevant metrics for the different stakeholders are identified;
- validate the factors considered in Vista: ensure that all relevant factors have been identified and that their possible values are adequate and comprehensive;
- ensure that the evolution of the background scenarios for the 2035 and 2050 timeframe is adequate;
- prioritise the metrics generated and the scenarios to model (background scenarios and foreground factors);
- gain knowledge of overall results that would be interesting to produce in Vista;
- assess the TRL that could be achieved.

The consultation was sent to 15 senior experts from research, policy advisers, airports and industry institutions. Three responses were obtained. The number of responses is low due to the high profile of the experts targeted. For the same reason, the responses obtained are of high quality and provide a very valuable external view of the approach and characteristics of the project.

The main findings of the consultation are that new metrics could be developed for passengers and airlines, built as a combination of other metrics, to consider level of service. The consultation also points out the importance of providing, as an output, some variables that previously were considered internal to the model, e.g. passenger numbers. Some estimation of local impact on environment (noise and local air quality) could also be incorporated. For some of the factors, new possible values will be considered, e.g., reduction of regional airports infrastructure. The technology evolution considered in the project for 2035 and 2050 is reported as satisfactory for the objectives of the project. Finally, background scenarios will be prioritised following the advice of the experts.

The outcome of this consultation will be complemented with the site visits to airline members of the consortium: Icelandair, SWISS and Norwegian. These site visits will help with the prioritisation of scenarios and ensuring that the modelling of the impact of factors on the system is accurate. Finally, further discussions with EUROCONTROL and Belgocontrol will ensure the adequate modelling of airport- and ANSP-related factors, and complement the prioritisation of factors, scenarios and metrics.

1 Introduction

1.1 Objectives of Vista and previous deliverables

Vista examines the effects of conflicting market forces on European performance in ATM, through the evaluation of impact metrics on four key stakeholders, and the environment. The project comprises a systematic impact trade-off analysis using classical and complexity metrics, encompassing both fully monetised and quasi-cost impact measures. To achieve these objectives, Vista models the current, 2035 and 2050 timeframes based on various factors and their potential evolution. These factors influence the choices of the actors in the ATM system: prices of commodities and services, regulations from national and supranational entities, and new technologies are all part of a complex socio-economic system that results in evolving business models, passenger choices, etc.

Some of these factors, foreground factors, will be analysed in detail in order to understand their impact on the system's metrics. The others, background factors, will be grouped giving them predefined possible values to generate future background scenarios onto which to test the foreground factors. This approach allows us to model possible future evolution of the system while understanding the impact of individual parameters.

'Deliverable 4.1 Initial framework definition' defined the framework and modelling approach of the Vista project. The characteristics of the four stakeholders and environment considered in Vista with the metrics identified for each one of them were also presented in that deliverable. 'Deliverable 2.1 Supporting data for business and regulatory scenarios' identified the regulatory and business factors considered in Vista and their possible evolution. Finally, 'Deliverable 3.1 Business and regulatory scenarios report' classified those factors between foreground and background, grouped the background factors to generate the possible scenarios considered in Vista and presented a preliminary identification of which part of the model impacted by the individual factors.

1.2 Overview of this deliverable

A consultation with experts has been carried out in order to help us validate the approach taken in Vista, and to prioritise the scenarios and factors to model. This prioritisation will be used during the development of the project. This deliverable summarises the main finding from this consultation activity. The deliverable presents:

- Summary of stakeholders/experts to which the consultation has been send.
- Analysis of the responses obtained and how this information will be used in the project.
- Next steps and look ahead on the Vista development.
- An annex with the consultation questionnaire.

The opinions expressed herein reflect the authors' views only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.

2 Stakeholders and experts

The consultation was sent to 15 senior experts from research, policy advisers, and airports and industry institutions. The experts were selected to cover different topics relevant for Vista and for the view of the ATM system and its evolution.

Three responses were obtained. Two reminders were sent after the initial contact to increase the response rate. If the expert was not available, a suitable colleague has been contacted and the deadline for receiving the replies has been extended on several occasions. The number of responses is, however, low due to the high profile of the experts targeted. For the same reason, the responses obtained are of high quality and provide a very valuable external view of the approach and characteristics of the project.

The identities of the experts remain anonymous in this deliverable. The list of experts to which the questionnaire was submitted and the responses obtained have been disclosed to the Project Officer.

3 Consultation responses and considerations in Vista

This section contains for each of the topics put under consultation (see Annex I), the experts' responses and how they will be considered on the next steps of Vista.

3.1 Stakeholders considered and metrics

3.1.1 Consultation results

Table 1. Stakeholders metrics responses

Stakeholder	Expert 1	Expert 2	Expert 3
Passengers	Apparently, no metric is missing, although an overall "passenger experience" metric would be interesting to be researched, based on the weighted function of Vista metrics.	• Generalised costs/trip (hence monetary and time cost for the door-to-door trip) • Ticket price • Why do you make the difference between hard and soft costs for the passengers? Is it more relevant for the airlines? • Is value of time the value for the whole trip? They will be correlated with door-to-door time, hence I would go for generalised costs which weights monetary costs to travel time.	• Level of Service (Quality) • Reliability of connection

Stakeholder	Expert 1	Expert 2	Expert 3
Airlines	Not clear from Table 7 if only mean values of the delay distribution are included, or also other moments (i.e. standard error, skewness and kurtosis). These are especially important to Airlines to define predictability of operations.	• The hard and the soft costs mentioned under passengers	• Level of Service (Quality)
ANSPs	Capacity resilience to non-nominal conditions (weather, industrial actions) is very important especially to guarantee minimal quality of service under all circumstances. Maybe this is equivalent to "mitigated delay" in Vista, but I suggest to align to the definitions given in the SESAR 2020 Performance Framework	• Navigation charge • Total costs	• ATCO hours • Capacity • Work Load • Detours
Airports	Similarly to ANSPs	• Total number of passengers (total/transit/with Origin or Destination) • Airport charge • Revenue and costs would be total or per passenger?	• Capacity (Runway, Apron)

