EASA.2021.HVP.30 HORIZON EUROPE PROJECT

D-2.1/2/3/4 ANALYSIS OF RECENT RUNWAY INCURSIONS AND OF LOSS OF SITUATIONAL AWARENESS

IMPLEMENTATION OF THE AERODROME 'TRIPLE ONE' CONCEPT

Final Report
Version 1.7
Date: 3/26/2024

This project is funded from the European Union's Horizon Europe research and innovation programme.

airsight GmbH
Gustav-Meyer-Allee 25
13355 Berlin
Germany
Telephone: +49 30 45803177
E-Mail: info@airsight.de
www.airsight.de

Version	Date	Description	Prepared by	Audited by
0.9	25.10.2023	Triple One Study – D-2.1 – Report – initial version	R. Flicker	C. Schlemmer
1.0	24.11.2023	Triple One Study – D-2.1 – Report – final version	R. Flicker	C. Schlemmer
1.1	04.12.2023	Incorporating EASA comments on D-2.1 and adding report chapter for D-2.2 and D-2.3	C. Schlemmer	R. Flicker
1.2	26.01.2024	Incorporating EASA comments on report chapter for D-2.2 and D-2.3 and add report chapter for D-2.4 – initial version	C. Schlemmer	R. Flicker
1.3	29.02.2024	Incorporating EASA comments on report chapter for D-2.3 and D-2.4	C. Schlemmer	J. Walther
1.4	15.03.2024	Incorporating EASA comments on report chapter for D-2.1 to D-2.4	R. Flicker	J. Walther
1.5	22.03.2024	Incorporating EASA comments on report chapter for D-2.1 to D-2.4	R. Flicker	J. Walther
1.6	25.03.2024	Incorporating EASA comments on report chapter for D-2.1 to D-2.4	R. Flicker	J. Walther
1.7	26.03.2024	Incorporating EASA comments on report chapter for D-2.1 to D-2.4	R. Flicker	J. Walther

This report consists of:

57 pages.

Approval granted

Table of Contents

List of Figures

List of Tables

Executive Summary

EASA has commissioned a study to investigate possible safety gains and risks by the so-called 'Triple One' concept, describing the use of one frequency and one language for all movements associated with a runway. The intention of this concept is to improve the situational awareness of all aerodrome traffic participants and thus decrease the risk of runway incursions.

The study is divided into 6 tasks (refer to EASA Procurements Documents – EASA.2021.HVP.30). The present document refers only to the second task, the key objective of which is the study of relevant runway incursions (RI) and loss of situational awareness occurrences in Europe involving vehicle drivers in the last 15 years[1].

The data were taken from ECCAIRS and were filtered to include only the period from 2005 up to and including 2019 and aerodromes falling within the scope of Regulation (EU) 2018/1139. After applying the aforementioned filter 31,752 records remained, corresponding to 12,021 unique occurrences[2]. Based on additional information extracted from the data, another 1,104 occurrences that are not related to runway incursions were removed, resulting in remaining 10,917 occurrences.

About 68.8 % of all investigated runway incursions in the ECCAIRS data base with clearly identified origin are caused by an aircraft, 26.5 % are caused by a vehicle or equipment and only 4.7 % are caused by a person.

The analysis of the ECCAIRS data and the investigation reports revealed as the main contributing human factors for runway incursions caused by vehicles:

- Lack of communication: Failure to transmit, receive, or provide enough information to complete a task, including misunderstanding, missing / non-complete / failure to properly use phraseology.
- Lack of awareness: Failure to recognize a situation, understand what it is, and predict the possible results, including negligence and forgetfulness.
- Lack of knowledge: Shortage of the training, information, and/or ability to successfully perform, including briefing and instruction.

In addition to the human factors, further non-human factors were identified:

- Radio telephony equipment: Issues arising from the availability, functionality, and/or usage of radio telephony equipment are considered in this category.

[1] The analysis of the last 15 years is considered to be sufficient. An analysis of more than 15 years is not appropriate, as a reporting regulation was introduced in 2003 with Directive 2003/42/EC, and 10 further countries joined the EU in 2004. This means that the basis for an analysis with the most consistent conditions possible is only available from 2004 onwards.
[2] According to ECCAIRS coding guidance, the file number should be used by the Responsible Entity to group multiple reports of same occurrence [4]. The file number has therefore been used to identify unique occurrences.

- ATC errors: ATCO accidentally cleared a vehicle / aircraft to e.g., enter an occupied runway.
- Lack of procedures: Lack of procedures were explicit or implicit mentioned in the report.

In addition to ECCAIRS, also EVAIR – a voluntary reporting system run by EUROCONTROL – as well as available investigation reports from national investigation boards were analysed. Since EVAIR data is confidential, analysis was only possible through requesting analysis by EUROCONTROL who delivered responses. Out of 7,398 reports (2021-2023), 95 (1.2 %) were related to runway incursions, and within these runway incursions, 11 incidents involved a vehicle (11.6 %). A more detailed analysis was not feasible, namely as relevant parameters like what frequency was used or had to be used by vehicles are not tracked.

Several investigation reports related to runway incursions were also reviewed in order to extract relevant mitigation measures which were identified by the investigation bodies. It was concluded that the most prominent mitigation measure listed in the reports is the training of staff or its improvement. Further suggested measures included the improvement of the surveillance capabilities for vehicles and infrastructural and procedural improvements.

As a last step, the information available to the airport operators was analysed. Those airports, who participated in workshops as part of Task 3, were asked to share general information about how investigations of occurrences are carried out as well as what are specific aspects and local precursors identified by the investigation of runway incursions at airport level. Furthermore, the airports were asked to share the mitigations they identified based on the investigation of the occurrences. These are also mainly related to training and secondarily to infrastructural and operational changes.

The results of this task will be used for the specific analysis of benefits and risks in the following tasks 4 and 5 of the research project.

Part I Objective and scope of Task 2

I.1 The key objective of the second task is the analysis of runway incursions (RI) and loss of situational awareness occurrences in Europe involving vehicle drivers in the last 15 years, supplemented by the study of the related safety investigations and other available reports using a variety of sources.

I.2 Task 2 is divided in the following subtasks:

- Subtask 2.1 Identification of relevant European occurrences of RI and loss of situational awareness involving vehicle drivers in the last 15 years.
- Subtask 2.2 Study of the related investigation reports and/or other available information regarding these occurrences (e.g. the Eurocontrol Annual Summary Template of ANSPs relevant in the past).
- Subtask 2.3 Analysis of other reports (e.g. from Eurocontrol´s EVAIR database) for the last 15 years.
- Subtask 2.4 Review of the relevant safety reports from the Safety Management System (SMS) of the sampled aerodromes.

I.3 The task required the identification, study, and analysis of relevant RI occurrences in the European region in the last 15 years, to find the main contributory factors, with special emphasis on human factors. The contributing factors found are presented allowing for traceability to the related occurrence. All publicly available sources have been used, as well as safety reports concerning local occurrences and safety events from the SMS of the sampled aerodromes where contact was established during task 3.

Part II List of relevant occurrences of the last 15 years – D-2.1

II.1 Introduction

II.1.1 Mandatory occurrence reporting of runway incursions was introduced with Directive 2003/42/EC [1] in 2003 and EU regulation 1321/2007 [2] laying down implementing rules for the integration into a central repository of information on civil aviation occurrences in 2007. Both of these legal documents were repealed by EU Regulation 376/2014 [3], which in combination with Commission Implementing Regulation (EU) 2015/1018 [4] defines – among other issues – the occurrences that are to be reported and the way in which they are to be reported and stored.

II.1.2 ECCAIRS data were provided to analyse RIs of the last 15 years in Europe.

II.2 Requested ECCAIRS data

II.2.1 The information whether an occurrence is classified as a RI and therefore is relevant for the analysis, can be identified based on several attributes in the ECCAIRS database. Use was made of the fact that some attributes are organised hierarchically in the ECCAIRS database.

II.2.2 For RIs, four levels are implemented in ECCAIRS within the *Event Type*: “Operational > Aircraft Flight Operations > Incursions > Runway Incursion by a Vehicle/Equipment”, with “Operational” being the highest level (L1) and "Runway Incursion by a Vehicle/Equipment" being the lowest level (L4). Within “Operational > Aircraft Flight Operations > Incursions”, there are four values for level 4, that are relevant for runway incursions:

- Runway Incursion by a Person
- Runway Incursion by a Vehicle/Equipment
- Runway Incursion by an Aircraft
- Runway Incursion by Other

II.2.3 When logging an occurrence in ECCAIRS it is not mandatory to select a value on all four levels. Thus, a “Runway Incursion by a Vehicle/Equipment” (potential value in level 4) may only be categorized as “Incursion” in level 3 while level 4 is left empty.

II.2.4 According to the ECCAIRS coding guidance, occurrence category should be used to group the relevant occurrences at a high level while the event type should be used for coding detailed facts. [5]

II.2.5 Unfortunately, not all runway incursions are coded with the correct occurrence category, therefore multiple attributes must be considered to identify as many RIs as possible.

II.2.6 ECCAIRS data was received for the analysis of RIs involving vehicle drivers starting from the year 2000 until and including 2022. Entries related to the following attributes and values were requested:

- Event Type:
  - Operational > Aircraft Flight Operations > Incursions:
    - Runway Incursion by Other
    - Runway Incursion by a Person
    - Runway Incursion by a Vehicle/Equipment
    - Runway Incursion by an Aircraft
  - Operational > Aircraft Flight Operations:
    - Incursions: only selected when no entry in L4 (may contain entries referring to incursions other than RWY incursions, to be filtered at a later point)
- Occurrence Category:
  - RI: Runway incursion – vehicle, aircraft or person

II.2.7 It is expected that most of the entries match more than one of the selected attributes and values, e.g., an entry rated as “Runway Incursion by a Vehicle/Equipment” in the event type is also categorized as “RI: Runway incursion – vehicle, aircraft or person” in the occurrence category. But as the more detailed analysis given in section II.4.1 shows, not all of the relevant occurrences match all relevant attributes.

II.3 Filtered ECCAIRS data

II.3.1 General

II.3.1.1 The provided ECCAIRS entries cover the timeframe from 2000 to 2022. Since Reg. (EU) 376/2014 [3] requires the reporting of occurrences involving aircraft registered and/or operated by an organisation established in a Member State, the data contains occurrences that took place at airports both inside and outside of Europe.

II.3.1.2 Therefore, the data had to be filtered to include only:

- a 15-year period
- occurrences that happened within the territory of all EASA member states, and

- at aerodromes falling within the scope of regulation (EU) 2018/1139[3].

II.3.2 Period

II.3.2.1 ECCAIRS data has been provided for the period from 2000 to 2022. The years 2005 up to and including 2019 were chosen for the 15-year period, since this period:

- Covers the period after 10 states joined the EASA in 2004,
- Lies before the UK left the EU in 2020, and
- Lies before the COVID-19 pandemic (2020 to 2022), during which air traffic volumes were significantly reduced.

II.3.3 Countries

II.3.3.1 In the selected period (2005 to 2019), the following countries were EASA member states:

- Austria
- Belgium
- Bulgaria (since 2007)
- Croatia (since 2013)
- Cyprus (since 2004)
- Czechia (since 2004)
- Denmark
- Estonia (since 2004)
- Finland
- France
- Germany
- Greece
- Hungary (since 2004)

[3] During the 15-year period considered in this study, there was a change of the EASA Basic Regulation. In 2018 Regulation (EU) 2018/1139 came into force and repealed regulation (EC) No 216/2008. The group of aerodromes has not changed as a result of this change.

- Iceland
- Ireland
- Italy
- Latvia (since 2004)
- Liechtenstein
- Lithuania (since 2004)
- Luxembourg
- Malta (since 2004)
- Netherlands
- Norway
- Poland (since 2004)
- Portugal
- Romania (since 2007)
- Slovakia (since 2004)
- Slovenia (since 2004)
- Spain
- Sweden
- Switzerland
- United Kingdom (until 2020)

II.3.3.2 Only occurrences in these states and within the relevant time frame were considered.

II.3.4 Aerodromes

II.3.4.1 Only aerodromes falling into the scope of regulation (EU) 2018/1139 were considered. The number of corresponding aerodromes per country are summarized in Table 1.

Table 1: Number of aerodromes per country

Country	Number of aerodromes
Austria	6
Belgium	5
Bulgaria	4
Croatia	8
Cyprus	2

Country	Number of aerodromes
Czech Republic	5
Denmark	10
Estonia	5
Finland	24
France	54
Germany	32
Greece	25
Hungary	4
Iceland	4
Ireland	7
Italy	36
Latvia	2
Lithuania	3
Luxembourg	1
Malta	1
Netherlands	4
Norway	44
Poland	15
Portugal	11
Romania	17
Slovakia	4
Slovenia	1
Spain	36
Sweden	36
Switzerland	5
United Kingdom (aerodromes certified by CAA UK)	41
Total	452

II.4 Statistical analysis of the runway incursion data

II.4.1 General

II.4.1.1 After filtering the given data based on the criteria introduced in the previous section, a total of 31,752 unique entries remains, containing 12,688 unique occurrence IDs and 12,021 unique file numbers [4]. A spreadsheet has been created using these occurrence data as an addition to this report[5].

II.4.1.2 According to ECCAIRS coding guidance, the file number should be used by the Responsible Entity to group multiple reports (entries/lines in the spreadsheet file) related to the same occurrence [5]. Therefore, further below the file number will be used to identify unique occurrences.

