FINAL REPORT

on

THE ACCIDENT INVESTIGATION

OF US BANGLA AIRLINES, BOMBARDIER (UBG-211), DHC-8-402, S2-AGU, AT TRIBHUVAN INTERNATIONAL AIRPORT, KATHMANDU, NEPAL

ON 12 MARCH 2018

SUBMITTED BY:

ACCIDENT INVESTIGATION COMMISSION (DHC-8-402; S2-AGU) 2018

TO:

THE GOVERNMENT OF NEPAL
MINISTRY OF CULTURE, TOURISM AND CIVIL AVIATION

FOREWORD

On 12th March 2018, US Bangla Airlines' scheduled flight DHC-8-402, S2-AGU, BS-211 from Dhaka to Kathmandu crashed at Tribhuvan International Airport, Kathmandu while the aircraft was on landing phase.

After the accident, the Government of Nepal constituted an Aircraft Accident Investigation Commission on 12th March 2018, as per the provision of the Civil Aviation (Accident Investigation) Regulation, 2014 (2071 BS), to determine the cause and the circumstances of the accident. The Commission conducted the investigation based on the principles of ICAO Annex 13. This Final Report on the accident has been prepared by the Aircraft Accident Investigation Commission in accordance with Annex 13 to the Convention on International Civil Aviation and Civil Aviation (Accident Investigation) Regulation, 2014 (2071 BS) to identify the probable cause of the accident and suggest remedial measures so as to prevent the recurrence of such accidents in future.

The commission was also assisted by Accredited Representative Capt Salahuddin M Rahmatullah from Bangladesh, as a state of operator and Registration and Nora Valle from Canada, as a state of Design and Manufacturer.

The Commission would like to extend thanks with sincere appreciation to the Captain Riwaj Pradhan for his valuable advice and suggestion to the commission:

The Commission carried out thorough investigation and extensive analysis of the available information and evidences, statements and interviews with concerned persons, study of reports, records and documents etc.

The sole objective of this investigation is the prevention of recurrence of accidents of similar nature in future. It is not the purpose of this investigation to apportion blame or liability. As per the Civil Aviation (Accident Investigation) Regulation, 2014 (2071 BS), clause 20, this report doesn't carry any legal liability.

Chairman Yajna Prasad Gautam Former Secretary, Government of Nepal	Member Dr. Rajeeb Kumar Deo, Lt. Col. Nepal Army
Member Sunil Prasad Pradhan Senior Captain, Presently at Shree Airlines	Member Er. Uddhab Prasad Subedi Senior Engineer, Yeti Airlines
Member K.K. Sharma, Former Pilot Nepal Airlines	Member Secretary Buddhi Sagar Lamichhane, Joint Secretary Ministry of Culture, Tourism and Civil Aviation

Date: 2019/01/27 (2075/10/13B.S.)

SYNOPSIS

Operator:	US-Bangla Airlines
Aircraft Type and Model:	DHC-8-402 (Q400)
Registration:	S2-AGU
Type of Flight:	International Public Transport of passengers, UBG-211
Accident Location:	Tribhuvan International Airport, Kathmandu, Nepal
Persons on board:	Flight Crew- 2, Cabin Crew-2, Passengers-67
Date and Time of Accident:	12th March 2018 at 0834:10 (1419:10 LT)
All times in this report are in UTC	

On 12thMarch 2018, about 0834 UTC, an aircraft- Bombardier DHC-8-402, Registration S2-AGU, belonging to US Bangla Airlines limited while operating a scheduled passenger flight call sign BS-211, was on an VOR approach at Tribhuvan International Airport (TIA), Kathmandu, Nepal crashed about 442 meters southeast of the touchdown point of runway 20, just outside the inner perimeter fence of the aerodrome. All 4 crew members (2 cockpit crew and 2 cabin crew) 45 out of the 67 passengers aboard the aircraft were killed during accident. 2 more passengers succumbed to injury later in hospital during the course of treatment. The aircraft was destroyed by impact forces and a post-crash fire.

The accident was notified to the concerned International Authorities as per Chapter 4, Section 4.1 of ICAO Annex 13. The Government of Nepal constituted an Aircraft Accident Investigation Commission on 12th March, 2018 to determine the cause and the circumstances of the accident as per the provision of the Civil Aviation (Accident Investigation) Regulation 2014 of Nepal.

The commission followed the standard procedure of investigation approved by ICAO. The CVR/FDR/EGPWS/EMU etc. were sent to Transport Safety Board (TSB), Canada for the downloading/decoding and analysis process. TSB Canada performed the entire technical job witnessed by a commission member, and the Accredited Representatives (ACCREPs) from Bangladesh and Canada.

The Commission has made its best possible effort to find the possible cause of the accident by using all the required and possible investigation technique that are being used in present worlds Aircraft accident investigation field.

The Accident Investigation Commission determines that the probable cause of the accident is due to disorientation and a complete loss of situational awareness in the part of crewmember.

Contributing to this the aircraft was offset to the proper approach path that led to maneuvers in a very dangerous and unsafe attitude to align with the runway. Landing was completed in a sheer desperation after sighting the runway, at very close proximity and very low altitude. There was no attempt made to carry out a go around, when a go around seemed possible until the last instant before touchdown on the runway. The commission had received appropriate support from all concerned during the investigation process and believes that the proper implementation of the recommendation will enhance the safety of global civil aviation preventing the repetition of such occurrence.

FOREWORD
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List of Abbreviations

A/C	Aircraft
ACC	Area Control Centre
ACCREP	Accredited Representative
ADC	Air Defense Clearance
AP	Auto Pilot
APP	Approach
APU	Auxiliary Power Unit
ATC	Air Traffic Controller
ATIS	Automatic Terminal Information Service
ATPL	Airlines Transport Pilot licenses
CAAN	Civil Aviation Authority of Nepal
CAAB	Civil Aviation Authority of Bangladesh
CEO	Chief Executive Officer
CCTV	Closed Circuit Television
CDFA	Continuous Descent Final Approach
CVR	Cockpit Voice Recorder
CRM	Crew Resource Management
DFO	Director Flight Operation
DME	Distance Measuring Equipment
EGPWS	Enhanced Ground Proximity Warning System
EMU	Engine Monitoring Unit
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FO	First Officer
FDR	Flight Data Recorder
FGCP	Flight Guidance Control Panel
FMS	Flight Management System
FL	Flight Level
GPS	Global Positioning System
Hrs	Hours
HSI	Horizontal Situational Indicator
IAF	Initial Approach Fix
ILS	Instrument Landing System

IFR	Instrument Fight Rule
KTM	Kathmandu
MEL	Minimum Equipment List
MHz	Mega Hertz
NDB	Non- Directional Beacon
NOTAM	Notice to Airmen
PAPI	Precision Approach Path Indicator
PCN	Pavement Classification Number
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
QAR	Quick Accesses Recorder
RWY	Runway
RADAR	Radio Detection and Ranging
SMC	Surface Movement Control
TCAS	Traffic Alert and Collision Avoidance System
TRE	Type Rated Examiner
TSB	Transport Safety Board
TWR	Tower
TWY	Taxiway
THR	Threshold
TIA	Tribhuvan International Airport
UTC	Universal Coordinated Time
VFR	Visual Flight Rule
VHF	Very High Frequency
VOR	VHF Omni directional Radio Range

1. Factual Information

1.1 History of the flight

On March 12, 2018, a US Bangla Airlines, Bombardier DHC-8-402, S2-AGU, flight number BS-211 departed Hazrat Shahjalal International Airport, Dhaka, Bangladesh at 06:51 UTC on a schedule flight to Tribhuvan International Airport (TIA), Kathmandu, Nepal. The aircraft overflew part of Bangladesh and Indian airspace en-route to Nepal.

At 0641, Dhaka Ground Control contacted the aircraft requesting for its Bangladesh ADC number which was recently made mandatory a few weeks ago by Bangladesh authority for all international outbound flights. The crew provided the ADC number as 2177 as provided in the Flight Plan. The Ground Controller again asked the crew if they had the ADC for Bangladesh. At 0642, PIC then contacted the Operations to confirm the Bangladesh ADC number. As per the CVR records, changes in the PIC's vocal pitch and language used indicated that he was agitated and experiencing high levels of stress at the time while communicating with Dhaka Ground Control and airlines operations. The aircraft finally took off at 0651.

As the aircraft was in a climb phase, the PIC overheard a communication between Operations and another US Bangla aircraft regarding the fuel onboard but the PIC without verifying whether the message was meant for him or not, engaged in some unnecessary conversation with the Operations staff. The Captain's vocal pitch and language used indicated that he was very much emotionally disturbed and experiencing high level of stress.

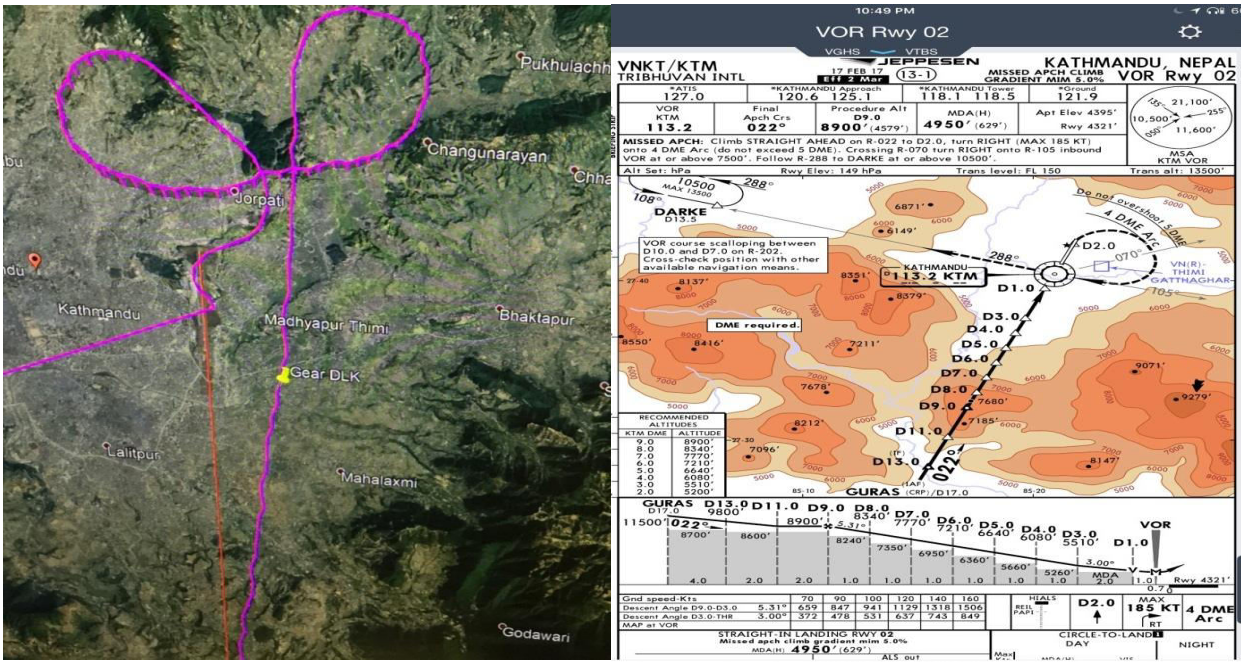
The aircraft established its first contact with Kathmandu Control at 0752:04. At 0807:49 the First Officer contacted Kathmandu Control and requested for descent. Kathmandu Control gave descend clearance to FL160 with an estimated approach time of 0826 which was acknowledged by the First Officer. At 0810 the flight was handed over to Kathmandu Approach. At 0811, Kathmandu Approach instructed the aircraft to descend to 13500ft and hold over GURAS. The crew inserted the HOLD in the Flight Management System.

At 0813:41 Kathmandu Approach further instructed the aircraft to reduce its speed and descend to 12500 ft. At 0816 Kathmandu Approach instructed the aircraft to further descend to 11500 ft., and cleared for VOR approach RWY 02 maintaining minimum approach speed. Both the crew forgot to cancel the hold on the FMS as they were engaged in some unnecessary conversation. Upon reaching GURAS, the aircraft turned left to enter the holding pattern over GURAS, it was noticed by PIC and FO and immediately PIC made correction and simultaneously this was alerted to the crew by Approach Control also. Once realizing the aircraft flying pattern and ATC clearance, the PIC immediately selected a heading of 027° which was just 5° of interception

angle to intercept the desired radial of 202° inbound to KTM. The spot wind recorded was westerly at 28kt. The aircraft continued approach on heading mode and crossed radial 202° at 7 DME of KTM VOR. The aircraft then continued on the same heading of 027° and deviated to the right of the final approach course.