Stakeholder	Expert 1	Expert 2	Expert 3
Environment	Increasingly higher importance is given to Noise and Local Air Quality both from a regulatory and an economic perspective. I suggest to have a look at the SESAR 2020 Performance Framework for an overview of related metrics and tools.	• Noise • H_2O and contrails	

3.1.2 Consolidated implications for Vista

Table 2. Stakeholders metrics implication for Vista

Stakeholder	Implications for Vista
Passengers	• A metric indicating the Level of Service (passenger experience) could be considered as a weighted function of Vista metrics. • A generalised costs/trip monetising time costs could be considered. • Some airlines do not track detailed soft costs. For this reason, it is reasonable to model them separately, but they will be reported as total cost experienced by the airline.
Airlines	• The importance of the distribution of delay and not only mean values is pointed out. • Level of service could be considered as for passengers weighting different metrics in Vista.

Stakeholder	Implications for Vista
ANSPs	• Parameters considered within the model that should be reported o Navigation charges and total costs should be produced as output o Capacity estimations and detours could be added as output. • Metrics estimations indicated on the consultation but that are out of scope of Vista o Capacity resilience is not estimated in Vista project. o ATCO hours and workload out of scope of Vista
Airports	• Parameters considered within the model that should be reported o Passengers numbers could be produced as output. This will be part of the validation of itineraries generated. o Capacity could be produced as output. o Airport charges could be produced as output. • Metrics estimations indicated on the consultation but that are out of scope of Vista o Revenue and costs levels are out of scope of Vista.
Environment	• Local quality around airports could be estimated as a function of demand, in particular: o Noise o Local air quality

3.2 Metrics importance ranking

3.2.1 Consultation results

The metrics are ordered by the sum of ranks within each stakeholder group. Again, within these groups, if any expert indicates a metric as rank 1, it is included in the table and indicated "^". This allows us to ensure that a metric ranked as important by just one expert is prioritised, as for example is the case for gate-to-gate time for airlines, marked as the most important by one expert but with a low priority for the other two.

Table 3. Metrics ranking responses

Stakeholder	Metric	Expert 1	Expert 2	Expert 3	Sum of ranks
Passengers*	Door-to-door time^	1	1	1	3
	Value of time (utility)	2	5	2	9
	Delay (departure, arrival; reactionary)	5	2	4	11
	Missed connections	6	3	3	12
	Gate-to-gate time	4	4	6	14
	Hard / soft costs	3	6	5	14
Airlines	Revenue and costs (incl. delay)^	2	1	1	4
	Delay and costs (incl. delay)	4	2	2	8
	Missed connections	3	3	3	9
	Gate-to-gate time (absolute time)^	1	4	4	9
ANSPs	Flight-km controlled^	2	1	1	4
	Revenue and costs (incl. delay)^	1	2	3	6
	Delay (generated, mitigated)	3	3	2	8
Airports**	Revenue and costs (incl. delay)^	1	1	1	3
	Delay (departure, arrival, reactionary)	2	2	2	6
	Missed connections	3	3	3	9
Environment	CO_2^	1	1	1	3
	NO_x	2	2	2	6

* Expert 2 would have ranked 'generalised costs/trip' as the most relevant for passengers and consider number of passengers too.

** Expert 2's ranking for airports would depend on the airport business model

^ Metric ranked 1 by at least one expert.

3.2.2 Consolidated implications for Vista

The project team will take into careful consideration the metrics prioritisation by the experts. In general, there is agreement regarding the most important metrics.

3.3 Regulatory and business factors

3.3.1 Consultation results

Table 4. Regulatory and business factors responses

Stakeholder	Expert 1	Expert 2	Expert 3
Are there any regulatory factors missing from the planning in Vista?	Apparently not, even if I would put the Charging Scheme and Performance-based regulation together under SES since they are regulated by EU Reg. 390/2013 and 391/2013, intimately connected.	Internalisation of external cost. What if aviation is also included (e.g. By using fuel tax, stronger ETC regulation, obligation to use biofuels (cf. revised RED directive) "2050 vision": seems a bit vague: what would this add, which cannot be included in the other regulatory factors. I would say the 2050 vision is a particular combination Not sure why performance based regulation has the "PRB" as a factor?	-
Are there any business factors missing from the planning in Vista?	I can't find any factor related to the responsiveness of the flight planning to the dynamic capacity allocation (e.g., collaborative DCB)	ANSP business models Airport business models Are drones included both in BTO1 and ROR6?	-

Stakeholder	Expert 1	Expert 2	Expert 3
Are there any 'possible values' considered for the foreground factors that you would modify?	I cannot find flight demand anywhere (neither in background nor in foreground). This is a crucial factor determining the quality of service of ATM and ATC. I think it should be at list appearing through its main explanatory variable: GDP.	RAD2 (and related ROR9): why not a decrease in regional airports (which are currently very heavily subsidised) – especially in relation to potential of increased high speed rail travel BE02: introduction of peak/congestion pricing (unless this is already captured in modulation of charges – in that case I would rename this to congestion pricing?)	-
Which factors, currently considered as background factors, should instead be considered as foreground factors, if any? Please state why	-	Technology uptake will probably depend on incentives (regulatory factors)?	-

3.3.2 Consolidated implications for Vista

Table 5. Regulatory and business factors implication for Vista

Stakeholder	Implications for Vista
Regulatory factors missing	• Regulation relating to external costs: in particular fuel tax. These regulations could be considered as having an impact on higher fuel price.