II.4.1.3 To decide, if an entry, that was captured by the Event Type L3 being “Incursion” but not having a value for level 4, refers to a RI, the translation of the corresponding headline was used and filtered for “runway incursion” or “rwy incursion” (case insensitive)[6]. The captured entries are considered with the term “Event_Type L3 is RI” in Figure 1.

II.4.1.4 The filtered data are shown in Figure 1, indicating whether the value for the event type and occurrence category corresponds to a RI. All entries are categorized by event type and occurrence category as follows:

- Event type (vertical axis of the graph)
  - Event Type L3 and L4 are NA: entries without values in the event type on levels 3 and 4
  - Event Type L3 is RI: all entries determined by filtering the headline (see section II.4.1.3)
  - Event Type L4 is RI: all entries identified by the event type level 4 with values “Runway Incursion by [...]”
  - No RI: all entries that are not classified as RIs based on the values given in the event type
- Occurrence Category (horizontal axis of the graph)

[4] Most of the events are captured by several entries in the database (leading to several lines per event in the spreadsheet file). Every entry contains a value for the occurrence ID and the file number. But other attributes (organized as columns in the spreadsheet file) may be either empty or may contain more than one unique value for one event.
[5] This file is confidential and only available to EASA.
[6] 1,635 out of 12,021 occurrences have been analysed based on the translated headline. Out of the 1,635, 22 were missing the headline and 22 could be identified as runway incursion, even if they were not correctly coded as runway incursions. The remaining 1,591 occurrences were sample checked, so that the error can be estimated to be less than 10 % (most of the occurrences are taxiway incursions).

- FALSE: all entries that are not classified as runway incursion based on the occurrence category
- TRUE: all entries that are classified as runway incursions based on the occurrence category

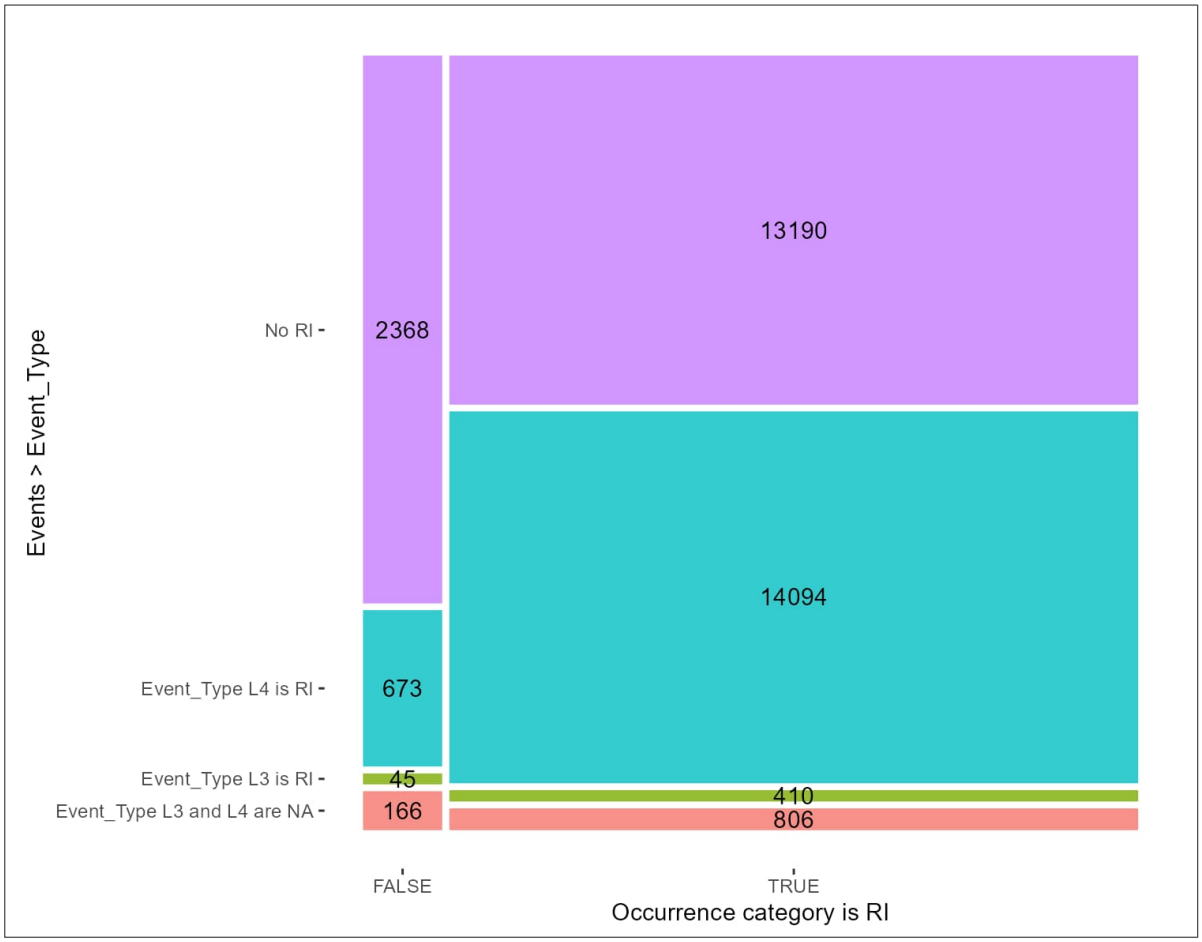

Figure 1: Occurrence category and event type-based classification of runway incursions

II.4.1.5 The analysis of Figure 1 indicates that 2,368 records do not actually represent a runway incursion either by occurrence category or by event type, but consists of the following occurrences, among others:

- Taxiway incursions
- Aircraft priority not given on the apron
- Unauthorized person on the apron
- FOD

II.4.1.6 These 2,368 records correspond to 1,104 occurrences and are excluded from further analysis, leaving 10,917 occurrences.

II.4.2 RI per year

II.4.2.1 Figure 2 shows the number of runway incursions per year from 2005 to 2019. It can be derived from Figure 8, which shows also the share of the runway incursion originator (aircraft, vehicle or person), that increase in number of runway incursions mainly was caused by aircraft. The drop in the number of reported of runway incursions in the years 2012 to 2015 and the subsequent increase after 2016 is presumably due to a change in reporting behaviour.

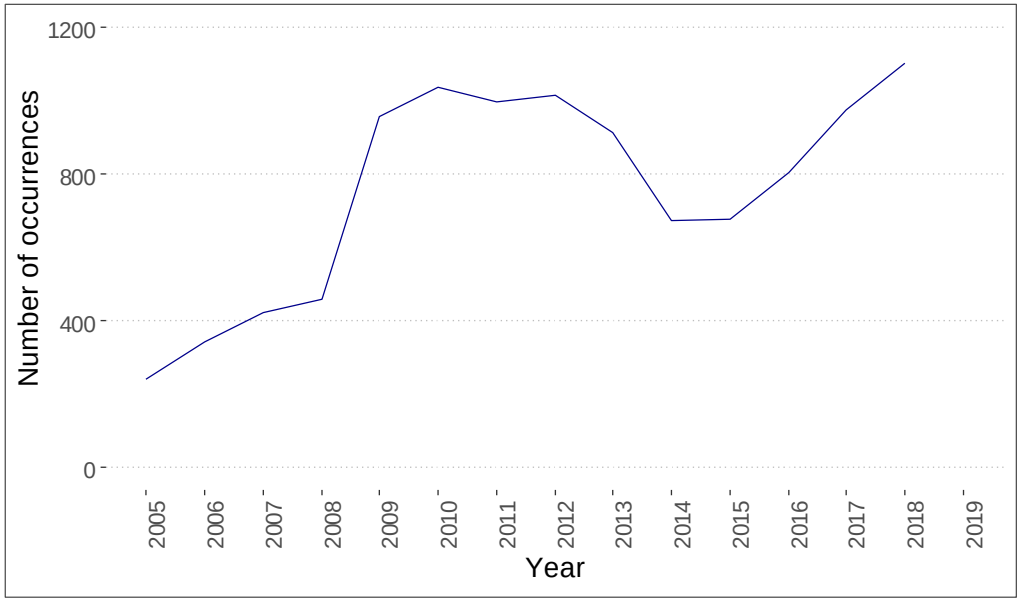

Figure 2: Number of runway incursions from 2005 to 2019 in Europe

II.4.3 Country

II.4.3.1 Figure 3 shows the number of runway incursions per country from 2005 to 2019. The number of runway incursions varies considerably between countries. This may be due to the following reasons:

- Varying numbers of airports falling within the scope of regulation (EU) 2018/1139 per country
- Different number of flight movements per airport
- Different reporting periods for RIs
- Different reporting culture

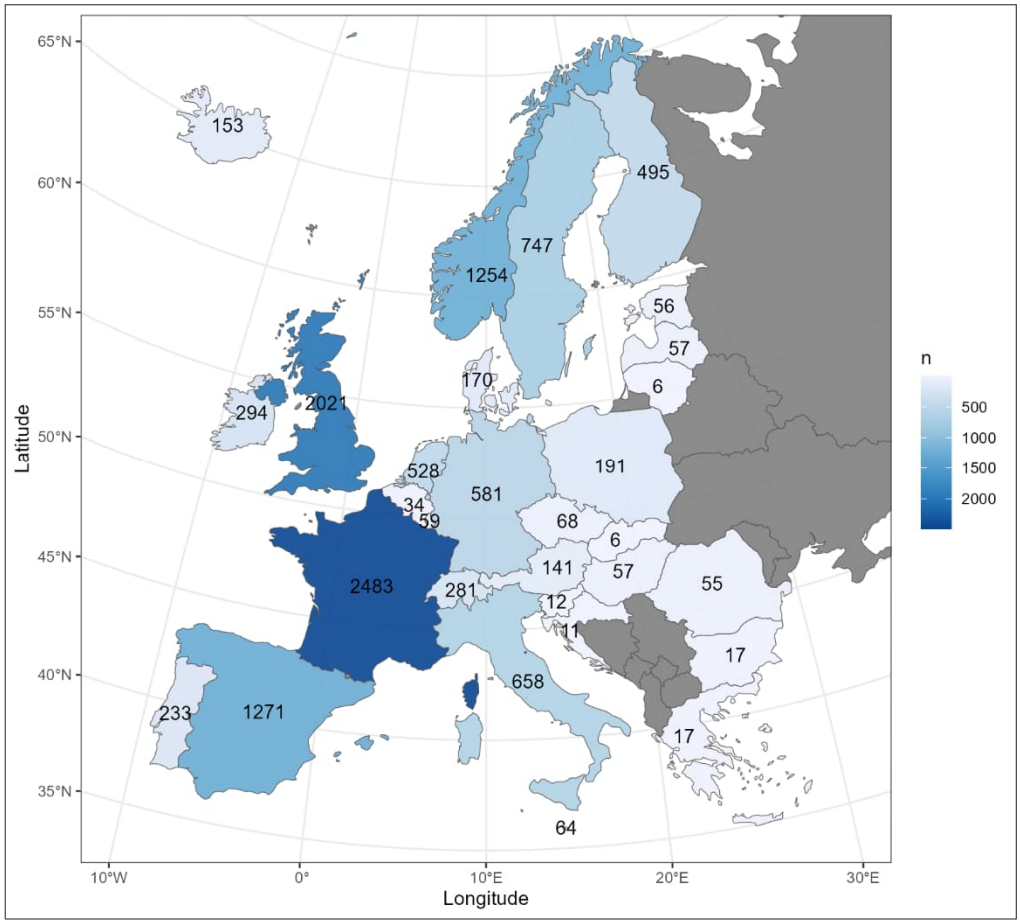

Figure 3: Number of RIs per country from 2005 to 2019

II.4.3.2 Figure 4 shows the number of RIs per country from 2015 to 2019. Looking only at the last 5 years, a more homogeneous picture emerges. Larger countries with many aircraft movements such as France, Spain and Italy are in the same order of magnitude.

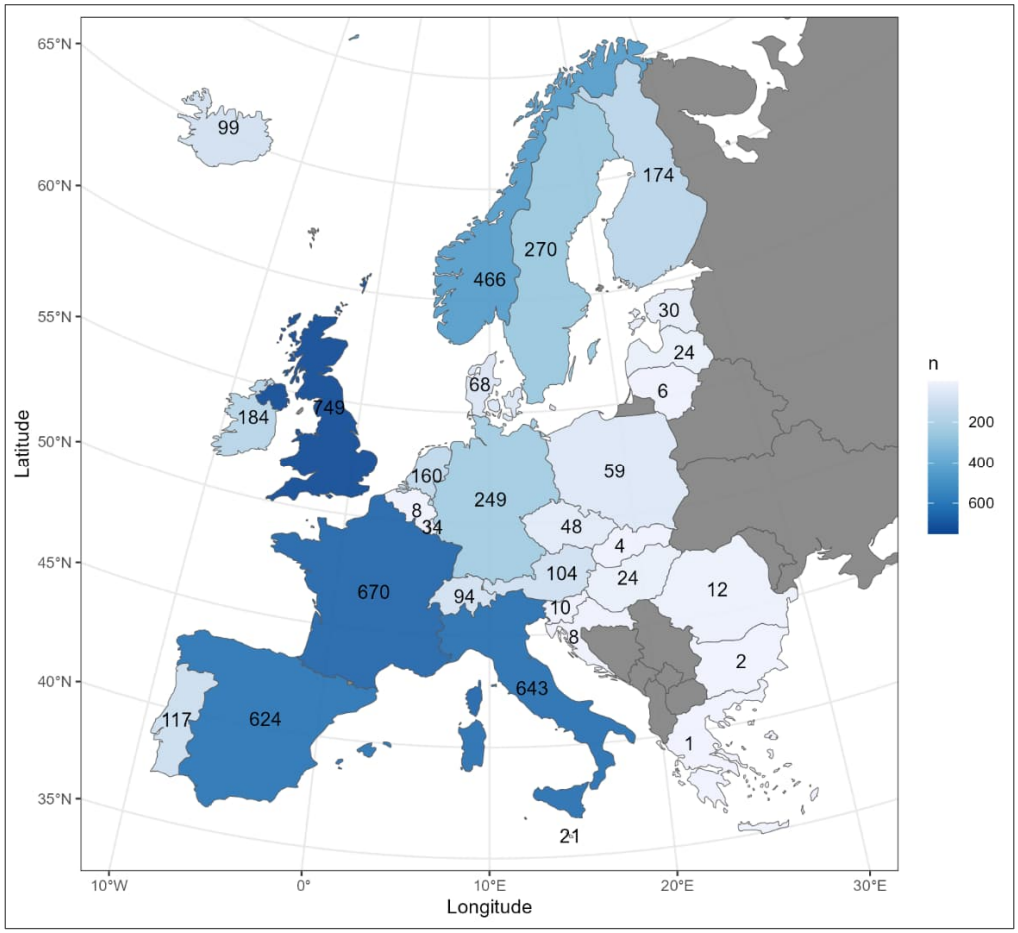

Figure 4: Number of RIs per country from 2015 to 2019

II.4.3.3 The number of RIs in relation to the number of aerodromes per country is shown in Figure 5. The rate per country is significantly higher for the Netherlands than all of the other countries, since only 4 aerodromes are within the EASA scope and Amsterdam Schipool is one of the aerodromes with the most aircraft movements in Europe.

