Final Report

AIRBUS A350-900, REGISTRATION 9V-SMU

TAKE-OFF WITHOUT CLEARANCE,

BARCELONA AIRPORT

24 OCTOBER 2020

TIB/AAI/CAS.193

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

6 September 2021

The Transport Safety Investigation Bureau of Singapore

The Transport Safety Investigation Bureau (TSIB) is the air, marine and rail accidents and incidents investigation authority in Singapore. Its mission is to promote transport safety through the conduct of independent investigations into air, marine and rail accidents and incidents.

The TSIB conducts air safety investigations in accordance with the Singapore Air Navigation (Investigation of Accidents and Incidents) Order 2003 and Annex 13 to the Convention on International Civil Aviation, which governs how member States of the International Civil Aviation Organization (ICAO) conduct aircraft accident investigations internationally.

The sole objective of TSIB's air safety investigations is the prevention of aviation accidents and incidents. The safety investigations do not seek to apportion blame or liability. Accordingly, TSIB reports should not be used to assign blame or determine liability.

Table of Contents

GLOSSARY OF ABBREVIATIONS

ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
CVR	Cockpit Voice Recorder
INTAM	Internal Notice to Airmen
ND	Navigation Display
NM	Nautical Miles
PED	Personal Electronic Device
PF	Pilot Flying
PIC	Pilot-in-Command
PM	Pilot Monitoring
SFO	Senior First Officer
SOP	Standard Operating Procedures
TCAS	Traffic Collision Avoidance System

SYNOPSIS

On 24 October 2020, an Airbus A350-900 aircraft was scheduled to fly from Barcelona, Spain to Milan, Italy. During departure, the aircraft was instructed by the air traffic control (ATC) to line up and wait on Runway 07R. However, the aircraft took off without a take-off clearance after entering the runway. At that time, another aircraft was on approach to land on Runway 02, a runway with an approach path that crosses over Runway 07R. The nearest distance between the two aircraft was about 2.8 nautical miles. The A350-900 proceeded to Milan without further event.

The Transport Safety Investigation Bureau classified this occurrence as an incident.

AIRCRAFT DETAILS

Aircraft type	:	Airbus A350-900
Operator	:	Singapore Airlines
Aircraft registration	:	9V-SMU
Numbers and type of engines	:	2 x Rolls Royce Trent XWB
Date and time of incident	:	24 October 2020, 1052 hrs Local Time
Location of occurrence	:	Barcelona Airport, Spain
Type of flight	:	Scheduled
Persons on board	:	28

1 FACTUAL INFORMATION

All times used in this report are Barcelona Local Time unless otherwise stated. Barcelona Local Time is two hours ahead of Coordinated Universal Time.

1.1 History of the flight

1.1.1 On the morning of 24 October 2020, an Airbus A350-900 aircraft (A350) was preparing for departure from Barcelona Airport, Spain to Milan Malpensa Airport, Italy. The flight crew consisted of a Pilot-in-Command (PIC) and a Senior First Officer (SFO). The PIC was the Pilot Monitoring (PM) and the SFO was the Pilot Flying (PF). There was another set of flight crew that had been rostered to operate the aircraft on the next leg from Milan to Singapore. The SFO of this other set of flight crew sat in the observer seat in the flight deck behind the PM and PF.

1.1.2 The Air Traffic Control (ATC) was using Runway 07R as the departure runway and Runway 02 (a runway with an approach path that crosses over Runway 07R) as the arrival runway (see **Figure 1**). The A350 was assigned Runway 07R for departure. At about 1044hrs, the A350 was pushed back from its parking stand. It then taxied to the holding point[1] of Runway 07R via Taxiway K, a taxiway which is parallel to Runway 07R.

[1] The holding point of the runway is a designated position where a taxiing aircraft is required to hold until clearance has been obtained to enter the runway.