Stakeholder	Implications for Vista
Business factors missing	• Changes on ANSP and airports business models. • Other suggestions by reviewers already considered in Vista: o DCB is captured by BTS11 and BTS12 (Demand and Capacity Balancing at Airports and En-route). o Drones are included in BTO1 and ROR6 as one is the technology and the other the regulation changes.
Values that should be considered in foreground factors missing	• The consideration of reduction of regional airports should be added as a possible value for RAD2/ROR9 • Other suggestions by reviewers already considered in Vista: o Demand is implicitly considered on economic development o BEO2 includes modulation of charges.
Background factors that should be foreground factors	• Regulatory factor on incentive to uptake technology. This is considered implicit on the scenario affecting the technology uptake.

3.4 Interest of foreground factors

3.4.1 Consultation results

Ordered as sum of ranks.

Table 6. Foreground factors ranking responses

Factor	Expert 1	Expert 2	Expert 3	Sum of ranks
BTS5 - 4D trajectory management^	5	2	2	9
RAD1 - Airport slots^	7	3	5	15
ROR4 - Noise pollution^	9	5	3	17
BEO1 - Fuel price^	3	4	12	19
ROR1 - Passenger provision schemes^	1	10	8	19

Factor	Expert 1	Expert 2	Expert 3	Sum of ranks
RAD2 - Regional airport development^	2	11	7	20
BTS9 - Traffic synchronisation^	12	9	1	22
ROR3 - Emission schemes	10	6	6	22
BEO3 - Airline business models	6	7	10	23
RAA1 - Airport access	8	12	4	24
BEO2 - Airspace charges^	11	1	13	25
ROR9 - Operation of air services	4	13	11	28
BTO4 - Passengers reaccommodation tool	13	8	9	30
BEO4 - Smart ticketing	14	14	14	42

^ Factor ranked 1-3 by at least one expert.

Comments from Expert 2:

- With respect to ROR1: it does not make sense to have load factors significantly below 100%. This can never be an optimal solution: you should stick with compensation. This makes economically more sense.
- Would BTO4 not be linked to ROR1?
- Why no “very high” for fuel price (eg. If obligation biofuels)
- BE01: low or high – what would be situation of today: Low?

3.4.2 Consolidation implications for Vista

Efforts will be made by the project team to prioritise the modelling of the foreground factors in the order of their prioritisation as indicated by the experts.

Table 7. Prioritisation of foreground factors

Priority	Factor
1	BTS5 - 4D trajectory management
2	RAD1 - Airport slots
3	ROR4 - Noise pollution
4	BEO1 - Fuel price
5	ROR1 - Passenger provision schemes

Priority	Factor
6	RAD2 - Regional airport development
7	BTS9 - Traffic synchronisation
8	BEO2 - Airspace charges
9	ROR3 - Emission schemes
10	BEO3 - Airline business models
11	RAA1 - Airport access
12	ROR9 - Operation of air services
13	BTO4 - Passengers reaccommodation tool
14	BEO4 - Smart ticketing

- For ROR1 the reduction of capacity below 100% would be considered lower priority with respect to other possible modifications of the regulation.
- BEO1 Fuel price should include a very high case.

3.5 Background scenarios technological evolution

3.5.1 Consultation results

Number of responses on views regarding the technological evolution suggested below for each of the background scenarios.

Table 8. Technological evolution of background scenarios responses

Background scenario	Description (TD: Technology development as defined in SESAR) (ED: Economic development)	Much too low	Somewhat too low	About right	Somewhat too high	Much too high	Don't know
L35 - Low 2035	TD: Trajectory-based performances ED: Low			1			2

M35 - Medium 2035	TD: Trajectory-based performances ED: Medium – with increase of high-income profile share		1	2
H35 - High 2035	TD: Performance-based performances ED: Medium – with increase of high-income profile share	1		2
L50 - Low 2050	TD: Performance-based performances ED: Medium - with increase of high-income profile share			3
M50 - Medium 2050	TD: Performance-based performances ED: High - with increase of high-income and environmental-friendly profile share	1		2
H50 - High 2050	TD: Enhanced Performance-based performances ED: High - with increase of high-income and environmental-friendly profile share		1	2

Comments from Expert 2:

Why is there a shift in the eco scenario: low goes from low growth to medium and high goes from medium to high? Would results not be clearer if you keep low-low and high-high?

3.5.2 Consolidated implications for Vista

Due to the number of "Don't know" responses, the likelihood of the technology evolution is inconclusive. The scenarios with high economic development with stagnant technological development are defined in Vista to test the impact of not implementing the technological solutions during high economic growth. Another trend from the consultation is that scenarios could be slightly pessimistic overall, as indicated by expert 1.

3.6 Interest of background scenarios

3.6.1 Consultation results

Ordered as sum of ranks.

Table 9. Background scenarios ranking responses

Background scenario	Expert 1	Expert 2	Expert 3	Sum of ranks
L35 - Low economic, Low technology^	1	1	2	4
H35 - High economic, High technology^	3	2	1	6
H50 - High economic, High technology	4	4	3	11
M35 - High economic, Low technology	2	5	6	13
L50 - Low economic, Low technology	6	3	4	13
M50 - High economic, Low technology	5	6	5	16

^ Background scenario ranked 1 by at least one expert.

3.6.2 Consolidated implications for Vista

2035 scenarios seem to be of higher interest than 2050 and high technology scenarios more interesting than low technological development. Scenarios will be prioritised as follows:

Table 10. Background scenarios ranked

Priority	Background scenario
1	L35 - Low economic, Low technology
2	H35 - High economic, High technology
3	H50 - High economic, High technology
4	M35 - High economic, Low technology
5	L50 - Low economic, Low technology
6	M50 - High economic, Low technology

3.7 Technology Readiness Level (TRL)

3.7.1 Consultation results

Table 11. TRL responses

	Number of replies	Comment on how to reach follow TRL
TRL1	1	Having Vista as a model which can be run by a client/interested stakeholder and not only by the researchers themselves
TRL2	1	Allowing for customers/stakeholders to define their own scenarios with more flexibility than low/high
TRL3	1	-

3.7.2 Consolidated implications for Vista

TRL2 could be achieved if Vista is developed as a tool that allows stakeholders to produce their own results.