II.4.3.4 The number of RIs per number of aerodromes per country is more homogeneous than the number of RIs per country. A better reference value for the number of RIs is the number of flight movements per country. Unfortunately, the number of all flight movements across Europe is not available.

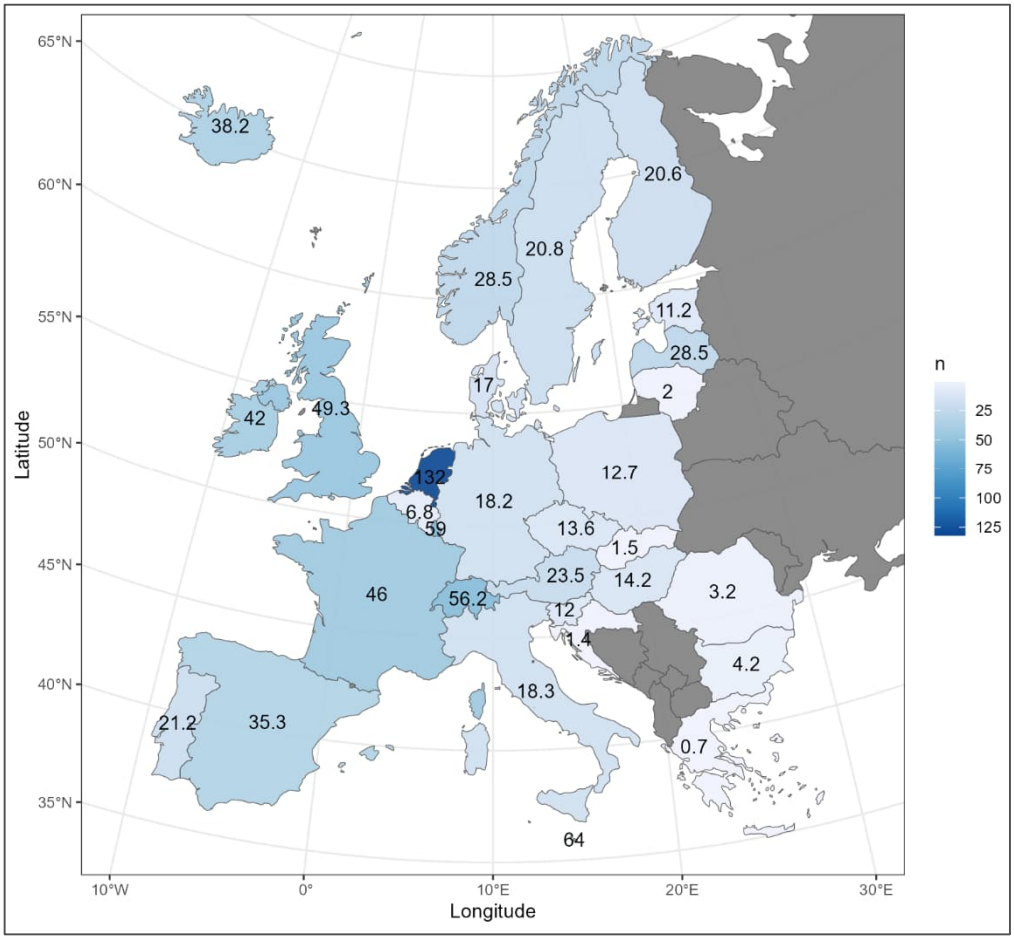

Figure 5: Number of RIs in relation to the number of aerodromes per country (2005 to 2019)

II.4.4 Aerodrome

II.4.4.1 Figure 6 shows the number of runway incursions per aerodrome[7] from 2005 to 2019. Aerodromes with more than 50 occurrences are labelled with their ICAO 4-letter code.

[7] Falling in the scope of regulation (EU) 2018/1139

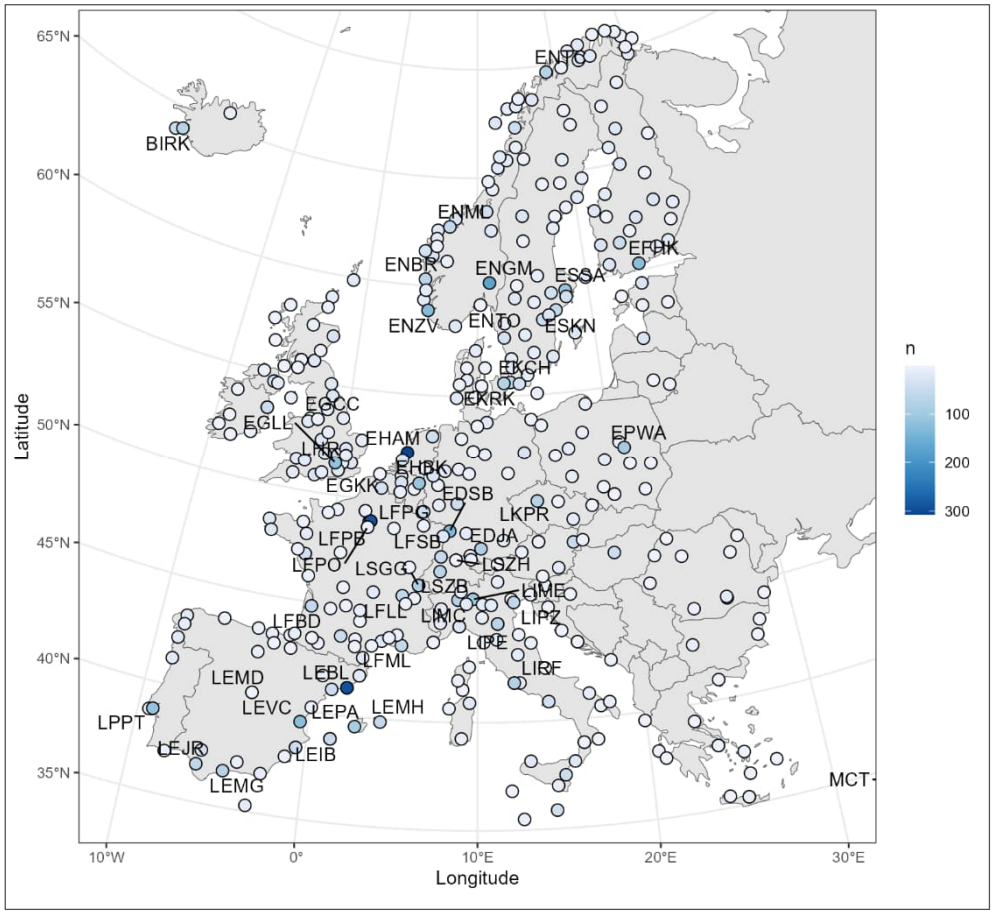

Figure 6: Number of runway incursions per aerodrome from 2005 to 2019

II.4.5 Runway incursion originator

II.4.5.1 The 10,917 unique events that were identified in section II.4.1.5 were assigned different event types at level 4 (see explanation in section II.4.1.1). This led to 14,543 entries for those 10,917 occurrences. The assigned values are shown in Figure 7.

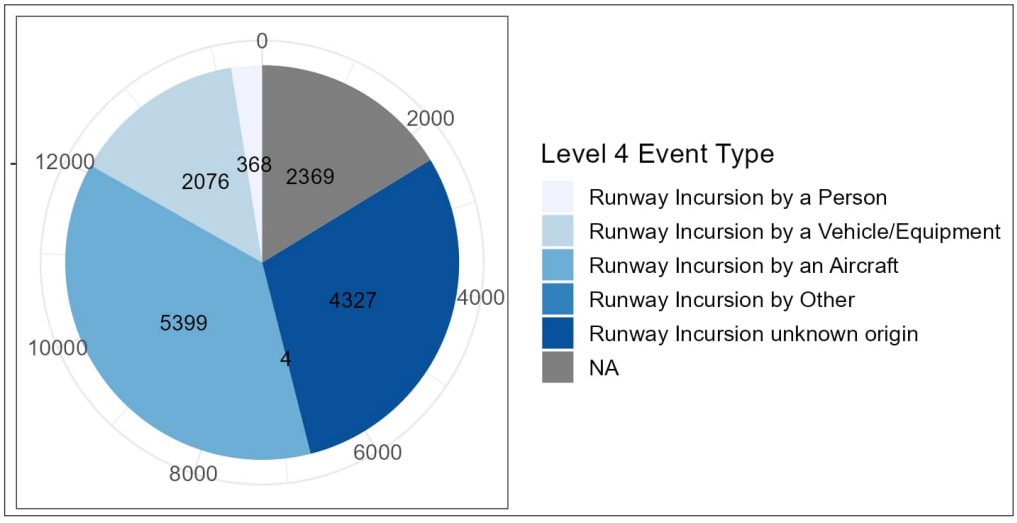

Figure 7: Runway incursions per event type

II.4.5.2 By looking only at the event types of those runway incursions originating from persons, vehicle/equipment, and aircraft, a total of 7,843 entries remains. About 68.8 % of those are caused by an aircraft, 26.5 % are caused by a vehicle/equipment and only 4.7 % are caused by a person.

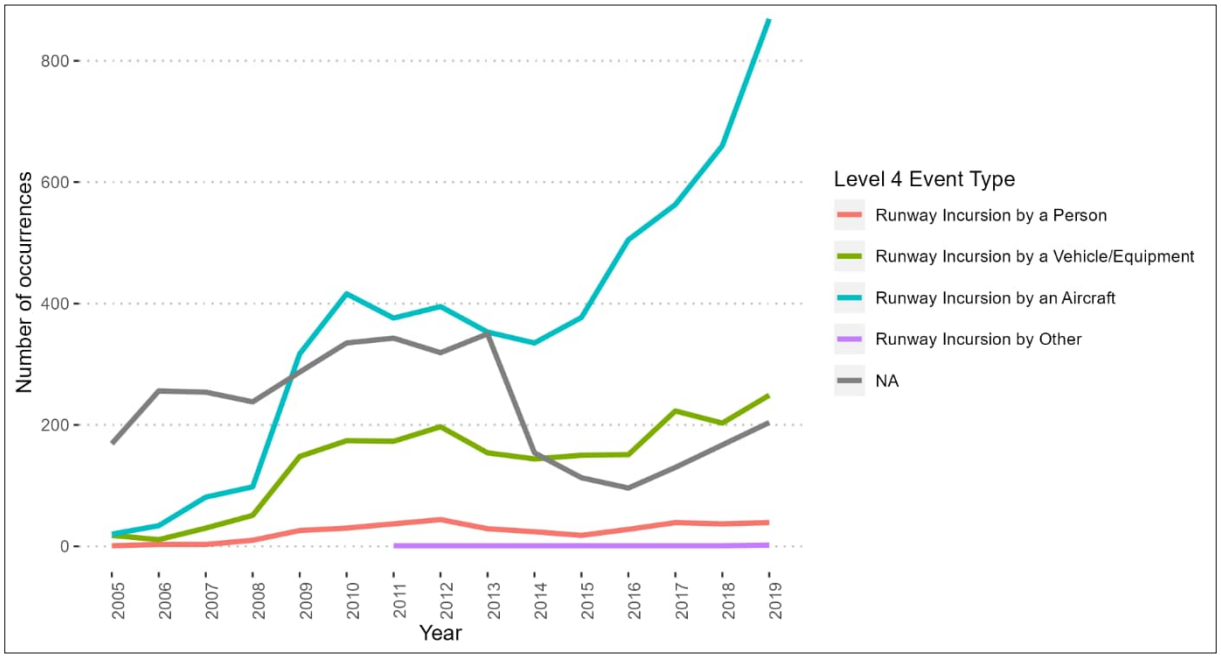

Figure 8: Number of runway incursions per year and event type

II.4.5.3 Figure 8 illustrates the number of runway incursions per event type over time. It is interesting to note that in the recent years, the number of runway incursions caused by an aircraft has increased significantly, while runway incursions caused by vehicles has increased only slightly [8]. One reason for this increase could be the improved reporting culture, as the number of reported runway incursions without event type has decreased significantly, while the number of runway incursions caused by an aircraft increased at the same time.