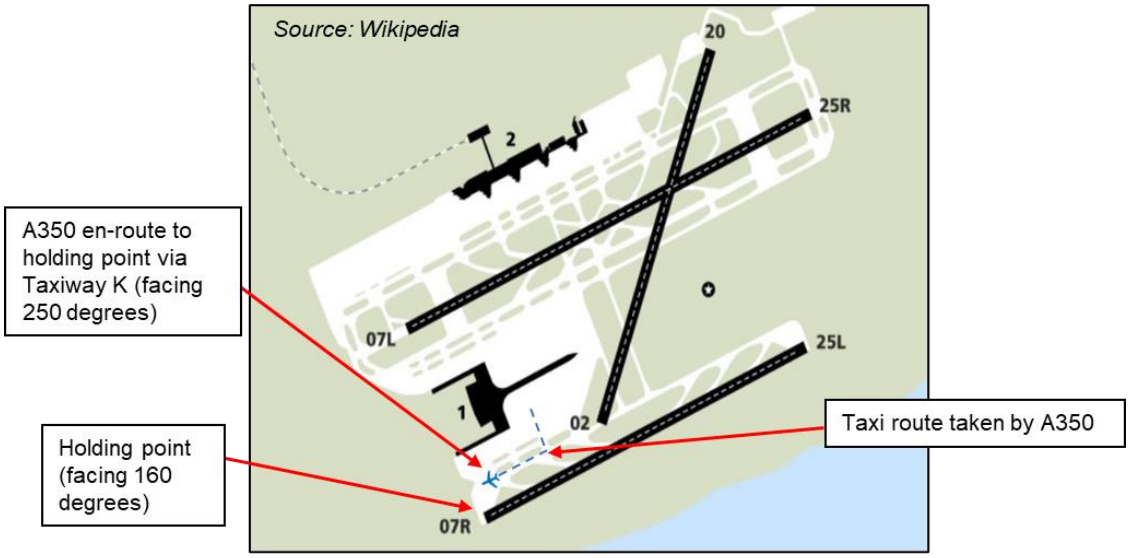

Figure 1: Runway map of Barcelona Airport and the A350's taxi route

1.1.3 The flight crew were communicating with the ground controller on radio frequency 122.230 MHz for taxiing instructions[2]. While the A350 was taxiing to the holding point of Runway 07R, the observer SFO was checking the taxi route on his personal electronic device[3] (PED). During this time, the flight crew carried out the tasks according to the Before Take-off Standard Operating Procedures (SOP)[4]. The tasks included preparing the aircraft for take-off, confirming the take-off runway, checking the approach path of the runway was clear, obtaining line-up clearance[5], and obtaining take-off clearance[6].

1.1.4 The aerodrome traffic at the time was low. The flight crew did not see any other aircraft traffic on the ground during their taxiing to the holding point of Runway 07R. The recording of the aerodrome's ground surface movement radar showed that the A350 was the only aircraft taxiing to Runway 07R at that time.

[2] The ground controller directs a departing aircraft to move from the terminal building to the runway, after which the aircraft is handed over to the tower controller who would issue clearances to the aircraft for take-off and landing.
[3] PED is an approved device that provides pilots with manuals, checklists, maps, charts and other relevant documents.
[4] The Before Take-off SOP comprises a list of tasks that should be performed by the pilots prior to take-off. Its purpose is to improve safety by ensuring that important tasks are not left out.
[5] The line-up clearance is given by the ATC to allow the aircraft to go onto the runway and align itself in preparation for take-off. Unlike take-off clearance, this is not a permission to take-off.
[6] The take-off clearance is given by the ATC to allow an aircraft to take off from the runway. It is given after the ATC has ensured that the take-off can be performed safely without conflict with the surrounding aircraft traffic.

1.1.5 According to the ATC voice recording and the video recording from the ground surface movement radar, as the A350 was taxiing down Taxiway K to the holding point of Runway 07R, the ground controller instructed the A350's flight crew to contact the tower controller (on radio frequency 118.105 MHz) when they were ready for departure. The flight crew acknowledged and continued clearing the tasks according to the Before Take-off SOP. They switched to the tower frequency just before reaching the holding point of Runway 07R.

1.1.6 As soon as the flight crew switched to the tower frequency, they were asked by the tower controller if they were ready for departure. The flight crew confirmed that they were, and the tower controller instructed them to "line up and wait". The flight crew read back[7] "line up and wait". The flight crew then continued completing the remainder of the tasks on their Before Take-off SOP as they taxied the A350 from the holding point onto Runway 07R to line up.

1.1.7 According to the PF, at the holding point of Runway 07R (the aircraft was then facing the direction of 160 degrees) and prior to entering Runway 07R, he scanned the Navigation Display (ND) (more on the ND in paragraph 1.8.1) and did not see any aircraft on the approach path to Runway 07R or in the vicinity[8]. He then visually scanned the approach path of Runway 07R and the area ahead of his aircraft and did not see any aircraft either. The PM checked that the PF was taxiing correctly for the line-up while the flight crew continued completing their checklist. The PF visually checked that the take-off runway in front of them was clear of traffic.