3.8 Closing comments – what particular results are of interest to you, from Vista?

3.8.1 Consultation results

Expert 1 - New insights on the macro-economic links between socio-economic factors and traffic demand

Expert 2 - I would be mainly interested in the combined effects of measures: are they complements, do they enforce each other or the contrary?

Expert 3 - Simulation results, sensitivity analyses, identification of future research focuses

3.8.2 Consolidated implications for Vista

These comments will be used when defining the analysis and when the trade-offs are carried out.

4 Next steps and look ahead

The outcome of this consultation with experts and stakeholders allows us to prioritise the scenarios to model and to adjust the possible values of some of the factors to be modelled as reported in Section 3. These views will be complemented with the outcome of the site visits to the airline partners of the consortium (Icelandair, SWISS and Norwegian) and with discussions (and site visits, if required) with ANSP and airport experts (Belgocontrol and EUROCONTROL). The site visits with airlines are scheduled for between mid-May and mid-June and feedback on how to model the impact of some factors, and on the prioritisation of outcomes to be generated, will be obtained. Once these visits are completed, milestone MS2 will be achieved.

The implementation of the model is under development. The prioritisation of the factors and metrics to model will be done following the outcome of the consultation and site visits. Milestone MS3 will be achieved once the initial evaluation framework is completed. The outcome of the first evaluations of the model will be reported in D5.1 Initial Assessment Report due in M16 (OCT 2017). Those results will be put under consultation with stakeholders and reported in D6.3 Stakeholder Consultation on Initial Assessment due in M18 (DEC 2017), this will represent the achievement of milestone MS4.

5 Annex I – Consultation document

1 Introduction

This is a consultation document for the SESAR 'Vista' project, coordinated by the University of Westminster, with partners: Innaxis, EUROCONTROL, Icelandair, Norwegian, SWISS and Belgocontrol. The primary objective of Vista is to quantify the current and future (2035, 2050) relationships between a currently non-reconciled set of performance targets in Europe, specifically, the trade-offs between, and impacts of, regulatory and business factors and whether their alignment may be expected to improve or deteriorate in future. Further details follow below. The objectives of this consultation are to seek your views regarding the **coverage and priorities** of the project. In addition, we wish to capture your view of the current and likely final Technology Readiness Levels (TRLs) of the project.

Our questions are at the beginning of each section, in blue, followed by the information required to understand their context. References to specific parts of deliverables are provided for consultation, if further details are required. At the end of the document, there is an additional question to capture any comments that you might have on any of the previous questions or material.

Below are the links to the three deliverables for further consultation, if further details are required:

- D2.1 - Supporting Data for Business and Regulatory Scenarios Report
- D3.1 - Business and Regulatory Scenarios Report
- D4.1 - Initial Framework Definition

1.1 Objectives of Vista

Vista examines the **effects of conflicting market forces on European performance in ATM**, through the evaluation of impact metrics on **four key stakeholders** (passengers, airlines, ANSPs and airports), **and the environment**. The project comprises a **systematic, impact trade-off analysis using classical and complexity metrics**, encompassing both fully monetised and quasi-cost impact measures (for more details regarding the metrics see Section 2.3 in Deliverable 4.1 - pages 25-29). To achieve these objectives, Vista models the **current, 2035 and 2050 timeframes** based on various factors and their potential evolution. These factors influence the choices of the actors in the ATM system: prices of commodities and services, regulations from national and supranational entities, and new technologies are all part of a complex socio-economic system that results in evolving business models, passenger choices, etc.

The factors considered in Vista are divided between **regulatory and business factors**. Regulatory factors are regulations that define the operational framework modelled and that might well affect how a process or operation in the system functions. Also included in this definition are (policy) instruments, i.e. policy objectives that are not binding (non-regulatory) but may also contain operational targets that influence behaviour. Business factors are such factors other than regulatory that are considered within the model. These are non-regulatory ('market') factors that affect (business) operations and are set by the stakeholders or in the wider economic environment. These factors include tools, technologies and processes.

Regulatory and business factors are classified between **foreground and background factors**. Foreground factors, will be analysed in detail in order to understand their impact on the system's

Founding Members

metrics. Background factors, will be grouped giving them predefined possible values to generate future background scenarios onto which to test the foreground factors. This approach allow us to model possible future evolution of the system while understanding the impact of individual parameters.

1.2 Foreground factors, background factors and scenarios

Regulatory and business factors have an impact on the stakeholders' behaviour and/or on the system affecting the different KPAs and KPIs that are of interest in Vista. Some of those factors define the background onto which the individual factors are assessed. As shown in Figure 1, the regulatory and business factors are divided between foreground and background factors. The background factors are grouped with their possible values to define the scenarios.

In some cases, instead of testing each of the individual factors independently, these can be grouped to test higher level policies which might affect more than one factor at once. For example an environmental impact mitigation strategy or a passenger focus approach. In these cases, the effect of applying these factors can be compared against a default evolution of them.

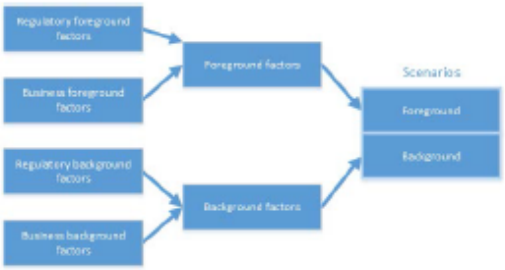

Figure 1 Factors classification and scenarios definition

It is worth noting that regulatory factors might be different from business factors in the fact that some of them play a role of enablers of technology or operational concepts to be deployed while others have a direct impact as they have a direct impact on the stakeholders/system. For example, regulation on ATCO interoperability is required in order to develop the concept of FABs with seamless management of traffic but the regulation itself does not has a direct impact on Vista model, the regulation might be implemented but its translation into technological and/or operational changes not materialised; while the regulation defining the passengers' compensations in case of disruption must be followed by all aircraft operators and the disposition of the regulation has a direct impact on airlines' costs of delay and hence on their behaviour when dealing with disrupted itineraries or planning the flights. All the regulation that is considered as enabler will be part of the background factors and it is assumed that the regulation will reflect the legal framework changes to allow the business factors modelled along it to be implemented and deployed.