[8] It is not the purpose of this study to investigate the factors that have led to this increase, but the increase could be taken as an opportunity to investigate this in more detail in a new study.

Part III Study of the occurrence reports

III.1 Introduction

III.1.1 The study of occurrence reports aims at the identification of the main contributing factors to runway incursions by vehicles. Special emphasis is placed on human factors. Occurrence and investigation reports are analysed, categorized, and evaluated to draw the corresponding conclusions.

III.1.2 Three sources are made use of to fulfil this task:

- A filtered set of ECCAIRS entries, coming from the list introduced in Part II, that was analysed by hand.
- EUROCONTROL evaluated voluntary incident reports collected in their EVAIR[9] ("EUROCONTROL voluntary ATM incident reporting") database. The result is shown in III.2.4.
- Investigation reports of runway incursions, coming from the investigating authorities of the European countries, that were gathered based on the list given in Part II and analysed.

III.1.3 To identify ECCAIRS entries that are worth to be evaluated in more detail, an additional filter was applied to the list of occurrences derived in Part II. This was done to identify those entries that may contain a more detailed analysis of the occurrences or even the specific formulation of contributing factors. More details on the filtering are given in section III.2.2.

III.1.4 Based on the ECCAIRS entries related to accidents and serious incidents, the investigation reports of the national aircraft accident investigation centres were obtained and analysed for contributing factors. The results are presented in section III.2.5.

III.2 Identification of contributing factors – D-2.2

III.2.1 Considered factors

III.2.1.1 To identify the human factors that contributed to the occurrences, the so-called *Dirty Dozen* was used as a guidance. According to the FAA safety department, twelve causes of mistakes in the aviation workplace are commonly seen [6]. This approach originally

[9] EVAIR is a platform to exchange safety related information about incidents between aircraft operators, airline associations (IATA, ERA), air navigation service provides (ANSPs), and airports.

comes from maintenance, but its application was extended to a more general usage within the aviation domain. Analysing the occurrences led to the identification of the relevant and irrelevant human factors mentioned in the dirty dozen.

III.2.1.2 Contributing factors were identified, categorized, and – as far as possible – linked to the *Dirty Dozen* factors. Additional (non-human) factors were introduced as well.

III.2.1.3 This led to the following list of contributing human factors that was considered for the analysis and is given in Table 2:

Table 2: List of relevant human factors (extracted from the *FAA Safety Team - Avoid the Dirty Dozen*, reference 6 in the bibliography)

Human Factors	
Lack of communication	FAA definition: Failure to transmit, receive, or provide enough information to complete a task. Never assume anything. For the evaluation, the following aspects were considered to fall into this category: misunderstanding, missing / non-complete / failure to properly use phraseology.
Complacency	FAA definition: Overconfidence from repeated experience performing a task. For the analysis, complacency was only considered to be a contributing factor if it was explicitly stated in the report.
Lack of knowledge	FAA definition: Shortage of the training, information, and/or ability to successfully perform. For the analysis those cases were considered, that either explicitly state insufficient / lack of training/briefing/instruction, experience and/or information or those with clear indications in their descriptions (e.g., “the driver was not instructed on how to...”, “the driver was not fully trained...”, etc.).
Distraction	FAA definition: Anything that draws your attention away from the task at hand. For someone driving on / in the vicinity of the runway usually two tasks must be focused on: the safe driving and communicating on the one hand and to execute their actual work order (e.g., FOD check) on the other hand. Thus, either task can draw a driver’s attention away from other one. For the analysis, those cases were counted in which the driver’s attention was drawn away from the safe driving / moving by anything else.

Human Factors	
Lack of Teamwork	FAA definition: Failure to work together to complete a shared goal. *This factor was only recognised in the investigation reports presented in III.2.5.*
Fatigue	FAA definition: Physical or mental exhaustion threatening work performance. For the analysis fatigue was only considered if explicitly stated in the report.
Lack of resources	FAA definition: Not having enough people, equipment, documentation, time, parts, etc., to complete a task. For the analysis 'rushing' was considered as lack of time and thus as "lack of resources". It could have been merged with either "pressure" or "stress" as well, however, for most of the cases the event descriptions are insufficient to differentiate what category would match the best. Therefore, it was consistently considered as "lack of resources".
Lack of Assertiveness	FAA definition: Failure to speak up or document concerns about instructions, orders, or the actions of others. *This factor was only recognised in the investigation reports presented in III.2.5*
Pressure	FAA definition: Real or perceived forces demanding high-level job performance. For the analysis pressure was only considered if explicitly stated in the report.
Lack of awareness	FAA definition: Failure to recognize a situation, understand what it is, and predict the possible results. For the analysis, the following aspects were considered as part of "lack of awareness": lack of situational awareness, negligence, and forgetfulness.

III.2.1.4 Some events happened due to other/non-human factors, that are not captured by the *Dirty Dozen*. The list of contributing factors was therefore supplemented by the factors listed in Table 3.

Table 3: List of *other* contributing factors

Other / non-human Factors	
Radio telephony equipment	Issues arising from the availability, functionality, and/or usage of radio telephony equipment are considered in this category.
Security	Vehicles or persons breaching security were captured under "security" (e.g., intrusion of unauthorised vehicles into the airside).
Closed ATC	One event was identified, where *the incident occurred when the air traffic control service (ATC) at the airport was closed*. This was during snow removal.
Absence of visual aids	This factor is related to a potential non-compliance in terms of missing markings, lights, and signs.
ATC error	An event was declared to have happened due to an "ATC error" if an ATCO accidentally cleared a vehicle / aircraft to e.g., enter an occupied runway. Why this happened was not further considered (may even have happened due to human factors) as the main focus lies on drivers and the reports do not provide the necessary information.
Lack of procedures	"Lack of procedures" is indicated if it was stated in the report, either explicitly or implicitly. This also refers to the lack of specific aspects within an existing procedure.
Human error	Some reports only contain a very general classification of the contributing factor. Therefore, some only state "human error" or "due to a mistake" as the cause. Those entries were captured in this category if it was explicitly stated in the corresponding report and if no other human factor was identified.

III.2.1.5 It needs to be stated, that the quality of the event descriptions in ECCAIRS (narratives) varies a lot, resulting in the inability to (clearly) identify the contributing factors. This is assumed to be due to:

- Different understanding of relevant keywords. Terms are being used differently.
- No use of standardised definitions (neither used nor required).
- Usage of synonyms.

- Reports are written in local languages; translations don't always allow exact interpretations.
- Variation in training of personnel that accesses ECCAIRS.
- Often only little detail given.

III.2.2 Analysis of ECCAIRS data

III.2.2.1 The translated narratives of the ECCAIRS entries were filtered for the following keywords: *conclusion*, *finding*, *contributing*, *contribute*, *cause*, *RCA* (short for "root cause analysis"), *investigation*, *investigate*, and *conclude*. A total of 513 entries was extracted, corresponding to 455 unique occurrences. Thus, some of the occurrences had more than one unique description (narrative translated into English) of the event.

III.2.2.2 All 513 descriptions were read and screened for an indication of those factors, that led to the runway incursion. Some descriptions contain very precise information concerning contributing factors, others need to be interpreted based on the given information.

III.2.2.3 Since a distinction between causes, contributing factors, and root causes was made only for a few cases, all factors mentioned in the report were considered for the analysis. That means that for some of the events more than one contributing factor applies.

III.2.2.4 In total, a contributing factor or (root) cause was identified in 264 reports. Numerous reports were too short or did not provide sufficient information to link them to a contributing (human) factor. Those reports were excluded for the evaluation.

III.2.2.5 Additionally, some occurrences were excluded as they turned out to not be a runway incursion when read in detail.

III.2.2.6 For each identified factor it was counted, how often it contributed to one of the events (one event can be affected by more than one factor). The sum was then divided by the number of reports that clearly stated a cause / contribution to the event (264 events).

III.2.2.7 "Human factors" were identified to be the main factor leading to runway incursions by vehicle drivers: "Lack of communication" is the leading contributing factor, followed by "lack of awareness" and "lack of knowledge". Regarding non-human factors "RT equipment" has the biggest impact, contributing in almost as many cases as "lack of knowledge". "ATC errors" was identified as contributing to about 10% of the occurrences, while "Lack of procedures" contributed to 8% of the events.

III.2.2.8 Especially the "ATC error" should be pointed out since those cases are the ones that Triple One could contribute to the most, as it is understood to include those events, where a vehicle or an aircraft is cleared for an occupied runway.

III.2.2.9 The evaluation of the contributing factors led to the following result:

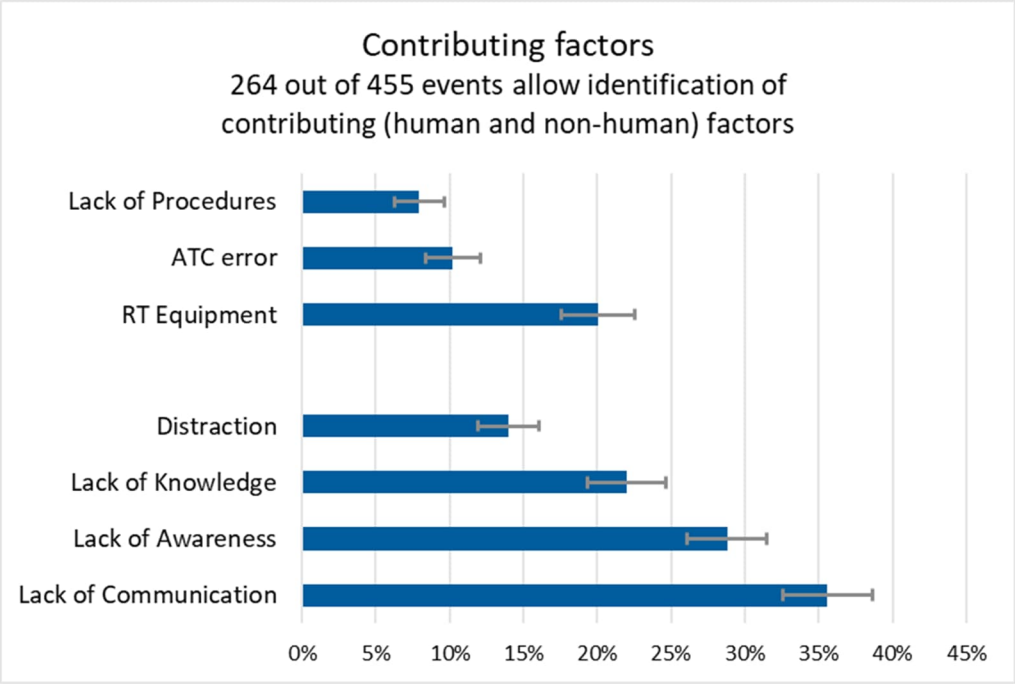

Figure 9: Factors contributing to the analysed events[10]

[10] The error bars in the diagram represent the standard error, which is a measure of the deviation of a value estimated with a sample from the real value. The standard error was calculated using the bootstrap method (a statistical resampling method) with 999 replicates.

III.2.3 Applicability of the analysed sample to the ECCAIRS data set

III.2.3.1 The analysed sample of ECCAIRS data was not randomly drawn and therefore it must be verified to what extent the statements of the analysed sample can be applied to the complete ECCAIRS data set. This is evaluated based on two attributes, available for each occurrence[11]:

- Occurrence classification
- Year

III.2.3.2 The distribution of the occurrence classification is shown in Figure 10. Having a proportion of 0.5 means, a class is equally distributed in both samples. Most occurrence classes are near to a proportion of 0.5 and therefore equally distributed in both samples, except of the occurrence class “accident”. The analysed ECCAIRS sample contains significant more accidents compared to the filtered ECCAIRS data set described in section II.3. Applying a statistical test on the distribution of the occurrence classification resulted in statistically significant differences between both samples for all occurrence classes[12].

III.2.3.3 The distribution of the occurrences per year is shown in Figure 11. In particular for the years 2005 to 2009 the proportion deviates significantly from 0.5 and therefore from an equal distribution in both samples. This deviation is also statistically significant[13].

[11] Other attributes could be also useful but are not available for each occurrence.
[12] The difference between both samples has been tested with a statistical test. The applied statistical test showed statistically significant differences between both samples (Kruskal-Wallis rank sum test [8], χ^2=0.010909091, df = 1, p-value = 0.9168149).
[13] The applied statistical test showed statistically significant differences between both samples (Kruskal-Wallis rank sum test [8], χ^2= 0.31368796, df = 1, p-value = 0.5754259).