Having deviated to the right of the final approach path, the aircraft reached about 2-3 NM North east of the KTM VOR and continued to fly further northeast. At 0827, Kathmandu Tower (TWR) alerted the crew that the landing clearance was given for RWY 02 but the aircraft was proceeding towards RWY 20. At 0829, Tower Controller asked the crew of their intention to which the PIC replied that they would be landing on RWY 02. The aircraft then made an orbit to the right. The Controller instructed the aircraft to join downwind for RWY 02 and report when sighting another Buddha Air aircraft which was already on final for RWY 02. The aircraft instead of joining downwind leg for RWY 02, continued on the orbit to the right on a westerly heading towards Northwest of RW 20. The controller instructed the aircraft to remain clear of RWY 20 and continue to hold at present position as Buddha air aircraft was landing at RW 02 (from opposite side) at that time. After the landing of Buddha Air aircraft, Tower Controller, at 08:32 UTC gave choice to BS211 to land either at RW 20 or 02 but the aircraft again made an orbit to the right, this time northwest of RWY 20.

While continuing with the turn through Southeastern direction, the PIC reported that he had the runway in sight and requested tower for clearance to land. The Tower Controller cleared the aircraft to land but when the aircraft was still turning for the RWY it approached very close to the threshold for RWY 20 on a westerly heading and not aligned with the runway. At 08:33:27 UTC, spotting the aircraft maneuvering at very close proximity of the ground and not aligned with the RWY. Alarmed by the situation, the Tower Controller hurriedly cancelled the landing clearance of the aircraft by saying, "Takeoff clearance cancelled".



Within the next 15-20 seconds, the aircraft pulled up in westerly direction and with very high bank angle turned left and flew over the western area of the domestic apron, continued on a southeasterly heading through the ATC Tower and further continued at a very low height, flew over the domestic southern apron area and finally attempted to align with the RWY 20 to land. During this process, while the aircraft was turning inwards and momentarily headed towards the control tower, the tower controllers ducked down their heads out of fear that the aircraft may hit the tower building. Missing the control tower, when the aircraft further turned towards the taxi track aiming for the runway through a right reversal turn, the tower controller made a halfhearted transmission by saying, "BS 211, I say again...".

At around 0834 UTC the aircraft touched down at coordinates N27^{0}41'48", E085^{0}21'34", 1700 meters down the threshold with a bank angle of about 15 degrees and an angle of about 25 degrees with the RW axis (approximately heading Southeast) and on the left of the center line of RWY 20, then veered southeast out of the runway through the inner perimeter fence along the rough down slope and finally stopped at coordinates N27^{0}41'41", E085^{0}21'32" about 442 meters southeast from the first touchdown point on the runway. All four crew members (2 cockpit crew and 2 cabin crew) and 45 out of the 67 passengers onboard the aircraft were killed in the accident. Two more passengers succumbed to injury later in hospital during course of treatment. The aircraft caught fire after 6 seconds of touchdown which engulfed major portions of the aircraft.

(Aircraft Movement as depicted by the Animation based on DFDR Data)

1.2 Injuries to persons

Injuries	Crew	Passengers	Other	Total
Fatal	4	47	-	51
Serious	-	20	-	20
Minor	-	-	-	-

1.2.1 Nationalities of the deceased:

Country	Total Fatality
Bangladeshi	28
Nepalese	22
Chinese	1

1.3 Damage to the aircraft

The aircraft was completely destroyed by impact forces and a post-crash fire.

1.4 Other damages

The portion of the aerodrome's inner perimeter fence was damaged.

1.5 Personnel Information

1.5.1Pilot-in-Command

Age:	52 years
Type of License:	ATPL
Aircraft Rating:	DASH-8; ATR-72
Recent Pilot Proficiency Check:	19th Feb 2018
Instrument Rating:	Valid till 11 July 2022
Operator's Line Check:	17th March 2017
Medical Certificate:	Valid to 27 June 2018
Flying Experience:	Total: 5518:20 hrs
	On Type: 2824:27 hrs
	Last 365 days: 667:50 hrs
	Last 90 days: 191:16 hrs
	Last 28 days: 24:13 hrs
	Last 7 days: 15:58 hrs
	Last 24 hrs: 6.10 hrs
Previous rest period:	15 Hours

1.5.2 Co-pilot

Age:	25 years
Type of License:	Commercial Pilot's License
Aircraft Rating:	C-152, DASH-8
Recent Pilot Proficiency Check:	17th Jan 2017
Instrument Rating:	Valid till 16 January 2019
Operator's Line Check:	18th Sep 2017
Medical Certificate:	Valid to 05 March 2019
Flying Experience:	Total: 390:18 hours
	On Type: 240:18 hours
	Last 90 days: 131:17 hours
	Last 28 days: 15:10 hours
	Last 7 days: 12.22 hours
	Last 24 hours: 4:10 hours
Previous rest period:	Within the limitation

1.6 Aircraft information

1.6.1 General Information

Manufacturer:	Bombardier Inc.
Model:	DHC-8-402
Date of manufacture:	April 2001
Manufacturer's Serial Number:	4041
First Flight:	April 2, 2001
Aircraft Registration Number:	S2-AGU
Owner of the Aircraft:	US-Bangla
Operator of Aircraft:	US-Bangla
Total Airframe Time since New:	21419:14 (as of March 9, 2018)
Total Cycle since New:	28649 (as of March 9, 2018)
Seating Configuration:	76

1.6.2 Power-plant Information

Number of Engines:	2
Type of Engine:	PW 150A
Make:	Pratt and Whitney, Canada

LH Engine:

Manufacturer's Serial No.:	FA0085 (Turbo Machinery)
Time since New:	22431:47 (As of March 9, 2018)
Time since Overhaul:	6778:47 (As of March 9, 2018)

RH Engine:

Manufacturer's Serial No.:	FA0195 (Turbo Machinery)
Time since New:	21993:04 (As of March 9, 2018)
Time since Overhaul:	9654:04 (As of March 9, 2018)

1.6.3 Certification of Aircraft

Certificate of Registration:	US-Bangla Airlines, S2-AGU
Certificate of Airworthiness:	Valid till June 24, 2018
Radio Mobile License:	Valid till December 2018
Certificate of Release to Service:	June 29, 2018 or 21630:57 hrs

As per the available evidences and documents, the aircraft was operated by US Bangla airlines since its induction into Bangladesh on June 26, 2014. Maintenance of the aircraft was carried out

in accordance with Maintenance Control Manual; (Initial Issue, Revision 6) approved by Civil Aviation Authority of Bangladesh on January 23, 2018.

The last maintenance carried out on the aircraft was A-check which was carried out on 9 March 2018. Daily inspection was performed on March 11, 2018 (time not specified in the work order) and Pre-flight inspection of the day was carried out on March 12, 2018 at 06:30 Hours (Bangladesh local time).

1.6.4 Fuel

JET A-1 fuel was used on the aircraft. As per the load sheet 4700KG fuel was onboard the aircraft before departure and remaining fuel on touchdown was approximately 2800 kg.

1.6.5 Aircraft load

As per the load sheet analysis, the following data regarding the aircraft load was revealed:

a. The maximum certificated take-off mass : 29257Kg
b. The maximum certificated landing mass: 28123Kg
c. The actual take-off mass: 28713Kg
d. Mass at the time of the occurrence: 26914Kg
e. The centre of gravity at take-off: 24.5% MAC
f. The centre of gravity at the time of the occurrence: 23.9% MAC.

1.6.6 Reviewed Documents

The following documents regarding the Operational procedures were reviewed:

a. CAAB Approved SOP
b. Company Operations Manual
c. Manufacturers operating Manual
d. Checklist
e. Operational flight plan
f. Load and Trim sheet
g. Approved ATC Flight Plan
h. NOTAM
i. METAR and TAF for origin, destination and Alternate airport
j. Approach Charts

No limitation regarding the performance of the aircraft was observed.

1.6.7 Equipment on board

The aircraft was equipped with Transponder, Traffic Alert and Collision Avoidance System (TCAS), Enhanced Ground Proximity Warning System (EGPWS) etc. All these equipment on board were serviceable.

1.7 Meteorological information

1.7.1 METAR

Time (UTC)	Wind(*^{0}/Kts*)	Visibility (Km)	Weather	Clouds	Temp. (^{0}C) *(Air temp/dew point temp)*	QNH (mb)	Trend
0650	310/08	06		Few 1500ft. Scattered 3000ft.	21.3/10.3	1017.5	
0720	310/06	06		Few 1500ft. Scattered 3000ft.	21.9/10.2	1016.9	
0750	250/07	06	Thunderstorm with no prevailing precipitation	Few 1500ft. Few Towering cumulus (TCU) 2500ft. Scattered 3000ft.	22.1/10.4	1016.4	
0820	280/08	06		Few 1500ft. Few cumulonimbus (CB) 2500ft to direction SE,S,SW. Scattered 3000ft SE,S,SW.	21.5/10.5	1015.7	
0850	260/07	07		Few 1500ft. Few cumulonimbus (CB) 2500ft to direction SE,S. Scattered 3000ft. Broken 10000ft.	20.6/10.2	1015.2	

1.7.2 Weather parameters at the time of Accident

The following weather conditions were observed at Tribhuvan International Airport, Kathmandu at the time of accident.

a. Wind: Westerly 07 to 08 kts.

b. Visibility: 06 to 07 km.

c. Cloud:

Scattered (3-4 Oktas) low clouds and few (1-2 Oktas) cumulonimbus cloud

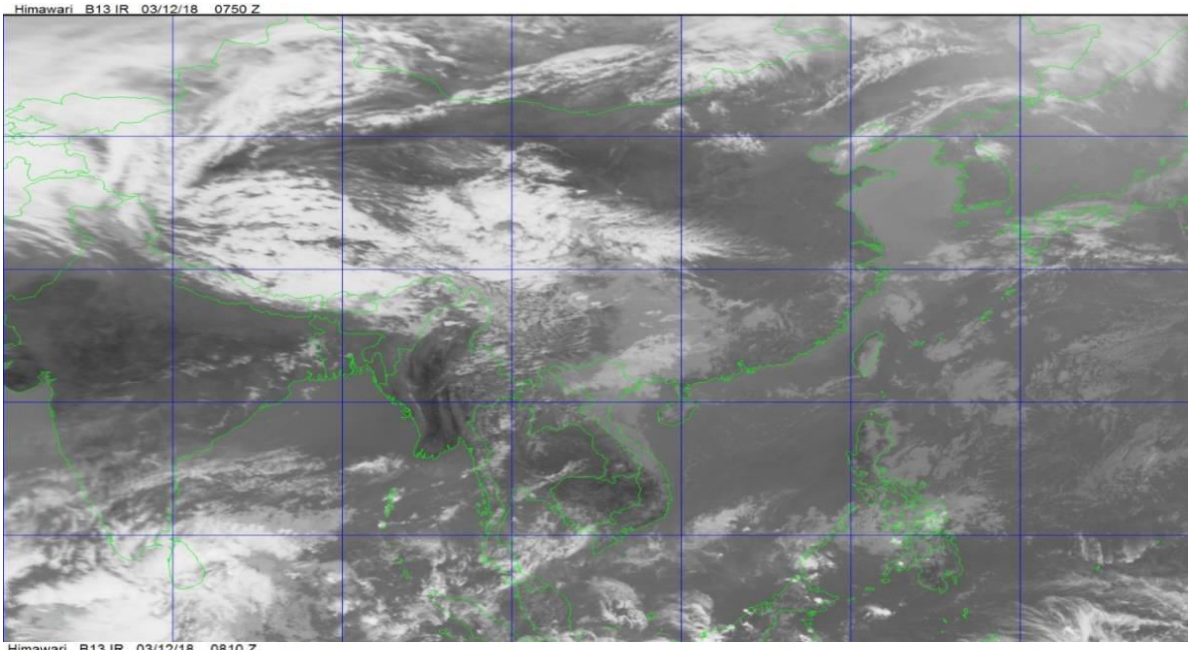
Cumulonimbus was observed towards Southeast, South and Southwest direction of Kathmandu valley.