1.1.8 After the tower controller had issued the "line up and wait" clearance to the A350, he went on to provide instructions to a business jet that had just landed on Runway 02[9]. His plan was to land the next aircraft (an Airbus A320) that was approaching Runway 02 before issuing the take-off clearance to the A350 which he had instructed to wait on Runway 07R.

1.1.9 While the tower controller was still speaking to the business jet that had just landed on Runway 02, he saw the A350 begin a take-off roll on Runway 07R. The tower controller assessed that there was sufficient separation between the

[7]Readback confirmation to the ATC is a standard procedure to prevent any wrong interpretation of an ATC instruction by providing the recipient an opportunity to reconfirm the instruction received. Crucial instructions like line-up clearance, take-off clearance and landing clearance would require a read back to the ATC.
[8]The Before Take-off SOP required the flight crew to check the approach path of the runway is clear using visual means and the ND.
[9]The orientations of Taxiway K and Runway 02 are such that, as the A350 was taxiing along Taxiway K to the holding point of Runway 07R, the A350's flight crew could not see the business jet that had just landed on Runway 02.

A350 and the approaching A320, and that the A350 would be clear of the approach path of Runway 02. Hence, he decided that it was safe to allow the A350 to continue taking off rather than to instruct the A350 to abort the take-off roll.

1.1.10 The tower controller subsequently contacted the A350's flight crew, after the aircraft was airborne, to inform them that they had not been given take-off clearance and that they were "number two in the sequence" (i.e. the second aircraft in the queue and was to only take off after the approaching A320 had landed). In this incident, the closest separation distance between the A350 and the approaching A320 was about 2.8 nautical miles (NM).

1.1.11 The A350 continued to Milan Malpensa Airport and landed without further incident.

1.2 Injuries to persons

1.2.1 There were no injuries to any person.

1.3 Damage to aircraft

1.3.1 There was no damage to the aircraft.

1.4 Personnel information

1.4.1 Pilot-in-Command (the PM)

Age	49
Gender	Male
Licence	Air Transport Pilot License
Medical certificate date	27 July 2020
Total flying hours	9,807 hrs
Total flying hours on A350	313 hrs
Flying in last 90 days	97 hrs
Flying in last 28 days	32 hrs

Flying in last 24 hours	Nil
Rest period before flight	More than 24 hrs

1.4.2 Senior First Officer (the PF)

Age	41
Gender	Male
Licence	Air Transport Pilot License
Medical certificate date	17 July 2020
Total flying hours	5,066 hrs
Total flying hours on A350	251 hrs
Flying in last 90 days	140 hrs
Flying in last 28 days	35 hrs
Flying in last 24 hours	Nil
Rest period before flight	More than 24 hrs

1.4.3 Senior First Officer (the Observer)

Age	48
Gender	Male
Licence	Air Transport Pilot License
Medical certificate date	27 July 2020
Total flying hours	11,699 hrs
Total flying hours on A350	1,750 hrs
Flying in last 90 days	94 hrs
Flying in last 28 days	22 hrs
Flying in last 24 hours	Nil
Rest period before flight	More than 24 hrs

1.5 Meteorological information

1.5.1 The flight took place in the daytime. At the time of departure, there were no significant meteorological reports on the weather, cloud or visibility at the aerodrome.

1.6 Aerodrome information

1.6.1 The ATC was using Runway 07R as the departure runway and Runway 02 as the arrival runway. This information was included in the Automatic Terminal Information Service (ATIS)[10] broadcast.

1.6.2 The ATC used the same radio communication frequency for both Runways 07R and 02 on the day of the incident.

1.7 Flight recorders

1.7.1 The A350 had a Cockpit Voice Recorder (CVR) that recorded all voice communications in the flight deck, including voice communications and warnings within the flight deck environment. The maximum duration of this recording was two hours.

After the incident when the aircraft had arrived at Milan Malpensa Airport, the CVR was removed and sent for download of the recorded data. The voice recording pertaining to the taxi and take-off phase of the flight had been over-written.