1.3 Vista model

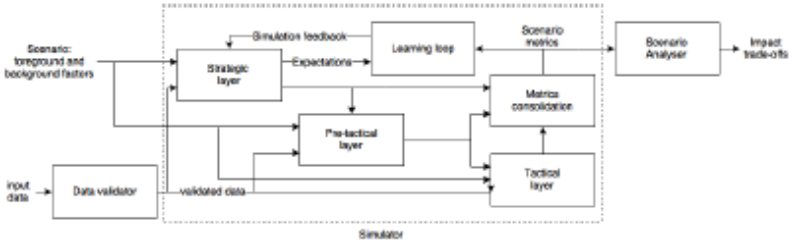

Figure 2 Vista high-level packages architecture

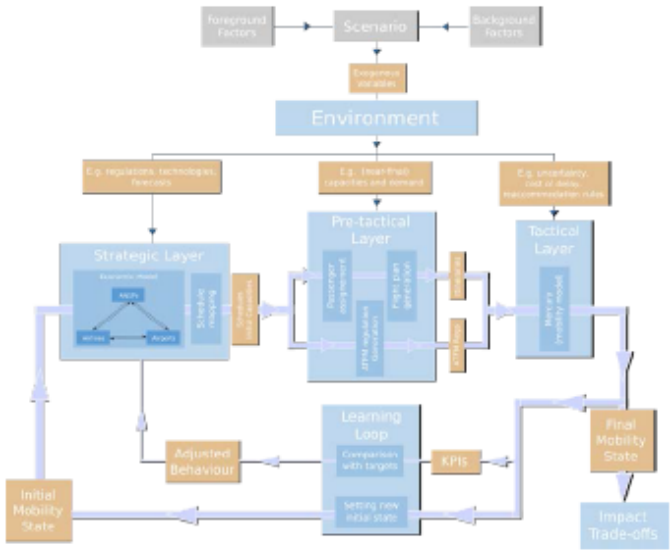

Figure 3 Vista layers

Vista will model the different phases of the ATM process from the strategic to the tactical phase. Figure 2 presents the high-level view of the different packages that will be developed in Vista and Figure 3 shows a detailed view of the different layers of the model with their sub-layers. For more detail on the different modelling approach considered in Vista see Section 2.4.1 in Deliverable 4.1 and in particular Table 8 and Section 2.4.2 for the justification of the approach selected for Vista.

As shown in Figure 3, a selection of values for the foreground and background factors describe a scenario which defines exogenous variables for the environment to which the air traffic model is evaluated. Note that the different factors in the model are meaningless unless they are considered in the model. The strategic layer defines, based on an economical model, the modifications to the schedules to generate the demand in the system and the initial capacities. The pre-tactical layer

assigns passengers' itineraries to flights and defines the individual flight plans; ATFM regulations are generated based on the traffic demand and the airport and airspace capacity along with other environment factors. The outcome of the pre-tactical phase contains all the parameters to model the day of operations by the tactical layer. This layer computes the tactical execution of the individual itineraries, flights and regulations on Mercury mobility model. As these models are stochastic, each layer or set of layers might be executed several times to consolidate the metrics of the environment under analysis which is defined by the factors and data sources. The model includes the possibility of developing a learning loop which would adjust the behaviour for the strategic layer based on the outcome of the consolidation of the metrics. This loop would allow us to provide a new initial mobility state to the model which would recalibrate the outcome of the economic model at the strategic level.

If required, for technical details on the implementation of the model, please see Section 3 of Deliverable 4.1.

2 Stakeholders and metrics

Please bear in mind that we put the questions for your consideration *before* the corresponding text.

Q1. Considering Table 7 in D4.1 (see main text below), are there any metrics missing, in your view, that should be included in the model?

(Please type any missing metrics in the corresponding boxes next to each stakeholder.)

Passengers	
Airlines	
ANSPs	
Airports	
Environment	

Founding Members

Q2. Please rank the metrics in order of importance (1= most important) for each stakeholder.

Stakeholder	Metrics	Stakeholder	Metrics
Passengers	1.	Airports	1.
	2.		2.
	3.		3.
	4.		
	5.		
	6.		
Airlines	1.	Environment	1.
	2.		2.
	3.		
	4.		
ANSPs	1.		
	2.		
	3.		

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Deliverable 4.1 defines the stakeholders, the metrics considered per stakeholder and the trade-off analysis methodology. This information is summarised below in Table 7-D4.1. Besides those metrics, indicators such as number/volume (flights, passengers) will be computed for passengers, airlines, ANPs and airports. For more details please see Deliverable 4.1 - Section 2.1 (pages 8 -13), Section 2.3.1 (pages 25 - 27) and Section 2.3.2 (pages 27-29).