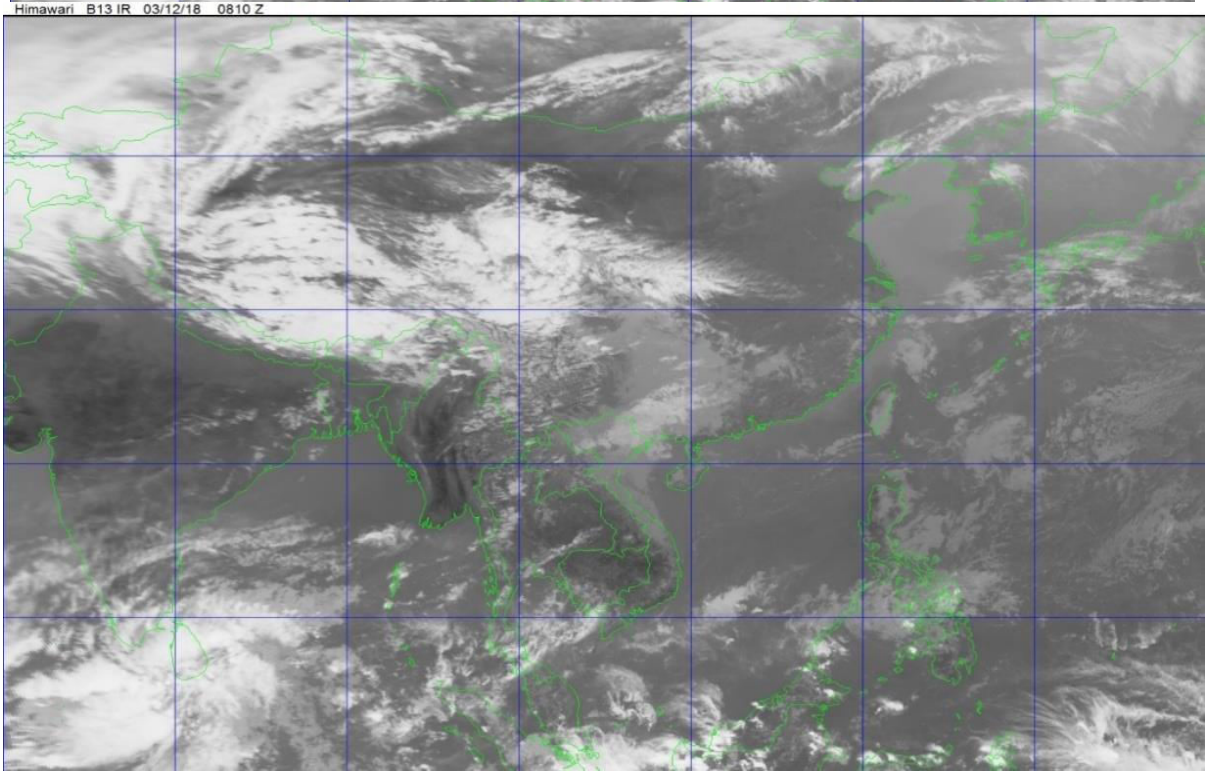
d. Temperature: 21^0C.

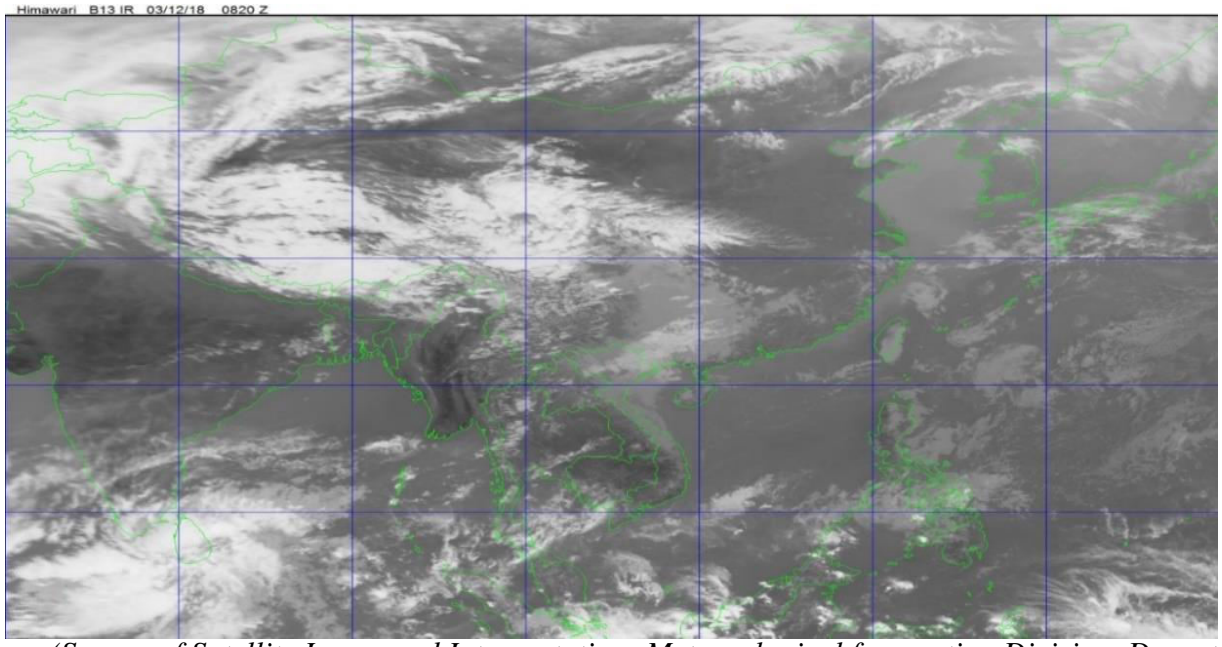
e. Meteorological Conclusion:

The sky was generally cloudy with cumulonimbus cloud seen towards southeast, south and southwest direction of the valley.

1.7.3 Satellite Images of Weather







(Source of Satellite Image and Interpretation: Meteorological forecasting Division, Department of Hydrology and Meteorology, Government of Nepal)

1.8 Aids to Navigation

Kathmandu International Airport is equipped with navigation aids like VOR/DME, NDB and surveillance aid like RADAR. As per the flight calibration report conducted in November, 2016 by Flight Inspection Services Bureau of Aero Thai, Kathmandu NDB, VOR/DME and RADAR are certified for operation.

PAPI is installed at Kathmandu as landing aids for both runways 02 and 20. As per the flight calibration report of May 7, 2014, Kathmandu PAPI is certified for operation. PAPI was operational on that day.

Bombardier DHC-8-402 turboprop aircraft was equipped with navigational aids like VHF NAV., GPS, Air Data Computer, Auto-Flight System and Flight Management System (FMS). The aircraft was also equipped with TCAS II and EGPWS. As per the available documents and FDR data analysis the above mentioned equipment were operational.

1.9 Communication facilities

Service Designation	Call Sign	Frequency	Hours of Operation	Remarks
TWR	Kathmandu Tower	118.1 MHZ	0015-1845	
SMC	Kathmandu Ground	121.9 MHZ	0015-1845	
APP	Kathmandu Approach	120.6MHZ 125.1 MHZ	0015-1845	
ACC	Kathmandu Control	126.5 MHZ 124.7 MHZ	0015-1845	
TIS	Kathmandu Terminal	127.0 MHZ	0015-1845	

All The communication equipment at Kathmandu tower were operating normal.

All the communication logs and recordings were collected and analyzed by the commission as necessary.

1.10 Aerodrome information

1.10.1 General Information

Name	Tribhuvan International Airport
Location	Kathmandu
Location Indicator	VNKT
Elevation	1339.54m (4394.76ft) AMSL
Runway Identification	02/20
Runway Markings	RWY 02/20, Threshold (THR), Touchdown Zone (TDZ), Center Line, RWY Edge marked and RWY End,Threshold,RWY edge lights
Taxiway Markings	Centre line, Holding positions at all TWY/RWY intersections marked and TWY edge with blue lights
Runway Length and slope	3050m and 1.2%
Runway conditions; strength	Bitumen; PCN 54F/A/W/T
Approach and Runway Lighting RWY 02	High intensity consisting of extended centerline 870mt (Approach); Green (THR); PAPI

	3.00^0;Runway Centre line NIL; High intensity, bidirectional raised white amber edge lights (RWY Edge); RED (RWY end), Nil (Stop way)
Approach and Runway Lighting RWY 20	Nil (Approach), Green (Threshold), PAPI 3.00^0, Nil(Centre Line), Bi-directional raised white amber edge lights (RWY edge), Red (RWY end), Nil (Stop way)

1.11 Flight Recorders

The aircraft was equipped with the following recorders onboard; Cockpit Voice Recorder (CVR), Flight Data Recorder (FDR), Engine Monitoring Unit (EMU), Quick Access Recorder (QAR). CVR, FDR and EMU were recovered in good condition but the memory chip of QAR could not be recovered. All the recorders were sent to TSB, Canada for downloading, decoding and analysis. The job was completed in the TSB in the presence of the Commission member, ACCREP from CAAB and TSB, Canada. The quality of recorded Data from CVR, FDR and EMU was good enough for proper analysis.

1.11.1 Cockpit Voice Recorder

The aircraft was fitted with one CVR of 120 minutes recording capacity. No mechanical and significant thermal damage was found during its recovery from the crash site.

The details of installed CVR on S2-AGU (Q400) aircraft is as follows:

Manufacturer:	Honeywell
Model:	*Identification Plate destroyed by fire*
Serial Number:	CVR120-04929

1.11.2 Flight Data Recorder

The aircraft was equipped with a flight data recorder of at least 25 Hrs recording capacity. The unit was retrieved in good condition. No mechanical and significant thermal damage was found during its recovery from the crash site.

Manufacturer:	Honeywell
Model:	*Identification Plate destroyed by fire*
Serial Number:	*Identification Plate destroyed by fire*

1.11.3 CCTV at Kathmandu Airport

CCTV video recordings of the particular moments of the aircraft movement was collected and reviewed in depth in order to verify the witness information and supplement the FDR findings regarding the A/C motion and position. The CCTV video recording was of good quality, covered most of the final events till touchdown and movement of fire vehicles after the accident.

1.12 Wreckage and Impact Information

The aircraft touched down at coordinates N27^{0}41'48", E085^{0}21'34", 1700 meters down the threshold and on the left of the center line of Runway 20, then veered southeast out of the runway through the inner perimeter fence along the rough down slope and finally stopped at coordinates N27^{0}41'41", E085^{0}21'32"about 442 meters southeast of the runway.

The aircraft was fragmented into number of debris along the rough down slope before coming to a stop. Engines, APU, landing gears were almost detached from the aircraft; wings were broken and most of the aircraft parts were damaged due to post crash fire.

Aircraft Wreckage at Accident Site

1.13 Medical and pathological information

Postmortem examination of all 49 victims, crew and passengers were carried out in Department of Forensic Medicine, Institute of Medicine, Maharajgunj, Kathmandu, Nepal.

1.13.1 PIC

The PIC was released from Bangladesh Air force in 1993 due to depression. As per the available medical records, he was declared fit to fly with civilian aircraft by Medical Assessor after detailed medical evaluation in 2002. During his routine annual medical evaluation, he was assessed fit for flying and was considered free from any symptoms/signs of depression. None of the medical examination reports that commission reviewed, from 2012 to 2017, mentioned any symptoms about depression and was cleared by assessor for flying duties.

Postmortem examination of **PIC** was conducted in Department of Forensic Medicine, Institute of Medicine, Maharajgunj, Kathmandu, Nepal.

Details of injuries on External and Internal Examination are attached in Appendix**.**

The detailed external and internal examination suggested MULTIPLE BLUNT TRAUMA TO HEAD AND CHEST in presence of Carbon Monoxide poisoning as likely cause of death.

Viscera from stomach with its contents, kidney and liver were analyzed by Thin Layer Chromatography (TLC). The samples were also chemically analyzed for Ethyl alcohol, Methyl alcohol and Phosphine gas. The tests were further confirmed by Gas Chromatography-Mass Spectroscopy (GC-MS) technique.

Toxicological analysis of all the samples was **NEGATIVE** for Insecticides, Narcotic drugs, Ethyl alcohol, Methyl alcohol and Phosphine gas. However the toxicology testing did not include prescription medications that are commonly used to treat depression (e.g., anti-depressants) or anxiety (e.g., benzodiazepines, anxiolytics).

1.13.2 First Officer

Postmortem examination of **FO** was conducted in Department of Forensic Medicine, Institute of Medicine, Maharajgunj, Kathmandu, Nepal.

Details of injuries on External and Internal Examination are attached in Appendix.

The detailed external and internal examination suggested BLUNT FORCE INJURY HEAD as likely cause of death.

Viscera from stomach with its contents, kidney and liver were analyzed by Thin Layer Chromatography (TLC). The samples were also chemically analyzed for Ethyl alcohol, Methyl alcohol and Phosphine gas. The tests were further confirmed by Gas Chromatography-Mass Spectroscopy (GC-MS) technique.

All the samples were **NEGATIVE** for Insecticides, Narcotic drugs, Ethyl alcohol, Methyl alcohol and Phosphine gas.

1.14 Fire

Tribhuvan International Airport maintains Category IX- Firefighting services. There are four large and one medium foam tender, two water tenders, three ambulances and one Rescue vehicle.

All the evidences and eyewitness reveal that till touchdown the A/C was intact and there was no evidence of any in-flight fire.