1.8 Additional information

1.8.1 Navigation Display (ND)

1.8.1.1 The A350 aircraft type has onboard a Traffic Collision Avoidance System (TCAS)[11] that presents traffic information to the flight crew on their ND[12] with

[10]The ATIS is a continuous broadcast of essential airport information such as weather, wind information, runways in use and their direction of use, and other important information for pilots. Pilots usually listen to the ATIS broadcast to get essential information before their flight.
[11]In flight, the TCAS monitors the airspace around an aircraft by detecting other aircraft equipped with an active transponder and warns the pilots of the presence of other aircraft in the vicinity. On the ground, TCAS can provide some information of other aircraft in the vicinity but the warnings are inhibited.
[12]A display screen with different modes providing information such as navigation, weather, TCAS etc.

visual indications of any nearby aircraft.

1.8.1.2 The ND has a display field of view from 90 degrees left of the aircraft to 90 degrees right of the aircraft (i.e. the field of view in front of the aircraft). The visual indications displayed on the ND show the traffic within the 180 degrees field of view ahead of the aircraft and the relative position of the traffic changes[13] as the aircraft moved.

1.8.1.3 The PF's ND was set at a display range of 10NM (i.e. able to display visual indications up to 10NM away).

1.8.2 Take-off clearance

1.8.2.1 According to the flight crew, they received the take-off clearance and wind information just after the line-up clearance was given. However, ATC recording showed that no take-off clearance or wind information was issued to the A350, and there was no readback of such a take-off clearance by the A350 flight crew.

1.8.3 Chronology of communications between the A350 flight crew and the ATC

1.8.3.1 The following table shows the communications made between the A350 and the ground controller and the tower controller. When the A350 flight crew were listening on the ground frequency, they could not hear the communication on the tower frequency, and vice versa.

Local Time	**Ground controller**	**Tower controller**
1040 hrs	The A350 flight crew began talking to the ground controller and obtained the pushback clearance.	
	(A350 was being pushed back.)	
1047 hrs	Ground controller provided taxi route details to the A350.	
	(A350 started taxiing towards runway.)	

[13]Since the ND has a limited field of display, the display of other aircraft traffic depends on where the aircraft is facing when the ND is checked.

1049 hrs	Ground controller informed the A350 to switch over to tower controller frequency when ready for departure.	
1051 hrs, 14 sec	(At this time, the A350 was still taxiing to the holding point of Runway 07R and was still on the ground controller frequency. The flight crew would not have heard the tower controller's communication with the A320.)	Tower controller was talking to the approaching A320, providing runway details, wind information and instruction to continue its approach.
1051 hrs, 36 sec		(Before the A350 approached the holding point of Runway 07R, the flight crew switched over to the tower frequency.)
		Tower controller contacted the A350 to ask if they were ready and subsequently provided the line-up clearance.
1051 hrs, 45 sec		(The business jet landed on Runway 02 around this time.)
1052 hrs, 6 sec		(The A350 proceeded past the holding point, taxiing towards Runway 07R.)
1052 hrs, 38 sec		Tower controller provided taxi instruction to the business jet that had just landed, asking that aircraft to switch to the ground frequency.
		(The A350 completed turning onto Runway 07R and started to take off.)
1053 hrs, 27 sec		(At this point, the A350 was still rolling for take-off but had past the approach path of Runway 02.)
		Tower controller gave the landing clearance and wind information to the approaching A320.
1053 hrs, 47 sec		Tower controller informed the A350 flight crew that they had not been cleared for take-off.

2 ANALYSIS

The investigation looked into the following issues:

(a) Situational awareness of flight crew

(b) Readback by flight crew

(c) Operations involving intersecting runways

(d) ATC's provision of additional information

2.1 Situational awareness of flight crew

2.1.1 The A350 flight crew had believed that their flight was the only aircraft traffic in the vicinity because:

1) The aerodrome traffic was low at the time and they did not see any aircraft taxiing or landing while they were taxiing to Runway 07R.

2) They did not hear any radio communication made between the ATC and other aircraft.

2.1.2 If the flight crew had seen the business jet landing or had heard the tower controller communicating to another aircraft over the radio, the flight crew might have been alerted to the presence of other aircraft landing on Runway 02 and might have paid more attention to other approaching traffic to Runway 02.

2.1.3 Due to the low aerodrome traffic, the flight crew were likely having low workload in traffic monitoring. However, it has been known that an individual's performance and situational awareness may not be optimum in a low workload situation. In this case, the low workload could have resulted in some form of reduced alertness by the flight crew.