Table 7-D4.1 - Initial metric groupings by stakeholder type

Stakeholder	Metrics	Stakeholder	Metrics
Passengers	• Delay (departure, arrival; reactionary (delay propagated, e.g., due to missed connections)) • Missed connections • Gate-to-gate time • Door-to-door time, considering time to access/egress the airport and the processes from kerb-to-gate and gate-to-kerb • Hard costs (with direct monetary impact, e.g., fuel, passenger, maintenance, crew and (strategically) fleet costs) / soft costs (associated primarily with market share loss driven through unpunctuality) • Value of time (utility)	Airports	• Delay (departure, arrival; reactionary) • Missed connections • Revenue and costs (incl. delay)
		ANSPs	• Flight-km controlled • Delay (generated, mitigated) • Revenue and costs (incl. delay)
Airlines	• Delay (departure, arrival; reactionary (delay propagated, e.g., due to late arrival of inbound flight)) • Gate-to-gate time (absolute time) • Missed connections • Revenue and costs (incl. delay)	Environment	Emissions • CO_2 • NO_x

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3 Regulatory and business factors review

Please be reminded that we put the questions for your consideration *before* the corresponding text.

Q3. Are there any regulatory factors missing from the planning in Vista?

Q4. Are there any business factors missing from the planning in Vista?

An extensive review of sources to identify regulatory and business factors has been carried out and reported in **Deliverable 2.1**. In Vista, we identify factors likely to affect the evolution and performance of the system with their impact on the system and potential evolution. These factors are differentiated between regulatory and business factors. The former include all the **legal requirements** emanating from national and supranational entities in order to regulate a certain part of the system. These factors are by nature known (at for the current situation), and their immediate effects are unambiguous. However, indirect effects due to changes of business models can be present in the medium to long term, which could decrease the efficiency of the regulation, have an opposite effect to the expected one, or simply have another effect in another part of the system. Some of those regulatory factors can be seen as enablers of operational and technology modifications in the system while others have a direct impact on the behaviour of the actors in the system. The regulatory factors have been grouped based on the phase of the operations affected by them.

Business factors are more generic and their effects are sometimes less clear. In essence, a business factor is a **service, technology, operational concept or commodity** which may impact a stakeholder's business model, or the customer satisfaction of a passenger, when it is available or changes its price. Obviously, there is a great number of business factors, especially if one considers the heterogeneity of the actors implied. As a consequence, Vista tries to group them in common areas.

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Vista is first interested in the new services and technologies which are likely to be introduced in the future affecting the gate-to-gate performances. For this, Vista looks specifically at major R&D initiative, and in first place SESAR. SESAR has indeed a very clear structure in terms work packages and the targets which are likely to be achieved by different dates. These clearly defined new solutions can be directly used in the Vista model, either using some heuristic impacting one part of the model (e.g. factor X decreases the airport access time by Y%) or directly modelling the new mechanism (e.g. implementation of DCI). Since Vista also deals with the home-to-gate and gate-to-home travel legs, changes related to the airport access and processes are also considered. The third kind of business factors reviewed are related to socio-economic changes within Europe. Several non-independent factors are gathered under the same umbrella to avoid unwanted complexity within the model and inconsistent values of the different factors. Most of the forecast for these factors are based on economic and social prediction studies like STATFOR. Finally, with respect to commodities, Vista will consider fuel as an independent variable from the global economic development of Europe.

3.1 Regulatory factors

Regulatory factors are summarised, as shown below, in Table 1-D2.1 and summarised in Deliverable 2.1 - Section 2.2 (pages 12-40). Tables 2 to 4 in Deliverable 2.1 (see pages 15-40) describe in detail the factors, their expected effect and their evolution. For more information regarding the data sources used to carry out the regulatory review, please see Deliverable 2.1 - Section 2.1 (page 12).

Table 1-D2.1 - Summary of regulatory factors

Regulatory area	Regulatory factor	Factor ID
SES development and integration	Single European Sky integration	RSI1
	Common projects	RSI2
	Network Manager	RSI3
Performance-based regulation	Performance Scheme	RPB1
	Performance Review Body	RPB2
ANSP requirements	Common requirements	RAR1
Airport demand	Airport slots	RAD1
	Regional airport development	RAD2
	Airport charges	RAD3
Airport processes	Ground handling market	RAP1
	Industry standardisation of airport procedures	RAP2
Airport access/egress	Airport access	RAA1
Other regulatory factors	Passenger provision schemes	ROR1
	Common charging scheme	ROR2
	Emission schemes	ROR3
	Noise pollution	ROR4
	ANSP labour agreements	ROR5
	Drone	ROR6

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ATCO interoperability	ROR7
Safety	ROR8
Operation of air services	ROR9
2050 vision	ROR10

3.2 Business factors

Business factors are summarised in Table 8-D2.1 (see below) and summarised in Deliverable 2.1 - Section 3.2 (pages 66-90). Tables 9 to Table 11 in Deliverable 2.1 (pages 69-90) describe in detail the factors. An extended review of the business factors is presented in Deliverable 2.1 - Section 3.1 (pages 41-66). For SESAR-related business factors, their expected effect (for the 2035 timeframe) has been obtained from the ATM Portal. Note that in this case, the evolution of the factor is linked with the uptake/development of the technology and/or its effectiveness.

Table 8-D2.1 - Summary of business factors

Business area	Business factor	Factor ID
SESAR Operational Changes packages	Weather Resilience	BTS1
	Airport Safety	BTS2
	Enhanced Runway Throughput	BTS3
	Enhanced Route Structures	BTS4
	4D Trajectory Management	BTS5
	Airborne Spacing and Separation	BTS6
	Ground Based Conflict Management	BTS7
	Air Safety Nets	BTS8
	Traffic Synchronisation	BTS9
	Integrated Surface Management	BTS10
	Demand and Capacity Balancing Airports	BTS11
	Demand and Capacity Balancing En-Route	BTS12
	Remotely provided Air Traffic Services for aerodromes	BTS13
	CNS	BTS14
	System Wide Information Management (SWIM)	BTS15
Other operational changes and technology changes	Drones / Remotely piloted aircraft systems (RPAS)	BTO1
	Performance-based operations	BTO2
	Virtual control centre	BTO3
	Passenger reaccommodation tools	BTO4
	Machine learning and deep learning	BTO5
	On-Time Performance monitoring	BTO6