As per analysis of the available CCTV footage, the fire broke 6 seconds after initial touchdown. One medium foam tender was dispatched after 16 seconds and a large foam tender was

dispatched within 25 seconds of touchdown. Firefighting and emergency services reached within 2 minutes at crash site to douse the flames. The firefighting services had to extinguish en-route grass fire to reach to the crash site. Four large foam tenders, one medium foam tender and two water tankers were used effectively.

1.15 Survival aspects

Out of 67 Passengers and 4 crew members, 22 passengers were rescued from the crash site and sent to different hospitals within Kathmandu valley. But two of the surviving passengers succumbed to injury during the course of treatment at the hospital.

The impact forces of the accident were survivable to most of the occupants seated to the right. The passengers seated to the left most likely succumbed to death due to impact forces. The immediate and rapidly spreading post-crash fire likely precluded the possibility of escape for remaining passengers who might have survived the impact.

1.16 Test and Research

The CVR, FDR, EGPWS and EMU were sent to Transport Safety Board (TSB) Canada for decoding, analysis and animation. The analysis from the TSB was very helpful to the commission in determining the probable causes and drawing a final conclusion.

1.17 Organization and Management Information:

1.17.1 Company Profile

US-Bangla Airlines Limited is a privately-owned commercial scheduled Air Carrier from Bangladesh which launched commercial operations on 17th July, 2014 from its operational base at Hazrat Shahjalal International Airport (ICAO: VGHS / IATA: DAC). Prior to the launching of commercial operations, the airline received its Air Operator Certificate (AOC # 20) from the Civil Aviation Authority of Bangladesh (CAAB) after having successfully fulfilled the requirements thereto as set forth by the International Civil Aviation Organization (ICAO) and duly adopted by the Civil Aviation Authority of Bangladesh (CAAB) and its published Air Navigation Orders (ANOs). The airline's IATA-2-letter code is 'BS', ICAO 3-letter designator is 'UBG' and ICAO Telephony Designator is 'Bangla Star.'

The initial fleet of the airline consisted of 2x Bombardier Q400 aircraft (DHC-8-400) which are the airline's own. These aircrafts were operated throughout the domestic network of the airline in the first year as per the local regulations before becoming eligible to apply for scheduled

international operations. By the time the airline operated its first flight to Kathmandu, Nepal on 15th May, 2016, it had completed nearly 2 years of successful domestic operations (and the fleet had grown to 3x Q400 aircraft.

With expansion of international network in the immediate plan thereafter, US-Bangla Airlines inducted 4x Boeing 737-800 aircraft between October 2016 and September 2017. The fleet size by February 2018 stood at 4x Q400 aircraft and 4x Boeing 737-800 aircraft.

The airline's current network of operations based out of Dhaka is as follows:

Domestic

Chittagong (VGEG/CGP)

Cox's Bazar (VGCB/CXB)

Jessore (VGJR/JSR)

Barisal (VGBR/BZL)

Sylhet (VGSY/ZYL)

Rajshahi (VGRJ/RAJ)

Saidpur (VGSDSPD)

International

Kathmandu, Nepal (VNKT/KTM) withheld after accident

Kolkata, India (VECC/CCU)

Muscat, Oman (OOMS/MCT)

Doha, Qatar (OTHH/DOH)

Bangkok, Thailand (VTBS/BKK)

Kuala Lumpur (WMKK/KUL)

Singapore (WSSS/SIN)

Guangzhou, China (ZGGG/CAN)

At present, US-Bangla Airlines has 11 rated and 02 under-training PIC and 12 rated and 09 under-training First Officers for the Q400 (DHC-8-400) fleet. For the Boeing 737-800 (B737NG) fleet the airline as 20 rated PICs, 16 rated First Officers, and 03 under-training First Officers.

1.17.2 Organizational Factors

US-Bangla Airlines is headquartered in Dhaka, Bangladesh. The organization is led by the Managing Director (MD), and subsequently by the Deputy Managing Director (DMD) and the Chief Executive Officer (CEO) who is also the Accountable Manager, with effective from 18 March, 2018. The Flight Operations department is led by the Director of Flight Operations (DFO) who, through the respective Fleet Chiefs for the Q400 and B737-800 fleet, manages the airline's cockpit crew team with support from the fleet Instructors, and the Chief of Training.

The airline follows and adheres to the policies and standards set forth by the Civil Aviation Authority of Bangladesh (CAAB) including compliance to all standard operating procedures prescribed by the CAAB.

Crew rosters are prepared on fortnightly basis and are generally followed unless sometimes to adjust for crew sickness or convenience needs. However, there is no written policy on crew rostering/pairing.

It is also revealed that US-Bangla Airlines has a Memorandum of Understanding (MOU) with Biman Bangladesh Airlines which is in effect, as both airline operates common fleet types and the state-owned carrier needed crew support from US-Bangla Airlines when it inducted the Q400 aircraft much after US-Bangla Airlines did. To support Biman Bangladesh Airlines, US-Bangla Airlines has often deputed its spare pilots on deputation. This way, the crew stayed current and active in flying duties while US-Bangla Airlines earned from such crew leasing to well compensate for the remuneration of its spare crew in the short to mid-term.

The airline does not have any airline doctor attached to the Company. Any health-related issues of the crew are being monitored by the DFO and the crews are free to see consulting doctors of different specializations on their own issues and report to the DFO regarding any matters pertinent to their performance of flying duties.

Safety reporting procedure is fairly well-established at the airline. Every member of the Company is encouraged to proactively report safety hazards he or she observes. Prescribed reporting forms are available for dangerous goods incidents, lighting strike reporting, food complaints, flight crew rest period deviation report, aircraft occurrence report, air proximity report, to name a few. These reports are forwarded to the CAAB if pertinent and necessary. It was also observed that Line Oriented Safety Audit (LOSA) was not carried out periodically by the company.

Preflight briefing is a standard procedure in the airline and is done before each flight covering all standard matters. However, the recently introduced requirement for Bangladesh ADC number for international flights took longer than ideally would have been expected to circulate among the crew through specific briefing. The proper preflight briefing by the dispatch including the recently introduced Bangladesh ADC number was not carried out.

Following the accident of March 2018, the airline's Operations Manual Part C was found to have erroneously mentioned the distance from waypoint GURAS to the KTM airport to be 16 nautical miles instead of the correct figure of 17 nautical miles. However, the crew was seen to be using current Jeppesen charts for all approaches including those to Tribhuvan International Airport, Kathmandu (VNKT/KTM) wherein the distance is shown correctly.

1.18 Additional Information

1.18.1 Standard Instrument Arrivals:

There are two standard instrument arrivals at Tribhuvan International Airport; RNAV (RNP AR) approach and VOR/DME approach attached in appendix.

1.18.2 Changes from IFR Flight to VFR Flight:

An aircraft electing to change the conduct of its flight from IFR to VFR shall, (if a flight plan was submitted), notify the appropriate air traffic services unit specifically that the IFR flight is cancelled and communicate thereto the changes to be made to its current flight plan.

When an aircraft operating under the instrument flight rules is flown in or encounters visual meteorological conditions, it shall not cancel its IFR flight unless it is anticipated, and intended, that the flight will be continued for a reasonable period of time in uninterrupted visual meteorological conditions.

1.18.3 Visual Approach:

An IFR flight may be cleared to execute a visual approach provided that the pilot can maintain visual reference to the terrain and;

a) The reported ceiling is at or above the approved initial approach level for the aircraft so cleared; or

b) The pilot reports at the initial approach level or at any time during the instrument approach procedure that the meteorological condition are such that with reasonable assurance a visual approach and landing can be completed.

c) The visibility at the aerodrome is 5 km or more.

Notwithstanding (b) and (c), if the pilot reports that he has the aerodrome in sight and conduct his approach with visual reference to terrain, the flight may be cleared for a visual approach/ circle to land. Separation shall be provided between an aircraft cleared to execute a visual approach and other arriving and departing aircraft.

1.19 Useful or Effective Investigation Techniques

Commission performed following procedure during the course of investigation:

a. Visit to the Crash site to observe the wreckage and evidences of the crash, if any.
b. Visit to TIA fire station to interview the firemen and officers.
c. Visit to Aerodrome Control Tower, Approach and Area control centre.
d. Visit to Various Hospitals to inquire about the conditions of injured passenger and also conduct interview with them.
e. Collection of ATC- Pilot Records, RADAR Image Record, CCTV footage and prepared Transcripts.
f. Necessary Engineering and Operations documents were collected from CAAN, CAA Bangladesh and US-Bangla Airlines.
g. Collection of CVR, FDR, EGPWS, QAR, EMU and sent to TSB, Canada for download, decode, analysis of data and animation.
h. Collection of the weather information.
i. Interview with concerned ATC Officers, and senior officials from the TIA and CAAN Head Office. .
j. Interviewed with US-Bangla Airlines CEO, DFO and Flight dispatcher.
k. Postmortem examination and toxicological analysis of viscera of PIC and FO.
l. Upon examining all components, documents and available information, the commission analyzed in minute detail the contributing factors and probable cause of the accident to prepare the final draft report.
m. Written statement from different persons from US-Bangla which are seemed more relevant.

2. Analysis

2.1 General

The Flight crews were found properly certified and qualified in accordance with CAAB regulations and company requirements. No evidence was found indicating that the flight crew's performance was affected by toxins, alcohol and other drugs.

Post-accident examination of the airplane found no evidence of any pre-impact structural, engine or system malfunctions. However, the investigation revealed that the 'YAW DAMPER' of the aircraft was ON and the system functioned until 05 seconds prior to touch down. The aircraft failed to approach the runway in proper touchdown attitude; given that the aircraft attempted touchdown in extreme attitudes, the flight crew followed a non-prescribed procedure and that the situation was further complicated by prevailing westerly crosswind conditions at Kathmandu (VNKT), the aircraft departed the runway surface towards the southeasterly direction.

The Cockpit Voice Recorder data revealed some confusion in communication within the terminal area between the crew and the air traffic controller (VNKT Tower) regarding intentions of the flight crew and clearances for runways 02 and 20. Some of the weakness on Air Traffic parts like poor monitoring the aircraft visually after giving landing clearance for RWY 02, confusion on issuing instruction for a go around though the ATC alerted the crew that the aircraft was proceeding towards runway 20 even the landing clearance was given for runway 02. The above mentioned lapses and assertiveness may have prevented the ATCs to become the last line of defense in this accident. Whereas a complete loss of situational awareness due to negligence in the basic procedural discipline and non-adherence to Standard Operating Procedures was evidenced in the part of the flight crew.

The TIA security video footages show that the fire erupted 6 seconds after impact. The load sheet data from the flight suggested that the aircraft had approximately 2800 kgs of fuel onboard during touchdown. The investigation commission also concludes that the impact forces of the accident were survivable to most of the occupants, but the immediate and rapidly spreading post-crash fire likely precluded the possibility of escape for most of the passengers. The footage also indicates that the first TIA Fire brigade vehicle movement was initiated within 16 seconds of impact.

2.2 The Accident Sequence

2.2.1 Pre approach

The flight departed Dhaka at 0651:40 UTC and at around 0746:27 UTC the flight crew began preparing for the arrival into VNKT by attempting to receive the weather for VNKT via the ATIS frequency 120.7 Mhz. The reported weather at the time was, 6000m, 210° at 06kts, few at 1500ft, scattered at 3000ft, temperature 22°C and dew point 10°C, and QNH 1016mb.

While monitoring the ATIS and performing other flight duties, the flight crew were busy discussing their personal issues and worries. The PIC was engaged in lengthy one-way conversation with the first officer since the beginning of the flight and made multiple unnecessary statements and comments against another colleague in the company who had questioned his reputation as an instructor in the company. As this conversation regarding the above colleague was repeated several times during the flight, the captain definitely seemed very much emotionally disturbed and stressed. At times the Captain even seemed to have emotional breakdown as revealed in the CVR. This stress might have led him to smoke in the cockpit during the flight and this clearly is against the Company Standard Operating procedure. This state of mind with high degree of stress and emotional state might have led him to all the procedural lapses.

With this state of mind, the PIC was trying to perform his role as pilot flying, instructor coaching the first officer about various aspects of flying and operations environment in VNKT. These factors might have escalated his flight duty workload even further. The first officer was performing her flight duties in this particular sector for the "first time" whereas the PIC was flying this sector after 24 days. Between these periods, he was in Ethiopia as a Type Rated Examiner (TRE), engaged in routine simulator training sessions for other pilots in the company.