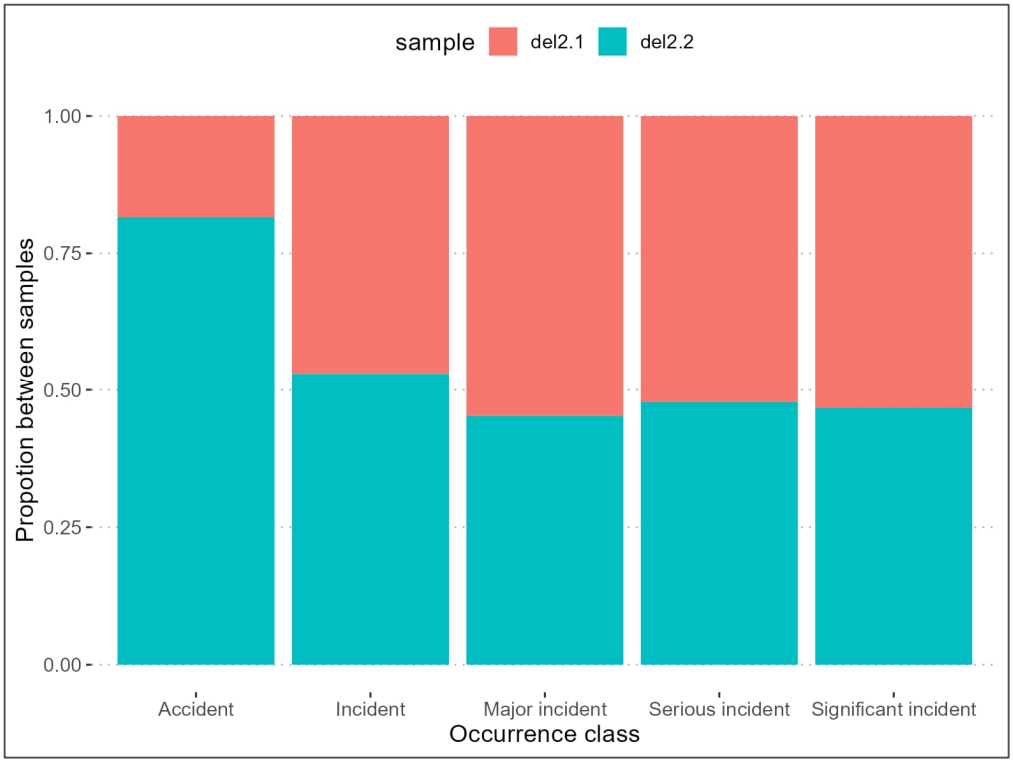

Figure 10: Distribution of occurrence classification in both samples

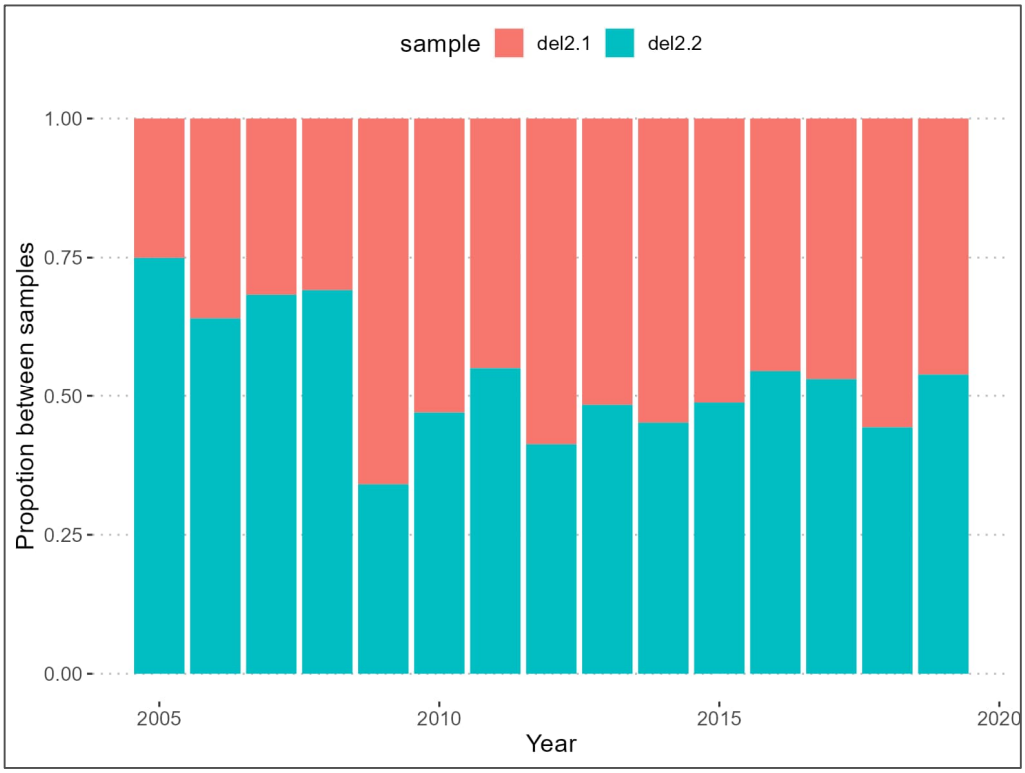

Figure 11: Distribution of occurrences per year in both samples

III.2.3.4 It can be concluded that the results of the analysed ECCAIRS sample cannot simply be applied to the entire ECCAIRS data set without limitations. The analysis of the two samples indicates that there is a sample bias. That means, that the distribution of the dirty dozen may vary, if all runway incursions involving a vehicle had been investigated.

Unfortunately, not all occurrences have the necessary information for analysing the contributing factors. The conclusions drawn from the analysed ECCAIRS data may therefore not necessarily apply to the entire ECCAIRS data set.

III.2.4 Analysis of EVAIR data

III.2.4.1 EUROCONTROL provides a platform to exchange safety related information about incidents between aircraft operators, airline associations (IATA, ERA), air navigation service provides (ANSPs), and airports called EVAIR (EUROCONTROL voluntary ATM incident reporting).

III.2.4.2 The EVAIR data is confidential and can only be analysed internally by EUROCONTROL. Therefore, no dedicated analysis of individual occurrences was possible and only statistical results could be requested to which responses from EUROCONTROL were received. The following aspects were requested:

- Were the aircraft and vehicles on the same frequency?
- What language did the pilots, ATCOs and vehicle drivers speak?
- Was standard phraseology used?
- Were there one or more other safety nets active?
- Was the training of the vehicle drivers a contributing factor?
- What type of vehicle was involved?
- Did a frequency congestion occur?

III.2.4.3 The period of January 2021 to August 2023 was analysed, including 7,398 reports in total.

III.2.4.4 Runway incursions caused by a vehicle have been identified based on EVAIR “Type of occurrences – Runway Incursion – Vehicle” and in addition by the narrative part of runway incursion reports. The analysis was limited by the information contained in the reports and therefore not all requested information could be derived from the reports.

III.2.4.5 Out of 7,398 reports, 95 incidents were runway incursions (1.2 %), and within these runway incursions, 11 incidents involved a vehicle (11.6 %). Not all above- mentioned aspects could be analysed as the requested information was not available in the reports. Only the following aspects could be analysed:

- Were the aircraft and vehicles on the same frequency?
- What language did the pilots, ATCOs and vehicle drivers speak?

- Were there one or more other safety nets active?
- What type of vehicle was involved?

III.2.4.6 For most reports, information on whether the aircraft and vehicle were on the same frequency was not available. For two out of six reports, it could be concluded from the narrative, that the pilot and vehicle driver were on the same frequency.

III.2.4.7 In the same way, information on whether the pilot, ATCO and driver communicated on the same language is only included in a few reports. For two reports, where pilots and vehicle drivers were on the same frequency, communication was in English in one report and local language in the other report.

III.2.4.8 For the majority of the reports, the information about active safety nets was not available. Only a few reports have mentioned that the stop bars are permanently activated.

III.2.4.9 With regard to the vehicles involved, the fire brigade was involved in most cases (5). In two cases, a RWY inspection vehicle was involved. For the other four cases, no information was available.

III.2.4.10 Table 4 summarizes the above presented analysis.

Table 4: Summary of EVAIR analysis 2021 - August 2023

No. of reports	Year	Were the aircraft and vehicles on the same frequency?	What language did the pilots, ATCO and vehicle drivers speak?	Were there one or more other safety nets active?	What type of vehicle was involved?
1	2021	Information not available	Information not available	Information not available	Fire vehicle in one report.
6	2022	Information not available but from the narrative part for 2 reports out of six could be concluded that vehicle and aircraft were on the same freq. Communication with vehicle was on the local language.	English and Local language in 2 reports.	Stop bars for CATII and CAT III	Fire track; Fire brigade in one report; Inspection vehicle in one report;
4	2023	Information not available. From the narrative part of all four reports, it could be concluded that vehicle and aircraft were not on the same freq.		Information not available	Fire vehicle, fire brigade, one report and vehicle for the RWY inspection in one report.

III.2.5 Analysis of investigation reports

III.2.5.1 Based on the list of ECCAIRS occurrences provided in Part II, investigations reports related to accidents and serious incidents issued by national aircraft accident investigation boards were researched. 40 ECCAIRS occurrences were categorised as accidents or serious incidents. An investigation report could be found for 18 out of these

40 occurrences. 12 out of those 18 investigation reports (all serious incidents) contained sufficient information to analyse the main contributing factors, the other reports were too short to extract useful information. These 12 occurrences are listed in Table 5 and the analysis results are listed in Table 7 (Annex B).

Table 5: ECCAIRS occurrences with an investigation report issued by a national aircraft accident investigation board

Occurrence > e2Id	Date	Type of vehicle	Main contibuting factors identified in the investigation report
OC-0000000000713592	2007-11-12	Winter operations	- Insufficient situational awareness of ATC
OC-0000000000346209	2008-02-27	Maintenance	- Maintenance works procedure incomplete (exact working position not specified in form) - ATCO did not monitor maintenance works - Miscommunication between Airside Operations Manager and maintenance workers - ATC did not have information about exact work position of the maintenance workers
OC-0000000003138001	2010-01-06	Snow plow	- Insufficient training of the ATCOs for low visibility and winter operations - ATCO did not check position of vehicle - Deficiencies in ATC procedure definition
OC-0000000000437862	2012-01-21	Wildlife	- ATCO did not check number of remaining vehicles on the RWY - Deficiencies in ATC procedure definition - Two aircraft and one vehicle were on three different frequencies
OC-0000000000698923	2012-02-15	Snow plow	- Failure of the vehicle driver to answer radio communications - Misinterpretation of the situation on the runway by the vehicle driver and loss of situational awareness
OC-0000000002342924	2018-02-09	Snow plow	- Incorrect interpretation of situation by the snow plug driver and therefore insufficient training
OC-0000000001792668	2019-01-28	Snow plow	- No communication between vehicles and pilots possible and ATC was not in service - Deficiencies in airport procedure definition regarding communication and coordination between vehicles and pilots, if ATC is not in service
OC-0000000002699770	2019-02-26	Construction vehicle	- Vehicle driver was not aware of RWY ahead (disorientated) - Vehicle driver was unclear about the rules
OC-0000000003339894	2019-11-14	Snow plow	- High workload due to underestimated snowfall - Deficiencies in procedure definition regarding runway closure and snow plan was not aligned with operational realities - Insufficient coordinaten between ATCOs
OC-0000000002102722	2020-03-15	Police	- Vehicle was not equipped with radio and entered RWY without authorization - Procedure was not in line with airport safety policy
OC-0000000002976387	2021-04-27	RWY inspection	- Organizational deficiencies
OC-0000000002974574	2021-08-23	RWY inspection	- Warning light on the vehicle had a limited light intensity - Flight Progress Board not being checked prior to giving the take-off clearance due to distraction (reading new RWY condition codes implemented a short time before)

III.2.5.2 The analysis of the 12 investigation reports with sufficient information regarding the main contributing factors or (root) causes are shown the following figure:

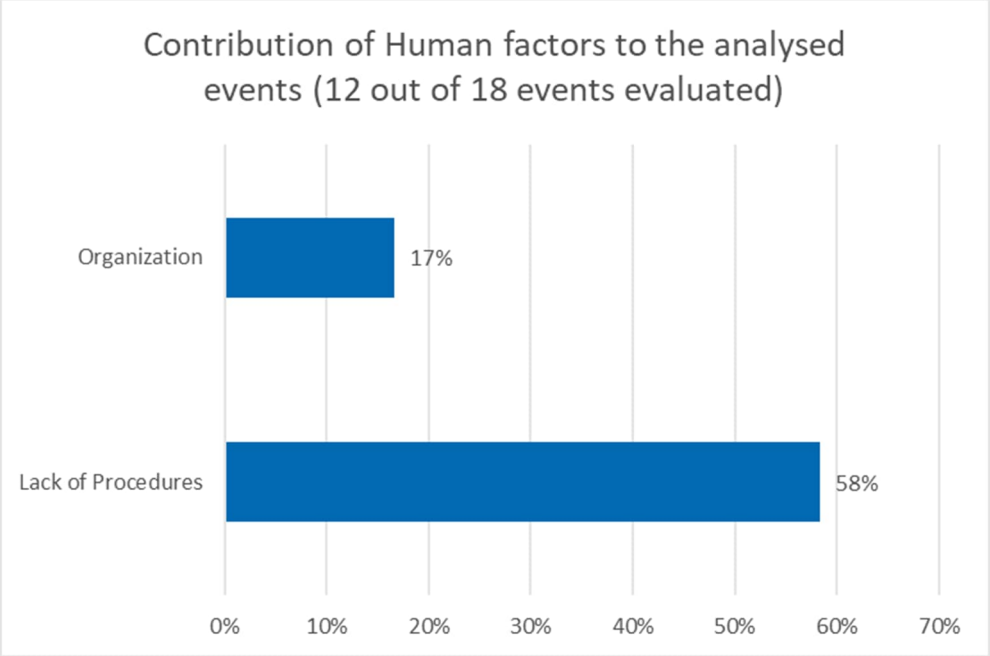

Figure 12: Contribution of Human Factors within the analyzed investigation reports

III.2.5.3 Two other main contributing factors besides of Human factors have been identified in the reports. These are "Lack of procedures" (58 %) and organizational deficiencies (17 %).