Business area	Business factor	Factor ID
	Integrated turnaround/hub operations control	BTO7
	Cybersecurity	BTO8
	Development of carbon-neutral fuels	BTO9
Airport access/egress	Airport multi-modal connectivity	BAA1
Airport processes	Self-processing at airport	BAP1
	Resource allocation at airport	BAP2
Demand evolution	Economic development of European Union (EU) – European Free Trade Association (EFTA) countries	BED1
	Development of high-speed trains	BED2
	Societal travel characteristics changes	BED3
	Travel substitutes	BED4
	Air traffic predictability	BED5
	Modal competition *versus* cooperation	BED6
Other economic factors	Fuel prices	BEO1
	Airspace charges	BEO2
	Airline business models	BEO3
	Smart, integrated ticketing	BEO4

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4 Regulatory and business factors

Q5. Are there any 'possible values' considered for the foreground factors that you would modify (please see Table 1-D3.1 and Table 2-D3.1, below)?

Q6. Please rank the foreground factors in order of interest (1 = most interesting) from the modelling perspective, in your view.

1.		8.	
2.		9.	
3.		10.	
4.		11.	
5.		12.	
6.		13.	
7.		14.	

Q7. Which factors, currently considered as background factors, should instead be considered as foreground factors, if any? Please state why.

Factors are divided between foreground and background factors. **Foreground factors**, will be analysed in detail in order to understand their impact on the system's metrics. **Background factors**, will be grouped giving them predefined possible values to generate future background scenarios onto which to test the foreground factors.

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Possible values are considered for the different factors. For business factors their values correspond to different advancements in the technological and managerial fields concerned. These values relate to the **same baseline**, which is the baseline used by SESAR to set its targets. In particular, if a factor is set to 'Medium' in a 2035 scenario, it should not be understood as 'Medium for the 2035 horizon', but medium with respect to a fixed baseline. Some factors do not fit well in the 'Low/Medium/High' pattern, and thus they have some more customised values. Considering that the timeframes modelled in Vista are 2035 and 2050, the references to 'Low/Medium/High' are defined as follows (from the SESAR perspective):

- 'Low' values correspond to trajectory-based operations;
- 'Medium' values correspond to performance-based operations; and,
- 'High' values to an enhancement of performance-based operations.

This reference represents our current view which has been adjusted since the production of Deliverable 3.1.

4.1 Foreground factors

The foreground factors selected are described in Section 2 of Deliverable 3.1 (pages 12 -16) . Table 1 and Table 2 of the deliverable, see below, summarise the regulatory and business factors with their possible values, respectively.

Table 1-D3.1 - Foreground regulatory factors

Id	Factor	Possible values	Notes
ROR1	Passenger provision schemes	• Current passengers' compensation regulation (Regulation 261) • Modification of compensation requirements (right to care independent of flight distance, ensuring passengers right to be re-routed by another airline or transport mode in case of cancellation when the carrier cannot re-route on its own services, rights to assistance and compensation apply if connecting flights are missed because the previous flight was delayed by at least 90 minutes, application of three hours threshold for compensation for short and medium flights, technical faults not exempt from compensations). • Passengers entitled to compensation being automatically compensated; • Load factors maintained significantly below 100% on key/connecting/trunk routes to reserve some capacity for rebooking passengers who miss flights/connections - a 'social' capacity and resilience provision supporting Flightpath 2050 ambitions through new regulatory paradigms; • Enhanced identification of primary delay reasons to assign airline liability.	In this case some values can be combined, e.g. flights operated maintaining a load factor lower than 100% to maintain capacity to rebook passengers who miss connections and automatic compensation for passengers which are entitled.

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Id	Factor	Possible values	Notes
ROR3	Emission Schemes	• Low environment impact • High environment impact	ETS combined with CORSIA will regulate the CO_2 market. NO_x pollution, and particularly applied to local air quality around airports, can have a higher relevance in the future. Low environment impact represents the implementation of CO_2 market with a relatively low value for emission allowances. High environmental impact increases the cost of CO_2 allowances and affect the cost of operating at congested infrastructures due to local air quality.
ROR4	Noise pollution	• Same level of noise restrictions • Increased protection to noise pollution	Increased protection due to noise pollution will lead to airport operation restrictions and/or higher charges for airlines.
RAD1	Airport slots	• Allocation of slots as current • Allocation with secondary market	Affecting the accessibility of airports
RAD2	Regional airport development	• Maintain level of incentive to develop regional airports • Increase level of incentive to develop and connect regional airports	Regulatory factors related to the regionalisation of the traffic and the development of regional infrastructures.
RAA1	Airport access	• Maintain level of incentive to develop intermodality • Increase level of incentive to develop intermodality	
ROR9	Operation of air services	• Maintain level of incentive for regional development • Increase level of incentive for regional development	

Table 2-D3.1 - Foreground business factors

Id	Factor	Possible values
BTS5	4D Trajectory Management	• Low • Medium • High
BTS9	Traffic Synchronisation	• Low • Medium • High

Id	Factor	Possible values
BTO4	Passengers reaccomodation tool	• Low • High
BEO1	Fuel price	• Low • Medium (Current level for current timeframe) • High
BEO2	Airspace charges	This business factor has two dimensions: how the airspace charges are implemented and computed geographically and what is their economic value (low or high)
		• Homogeneous (reshaping of charging zones with regional common charges) • Low • High • Heterogeneous (current scheme) • Modulation of charges (based on demand) • New definition of service units based on actual flown route
BEO3	Airline business models	Different market shares between different airlines models.
BEO4	Smart ticketing	• Low • High

4.2 Background factors

The majority of the background regulatory factors are composed of the regulations that are enablers of technology and operational change. These regulations, when combined with the background factors to generate the background scenarios, are considered to define the regulatory framework to allow the business factors to be implemented and developed as required. The business background factors, in general, follow the 'Low', 'Medium', 'High', approach described above.

