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Research Article

Aircraft Accidents in India

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ABSTRACT

Air transport in India over a period of time has increased and so has the number of mishaps and emergencies. There is an imperative need to understand the causes of accidents. In addition to this to study the impact of such accidents on human life and financial losses in aviation industry. Additionally, there is need to suggest effective remedial measures. Directorate general of civil aviation (DGCA) is the regulatory body which deals with issues related to safety in aviation industry in India. Airport authority of India is responsible for planning, developing, and maintaining airport infrastructure, including runways, taxiways, terminal buildings, and parking areas. The Indian aviation industry has grown rapidly in the recent years. There is an increase in the number of flights per day. Such a surge in the number of flights per day has led to spurt in the number of air accidents occurring each day. An elaborate study including planning and re-planning to avoid disasters is the part of study undertaken. Important issues human errors, defective equipment and inclement weather are included in the study undertaken.

Keywords: Aircraft accidents, Aviation accidents, Plane crashes, Indian aviation, India.

INTRODUCTION

Air transport in India over a period of time has increased and so has the number of mishaps and emergencies. There is a need to understand the causes and the details for accidents to decrease the loss of human life and financial losses in the aviation industry. There is a special need to undertake remedial measures at the ground level ie at the apron and in the air. Directorate general of civil aviation is the regulatory body (DGCA) which deals with safety issues. Due to increase in the number of air accident on daily basis and elaborate study of planning at the management level as per the guidelines and at the ground level is needed significantly.

A systematic literature review to understand the reason of accidents have been carried from 2015

DGCA under ministry of civil aviation has set guidelines for the safety issues at all level. In this paper the ground management at airports are being discussed where it has been observed that major causes for accidents are

1. Descend and landing (37%)
2. Taxi and take-off (18%)
3. Flight manoeuvres (7%)
4. Fuel management (4%)
5. Mechanical problem (17%)
6. Weather (17%)

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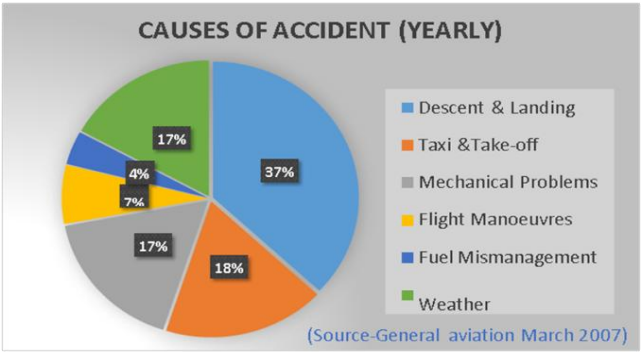

Figure 1. Causes of Aircraft Accidents (Yearly)

From the above table one describes the operations at the ground management at the airport to understand why accidents at the apron area take place.

Occurrence of Incidents at Air Side

Incident, as defined by DGCA, means an occurrence other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Airport Ramp

1. The airport Apron, Ramp, or Tarmac consists of area of an airport where aircrafts are parked, unloaded or loaded, refuelled, boarded, or maintained.
2. Use of the Apron is covered by regulations, typically more accessible to users than the runway or taxiway.
3. The Ramp area (sometimes called Apron) is under the responsibility of both the Airport Management and the Airlines. The Airport Management enable passengers and cargo access to air transportation such as gates, cargo hard stands, passenger loading bridges, and fuelling systems. Airlines lend gates and obtain rights to use the facilities from the Airport Management.
4. Ground operations which occur in the ramp areas include a number of services. These operations are either managed by the airlines or outsourced to subcontractors (Landry & Ingola, 2011).

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Ramp Accidents

According to the researchers, the factors, responsible leading to ground crew error are listed below.
Poor situational awareness (clearance, air stair/jet bridge/ vehicle operations);
Ineffective communication (tug/truck/belt loader driver– pilots– wing walkers);
Lack of supervision including quality assurance;
Ramp agents - ignorance of safety criteria;
Physical fatigue;

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Personal health and medication:

Types of Damage Occurance

Ground equipment, and ground personnel, are generally vulnerable to damage or injury in ramp operation incidents.

Ground equipment damage generally occurs in the gate stop area, lesser in the gate entry/exit areas, and rarely on the ramp fringe areas.