2.2 Readback by the flight crew

2.2.1 The A350 took off without ATC take-off clearance. The flight crew recalled having received the take-off clearance. However, ATC recording showed that no take-off clearance was issued to the A350. Other than the flight crew's "line up and wait" readback, there was no other readback by the flight crew. Based on the evidence collected, the investigation team would have to discount their

recollection.

2.2.2 The PM and PF were not able to explain how they might have heard a take-off clearance.

2.3 Operations involving intersecting runways

2.3.1 Before entering Runway 07R, the flight crew were concerned primarily about checking for traffic on the approach path of Runway 07R. The flight crew mentioned that they had confirmed visually and on the ND that there was no traffic approaching Runway 07R.

2.3.2 For most aerodromes, including those with more than one runway in operation, the flight crew mainly rely on ATC guidance to safely navigate their aircraft around and to ensure safe separation with other aircraft. In addition to ATC's instructions, the ND could act as an information tool to provide the flight crew with additional awareness on surrounding aircraft traffic.

2.3.3 The flight crew also mentioned that they were aware that Runway 02 was the arrival runway in use. After checking the ND for approaching traffic to Runway 07R, the PF mentioned scanning the ND briefly and looking out ahead to get an awareness of the surrounding aircraft traffic, but he did not notice any traffic. At the time when the A350 was about to enter Runway 07R, the approaching A320 should have been within range to be shown on the ND. The investigation team is not able to determine if the approaching A320 was visible in the horizon or if the ND had displayed the approaching A320 or whether the PF has seen the A320 displayed on the ND.

2.4 ATC's provision of additional information

2.4.1 After the A350 had taken off, the tower controller informed the flight crew that they were the second aircraft in the queue. This piece of information about being in a queue if provided to the flight crew together with the clearance to line up, would have been useful in alerting the flight crew that their aircraft was in a queue and that they had to wait for further ATC instructions before taking off.

3 CONCLUSIONS

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 The flight crew had believed that they were the only aircraft traffic in the vicinity. The low workload in traffic monitoring due to the low aerodrome traffic could have resulted in some form of reduced alertness by the flight crew.

3.2 The flight crew claimed that they heard a take-off clearance when there had not been one. There was no readback of take-off clearance by the flight crew.

3.3 The flight crew had checked the approach path of Runway 07R and found it to be clear. The PF mentioned checking the surrounding vicinity for approaching aircraft traffic but did not detect the A320 that was approaching Runway 02.

3.4 Although the tower controller had managed the take-off situation appropriately, it would be desirable if the flight crew could have been made aware of other aircraft traffic in the vicinity. The tower controller could have assisted by providing additional information (when issuing the line-up clearance) to the flight crew of the departure aircraft (such as stating the order of the aircraft in the queue with respect to other aircraft traffic), so as to enhance the awareness of the flight crew to the presence of other aircraft.

4 SAFETY ACTIONS

Arising from discussions with the investigation team, the aircraft operator has taken the following safety action.

4.1 The aircraft operator has taken the following actions:

(a) briefed the incident flight crew to emphasise the importance of reading back take-off clearance and clarifying any doubts before taking off.

(b) arranged for the incident flight crew to undergo a refresher crew resource management training on 2 November 2020.

(c) issued an INTAM (Internal Notice to Airmen) for all flights operating to or from Barcelona Airport immediately after the incident to require the flight crew to adhere to proper radio communication and readback procedures. The INTAM also reminds the flight crew that ATC instructions should be verified and cross-checked amongst them, and that any doubt should be clarified with the ATC. The information in the INTAM was also incorporated into the Barcelona Airport Briefing given to the flight crew.

(d) shared the incident with its pilots via a Preliminary Factual Bulletin to raise an awareness of this incident. The bulletin also provided an overview of some common human factor elements that any flight crew should be aware of.

(e) enhanced its existing Additional Crew Support Tool with a pictorial quick reference version. This Tool provides guidance on how additional crew members in the flight deck (e.g. an observer crew member) can support the flight crew during certain phases of the flight. The Tool is available on the PEDs that the air operator issued to the flight crew.

(f) issued a reminder to its pilots reiterating the importance of securing the flight recorders in a timely manner after an incident.

5 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

It is recommended that:

5.1 The ATC service provider consider offering additional information, when available, to departure and arrival aircraft so as to enhance the awareness of the flight crew to the presence of other aircraft (e.g. the order of an aircraft in the queue with respect to other aircraft traffic). [TSIB Recommendation RA-2021-011]