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5 Scenarios

Q8. What is your view regarding the technological evolution suggested below for each of the background scenarios?

Background scenario	Description (TD: Technology development as defined in SESAR) (ED: Economic development)	Much too low	Somewhat too low	About right	Somewhat too high	Much too high	Don't know
L35 - Low 2035	TD: Trajectory-based performances ED: Low	○	○	○	○	○	○
M35 - Medium 2035	TD: Trajectory-based performances ED: Medium – with increase of high-income profile share	○	○	○	○	○	○
H35 - High 2035	TD: Performance-based performances ED: Medium – with increase of high-income profile share	○	○	○	○	○	○
L50 - Low 2050	TD: Performance-based performances ED: Medium - with increase of high-income profile share	○	○	○	○	○	○
M50 - Medium 2050	TD: Performance-based performances ED: High - with increase of high-income and environmental-friendly profile share	○	○	○	○	○	○
H50 - High 2050	TD: Enhanced Performance-based performances ED: High - with increase of high-income and environmental-friendly profile share	○	○	○	○	○	○

Q9. Please rank the background scenarios in order of interest (1 = most interesting) from the modelling perspective, in your view.

1.
2.
3.
4.
5.
6.

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Section 4 in Deliverable 3.1 (pages 22 - 28) defines the creation of the scenarios in detail. The combination of the background scenarios with foreground factors and/or foreground factors groups will provide the different scenarios to be tested in Vista. Figure 5-D.3.1 shows how the scenarios are created by selecting a background scenario, setting some values for the foreground factor groups and finally setting values for the remaining foreground factors.

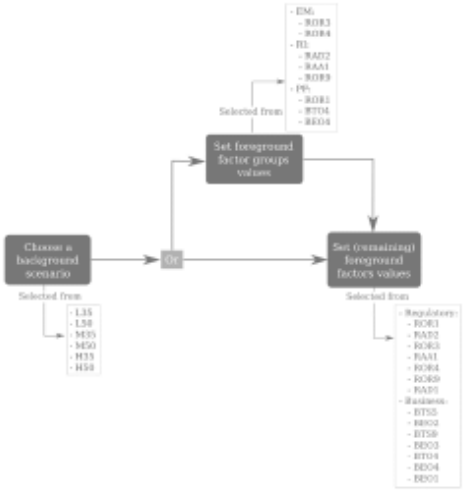

Figure 5-D3.1 - Process to define a scenario for the Vista model

As shown in Table 5-D3.1 (see below), when creating the background scenarios, the economic and technology evolution is considered decoupled. The project has isolated two main underlying drivers which might affect the impact of other factors on the system. First, it is clear that changes in demand for travel in Europe will affect the future air transport system. In particular, it is important to take into account the many dimensions of the demand, for instance its volume, its geographical distribution, its structure in terms of passenger profiles. We collect all these concepts under the broad term of 'economic development'. On the supply side, it is clear that technological advancements (in which we include process management processes) will shape also the future ATM system. As a consequence, we consider that the technologies can have different maturing speeds, drawing on the experience of the targets set by SESAR in particular.

Of course, it is clear that the demand and supply sides are strongly related in reality. In particular, economic development helps research initiatives to get funded, and the latter drives the economic development in return. However, Vista tries to keep them apart, specifically because it wants to discriminate between one effect and the other in order to be able to form a view about the impact of the research initiatives in Europe, like SESAR, and how they can be enhanced within the right environment.

Table 5-D3.1 - Background scenarios

Period	Name	Technology development	Economic development
Current	Current	Current	Current
2035	L35: Low economic, Low Techno	Trajectory-based performances as defined in SESAR	Low economic development
	M35: High economic, Low Techno	Trajectory-based performances as defined in SESAR	Medium economic development with increase of high-income profile share
	H35: High economic, High Techno	Performance-based performances as defined in SESAR	Medium economic development with increase of high-income profile share
2050	L50: Low economic, Low Techno	Performance-based performances as defined in SESAR	Medium economic development with increase of high-income profile share
	M50: High economic, Low Techno	Performance-based performances as defined in SESAR	High economic development with increase of high-income and environmental-friendly profile share
	H50: High economic, High Techno	Enhanced Performance-based performances as defined in SESAR	High economic development with increase of high-income and environmental-friendly profile share

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6 Technology Readiness Levels (TRLs)

The Horizon 2020 rules establish technology readiness levels (TRL) as the maturity assessment approach for SESAR projects to apply. We are interested in your views on the TRL that Vista is likely to achieve. There are eight TRL levels defined, which range from fundamental exploratory research at the scientific level (pre-TRL 1) to system demonstration in an operational environment (TRL 7). The TRLs to consider here, are:

- Exploratory research:
  - TRL 1: Basic principles observed and reported - Exploring the transition from scientific research to applied research by bringing together a wide range of stakeholders to investigate the essential characteristics and behaviours of applications, systems and architectures. Descriptive tools are mathematical formulations or algorithms.
  - TRL 2: Technology concept and/or application formulated - Applied research. Theory and scientific principles are focused on very specific application area(s) to perform the analysis to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.
- Industrial Research & Validation:
  - TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept - proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies including verification of technical feasibility using early prototype implementations that are exercised with representative data.

Q10(a). Which TRL level do you consider that Vista is likely to achieve by the end of the project?

- ☐ TRL 1
- ☐ TRL 2
- ☐ TRL 3

Q10(b). What activities would be required in the project to achieve the next level higher than the one you selected (unless you selected TRL 3)?

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7 Closing comments

Q11. What particular results would you find of interest for Vista to produce?

Q12. Do you have any additional comments on any of the previous questions or material?

Our sincere thanks for kindly contributing to this important consultation. Your answers will be treated in strict confidence and not attributed to you.

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