Aircraft-to-aircraft damage usually occurs in the ramp and gate entry/exit areas, where the taxiing aircrafts share the common manoeuvring area. They are generally in radio contact with a controlling agency. Occurrences mentioned cause large financial loss to the company in flight delays, employee lost-time, insurance, medical, and other costs.

Ground Management at the Airport

This table outlines key operational zones, their descriptions, and functions, with a focus on machinery, aviation management, and airport management responsibilities.

Table 1. Airport Areas, Operations, and Management Roles

Area	Description of area	Operations
Landside Area	Parking lot, terminal building, fuel tank farms, access roads, public transportation, shop for passengers, airline cargo terminal, airport check-in area	(1) customer service roles-includes overseeing the terminal, concourses, roadways and properties surrounding the airport. Fuel pump store fuel, public transport facilities for, shops offer variety of options ie electronics, gifts. (2) Activities-day to day operations inside the terminal. Check-in area, boarding gates, arrival area, departure area, baggage makeup area, ticketing counter.
Airside Area	Runways, taxiways, aprons, hangars, warehouses,	(i) Movement of goods and passengers from terminal to airside. (ii) Movement of equipment like trolleys, baggage freight loader, fuel tanker, follow-me vehicle, catering vehicles, aerobridge. (iii) Mechanical work on the aircraft inside the hangar. (iv) Air freight goods are stored inside the warehouse. (v) Public access is restricted in apron area
Source: Ankush Malik		
Machinery	**Non-powered ground support equipment-** Aircraft Tripod Jacks, Baggage trolley, ladder, chocks **Powered ground support equipment-** Pushback tractor, Baggage freight	Needed for passenger and baggage movement. Refueler is a vehicle that fills aircraft with fuel. Ground power unit provides electrical power to an aircraft on ground. Pushback tractor is a vehicle used to move aircraft from parking bay to taxiway at airport. Lavatory truck is used for storing wastewater and it has systems for removing waste from the aircraft's lavatory system. Portable water trucks provide clean water to aircraft.

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	loader, Lavatory trucks, Portable water trucks, Ground Power Units, Buses, Refueler, Tugs and Tractors	
Aviation Management	Coordinating operations in the airline and airport industries, and other businesses related to aerospace.	Safety and maintenance: Ensuring the safety and maintenance of aircraft Planning: Making flight schedules and dealing with emergencies Quality assurance: Ensuring quality and safe procedures Cargo and passenger services: Managing cargo and passenger services.
Airport Management	Safe and secure operation of an airport for passengers. Administration of airports and airlines and assessing information that is crucial for airline operations.	Airport management is the administration of airports and airlines. This field includes activities like setting the strategy of airports and assessing information that is crucial for airline commercial and operational priorities. Airport management ensures smooth functioning of aviation practices essentially needed for the safety of flyers, flight management and commercial operations.
To ensure safety of flyers, flight management and commercial operations.		

The responsibility of the airlines and operator is mentioned to get insight of the operations at the airport.

Accidents at Airports

This table outlines the Airside operational areas, specifically the Ramp (Apron, Tarmac), detailing the shared responsibilities of airport operators and airlines in facilitating safe and efficient passenger and cargo services.

Table 1. Airside Areas, Descriptions, and Operations at Airports

AIR SIDE	AREA	OPRATIONS
Ramp	Apron, ramp or tarmac	Responsibility of airport operators and airlines. Airports management enables passengers and cargo access to air transportation such as gates, cargo hard stands, passenger boarding bridges and fuelling systems. Airlines obtain rights to use the facilities from airport operator. Movement of cargo, movement of engineering ground staff, pilots and crew etc. passenger boarding and de-boarding

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Accident and Reasons

According to the researchers, the factors, responsible leading to ground crew error are listed below.
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Ineffective communication (tug/truck/belt loader driver– pilots–
wing walkers);
Lack of supervision including quality assurance;
Ramp agents - ignorance of safety criteria;
Physical fatigue;
Personal health and medication:

Manpower

RECOGNITION OF HUMAN FACTORS FOR INCIDENT AT AIRPORTS

Human factors impact the efficiency of aviation system considerably. These factors are recognised as 'The Dirty Dozen'. These twelve elements (Developed by Gordon DuPont, in 1993.) influence adversely the people employed in aviation sector.

Lack of Communication

Lack of communication means unclear communication. It is one of the major causal factors for occurrence of an air accident. And appears to be at the top of contributing and causal factors in accident reports. Therefore, it is one of the most critical human factors.