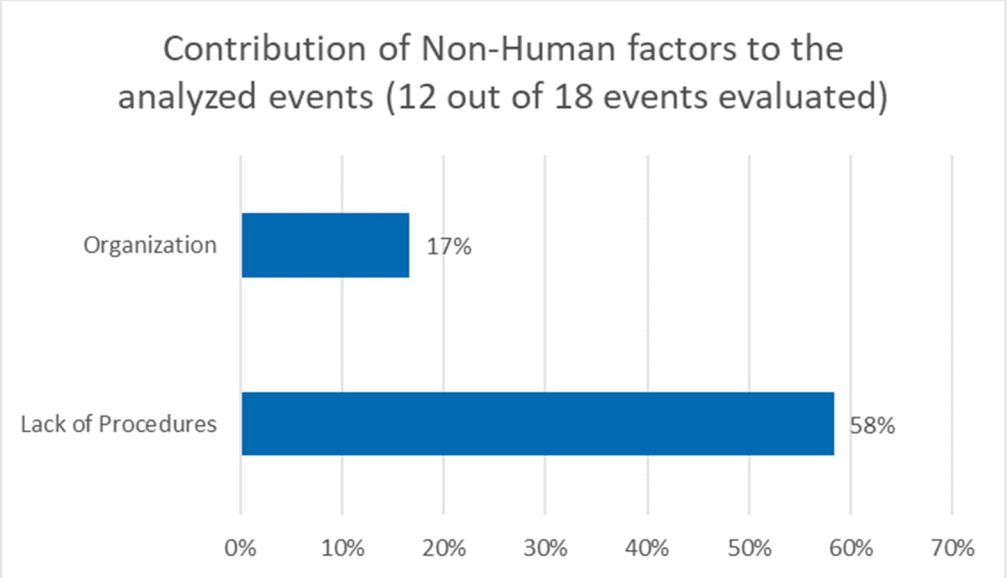

Figure 13: Contribution of Non-Human Factors within the analyzed investigation reports

III.2.6 Summary

III.2.6.1 The analysis of the ECCAIRS data and the investigation reports come to slightly different conclusions. This difference is mainly due to the small number of reports that could be analysed.

III.2.6.2 The main contributing human factors identified in the analysed ECCAIRS data are:

- "lack of communication",
- “lack of awareness”, and
- “lack of knowledge”.

III.2.6.3 The main contributing human factors identified in the analysed investigation reports are:

- “lack of awareness” and
- “lack of knowledge”.

III.2.6.4 The main other factors, contributing to the analysed occurrences are:

- "Radio telephony equipment”,
- “ATC errors”, and
- “lack of procedures”.

ATC errors may be caused by human factors as well, but in most cases, no indication is given. Thus, “ATC error” was treated isolated as a separate contributing factor.

III.2.6.5 Unfortunately, the ECCAIRS sample analysed is not representative for the entire ECCAIRS data set and therefore the results cannot be applied to all runway incursions. The same applies to the investigation reports, which are only drawn up by the national aircraft accident investigation boards in the case of an accidents or serious incidents. This sample is therefore also not necessarily representative of the entire ECCAIRS data set.

III.3 Identification of mitigation measures – D-2.3

III.3.1 An occurrence investigation usually consists of four main parts:

1. Collecting evidence and factual information,
2. Analysing information,
3. Deriving contributing factors and defining mitigation measures,
4. Followed by the documentation (writing a report).

III.3.2 Factors contributing to runway incursions and Triple One related occurrences were already discussed in chapter III.2, lists of (Human) Factors being relevant for those occurrences are given in section III.2.1 (Table 2 and Table 3). Additionally, contributing factors and aspects, that were specifically pointed out by the aerodromes that provided information for Part IV, are given in section IV.3.2.3.

III.3.3 The subject of the present chapter are the mitigation measures, that were derived during the investigations of Triple One related occurrences. The analyzed ECCAIRS data and the provided investigation reports do not contain any general mitigation measures to prevent runway incursions. However, mitigation measures were proposed for the specific occurrences investigated, but it is not known from these reports whether these were actually implemented subsequent to the investigation. In many cases, the proposed measures are only suitable for one specific occurrence. These occurrence specific measures are the basis of the present chapter and are presented in the following paragraphs.

III.3.4 One of the most common types of mitigation, that aerodromes identified as to be suitable for the occurrences under investigation, is training. Training is relevant for several aspects, such as communication, equipment handling, and knowledge. Thus, it counteracts a broad range of contributing factors. Since the reports that were analysed in section III.2 are related to runway incursions by vehicles, most of the identified mitigations affect the corresponding driver training. Thus, the following topics to be covered during initial trainings and refreshers for vehicle drivers were identified as to be relevant:

- Runway safety areas,
- Marking, lighting, and signs, especially of holding positions,
- Hot spots,
- Phraseology,
- Use of equipment,

- Procedures,
- Radiotelephony skills,
- Operating hours of ATC[14],
- Snow-clearance operations (ensure training in advance),
- Procedures for being escorted

It must be noted that training and maintenance of an appropriate level of proficiency is a common and known key aspect as well as a prominent challenge at most airports in order to ensure a high level of safety. Training aims at both, knowledge and familiarity with the airport layout, infrastructure and procedures, as well as improvement of the awareness of hazards.

III.3.5 Not only vehicle drivers are involved in runway incursions, but also air traffic controllers and pilots. Since the focus was not on runway incursions by aircraft, pilots were not focused on in most of the analysed occurrences. On the contrary, since controllers have been directly involved in the events that led to the majority of the runway incursions, it is possible to draw conclusions about the necessary mitigation measures, as follows:

- Air traffic controllers should pay attention to correct phraseology,
- Air traffic controllers should avoid long clearances to vehicle drivers and divide them into short sections,
- Ensure ATC has capabilities to track vehicles on the runway (adequate surveillance) and
- Ensure information about vehicles on the runway are passed on during shift changes.

This emphasises the importance of a strong collaboration and coordination of measures and actions around runway safety with the local ANSP, including the sharing of data and close involvement in the change management process.

III.3.6 A few occurrences could also be linked to infrastructural aspects. While infrastructural non-compliances must be fixed or assessed, some mitigations aim at improvement through infrastructural changes or upgrades, even if the infrastructure is compliant:

- Avoid infrastructure naming that could lead to confusion (e.g., crossing point with “crossing” in its name), and

[14] Some occurrences happened slightly before or after the start/end of the hours of operation, thus, knowledge of responsibilities and transition handling were considered during trainings that followed the investigation.

- Improve the design of taxiway areas close to runways, holding positions and its visual aids.

Whereas the infrastructural change aimed at avoiding crossing traffic has an immediate effect on the resulting runway incursion risk (such as perimeter roads or runway end-around taxiways), the compliant, consistent and clear design targets on human factors, to facilitate orientation, navigation and the identification of critical areas.

III.3.7 The last set of mitigations mainly focuses on providing proper and sufficient resources and procedures, especially for vehicle driver. The aerodrome operators and the ATS providers should ensure:

- Existence and functionality of radiotelephony equipment for all vehicles operating on or crossing a runway,
- A sterile cab policy for all vehicle drivers on the maneuvering area,
- Proper procedures for vehicles on the runway or crossing the runway, covering also rare situations and system failures (also construction works),
- Sufficient resources for vehicle drivers and ATC controller.
- Operation of the stop bars, if installed, on a 24-hour basis in specific cases, if deemed necessary based on a safety assessment.

III.3.8 The presented mitigation measures provide a summary of those that were mentioned in the analysed occurrences. The list is not comprehensive as it is limited to the data contained in ECCAIRS, EVAIR, and the relevant investigation reports. Additionally, the identified mitigation measures may not be applicable to all aerodromes.

Part IV Aerodrome Safety Investigations – D-2.4

IV.1 Introduction

IV.1.1 According to ICAO Doc 9859 (Safety Management Manual [7], chapter 9.4.5) "effective safety management depends on quality investigations to analyse safety occurrences and safety hazards, and report findings and recommendations to improve safety in the operating environment. [...] Service provider safety investigations are to be conducted as part of their SMS to support hazard identification and risk assessment processes. [...] Service provider investigation(s) (are) usually triggered by a notification (report) submitted through the [service provider's] safety reporting system." Similar intentions are expressed in Reg. (EU) 996/2010 "on the investigation and prevention of accidents and incidents in civil aviation". [8]

IV.1.2 The primary objective of service provider safety investigations is to understand what happened, and how to prevent similar situations from occurring in the future. "*The investigation should usually include:*

a) establishing timelines [...];

b) review of any policies and procedures related to the activities;

c) review of any decisions made related to the event;

d) identifying any risk controls that were in place that should have prevented the event occurring; and

e) reviewing safety data for any previous or similar events. [...]

The investigation should conclude with clearly defined findings and recommendations that eliminate or mitigate safety deficiencies." [7]

IV.1.3 In the aftermath of the workshops that were conducted in the context of Task 3 of the present research, the selected aerodromes were asked to provide more detailed information on how they investigate safety occurrences and how local precursors are dealt with. The focus was on runway incursions involving vehicles.

IV.1.4 To allow a comparison between the different aerodromes, a set of questions was sent out, using the ICAO Doc 9859 mentioned above as a guideline. The answers to those questions given by the aerodromes were then collected and summarized and the main conclusions is shown in the following. The provided data was screened to extract the relevant information, where necessary.

IV.2 Requested information

IV.2.1 The following aspects were covered by the request sent out to the aerodromes:

Firstly, how are investigations conducted and documented, e.g.,

- responsibility for the execution of an investigation,
- standard procedures being followed,
- analysis methods, and
- usage of templates for the documentation.

Secondly, Triple One relevant occurrences that were experienced at the corresponding aerodromes:

- Were runway incursions involving vehicle drivers experienced in the past?
- Were other occurrences experienced that are related to the main aspects of Triple One?
- In case those occurrences were investigated: What were the key conclusions, especially with regard to *Human Factors*?

IV.2.2 Answers and/or data were received from eleven airport operators. The conclusions that are presented in the next section were derived from those responses.

IV.3 Responses and conclusions

IV.3.1 Investigation and documentation of safety incidents

IV.3.1.1 In the following, summaries of the responses to the different aspects of how investigations of safety incidents are conducted and documented, are presented. If no specific answer was given by the aerodromes, the provided reports/documentation was used to extract the relevant information, if possible.

IV.3.1.2 It was derived, that the investigations are usually led and/or carried out by the safety manager and/or the safety team. Some aerodromes have a dedicated safety incident investigation team running the investigations. Depending on the occurrence, it is common to involve the affected department and/or a domain expert. Occurrences that falls into the categories of “accident” or “serious incident” under ICAO Annex 13 are in some cases investigated by other persons or departments than the other internal investigations.

IV.3.1.3 Standard procedures are used for both, the reporting / follow up of safety incidents (according to Reg. (EU) 376/2014) as well as for the investigation procedure. Aspects, that are part of the investigation procedures used and mentioned by the aerodromes, include:

- Event notification (triggering the investigation),
- Consideration whether to initiate an investigation,

- Data acquisition / gathering of evidence incl. execution of interviews,
- Checking procedures,
- Analyses, including root cause analysis (In some cases RCA is only done for mandatory occurrence reports),
- Hazard identification and risk assessment (HIRA),
- Evaluation of the risk level,
- Definition of preventive actions,
- Monitoring of the effectiveness of the measures and recommendations, and
- Definition of sanctions (if applicable under *Just Culture*[15]).

Some aerodromes mentioned the involvement of a *Just Culture* committee which is involved with the objective to follow the *Just Culture* objectives and to "*dig deep into the occurrence to uncover any system errors*".

IV.3.1.4 When it comes to analysis methods, the method that is most applied is *5-why* [16], sometimes being reduced to *3-why*. Other analysis methods that were mentioned are the *Human Factors Analysis and Classification System* [17], the *MEDA model* [18], *Event Risk Classification* [19] (as part of the ARMS methodology), and *Causal Analysis based on System Theory (CAST)* [20] by Leveson as well as using predefined questions.

IV.3.1.5 All aerodromes that replied to the questions stated that they use a template for their investigation reports. Some distinct, based on the extend of the investigation, whether they use the "full" template or a simplified version or even write an internal email only.

IV.3.1.6 Summarizing the given answers and/or provided SMS data, it can be stated that the corresponding aerodromes follow existing procedures and analysis methods as well as use templates to conduct and document safety incident investigations. Some of the

[15] Just Culture: An atmosphere of trust in which people are encouraged for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour. [9]
[16] 5 WHYs analysis is one of the most common ways to perform root cause analysis. 5 WHYs essentially involve starting at the hazardous condition, and asking, "Why did this happen." Each time you ask, you will write down the answer. For each answer, you will repeat the question. This question is generally repeated 5 times until you arrive at the root cause(s). [11]
[17] The HFACS framework provides a tool to assist in the investigation process and target training and prevention efforts. Investigators can systematically identify active and latent failures within an organisation that culminated in an accident. [10]
[18] The Maintenance Error Decision Aid (MEDA) is a structured process used to investigate events caused by maintenance technician and/or inspector performance. [12]
[19] "The main objective of Event Risk Classification is to act as the first screening of all incoming safety data and to identify when urgent action is necessary. This type of screening is necessary whatever methodology is used for risk assessment." [13]
[20] CAST (Causal Analysis based on System Theory) is meant "to identify the questions that need to be asked during an accident investigation and determine why the accident occurred. […] The analysis goal changes from the typical search for failures to instead look for why the systems and structures in place to prevent the events were not successful. Recommendations focus on strengthening these prevention (control) structures, based on what was learned in the investigation" and its "goal is to learn as much from every accident as possible." [14]

aerodromes differentiate depending on scope and/or content of the occurrence. *Just Culture* objectives are followed in any case.