At 07:48:59 UTC, the first officer reported position MONDA at FL240 to Kolkata Control and the controller instructed them to report establishing contact with Kathmandu Control. In between this period the PIC was teaching and explaining the FO in all areas as how to proceed further, selecting of the navigation and communication panels, recognizing the waypoints, setting up the Flight Management System and Flight Guidance Computer Panel etc. with great passion, calmness and professional efficiency. PIC then asked the FO if she was all comfortable with what he had explained and the FO replied "yes very comfortable Sir". The commission believes that the PIC was constantly trying to prove his professionalism and reputation as a competent trainer in front of a junior trainee in this flight.

At 07:52:07 UTC, the FO contacted KTM Control and passed on their ETA for position IPLAS at 0803UTC, GAURA at 0809UTC, ROMEO at 0813UTC and KTM at 0820UTC, maintaining

FL240 with squawk code 4716. KTM Control advised them to monitor ATIS on 120.7 MHz and to call back when released by Kolkata Control. The PIC complimented the FO for her good performance during this flight and mentioned that he would refuse to accept that she could not perform her flight duties up to standard as rumored in the company. At 07:52:57 UTC Kolkata Control handed over the flight to KTM Control.

The CVR revealed that the FO was trying continuously to pivot the situation by enquiring about the radio frequencies, navigation topics and reminding that the briefing from the PIC was due.

At 07:58:24 UTC, the PIC eventually initiated instructing the FO in finding the correct charts for preparation of arrival into VNKT. For the PIC who appeared also to be the PF for this sector, briefing the approach to be conducted would reinforce the approach requirements and procedures to perform as the pilot flying the approach mentioned that he did not have the Approach Charts, this could be interpreted as an indication that the Captain was not adequately prepared for flight operation at that time. Hence, the PIC made a very short briefing on the arrival into VNKT while referring to the First Officer's Charts. The Captain never carried out a complete briefing on VNKT RWY 02 approach, which requires a very high degree of flight deck preparation, orders and understanding of the very challenging operations environment. This might indicate his complacency as he had performed this approach several times before and not realizing that the First Officer was operating this flight for the first time.

At 0759:05UTC, the PIC briefed the arrival into VNKT while referring to the First Officer's charts. Starting from the Standard Terminal Arrival Route Chart (STAR) coded 10-2A dated 6 MAY 2016 for ROMEO arrival into VNKT which was their expected route for arrival, the PIC reviewed several waypoints with altitude restrictions and track to follow towards the Initial Approach Fix "GURAS". The CVR revealed that following the discussion on STAR, the crew did not review the more important and complex approach chart in detail and just a very brief discussion was conducted on chart coded 13-1 for VOR RWY 02 mentioning the procedure altitude of 8900ft at 9 DME and the obstacle clearance altitude for that particular segment of approach.

The PIC then directed the FO to clip those charts on her side console, so he had no other means of referring to chart again while performing the approach as a Pilot Flying himself. All the critical items such as minimum sector altitudes, final approach inbound course, type of approach (CDFA), surrounding terrain with highest obstacle sectors, descent rate requirements, aircraft configuration schedule, speed control, stabilization criteria, missed approach point and procedure, minimum descent altitude and runway lighting etc. were never reviewed.

In summary, the flight crew failed to conduct a complete approach briefing which was unstructured and inconsistent. The first officer also made several statements that indicated she had an incorrect understanding of the procedures to follow during approach and her confusion

over the missed approach procedure in VNKT was never resolved by the PIC, asserting that he would brief the remaining items later.

The investigation commission concludes that as a result of flight crew's failure to complete the approach briefing as per the Standard Operating Procedure, the PIC and the first officer did not have a shared understanding of how the approach was to be managed and conducted. Both pilots failed to recognize their lack of compliance to prescribed procedures and "threat identification techniques."

Following the briefing, the PIC went on to discuss the arrival time, guiding the FO on descent point, selecting the altitudes and minima. He discussed on techniques to set the radio altimeter so as to receive the EGPWS "100 feet above" auto calls before minimums.

At 08:06:08 UTC, the crew performed the descent checklist and requested for descent at 08:07:49 UTC. Kathmandu Control cleared the flight to descent to FL160 and assigned an estimated approach time (Correct term would be "Expected Approach Time") of 08:26 UTC. AT 08:10:33 UTC the flight was handed over to KTM Approach controller.

2.2.2 The Approach

At 0810:52UTC, The FO contacted KTM Approach. The controller instructed the flight to descent to 13500ft and cleared to hold over "GURAS" (IAF) via ROMEO arrival with QNH 1015mb and temp 21°C.

Having received the expected approach time of 08:26UTC by previous controller and holding instructions over GURAS, the crew discussed on the published holding pattern and procedures. Emphasizing to the clearance, the PIC coached the FO on setting up the NAV and "Arming the hold in their Flight Management System". Various aspects of LNAV, VNAV, FMS, Power setting, Altimeter setting etc. were discussed at this moment. At 0813:41UTC, KTM Approach instructed the flight to reduce the speed to minimum clean and cleared to descent to 12500ft. As of the current profile, the aircraft would arrive position GURAS at 08:20UTC, 6 minutes earlier from the assigned estimated approach time of 0826UTC and therefore the holding mindset was definite to the pilots and the FMS was programmed accordingly. In contradiction to the previously assigned expected approach time of 08:26UTC and holding instructions, the Approach Controller cleared BS 211 to descent to 11500ft and cleared for VOR Approach RWY 02 at 0816:13 UTC.

Though acknowledged the instructions the crew overlooked the preprogrammed FMS settings and missed to disarm the HOLD inputs. The PIC further demonstrated complacency and his gross negligence to procedural discipline by lighting up another cigarette at this stage when the

aircraft was just under 3 minutes to arrive the initial approach fix "GURAS". In the meantime, the approach checklist was also conducted ambiguously by the crew. The CVR also revealed that during this phase the FO was holding the power lever where the PIC corrected her to leave it as he was the pilot flying for the sector and reminded to keep the heading bug on top, which was 017 degrees, corrected for westerly winds.

At 08:20:04 UTC, the pilots received the cabin secured message from the cabin crew and after the ALT star FMA annunciation, the FO reported position GURAS at 11500ft to the ATC at 08:21:06 UTC. The flight was cleared to continue by the controller. This particular moment becomes the triggering factor for distraction and temporary confusion between the crew when the aircraft suddenly starts entering the hold over GURAS as programmed in their FMS, which was caught out of surprise as the hold input was erroneously not disarmed. This error was apparently realized by both pilots and was also alerted by the Approach controller also. The PIC hurriedly selected the Heading mode to 027 degrees towards the final approach inbound track overriding the autopilot FMS LNAV guidance in an attempt to continue the approach as cleared, keeping 5 degrees of intercept angle to the published the course towards west in an attempt to enter the hold over GURAS as programmed. This action on the FGCP led to become the primary cause of losing the FMS Auto Flight Final Approach lateral navigation guidance capability of the aircraft, where the command to autopilot was demanded to fly in "Heading Mode".

The airborne air data computer registered winds aloft data during this phase revealed strong westerly winds from 270 to 280 degrees at an average of 28 knots, seemingly drifting the flight path towards east with heading correction set at 027 degrees by the pilot in heading mode. In the meantime, the vertical flight profile had also deviated to be high as the descent was due; the PIC was distracted and the aircraft had gone to pitch hold mode reversion due to heading selection in HSI. The PIC commanded descent inputs in the FGCP pitch wheel to approximately 1300 feet per minute (fpm) to initiate descent.

AS per the airline's Operation Manual Part C guidelines sec 1.2, the aircraft should have already attained the full landing configuration with the landing checklist completed before the initial approach fix "GURAS" to meet the stabilization criteria. The initial flap 5 was requested at 15 DME after crossing the IAF. At 0822:5 UTC, the PIC requested for flap 15 and the landing checklist while crossing 13 DME on the approach. During the challenge and response sequence of the landing checklist which was conducted by the FO, the PIC confirmed the landing gears to be down by stating "gears down three greens" without checking to confirm the position of the landing gears which were actually not in down and locked position, this was also overlooked by the FO as well. At 0823:41UTC, the FO reported 10 miles final where the CVR also recorded the landing gear unsafe tone over the flight deck speakers continuously which was constantly disregarded by both the pilots.

At 08:23:45 UTC, the flight was handed over to KTM Tower and the initial contact with the tower was established at 0824:39 UTC, and was cleared to continue approach and the gear

unsafe tone continuously sounding in the cockpit. At 8 DME, the PIC erroneously set the minimums at 4688ft instead of 4950ft as published, though the radio altimeter was set to 629ft to receive the "100ft above" auto callouts above the correct minimums and the PIC (PF) possibly had no approach charts displayed in front of him to refer to. The PIC requested for the landing checklist again and the FO affirmed that it was already completed even though the landing gear unsafe tone was still active. During the final descent, the FO made call outs of the altitude constraints for the segments, and kept prompting the PIC that they were 500ft to 600ft high on profile.

With the noisy flight deck where the landing gear unsafe tone was continuously active and in an already rushed situation where the crew were dealing with correcting a significant vertical flight path deviation, the crew seemed so preoccupied that the interception of the final approach course 022 degrees by the aircraft in Heading mode at 7 DME went undetected to both the pilots and hence the flight path deviation started towards the East of final course as no attempt was made to rearm or reengage the FMS LNAV mode or select the VOR mode. The aircraft continued drifting east of final course in heading mode with heading still set at 027 degrees where the air data computer registered winds from 272 degrees at 24 knots at that altitude. The CVR did not revealed any evidence of ATC controllers providing any alert to the flight crew of the aircraft deviation to the right of the approach path. The CVR revealed that the PIC was having difficulty in understanding what the FO was saying due to the high noise levels inside the flight deck. Exhibiting his confirmation bias, the PIC again requested for the landing checklist for the third time where the FO again confirmed that it had already been completed regardless of the landing gear unsafe tone still stridently audible.

At 0825:25 UTC, the aircraft arrived the missed approach point in visual meteorological condition with descent rates as high as 1700 feet per minute and off the final approach course, followed by EGPWS "sink rate and too low gears" callouts. The tower reported winds from 220 degrees at 7 knots with tailwind component of 6 knots and cleared the flight to land RWY 02. On the other hand, regardless of the aerodrome environment not being visual to the crew and the stabilization criteria not being met in IFR operations, no attempt was made by the flight crew to carry out a standard missed approach procedure. At this point only, the FO realized that the landing gear was not actually down and initiated its extension under the instruction of the PIC. The PIC once again requested for the landing checklist for the fourth time. The further conversation between the crew, as revealed by the CVR, led to an ambiguous expectation of when they would acquire visual contacts with the runway environment while being unaware that the aircraft was already flown past and parallel way along the eastern side of the runway towards northeast direction. The PIC kept on assuming that the landing runway was still ahead of them, though the aircraft had already flown through the eastern part of the entire RWY at a position beyond the north east of RWY 20 threshold, approximately 3-4 NM northeast of KTM VOR. Autopilot was disengaged at 1.1 nm east of the VOR.

When the aircraft was at this position, at 08:27:30 UTC, KTM Tower contacted BS211, being concerned by observing that the aircraft had flown to the northeast of the airfield, whereas it should have landed by then, informed the flight crew that they had been issued a clearance to land on RWY 02 but instead they were going for RWY 20. This time the PIC replied that he thinks he is continuing for RWY 02. At this moment the tower OJT controller was replaced by the Tower Duty Controller who took over the microphone and *mistakenly* cleared the flight to land on RWY 20 on share assumption, in considering with the aircraft's current visual flight position that it could be pilots' intention to land on RW 20 though the PIC deliberately transmitted that he would land on RW 02. Soon after this time, the tower duty controller was replaced by the Tower Supervisor Controller who was present at the tower control.

While struggling to find the runway, the flight continued towards the northeast sector on the same heading. The CVR recorded continuous EGPWS warnings with various flight parameters exceeded. At around 6 DME northeast from the VOR the PIC started maneuvering the aircraft on a right hand orbit while sighting the dead end rising terrain ahead of them. During the maneuver the aircraft descended to as low as 175 ft above ground level with bank angles of up to 35-40 degrees triggering various EGPWS alerts and warnings. Desperate to find the landing runway and still unaware of their position, compounded by threatening high terrain all around and multiple EGPWS warnings, the commission concluded that there was a complete loss of situational awareness on the part of the flight crew at this stage. At 0829:02UTC, KTM tower inquired the crew about their intention and tried to reconfirm if they were still VFR. The PIC affirmed and radioed his intention to still land on RWY 02. In relation with the aircraft's current position towards northeast from RWY 02, the ATC cleared the flight to join the right hand downwind for RWY 02.