IV.3.2 Triple One related occurrences and local precursors

IV.3.2.1 The second set of questions is closely related to the Triple One concept. The aerodromes were asked to consider runway incursions by vehicles and other Triple One related occurrences. Since the extensive analysis of relevant occurrences was already done in Part II, this section will only address specific statements and additional observations.

IV.3.2.2 The consideration of additional occurrences that may be relevant or that are related to the elements of Triple One raised the attention to aspects such as:

- radio discipline (being a problem in general at one aerodrome),
- phraseology,
- situational awareness, and
- adequate knowledge of the English language.

Especially the latter was pointed out with respect to both, vehicle drivers and pilots, leading to miscommunication with ATC.

IV.3.2.3 Investigations done in the aftermath of the occurrences that were considered by the aerodromes that answered to this questionnaire led to different perceptions: both, Triple One could have helped to avoid the occurrences but also that Triple One would not have influenced the situation. Also, different opinions are stated concerning individual elements, such as the shared frequency vs. the common language – it highly depends on the occurrence whether those elements on their own would have changed the situation and/or averted the incident.

Factors (including Human Factors) and circumstances that were specifically mentioned by the aerodromes when answering the questions include:

- Driver inattention,
- Lack of proficiency,
- Lack of familiarity,
- Stress and fatigue,
- Overconfidence,
- Confusion between TWR and vehicle drivers,
- Increased workload due to changing frequencies whilst taxiing, which lead to a decreased situational awareness,

- Poor communication,
- Unclear communication caused by unsynchronized unlit stop bar light and instructions when to cross the RWY, and
- Radio station failure leading to ATC misunderstanding by vehicle driver.

Additionally, the following aspects were pointed out:

- A significant correlation between perception/attentional errors and environmental factors (physical/technological).
- Difficulties in finding personnel that satisfies the language proficiency requirements.

IV.3.2.4 In the following, a list of mitigation measures and (infrastructural) changes, that were mentioned in the replies coming from the aerodromes, is given. These measures were implemented consequently to the investigations of the relevant occurrences. They are assumed to be tightly connected to the local precursors.

- Compliant implementation of road holding positions (making it a lot clearer for the drivers on where to request a clearance).
- 24h usage of stop bars.
- Limiting access to active runways to the Airside Duty manager only. / Restriction of personnel authorised to enter the manoeuvring area.
- Retraining/refresher/promotions with respect to familiarization, hot spots, phraseology, infrastructural modifications (e.g., install signs, add markings etc.), and radio discipline.
- Establishing procedures for specific cases (e.g., intrusion).
- Security intrusion detection system optimisation.
- Language exercises in the driving simulator (at least) bi-monthly.
- AIP chart and hot spot map reviews.
- Additionally, discussions of the occurrences during local runway safety team meetings were mentioned to raise awareness and discuss further actions.

IV.3.2.5 The conclusions communicated by the aerodromes based on the investigations of Triple One related occurrences lead to the realisation, that Triple One is perceived to be a good solution in some situations, but not always. It is stated that generally it highly depends on the specific situation and a general statement is hardly possible. Infrastructural circumstances influence the effectiveness of Triple One as well as

prerequisites in terms of English proficiency and the basic habit of driving in the manoeuvring area. Thus, each aerodrome must be considered individually.

IV.3.3 Summary

IV.3.3.1 To summarize, the following topics are relevant to language and radio frequency related occurrences:

- Communication on aviation frequencies: Radio discipline and (non-standard) phraseology were mentioned as contributing factors in some cases. Additionally, both aspects were mentioned as relevant training/refresher topics as a mitigation measure in the aftermath of the corresponding occurrences.
- English language proficiency: adequate knowledge of the English language as well as difficulties in finding personnel that satisfies the language proficiency requirements were mentioned by the aerodromes when responding to the questions. This is an important fact as it represents one of the main prerequisites for the implementation of Triple One.
- Other Triple One relevant aspects: It is interesting to note, that it was stated once that an increased workload due to changing frequencies led to reduced situation awareness and a runway incursion. Thus, an increase of required frequency changes may represent a safety risk. This should be kept in mind when considering the introduction of new/additional frequencies when implementing Triple One.

IV.3.3.2 Further topics not related to language or frequencies are the following:

- With regards to human factors, the following aspects were pointed out: Driver inattention, lack of proficiency, lack of familiarity, stress, fatigue, and overconfidence, as well as lack of situational awareness. Most of these topics were also referred to in terms of additional training content as part of the corresponding investigations. Also, those aspects are in line with the results presented III.2.2.
- Procedures and permissions: In section III.2.2, lack of procedures was already identified as contributing to many occurrences. As part of the follow-up survey, the establishment of procedures for specific cases as well as the reduction of personnel having certain permits (such as driving onto an active runway) are also in line with this previously identified contributing factor. Another aspect is the usage of visual aids (e.g., stop bars).

- Infrastructural adjustments: Even if no non-compliance was registered, changes to the infrastructure or its usage were recorded. This mainly applies to the installation of visual aids.

List of Abbreviations

ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
CAA	Civil Aviation Authority
EAPRI	European Action Plan for the Prevention of Runway Incursions
ECCAIRS	European Co-ordination centre for Accident and Incident Reporting Systems
ERA	European Regions Airline Association
EU	European
EVAIR	EUROCONTROL voluntary ATM incident reporting
FAA	Federal Aviation Administration
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
RCA	Root Cause Analysis
RI	Runway Incursion
SMS	Safety Management System

List of References

[1] European Parliament and the Council, "Directive 2003/42/EC of the European Parliament and of the Council of 13 June 2003 on occurrence reporting in civil aviation (repealed)," 13 June 2003.

[2] European Commision, "Commission Regulation (EC) No 1321/2007 of 12 November 2007 laying down implementing rules for the integration into a central repository of information on civil aviation occurrences exchanged in accordance with Directive 2003/42/EC of the European Parliam," 12 November 2007.

[3] European Parliament and the Council , "Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation," 3 April 2014 .

[4] European Commission, "Commission Implementing Regulation (EU) 2015/1018 of 29 June 2015 laying down a list classifying occurrences in civil aviation to be mandatorily reported according to Regulation (EU) No 376/2014 of the European Parliament and of the Council," 29 June 2015.

[5] ECCAIRS Coding Guidance, "ECCAIRS Coding Guidance Chapter 2 - Regulation 376/2014 Annex I - Mandatory Data Fields," V1.0 March 2022.

[6] FAA Safety Team, “Avoid the Dirty Dozen,” 2012. [Online]. Available: https://www.faasafety.gov/files/gslac/library/documents/2012/nov/71574/dirtydozenweb3.pdf. [Accessed 04 12 2023].

[7] INTERNATIONAL CIVIL AVIATION ORGANIZATION, *Safety Management Manual,* Quebec, 2018.

[8] European Parliament and the Council , *Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC Text with EEA relevance,* 20.10.2010.

[9] D. J. Sheskin, Handbook of parametric and nonparametric statistical procedures, third ed., Boca Raton, USA: Chapmann & Hall/CRC, 2004.

[10] civil air navigation services organisation, *Safety Culture Definition and Enhancement Process,* 2008.

[11] SKYbrary, „Human Factors Analysis and Classification System (HFACS),“ [Online]. Available: https://skybrary.aero/articles/human-factors-analysis-and-classification-system-hfacs. [Zugriff am 25 01 2024].

[12] SMS Pro Aviation Safety Software Blog 4 Airlines & Airports, „How to Conduct Root Cause Analysis in Aviation SMS,“ [Online]. Available: https://aviationsafetyblog.asms-pro.com/blog/how-to-conduct-root-cause-analysis-in-sms-programs. [Zugriff am 25 01 2024].

[13] SKYbrary, „Maintenance Error Decision Aid (MEDA),“ [Online]. Available: https://skybrary.aero/articles/maintenance-error-decision-aid-meda. [Zugriff am 25 01 2024].

[14] A. W. Group, „The ARMS Methodology for Operational Risk Assessment in Aviation Organisations,“ 2010.

[15] N. G. Leveson, CAST HANDBOOK: How to Learn More from Incidents and Accidents, 2019.

Annex A ECCAIRS data

A.1 The following table lists the received attributes and those attributes selected for D-2.1.

Table 6: List of received and selected attributes

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
Occurrence > e2Id	x		ECCAIRS occurrence Id	
Occurrence > reportingEntity	x	447	The identification of the entity that provided the report	The identification of the entity or organisation that provided the report.
Aerodrome_General > Aerodrome_Type > L1		10	Aerodrome type	The type of aerodrome, whether this is a land or water aerodrome.
Aerodrome_General > Location_Indicator > additionalText		5	Aerodrome location indicator	Location indicator. A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.
Aerodrome_General > Location_Indicator > L1	x	5	Aerodrome location indicator	Location indicator. A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.
Aerodrome_General > Location_Indicator > L2	x	5	Aerodrome location indicator	Location indicator. A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.
Aerodrome_General > Location_On_Near_Aerodrome > additionalText		641	Location on aerodrome	Location of the occurrence on or near the aerodrome
Aerodrome_General > Location_On_Near_Aerodrome > L1		641	Location on aerodrome	Location of the occurrence on or near the aerodrome
Aerodrome_General > Location_On_Near_Aerodrome > L2		641	Location on aerodrome	Location of the occurrence on or near the aerodrome
Runway > Runway_Identifier		499	The identifier of a runway	A runway identifier consists of a two-digit number and on parallel runways is supplemented by a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parallel runways, one set of adjacent runways shall be numbered to the nearest one tenth magnetic azimuth and the other set of adjacent runways to the next nearest one-tenth magnetic azimuth. When the above rule results in a single digit number it is preceded by a zero. In the case of parallel runways, each runway designation number is supplemented by a letter as follows, in the order shown

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
				from left to right when viewed from the direction of approach: For two parallel runways: "L" "R"; for three parallel runways: "L" "C" "R"; for four parallel runways: "L" "R" "L" "R"; for five parallel runways: "L" "C" "R" "L" "R"; or "L" "R" "L" "C" "R" and for six parallel runways: "L" "C" "R" "L" "C" "R". Annex 14.
Runway > Runway_Number > L1		1119	The identifier of the runway	A runway identifier consists of a two-digit number and on parallel runways is supplemented by a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parallel runways, one set of adjacent runways shall be numbered to the nearest one tenth magnetic azimuth and the other set of adjacent runways to the next nearest one-tenth magnetic azimuth. When the above rule results in a single digit number it is preceded by a zero. In the case of parallel runways, each runway designation number is supplemented by a letter as follows, in the order shown from left to right when viewed from the direction of approach: For two parallel runways: "L" "R"; for three parallel runways: "L" "C" "R"; for four parallel runways: "L" "R" "L" "R"; for five parallel runways: "L" "C" "R" "L" "R"; or "L" "R" "L" "C" "R" and for six parallel runways: "L" "C" "R" "L" "C" "R". Annex 14.
Runway > Surface_Type > L1		509	Runway surface type	This provides information on the type of surface in the take-off/landing area.
Vehicle > Type_Of_Vehicle > additionalText	x	733	Type of aerodrome vehicle	The type of aerodrome vehicle involved in the runway incursion.
Vehicle > Type_Of_Vehicle > L1	x	733	Type of aerodrome vehicle	The type of aerodrome vehicle involved in the runway incursion.
Vehicle > Vehicle_Controlled > L1	x	743	Vehicle being controlled by an ATS unit	This is used to record whether the vehicle involved in the runway incursion was being controlled by an ATS unit.
Air_Navigation_Service > RIMCAS_Alerting > L1		366	Runway Incursion Monitoring and Collision Alert System alerting	Definition: Information on whether the Runway Incursion Monitoring and Collision Alert System was functioning.RIMCAS: The RIMCAS function is integrated in A-SMGCS and is a software module designed to monitor movements on the aerodrome surface, using data from a surveillance system, in order to predict and identify possible conflict situations (Conflict Alerts) within the surveillance area. In its basic form, RIMCAS will warn of runway area incursion by aircraft or vehicles, or incursion of mobiles into other designated restricted areas on the airport, such as Instrument Landing System (ILS) critical areas, when an aircraft is due to land or take off on the active runway. The open systems architecture makes it possible to extend the Advanced Surface Movement Guidance and Control System with approach control functionality to provide a fully Integrated Tower System.
Aircraft > Aircraft_Category > L1		32	Aircraft category	