The ATC was also handling another domestic traffic, Buddha 282 which was approaching 2 miles final for RWY 02 and had been cleared to land. This traffic information was passed on to BS211 cautioning them again that there was a landing traffic on short final for RWY 02 sequenced before them which was acknowledged by the PIC. In conflict to the clearance given, the ATC sighted BS211 proceeding towards RWY 20 instead of joining the right downwind for RWY 02. The ATC warned BS211 not to proceed towards RWY 20 as there was a landing traffic on RWY 02 and cleared to perform an orbit at their present position. At this time, the aircraft had already flown past north abeam threshold RWY 20 on a westerly heading of 280 degrees at 3.2 DME north from the VOR at 6000 ft. The aircraft continued to climb to 6500ft until when the PIC then again started maneuvering the aircraft on a steep right hand orbit, on the northwest sector and admitting to the FO that he had made a mistake as he was constantly talking to her.

During the turn, the bank angles reached up to 45 degrees with descent rates over 2000 feet per minute triggering the EGPWS warnings again. While the aircraft was maneuvering, the CVR also recorded another local pilot from the ground raising concern to the ATC that these pilots

seemed to have been disoriented and lost and also informed the ATC that the surrounding visibility towards hillside was marginal. The reported visibility at this moment was still 6000m. Until this moment the CVR recorded no statements from either pilot of BS211 to have located the RWY environment though they were flying in the vicinity of threshold RWY 20.

At 08:31:52 UTC, the tower issued a landing clearance to the flight for either runway (02 or 20) to their comfort realizing their confusion over the position and assured that the RWY was clear. The PIC replied that he would like to land on RWY 20 now though till this moment the RWY was not in sight to either crew. In spite being pilot flying, the PIC himself was communicating with ATC the entire time inflating his flight deck duties in an already overloaded situation. The aircraft now exiting the orbit and flying on a southeasterly heading of approximately 160 degrees at an altitude of 5400ft.The PIC rolled out of the turn and maintained this heading of 160 degrees momentarily to find the runway in the front because of the FO stating that the runway could be in front of them. Both the pilots were anxiously trying to locate the runway. The CVR revealed that both pilots made several statements which reflected that they had now completely lost their orientation of the runway, but this was not communicated to the ATC. At 0832:34UTC, the ATC tried to confirm with BS211 if the RWY was still not in sight and advised them to turn right in an attempt to assist the pilots in finding runway 20 as the aircraft position was just northeast abeam the threshold RWY 20 on a southeasterly heading.

At 0832:43UTC, the First Officer finally sighted the threshold RWY 20 at their 3 O'clock position at an altitude of 5500ft, 4.1 DME from the VOR and approximately 1.8 nm from the threshold RWY 20. Though it appeared unmanageable to land the aircraft on RWY 20 from the current position, attitude and altitude; for some undetermined reason, the PIC initiated desperate maneuvers in an attempt to put the aircraft on ground and requested landing clearance again affirming that he had the RWY in sight now. The Flight directors were set to standby at this point and the PIC reconfirmed the landing checklist was done again for the sixth time now. Still to his confusion he requested the FO to give him the heading bug of 022 degrees and set the same on her side, though the practical setting would have been 202 degrees for RWY 20. The FDR data shows that the aircraft overflew the threshold RWY 20 at 450ft above the ground on a westerly heading of 255 degrees and left bank angles of 40 degrees at an IAS of 150 knots. Distressed and panicked by the PIC's engagements, the FO made no callouts for go around or discontinue the maneuver.

At 0833:27UTC, spotting the aircraft carrying out reckless and irresponsible maneuvers at very close proximity of the ground within the aerodrome periphery and alarmed by the situation, the ATC hastily cancelled the landing clearance by saying "Takeoff clearance cancelled". At that critical moment ATC was confused sighting the unusual and abnormal maneuver of the aircraft and could not be assertive. The PIC still requested for clearance in a calm and content tone. But the aircraft was flying on improper attitude.

The EGPWS warnings "bank angle and sink rate" sounded continuously in the cockpit while the aircraft overflew the TIA domestic apron, cleared the hanger side and domestic passenger terminal by barely 45 feet as per the radio altimeter and FDR data. The ATC viewed all these unusual maneuvers of the aircraft and at one time the controllers, out of fear, ducked down themselves down below their table level. Thereafter, Overflying the TIA international parking bay, the aircraft finally made this time a right reversal right turn to align with the runway and eventually touching down on its right main landing gear 1700 meters past threshold RWY 20 (between intersection Charlie and Delta) left side of the RWY centerline with right bank angle. The aircraft hit the runway at an IAS of 127 knots and a heading of 190 degrees and immediately departed the runway surface towards the southeast direction in an uncontrollable manner further impacting the inner periphery fence, descending downslope and finally bursting into flames.

2.2.3 Organizational Factors

The company has a policy of 'No Smoking' in all the flights, domestic as well as international. The PIC was a smoker as per information received by the commission. The commission concluded from CVR record that PIC smoked in cockpit during this flight. However, the operation department and other authorities may not have been sure about this safety violation by the PIC during flight.

The company officials knew about PIC smoking habits as well. The company had made a policy of imposing monetary fine to anyone who smokes in cabin to discourage them to do so. Toxicological analysis done in samples from PIC however did not reveal any other substance abuse, confirming he was smoking tobacco only and did not use any other substances.

DFO of the company is a contact person for all crew to discuss any issues-professional as well personal. DFO also takes initiative to talk to crew whenever he feels it necessary to do so. PIC was once questioned by DFO regarding apparent close proximity to one of the female FO which was evident by more flights being scheduled/operated together. PIC replied that there was nothing going on and he treats her like his daughter. The matter was then rested and no further clarification seemed necessary.

CEO of the airlines knew PIC from 2010 from their association with other airlines together. He believed that PIC was a competent and professionally accredited pilot with sense of responsibility and leadership qualities.

As per the medical report received, PIC had history of depression while serving in Bangladesh Air-force in 1993 and was removed from active duty from Bangladesh Air force for the same reason after evaluation by psychiatrist. He was re-evaluated by psychiatrist on 9 January 2002 and was declared to be fit for flying. He however did not show any recurrence of symptoms

during medical examinations from 2002 to 2018 as well as at intervening period of examination. The company had no reason to evaluate about this issue of PIC further medically.

2.3 Maintenance and Technical

There is no evidence of aircraft releasing on multiple MEL/Deferred Defect for last flight from Dhaka to Kathmandu and there were no considerable repetitive defects reported by the pilots within last 3 months.

The aircraft maintenance documents whichever available to the commission did not show any system failures that could have jeopardized safety of the planned flight.

A review of the FDR and CVR revealed no aircraft system failures or faults that could have contributed to the accident. FDR/CVR data showed that since last departure from DAC to landing on KTM, no master caution, master warning or system failure messages were recorded except some configurations alert.

2.4 Human Factors

2.4.1 Psychological and physiological factors affecting the personnel involved

The investigation commission utilized information received from various sources to analyze human factor attributable to the accident. The investigation was focused primary on the evaluation of the human factor of PIC as well as co-pilot and other associated factors including organizational factors, aeromedical issues, crew resource management etc. For this purpose, mainly the information was received from cockpit voice recorder (CVR), interview with passengers who survived, interview with US Bangla officials, written interview/statement received from colleagues of deceased PIC and FO, officials US Bangla, and officials from Bangladesh Civil Aviation Authority (CAAB). All the information was analyzed systematically and inferences were drawn.

However it may be emphasized that due to unique nature of accident with country of occurrence being Nepal and country of registration being Bangladesh, differences in practices in both countries, cultural differences between both countries, accessibility to information, availability for cross questioning and clarification, distance between two countries and location of investigating commission in Nepal among many factors, have posed difficulty for the investigators to access all information closely and continuously. Remaining within these limitations, the investigation commission has approached this task with due care & attention and

evaluated human factor involved in US Bangla 211 crash in Tribhuvan International Airport in Kathmandu, Nepal.

2.4.1.1 PIC

The PIC had retired from Bangladesh Air force in 1993. He was a Fighter pilot of MiG21 and F-7 for 10 years. He flew cargo carrier briefly after retirement. He joined Regent Airways in 2010 and had 1000+ hours in DHC8, 100/300 as first officer. In 2011 he joined United Airways and flew ATR-72 for 2200+ hours as PIC. Became base, route and simulator check pilot of ATR-72. In 2015, he joined US Bangla as PIC DHC8, Q400. Base, route and simulator check pilot, also designated Check pilot for Q400. His total on type flying hours was 1793.

Medical records also indicated that the PIC did not reveal his smoking habit in self- declaration form. From 2012 to 2014, he mentioned that he had never smoked. In 2015, he mentioned that he used to smoke but left in 2010. However, in next medicals in 2016 and 2017 he again mentioned that he had never smoked. History of depression was also not declared by PIC in most of annual medical self-declaration form. This shows that there is no consistency in self-declaration regarding actual history and real habit.

The committee members were able to meet CEO, DFO and Operation staff (flight dispatcher) in person and also received written statements from his colleagues, friends and operation staff. Almost all were of opinion that PIC was very friendly, soft spoken and gentle person. He was level headed and would behave nicely with his colleagues and junior staffs. He was well spoken and would not use foul language in conversations. His attitude and behavior towards company, authority, colleagues, and juniors was good and he was liked by most of them. He was also a very good teacher and instructor. Most of the students were satisfied with his teaching techniques and were very happy and grateful to him for teaching them well.

The PIC was a teetotaler and he never consumed alcohol. He was happily married. They have a son who has turned 14 years now.

PIC went to Canada on 22 Jan, departed from Canada on 9 February and arrived in Dhaka 13 Feb, 2018. He was chosen as one of the 3 pilots to ferry S2AGX (DH8D) from Canada due to his competency, good nature and ability to deal with situations in a mature way. He flew to Kathmandu on 16 February, which was his last successful flight to Kathmandu before the fateful flight. He went to Ethiopia for PPC/IP training on 17 Feb, departed from Ethiopia on 6 Mar and reached Dhaka on 7 Mar, 2018. His official rest time before the flight on 12 March, 2018 was 15 hours.

CAAB had issued a new directive that all international flights departing from Bangladesh should get Air Defense Clearance (ADC) Bangladesh before departure. This was in addition to ADC Kolkata that flights needed to have before departure. PIC was not aware of this new requirement as he was not briefed about it. Before takeoff he was asked by Dhaka ATC to provide ADC Bangladesh which he was not aware of. This created some uncomfortable situation between the PIC and ATC and operation department at the time of the flight' departure from Dhaka.

CVR record showed that the PIC was talking almost non-stop throughout the duration of flight with FO being patient listener most of the times. The PIC did try to teach FO during the course of flight about various aspects of the flight, which at times seemed as if he was trying to impress FO about his skill and capability.

It seemed the PIC was worried about one particular aspect and was thinking about it all the time. This was about one particular female colleague's criticism on his competency. Most of the conversation in the cockpit was directed towards and aimed at the female colleague who apparently was telling others that the PIC was not a good instructor and he could not teach properly. This talk seemed to hurt the PIC very deeply as he really took pride in his teaching skills. He was telling the FO about how this particular talk going around had hurt him a lot, so much so that though he loved the company and liked the environment around, yet he would give notice for resignation from company because of the alleged behavior of the female colleague.

The effect of stress was evident with the fact that he was irritable, tensed, moody, and aggressive at various times. He also seemed to be fatigued and tired due to lack of sleep the previous night as well as due to the stress he was harboring. The PIC's impulsive and inappropriate behavior, or concentration, incomplete task as not completing before landing checklist, mentioning all 3 green for landing gear down in spite of not actually all 3 being green, repeatedly asking for before landing checklist in an obsessive manner; all was due to excessive stress he was harboring.

PIC seemed very unsecure about his future as he had planned to resign from this company. He said he did not have any job and does not know what he is going to do for living in future. The future financial insecurity may have augmented his stress.

The PIC was engaged in unnecessary conversation which was beyond the norms and violating the company SOP. This distraction as well as stress may have led to un stabilized approach-speed not under control, aircraft not fully configured and check list not completed. He had many opportunities to correct the maneuvers, if he had followed the SOP during descend and approach phase. It seems that the PIC was trying to prove to the FO that he was indeed a good pilot, good

teacher and competent in flying skill also and would be able to safely land the aircraft in any adverse situation.

The PIC's decision to land the aircraft at any cost after sighting the runway at a very close proximity, way off the final approach course, at very low altitude and decision for not initiating a go-around even after realizing that flight was not stabilized, is a very poor decision making on part of PIC.

2.4.1.2 The First Officer

FO was only daughter of a businessman. She received CPL training from Arrirang Flying School, Dhaka and joined US Bangla as first officer on 18th September, 2016. She did simulator training with the PIC of this flight on 2017.02.01 and 2017.07.15. She also did simulator training with another PIC on 2018.01.17. She had been with US Bangla from beginning.