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
Aircraft > Aircraft_Category > L2		32	Aircraft category	Aircraft category. Classification of aircraft according to specified basic characteristics, e.g. aeroplane, helicopter, glider, free balloon. ICAO Annex 1. Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface. (Annex 8)"
Aircraft > Aircraft_Category > L3		32	Aircraft category	
Aircraft > Aircraft_Category > L4		32	Aircraft category	
Aircraft > Aircraft_Registration	x	244	Aircraft registration	The mark used to identify an aircraft. The mark consists of a common mark or nationality mark followed by a registration mark. The nationality mark shall be selected from the series of nationality symbols included in the radio call signs allocated to the State of Registry by the International Telecommunication Union. The nationality mark shall be notified to the International Civil Aviation Organization. The registration mark shall be letters, numbers, or a combination of letters and numbers, and shall be that assigned by the State of Registry or common mark registering authority. When letters are used for the registration mark, combinations shall not be used which might be confused with the five-letter combinations used in the International Code of Signals, Part II, the three-letter combinations beginning with Q used in the Q Code, and with the distress signal SOS, or other similar urgent signals, for example XXX, PAN and TTT. Rules regarding registration marks do not apply to meteorological pilot balloons used exclusively for meteorological purposes or to unmanned free balloons without a payload. ICAO Annex 7
Aircraft > Filed_Flight_Rules > L1		117	Filed flight rules	The filed flight rules, e.g. IFR or VFR.
Aircraft > Manufacturer_Model > additionalText		21	Aircraft make/model/series	The name of the aircraft manufacturer and model (international standard for aircraft make, model, and series groupings - CICTT). The ICAO aircraft type designator - four character code assigned to the aircraft - is defined as an alias. [ICAO Doc 8643] The name of the aircraft manufacturer and model (international standard for
Aircraft > Manufacturer_Model > L1		21	Aircraft make/model/series	
Aircraft > Manufacturer_Model > L2		21	Aircraft make/model/series	
Aircraft > Manufacturer_Model > L3		21	Aircraft make/model/series	
Aircraft > Manufacturer_Model > L4		21	Aircraft make/model/series	
Aircraft > Operation_Type > L1		214	Operation type	The type of operation indicates whether this was a public transport operation (airline operation) or a general aviation flight.
Aircraft > Operation_Type > L2		214	Operation type	

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
Aircraft > Operation_Type > L3		214	Operation type	
Events > Event_Type > L1	x	390	Event type	The type of event, i.e. Consequential Events, Equipment, Operational, Personnel, Organizational or Unknown
Events > Event_Type > L2	x	390	Event type	
Events > Event_Type > L3	x	390	Event type	
Events > Event_Type > L4	x	390	Event type	
Events > Phase > L1	x	391	Event phase	The phase of flight that relates to the event.
Events > Phase > L2	x	391	Event phase	
Events > Phase > L3		391	Event phase	
Events > Phase > L4		391	Event phase	
Narrative > Narrative_Language > L1	x	424	The language of the narrative	The language used by the originator of the narrative.
Narrative > Narrative_Text	x	425	The text of the narrative	The text of the narrative entered by the reporter of the occurrence.
Occurrence > ATM_Contribution > L1	x	428	ATM contribution	Information on whether and to what extent, in the judgement of the investigators, the air traffic management contributed to the occurrence.
Occurrence > Cloud_Amount > L1		266	The amount of cloud	Sky cover classification for aviation weather observations.
Occurrence > Damage_Not_To_A_C > L1		448	Damage on aerodrome	Third party property damage (i.e. damage not to the aircraft) on the aerodrome.
Occurrence > Detection_Phase > additionalText		1072	Detection phase	Phase when the occurrence or finding was detected
Occurrence > Detection_Phase > L1	x	1072	Detection phase	Phase when the occurrence or finding was detected
Occurrence > File_Number	x	452	The occurrence file number	The file number allocated by the responsible entity.
Occurrence > Headline	x	601	Headline	A short message identifying the accident to the human reader.
Occurrence > Height_Of_Cloud_Base		140	Height of cloud base	Ceiling: height of the lowest opaque layer of clouds.

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
				Height: The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.
Occurrence > Highest_Damage > L1	x	432	Damage severity level	The highest level of damage sustained by any aircraft involved in the occurrence
Occurrence > Injury_Level > L1	x	451	Injury severity level	The highest level of injury sustained by any person in the occurrence.
Occurrence > Latitude_Of_Occ		439	Latitude of occurrence	Latitude of the place of the occurrence in degrees, minutes and seconds.
Occurrence > Light_Conditions > L1		168	Light conditions	The light conditions at the time of the occurrence.
Occurrence > Local_Date	x	433	Local date	The local date of the occurrence. This date is formatted according to the system short date format.
Occurrence > Local_Time	x	457	Local time	The local time of the occurrence time entered using the 24 hour clock e.g. 23:59.
Occurrence > Location_Name	x	440	Location of occurrence	Location of occurrence should be the name of the closest settled area or geographical feature.
Occurrence > Longitude_Of_Occ		444	Longitude of occurrence	Longitude of the place of the occurrence in degrees, minutes and seconds.
Occurrence > Maximum_Gust		176	Maximum wind gust	The maximum speed of a wind gust in knots or km/h. ICAO Annex 3. A gust is any sudden increase of wind of short duration, usually a few seconds.
Occurrence > Object_Damaged > L1		640	Object damaged by impact of the aircraft	The object(s) damaged by the impact of the aircraft.
Occurrence > Occurrence_Category > L1	x	430	Occurrence categories	The occurrence categories as developped by CAST/ICAO Common Taxonomy Team (CICTT). Commercial Aviation Safety Team [CAST] and International Civil Aviation Organization" [ICAO]. "Occurrence" is defined as "accident or incident" throughout this taxonomy. Generally, accidents and incidents differ only in the degree of injury sustained by persons involved or in damage sustained to the aircraft. Each category has a unique name and identifier to permit common coding in accident/incident systems, a text definition, and usage notes to further clarify the category and aid in coding occurrences. An important element of the occurrence category design is that it

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
				permits the association of multiple categories with an occurrence. Multiple coding supports the primary focus of CICTT- accident PREVENTION, in which every pertinent element should be investigated, recorded, and analyzed. Based on version October 2013 (4.6)
Occurrence > Occurrence_Class > L1	x	431	Occurrence class	The classification of the occurrence in relation to its severity.
Occurrence > Responsible_Entity > L1	x	453	The identification of the type of entity that is responsible for the occurrence record.	The identification of the type of entity or organisation that is responsible for the occurrence record. This does not mean the entity responsible for investigation of the occurrence, only the entity that is responsible for this particular occurrence record. Normally, the Responsible Entity is the Entity who enters the information into the ECCAIRS record. Responsible Entity cannot be reassigned to entities in other states without prior agreement. For records that will be transferred into the ECR, the Responsible Entity should be the Authority that transfers the data to the ECR.
Occurrence > Responsible_Entity > L2	x	453	The identification of the type of entity that is responsible for the occurrence record.	
Occurrence > Responsible_Entity > L3	x	453	The identification of the type of entity that is responsible for the occurrence record.	
Occurrence > State_Area_Of_Occ > additionalText		454	State or area of occurrence	The identification of the State or geographical area where the occurrence occurred. N.B. the designation employed for States and geographical areas do not imply the expression of any opinion whatsoever on the part of ICAO concerning the legal status of any country, territory, city, area or of its authorities, or concerning the delineation of its frontiers and boundaries.
Occurrence > State_Area_Of_Occ > L1	x	454	State or area of occurrence	
Occurrence > State_Area_Of_Occ > L2	x	454	State or area of occurrence	
Occurrence > State_Area_Of_Occ > L3		454	State or area of occurrence	
Occurrence > Third_Party_Damage > L1		456	Third party damage	Any property damage sustained by third parties, i.e. not to the aircraft involved, on the ground. It also captures the main source of the damage.
Occurrence > Total_Fatalities_Ground	x	460	Total fatal injuries on ground	The total number of fatal injuries sustained by persons on the ground.
Occurrence > Total_Injuries-Ground	x	463	Total injuries on ground	The total number of persons on the ground that sustained any injury in the occurrence.

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
Occurrence > Total_Minor_Injuries-Ground	x	469	Total minor injuries on ground	The total number of persons on ground involved in the occurrence with minor injuries.
Occurrence > Total_On_Board_A_C	x	462	Number of persons on aircraft	The total number of persons on board the aircraft involved in the occurrence.
Occurrence > Total_Serious_Injuries-Ground	x	472	Total serious injuries on ground	The total number of persons sustaining serious injuries on the ground. A serious injury is an injury sustained by a person in an accident and which: a) requires hospitalization for more than 48 hours, commencing within 48 hours from the date when the injury was received; or b) results in a fracture of any bone (except simple fractures of fingers, toes, or nose or; c) involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or d) involves injury to any internal organ; or e) involves second or third degree burns, or any burns affecting more than 5 percent of the body surface; or f) involves verified exposure to infectious substances or injurious radiation.
Occurrence > UTC_Date	x	477	UTC date of the occurrence	UTC: Time scale based on the second (SI), as defined and recommended by the CCIR, and maintained by the Bureau International des Poids et Mesures (BIPM). For most practical purposes associated with the Radio Regulations, UTC is equivalent to mean solar time at the prime meridian (0° longitude), formerly expressed in GMT. The UTC date entered in the format which depends on the local installation. Use yyyy-mm-dd otherwise.
Occurrence > UTC_Time	x	478	UTC time	The UTC time of the occurrence entered using the 24 hour clock e.g. 23:59. UTC: Time scale based on the second (SI), as defined and recommended by the CCIR, and maintained by the Bureau International des Poids et Mesures (BIPM). For most practical purposes associated with the Radio Regulations, UTC is equivalent to mean solar time at the prime meridian (0° longitude), formerly expressed in GMT.
Occurrence > Visibility		310	Visibility	Visibility for aeronautical purposes is the greater of: a) the greatest distance at which a black object of suitable dimensions, situated near the ground, can be seen and recognized when observed against a bright background; b) the greatest distance at which lights in the vicinity of 1 000 candelas can be seen and identified

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
				against an unlit background. N.B. The two distances have different values in air of a given extinction coefficient, and the latter b) varies with the background illumination. The former a) is represented by the meteorological optical range (MOR). The value 9999 indicates unlimited visibility.
Occurrence > Wind_Direction		320	Wind direction	Wind direction is defined as the mean wind direction in degrees true to the nearest 10 degrees, from which the wind is blowing. Range and increments: - Surface wind direction is reported between 10 degrees and 360 degrees; - The wind direction is indicated in multiples of 10° true rounded to the multiple or at the nearest number: - A wind blowing from the true north is indicated by 360° (and not 0°).
Occurrence > Wind_Gusts > L1		321	Wind gusts	Information whether the wind was gusting or not. Gusts are included when wind speed is 10 knots (20 km/h) or more above the mean. ICAO Annex 3. A gust is a sudden, brief increase in wind speed that generally lasts less than 20 seconds. Wind is the air motion relative to the earth's surface.
Occurrence > Wind_Speed		322	Wind speed	The speed of the wind in knots or kilometres per hour. Wind is the horizontal movement of air relative to the earth's surface and is

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
				caused by variations in temperature and pressure (for instance, air rises as it warms and a cool breeze moves in to take the place of the rising air.) The wind direction is the direction from which the wind is blowing (for example, a north wind comes from the north and blows toward the south.)
Occurrence > Wx_Conditions > L1		127	Weather conditions	Weather conditions
Precipitation_And_Other_Weather_Phenomena > Phenomenon_Intensity > L1		230	Weather phenomenon intensity	The intensity of the weather phenomenon.
Precipitation_And_Other_Weather_Phenomena > Phenomenon_Type > L1		299	Weather phenomenon type	The type of weather phenomenon. according to World Meteorological Organization (WMO) in consort with the International Civil Aviation Organization (ICAO).
Precipitation_And_Other_Weather_Phenomena > Phenomenon_Type > L2		299	Weather phenomenon type	The type of weather phenomenon. according to World Meteorological Organization (WMO) in consort with the International Civil Aviation Organization (ICAO).
Reporting_History > Conclusions		1070	Conclusions	Details on the conclusions for the organisation
Reporting_History > Description_Investigation		1067	Analysis / follow up	Description of occurrence analysis and follow up.
Reporting_History > Risk_Assessment		1068	Risk assessment	Details on the risk assessment done
Risk_Assessment > Risk_Level		940	Numerical risk level	Normalized numerical risk level. Possible values between 0 and 100.
Risk_Assessment > ERCS_Score > L1		1095	ERCS Score	
Runway_Incursion > Entity_Involved > additionalText	x	741	Entities involved in a runway incursion	The type(s) of entity involved in a runway incursion: aircraft, vehicle or person.
Runway_Incursion > Entity_Involved > L1	x	741	Entities involved in a runway incursion	The type(s) of entity involved in a runway incursion: aircraft, vehicle or person.
Separation > Est_Minimum_Horiz_Sep		575	Minimum horizontal separation estimated	The minimal horizontal distance during an incident involving two aircraft as estimated by the investigation taking into account all available evidence (witnesses, recordings). Note, if the incident involved more than two aircraft, the separation page needs to be repeated for each pair.
Separation > Min_Horiz_Sep_Rec		579	Minimum horizontal separation recorded	The minimal horizontal distance during an incident involving two aircraft as recorded by a recording system such as RADAR recording.
Separation > Req_Minimum_Horiz_Sep		577	Minimum horizontal separation prescribed	The minimum horizontal separation that was prescribed at the time of the loss of separation incident.

Attribute	Selected for D-2.1	ECCAIRS attribute ID	Detailed Description from ECCAIRS Taxonomy	Explanation from ECCAIRS Taxonomy
Headline_translated	x		English translation of "Occurrence > Headline"	
Narrative_translated	x		English translation of "Narrative > Narrative_Text"	

Annex B Analysis of investigation reports

Table 7: Analysis of investigation reports

Occurrence > e2Id	Lack of Communication	Complacency	Lack of Knowledge	Distraction	Lack of Teamwork	Fatigue	Lack of Resources	Pressure	Lack of Assertiveness	Stress	Lack of Awareness	Normalisation	Procedures	Organization
OC-0000000000713592											x			
OC-0000000000346209			x								x		x	
OC-0000000003138001			x				x				x		x	
OC-0000000000437862													x	
OC-0000000000698923			x								x			
OC-0000000002342924			x								x			
OC-0000000001792668													x	
OC-0000000002699770			x								x		x	x
OC-0000000003339894					x								x	
OC-0000000002102722			x										x	
OC-0000000002976387														x
OC-0000000002974574				x										