As per the information available the FO was very nice and friendly person. She used to get along well with her colleagues and would show great respect to seniors. She was good student and would get quickly when taught. Professionally she completed all her training with good grades.

This flight was her first to Kathmandu as a crew and during flight she showed utmost interest to learn. She also was keen to clear her doubts about flying and tried to learn in every step during the flight.

However, steep crew gradient, FO's inexperience in the sector and higher authority of PIC probably disallowed FO from being assertive even though she was effectively monitoring the progress of the flight and suggested/initiated corrective actions.

2.4.1.3 The ATC Controllers

No evidence was found regarding the continuous visual watch to the aircraft by the controller after issuing Landing clearance. After few moments having observed the aircraft flying from south to north along the downwind leg of RWY 20, the ATC warned the crew that the aircraft was flying towards the RWY 20, even the landing clearance was given to RWY 02.

CVR revealed that ATC has requested the intention of BS 211 and BS 211 replied its intention to land on RWY 02. Again ATC confirmed whether the BS 211 was on VFR or not. Once confirming the aircraft was on VFR condition then ATC instructed BS 211 to join the right downwind of RWY 02 and to sight the landing aircraft on RWY 02 then BS 211 immediately acknowledged it. Immediately by observing the aircraft movement towards RWY 20, ATC asked

to BS 211 "confirm you are tracking RWY 20?" PIC immediately replied "affirmative". To avoid the separation infringement and possible conflict between the landing aircraft and BS211 ATC again alarmed to BS211 regarding the position of landing traffic and instructed to join the Right downwind RWY 02. Even after acknowledging the ATC instruction to join Right downwind RWY 02, the aircraft continued to fly towards RWY 20. To manage this critical situation ATC instructed the BS211 to hold at its present position, then PIC replied it is making an orbit to the right.

When the runway was cleared by the previous landing aircraft, sighting the unusal maneuver of the BS211 ATC cleared to land either at RWY 02 or 20 and asked to the aircraft whether it needs VECTOR service or not ? BS211 did not confirm it, but communicated to ATC regarding its intention to land at RWY 20 and at the moment ATC immediately cleared the aircraft to land RWY20. After that ATC reconfirmed again whether the RWY was in sight or not, immediately the PIC replied "Affirmative, we have RWY insight, request clearance to land sir." ATC immediately replied "BS211 clear to land" and the PIC acknowledged the clearance. As per CVR then after there was no two way communication between ATC and PIC.

When the aircraft made a very steep turn at very low height over the domestic hanger and was passing its heading towards the tower building the tower controllers ducked down the console with fear. As per the many eye witnesses also the aircraft was making dangerous flight over the domestic apron and taxi area at very low heights without proper alignment with the RWY 20 and ultimately touched down at the edge of the runway and overrun towards the downslope grass field and crashed.

3. Conclusion

The PIC who was also the pilot flying was under stress and emotionally disturbed as he felt that the female colleague of the company questioned his reputation as a good instructor. This together with the failure on the part of both the crew to follow the standard operating procedure at the critical stage of the flight contributed to loss of situational awareness to appreciate the deviation of the aircraft from its intended radial that disabled them sighting the runway. Having missed the runway and loss of situational awareness, the crew seemed to be orbiting at very low altitude with all EGPWS warning, at north of runway not realizing their correct position. This loss of situational awareness indulged the PIC into some dangerous maneuver of aircraft at very low altitude in the hilly and mountainous terrain around TIA. Finally, when the crew sighted the runway, they were very low and too close to runway 20 and not properly aligned with the runway. For reasons unknown, probably in desperation to land, the PIC maneuvered the airplane in a very unsafe manner by forcing it to land while in a turn, with the right bank, at an angle of about 15 degrees with the RWY axis resulting the right main landing gear to make hard impact on the left of the centerline of runway 20, approximately 1700 meters from the threshold.

After impact on the ground the uncontrolled aircraft ran out of the runway, hit the runway perimeter fence and rolled down the slope into the grass field and caught fire which engulfed the aircraft.

3.1 Findings

3.1.1 Aircraft

a. The aircraft had a valid Certificate of Airworthiness and had been maintained in compliance with the regulations.
b. The aircraft was airworthy when dispatched for the flight.
c. The mass and the Centre of gravity of the aircraft were within the prescribed limits.
d. There was no evidence of any defect or malfunction in the aircraft that could have contributed to the accident.
e. There was no evidence of system malfunction prior to the accident.

f. All control surfaces were accounted for, and all damages to the aircraft was attributable to the severe impact forces.
g. The aircraft was destroyed by impact forces and a post-impact fire.
h. The aircraft was substantially damaged and burnt extensively.

3.1.2 Crew/Pilot

a. The flight crew were licensed and qualified for the flight in accordance with existing regulations.
b. The flight crews were in compliance with the flight and duty time regulations.
c. CVR recording revealed that the PIC Lacked adequate sleep the previous night prior to the flight.
d. The PIC had operated to Kathmandu several times however the FO was operating this sector for the first time as an active crew.
e. CVR and eyewitness account of the passenger confirm that PIC was smoking in the cockpit during the flight.
f. Neither the pilots had practiced visual landing on RWY 20 in the simulator.
g. The PIC was engaged in unnecessary, unprofessional and lengthy conversation even in critical phase of the flight. Thus, violating all norms of sterile cockpit.
h. Steep crew gradient and higher authority of PIC probably prevented FO in assisting and being more assertive in significant phases of flight like approach and landing.
i. The PIC did not provide his smoking habit and history of depression in the last medical self-declaration form.
j. While teaching the FO, the PIC was very calm and professional but while talking about other issues he seemed emotionally disturbed.

3.1.3 Flight Operations

a. It is evident that there were a number of SOP violations during the flight by the cockpit crew.
b. International flight, especially to an airfield like KTM, was scheduled following four successive short domestic flights which shows poor operational planning.
c. The flight crew had not been briefed about the recent requirement of Bangladesh ADC.
d. Lack of proper co-ordination between the Dispatch and the crew regarding the preflight briefing which led to the PIC experiencing high level of stress, frustration and anger.
e. A/C was not fully configured for landing over GURAS which was contradictory to the company SOP.
f. There was lack of clear communication between the crew members and also between crew members and ATC during the critical phases of flight.

g. During the initial approach phase of flight, the aircraft was flown with autopilot on HDG mode with just 5 degrees of interception angle to intercept the final approach course of radial 202 degrees inbound to KTM VOR. But the VOR mode was never armed. Hence, the Autopilot flew the aircraft from left through the final approach path to right of the intended track. The high approach speed due to landing gears in retracted position made the deviation more pronounced.

h. The aircraft reached the Minima about 1 NM offset with the Runway centerline path, but visual contact with the runway was not established due to low altitude and offset from final approach course. Thereafter, the crew were unable to locate the runway due to very low altitude on the downwind leg as well as they were on the northeast of the airfield with mountainous terrain.

i. The 'Heading made good' distracted the pilot vision to establish visual contact with the runway.

j. The lack of visual reference with the runway caused the crew to lose their situational awareness.

k. The VOR Approach procedure for Kathmandu RWY 02 was never briefed and followed properly.

l. A/C continued descent after Missed Approach Point instead of carrying Standard Missed Approach procedure.

m. Though PIC communicated FO three green, the landing gears were not in extended position.

n. Gear Unsafe tone and EGPWS warning continue but both the crew never noticed or neglected the warning.

o. The loss of situational awareness hindered the consciousness of PIC to execute a 'go-around' to gain altitude for wider vision and better ground orientation at any time during the conduct of visual flight at low heights.

p. The situational awareness having lost, the aircraft was flown manually in both vertical and horizontal planes at very low height with abnormally variable speeds and bank angles.

q. PIC had realized his mistake of talking a lot during the critical phases of flight.

r. During the final phase of the visual landing, the aircraft was flown manually at a very close proximity of the runway with high-angle bank of approximately 30 degrees in order to align with the Runway.

s. Considerable amount of centrifugal force persisted at this time due to high degree of bank angle, rapid descent rate and excessive threshold speed with apparently inadequate inner rudder input to generate sufficient centripetal force as a counter measure to centrifugal force.

t. Circumstantially, the aircraft made one outer main wheel hard contact with the runway and thereafter skidded out of the runway before catching fire.

u. The accident occurred during a visual landing phase of flight under the control of the PIC, who seemed to be unaware of the danger until it was too late.

3.1.4 Operator

a. GURAS was shown as 16 NM instead of 17 NM in the company procedure in OM-C. However, during the particular flight crew used the updated Jeppesen charts, (Other than that OM-C and KTM approach procedure was updated)
b. Flight crew scheduling was not appropriate as per the existing approved Company or CAAB regulation.
c. Company's operations Manual Part C were not updated.
d. Similarly, the procedure for the Kathmandu approach was also not updated.
e. There was a lack of coordination between Operations control and flight crew on pre-flight briefing for example implementation of ADC Bangladesh.

3.1.5 Air Traffic Services and Airport Facilities

a. There is facility to record all the communication and the secondary surveillance radar data in Kathmandu Airport.
b. The airport was equipped with required communication and Navigation aids and aerodrome and ground aids. All the aerodrome approach aids and lighting facilities were operating normally at the time of the accident.
b. The Air Traffic Control Officers are not provided with refresher training at regular interval.
c. ATC at Kathmandu tried their best to assist the PIC providing landing opportunity at any Runway in convenience of the PIC and ensuring the airspace clear to avoid further conflict with other aircraft and US-Bangla.
d. At times it was found that ATC were confused on pronouncing landing RWY 02 or 20, though this did not seem to have significant impact on the fate of flight.

3.1.6 Flight Recorders

a. The aircraft was equipped with a FDR, CVR, EMU, QAR, EGPWS.
b. The FDR, CVR, EMU and EGPWS were in good condition with good quality recording.
c. The Memory card of QAR displaced from its location and could not be recovered.

3.1.7 Medical/Human Factor

a. The PIC was declared unfit to fly in 1993 due to his medical condition (depression). He was later cleared medically only in 2002.
b. Medical examination of PIC in successive annual medical was not focused on his previous medical condition of Depression; which seemed mandatory. This may have been missed as this was not declared in self-declaration form in annual medicals.
c. There was no evidence that the pilot suffered any sudden illness or incapacitation which might have affected his/her ability to control the aircraft.
d. Toxicological analysis was Negative for Insecticides, Narcotic drugs, Ethyl alcohol, and Methyl alcohol and Phosphine gas. However the toxicology testing did not include prescription medications that are commonly used to treat depression (e.g., anti-depressants) or anxiety (e.g., benzodiazepines, anxiolytics.
e. There is clear evidence that PIC was harboring severe mental stress. The effect of stress was evident with the fact that he was irritable, tensed, moody, and aggressive at various times. This is probably the reason for his undue aggressive behavior and anger aimed at ATC personnel as well as operation staff.
f. The foul language and abusive words he was using in conversation with a junior female FO was very inappropriate and certainly not expected from a level headed person.
g. PIC also seemed to be fatigued and tired due to lack of sleep the previous night as well as due to the stress he was harboring.
h. PIC seemed very unsecure about his future as he had submitted resignation from this company, though only verbally. He said he did not have any job and did not know what he was going to do for living. The financial insecurity may have augmented his stress.
i. FO asked PIC about Missed Approach Procedure of Kathmandu but PIC never briefed her, rather got engaged in unnecessary and personal talks. Failure to react after missing the runway for the first time, not doing standard go around procedures after missing the Missed Approach Point (MAP) and impaired decision making; all were probably due to stress.
j. The PIC seemed to have loss of situational awareness. He did not realize that they had crossed VOR and was under impression that they are still behind it.
k. Even in the last moments of flight, PIC had fixation to land at any cost and he never considered for go around procedure even after realizing that flight was not configured to land. One of the reasons could be him trying to prove FO that he is a very competent pilot and would be able to safely land the aircraft in any adverse situation.

l. A post-mortem examination of the pilot showed that MULTIPLE BLUNT TRAUMA TO HEAD AND CHEST in presence of Carbon Monoxide poisoning as likely cause of death. While post-mortem examination of the FO showed BLUNT FORCE INJURY HEAD as likely cause of death.

3.1.8 Safety Oversight

The aircraft was under the safety oversight of the civil aviation authority of Bangladesh.

3.2 CAUSES

3.2.1 The Probable Causes

The Accident Investigation Commission determines that the probable cause of the accident is due to disorientation and a complete loss of situational awareness in the part of crewmember. Contributing to this the aircraft was offset to the proper approach path that led to maneuvers in a very dangerous and unsafe attitude to align with the runway. Landing was completed in a sheer desperation after sighting the runway, at very close proximity and very low altitude. There was no attempt made to carry out a go around, when a go around seemed possible until the last instant before touchdown on the runway.

3.2.2 Contributing Factors

a. Improper timing of the pre-flight briefing and the commencement of the flight departure in which the operational pre-flight briefing was given in early morning but the flight departure time was around noon and there were four domestic short flights scheduled in between.
b. The PIC, who was the pilot flying, seemed to be under stress due to behavior of a particular female colleague in the company and lack of sleep the preceding night.
c. A very steep gradient between the crew.
d. Flight crew not having practiced visual approach for runway 20 in the simulator.
e. A poor CRM between the crew.

f. Failure to ARM the VOR to intercept the desired radial (Aircraft never intercepted the radial, rather it crossed over from left to right of the desired approach path of the runway while remaining on HDG Mode with AP ON);
g. Failure to adhere to the standard operating procedure. Failure to perform proper briefing.
h. Not noticing the unsafe gear warning horn by the crew until approaching the MDA.
i. PIC did not make corrective action to EGPWS warnings on time.
j. Failure to carry out a standard missed approach procedure in spite of the runway not being visual at the MDA.
k. Failure to meet the stabilization criteria of the aircraft on approach.
l. Increased workload on the PIC as he was manually flying the airplane and communicating with the ATC;
m. Loss of situational awareness due to miss-alignment with the runway during initial approach, and eventually not being able to sight the runway;
n. High bank angle, rapid descent, excessive threshold speed, inadequate inner rudder input contributed for hard contact of the right main landing gear to the runway.
o. The speed, altitude and the radial was never monitored during approach.
p. Lack of assertiveness on the part of Air Traffic controller in monitoring the flight path of the aircraft and not issuing a clear instruction to carry out a standard missed approach procedure.
q. Lack of clear understanding and acknowledgment on the part of both ATC and the crew to clearly understand each other's communication regarding the landing runway.
r. Lack on the part of the ATC to alert the crew of their actual position.
s. Even though the copilot was operating to Kathmandu (CAT C) for the first time, the provision of a safety pilot which was not given a importance could have been of a great help in the situation.
t. Lack of simulator training dedicated to the visual approach for runway 20 to the PIC.

4. Safety Recommendation

4.1 To the CAAB

1. Before the renewal of license of any permanently grounded pilot due medical reason, a thorough periodic physical and psychological status should be assessed. A system should be adopted so as to monitor the medical condition closely in all subsequent medical examination as well.
2. Commission recommends that all airline pilots should undergo psychological evaluation as part of the training or before entering into the service. The airline shall verify that the evaluation has been carried out. The psychological part of the initial and recurrent aeromedical assessment and the related training for the aeromedical examiners should be strengthened.

4.2 To the Operator

1. The operator should give emphasis to the proper and effective implementation of CRM in the company.
2. The operator should establish a system to ensure the proper implementation of SOP in all phases of flight.
3. The operator should establish an effective mechanism to monitor and assess mental status of the crew in regards to profession development, financial issues as well as personal and psychological issues.
4. The operator should establish and implement a policy to de-roster any crew member found to be stressed, fatigued or emotionally disturbed.
5. The operator should reexamine its system to ensure that all the relevant documents are timely reviewed and updated.
6. The operator should revise their training process to include circling approach for RWY 20 Kathmandu on the simulator.
7. The operator should reassess its preflight briefing to ensure that a proper pre-flight briefing to the crew by the dispatcher has been conducted at the appropriate time.
8. The operator should revise their training process to include provision of safety pilot during KTM Route clearance training for less experienced pilots.
9. The operator should ensure that Line Oriented Safety Audit (LOSA) should be carried out periodically.

10. The operator should encourage the crew members to be specific regarding their medical issues and habits in the medical self-declaration form.
11. The operator should reinforce firm policy regarding No Smoking in the flight and have a system in place to monitor it proactively and take actions accordingly.

4.3 To the CAAN

1. CAAN should strengthen the capacity of the ATCs, by developing the appropriate training programme so that they become more assertive when handling the traffic and issuing clearances to such traffic especially in the event of the abnormal or emergency situations.

2. The ATC to be more vigilant and shall visually look out for the aircraft after the landing clearance has been issued in VMC.

APPENDIX 5.17 OF FINAL REORT PROVIDED BY AAIG-BD

(Comments from Bangladesh for inclusion as appendix to the Final Report as per Standard 6.2 of ICAO Annex 13)

Standard 6.2 of ICAO Annex 13 specifies, "If the State conducting the investigation receives comments from other States shall either amend the draft Final Report to include the substance of the comments received or, if desired by the State that provided comments, append the comments to the Final Report".

1. Bangladesh provided number of comments to the Accident Investigation Commission of Nepal which were included in the final report. However, a few of the comments provided, as below, have not been included in the final report.

2. Bangladesh requested the Accident Investigation Commission of Nepal to include them as Appendix 5.17 to the Final Report which is shown below.

3. The final report of Nepal together with the following comments are hereby published in the CAAB Website for the consumption of public.

The Comments are:

SL	COMMENTS IN PLAIN TEXT BY BANGLADESH	CORRELATED REFERENCE
1.	It is determined that the probable cause of the accident was due to, **in one hand,** the PIC's loss of situational awareness as a result of failure to capture and subsequently ending up offset to the proper approach path, thereafter descending lower than the minima, yet not initiating a go around and above all maneuvering of the airplane in unsafe attitude with an attempt to align the aircraft with the runway in shear desperation to land and, **on the other hand,** negligence on the part of the ATC Controller to monitor through the parallel monitor of the surveillance radar kept the in the control tower, thereby not having deliberately looked for the aircraft in the final in order to assess the extent of deviation of the aircraft from the final approach path for RWY 02, too late, yet arbitrarily informing the aircraft that it was going for the RWY 20, not having given radar vector with an assertive tone knowing well that the pilot was maneuvering the aircraft in a disoriented manner, ducking down under the table having seen the aircraft's reckless flight path being above the domestic tarmac and below the ATC tower height and above all, the absence from ATC of any instruction or advice for any probable last minute corrective action (go-around!) that the flight crew could take to avoid the accident.	To be read at the end of the 'SYNOPSIS' of the Final Report.
2.	The tower reported winds from 220 degrees at 7 knots with tailwind component of 6 knots and cleared the flight to land RWY 02 by neither monitored in the radar monitor, kept in front of the controller, of the actual position of the aircraft nor having seen the aircraft visually from the tower about its position or the position of the landing gear.	To be read at the end of the Para 2.2.2 (The Approach) of the Final Report.
3.	On the day of the accident, the TIA ATC Tower had at least three tower controllers who were involved in dealing with BS 211. Those were, one controller on 'OJT', one fully qualified instructor controller and the other one was the 'supervisor' controller. The 'OJT' controller was sitting on the 'hot' seat, the instructor controller was just beside the 'OJT' controller and	To be read at the end of the Para 2.4.1.3 (The ATC Controllers) of the Final Report.

the supervisor was seated behind the two. One surveillance radar monitor was located just on the table at 2 O'clock position of the 'Hot' seat. The radar monitor, a parallel set to actual radar monitor, usually provides the position of aircraft in and around the KTM Valley including the approach flight path of all landing aircraft.

Initially BS 211 was controlled by the 'OJT' controller who could possibly identify the deviation of BS 211 from its actual approach path of RWY 02 and inform the aircraft accordingly, but did not do so. Moreover, the 'OJT' controller waited for too long time, for reasons not known to the commission, until BS 211 had already had gone past the eastern downwind of KTM RWY and was beyond 3 NM northeast of KTM VOR when the 'OJT' controller alerted the PIC by merely assuming that the aircraft was going for RWY 20 for landing. As BS 211 was in the final and landing clearance was given by the 'OJT' controller, no evidence was also found that the 'OJT' controller applied the required effort to visually observe the aircraft position (including landing gear position) when on short final. Although there was ample time and opportunity for the 'OJT' controller, having observed that the aircraft was flying from south to north along the downwind leg on the eastern side of the RWY, to instruct the aircraft to commence a missed approach (go-around), the 'OJT' controller did not do so.

The duty tower controller then took over the R/T and soon after the supervisor took over, requested and confirmed that BS 211 was on VFR. At this position, although the PIC indicated that he wanted to land on RWY 02, the supervisor controller, though initially confused, saw the aircraft turning right from its position at about 4-5 miles northeast of the VOR waited for the aircraft to rollout on the right downwind of RWY 02. But, by having seen that the aircraft continued its right turn beyond the downwind heading and by then went about 3-4 miles northwest of the VOR and was turning further towards northerly heading, the supervisor advised the aircraft to hold at its present position because of a landing traffic for RWY 02. The investigation commission could not ascertain if the supervisor controller could appreciate regarding the abnormality of the aircraft flight behaviour at this stage. The investigation commission also did not find any logic for the ATC controller to give a landing clearance to another aircraft when the previously cleared BS 211 was yet to land but was seen maneuvering the aircraft in a disoriented manner at a very low altitude inside the northern part of Kathmandu valley.

However, the typical maneuvering behaviour of the aircraft triggered a local pilot in an aircraft on ground that the flight crew appeared to be disorientated. The local pilot spontaneously advised the tower to give the aircraft radar vector for the PIC's status being disoriented and also advised the tower to take him out of the area, for, the area having poor visibility. To this, the supervisor tower controller very timidly announced if the aircraft needed radar vector which was not acknowledged by the PIC. The instruction regarding the radar vector was never repeated assertively by the supervisor controller.

The aircraft was always in visual contact with the ATC Controllers as were expressed by the controllers when interviewed by the investigation commission. In a disoriented manner, when the aircraft was making very

	low maneuvers inside the valleys in dangerous way, the supervisor controller kept quiet and continued to observe the terrifying movement of the aircraft (aircraft at 90 degree angle with the TWY landing path) until at one time he announced that the landing clearance was cancelled. Thereafter, when the aircraft made a very steep turn at very low height over the domestic hanger and was passing its heading through the tower building during to align the aircraft with the RWY heading, the tower controllers ducked down out of fear. Seeing the aircraft's dangerous maneuvers at very low heights over the apron and taxi track areas while the PIC was trying to position the aircraft in line with the RWY, the supervisor controller remained numb and did not provide any positive evasive instruction (go-around!) to the aircraft from being crash.	
4.	The ATC controllers, who had the aircraft in visual contact at all times (as per their admission during the interrogation), did not contribute to regulate the aircraft flight movements in the right direction in spite of the fact that the local pilots advised the ATC controller of the status of ground disorientation by the flight crews of BS 211. To the effect, the local pilot's warning regarding the probable confusion by the flight crews on the issue of RW 02 and 20, the condition of visibility in the area the aircraft was flying at low altitude being poor due mountains and types of terrain and not the least, the advice given by the local pilots to give the aircraft radar vectors to safer areas were not addressed sincerely and effectively by the tower controllers. An instant and executive advice by the ATC Controller to the PIC to discontinue landing and climb up straight ahead at the very last moment, or words to that effect, just prior to its touch down, could have contributed favorably to evade the accident. The radar scope, kept in the ATC tower was not monitored as an alternate means to track this aircraft approaching for landing during its initial approach for landing at RWY 02. Should this monitoring conducted reliably, the deviation by the aircraft from the desired path for its approach to RW 02, at the very first instance, would have been detected and remedial instruction could have been advised by the ATC thereof to avert the pilot's loss of situational awareness and geographic disorientation.	To be read at the end of the Section 3 (Conclusion) of the Final Report.
5.	The probable cause of the accident was due to, **in one hand,** the PIC's complete loss of situational awareness which was compounded by geographic disorientation as a result of failure to capture and subsequently being offset to the proper approach path, thereafter ending up at low altitude yet not initiating a go around and above all maneuvering of the airplane in an unsafe attitude with an attempt to align the aircraft with the runway in shear desperation to land and, **on the other hand,** complete negligence on the part of the ATC Controller to monitor in the surveillance radar parallel monitor kept the in the control tower, the extent of deviation of the aircraft when in the final approach path for RWY 02, not having deliberately visually seen the aircraft in final, too late to advise the aircraft that it was going for the RWY 20, not having given radar vector with an assertive tone, ducking down under the table having seen the aircraft flight path and above all the absence from ATC of any instruction or advice what	To be read at the end of the Section 3.2 (Causes) of the Final Report.

	so ever for any probable last minute corrective action that the flight crew could take to avoid the accident.	
6.	3. The CAAN ATC controller should monitor the tracking of the aircraft approaching for landing for RW 02 at all times and provide instructions in cases of any deviation as soon as possible. 4. The CAAN ATC controllers of KTM should undergo Human Factor Training to better understand flight crew constraints in cases of situational awareness and/or geographic disorientation and provide prompt assistance if required.	To be read at the end of the Section 4.3 (Safety Recommendation to the CAAN)

END