Complacency

Complacency means a feeling of self-satisfaction. Such a feeling may arise while conducting the normal activity. Complacency can also occur while undertaking a highly intense activity.

Lack of Knowledge

The requirements for training and qualification can be comprehensive. Organisations have to strictly enforce this. Lack of experience and specific knowledge may lead workers to take incorrect and unsafe decisions.

Distraction

Anything that attracts the attention of a person away from the work on which they are working, is loud noise, which may lead to distraction of attention causing a severe accident.

Lack of Teamwork

In aviation many tasks and operations are team affairs. Someone's not contributing to the team effort leads to unsafe outcomes. The main reason for non-cooperation between colleagues may be due to non-existence of cordiality between the team members.

Fatigue

Fatigue is a natural physiological reaction and leads to physical and/or mental stress. Fatigue in chronic condition may require medical attention Can have significant effect on pilot's performance.

Lack of Resources

If all the members of the team are not available to complete a task, then there may be physical and mental pressure on team members. Various resources, such as personnel, time, data, tools, skills, experience, etc., are necessary to complete any task. Insufficient staffing, equipment, documentation, time, parts, etc., can interfere with one's ability to complete a task. In case of lack of resources do not hesitate to postpone the task.

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Pressure

Existence of pressure on team members, to meet a deadline interferes with their ability to complete tasks correctly. Pressure is a part of the working environment. It affects the ability to complete tasks correctly and in time frame. However, pressure becomes more on persons by taking on more work than what can be handled. If more time to complete a task, is needed it may be asked for clearly.

Lack of Assertiveness

Inability to express own concerns and not allowing others to express their concerns creates ineffective communications and damages teamwork. Lack of assertiveness can occur when someone lacks the self-confidence to speak up for their rights and ideas, ultimately leading to the failure to communicate.

Stress

There are many types of stress. Typically, Acute stress arises from dealing with an emergency work or working under time pressure with inadequate resources. In aviation stress is always present due to various factors. Aircraft must be airworthy and flying to make money for any airline. Maintenance must be done within a timeline to avoid flight delays or cancellations.

Lack of Awareness

Working in isolation can lead to stress, fatigue and pressure. lack of awareness. The lack of awareness means failure to understand the consequences of our actions. This does not mean that we do not have the knowledge needed to perform the task. It is just that occasionally we do not know the likely results of doing or not doing work.

Norms

Workplace practices are generally developed over time through experience under the influence of a specific workplace culture. These practices can be both, good and bad, safe and unsafe. Unfortunately, such practices follow unwritten rules or behaviours.

Safety Precautions

AIRCRAFT FUELING AND DE-FUELING

Fuelling and defueling of aircraft needs to done very carefully. None other than those required to undertake the process should enter the fuelling safety zone.

During fuelling and defueling operations, carrying open flames or lit open flame can be disastrous. When passengers are on board, just one exit from the aircraft may be kept open.

Common Accident at Ramp

In this area there is a conflict between Man, Machine and Meteorology

Anybody standing close to the aircraft's nose can be sucked in by the front side when the engine is running.

Due to the jet explosion, burnt body parts of those who were standing near to the aircraft on the back side have been discovered.

"Right of Way" regulations are required to be implemented strictly correctly followed, to avoid a collision between airplanes turning right.

Ground Crew Error in Aviation

Poor situational awareness (clearance, air stair/jet bridge/ vehicle operations);
Ineffective communication (tug/truck/belt loader driver– pilots–wing walkers);
Lack of supervision/quality assurance;
Ramp agents' ignorance of safety criteria;

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Physical fatigue;
Personal health and medication

Consequences of a Fuel Spill

A fuel spill may turn into a fire hazard in the close proximity of the aircraft. Failure of the hose/refuel connector and refuel trucks driving away from the aircraft are not uncommon. Occurrence of such incidents may lead to disruption of the airport operations. The primary risk is unintended ignition of fuel vapours, which can occur by a single spark. Sufficient quantity of fuel vapours can create a high risk of ignition. Spillage arising from procedural errors, leaks, aircraft tank venting, may get ignited due to a spark created (i) from the movement of the fuel in the aircraft tank during the fuelling process, (ii) or its accumulation on the surface of aircraft or vehicles. It is interesting to note that there were more incidents in the gate stop area during arrival (48%) than during departure (31%). It was also noted that there were fewer incidents on the ramp fringe areas during arrival (13%) than during departure (30%).

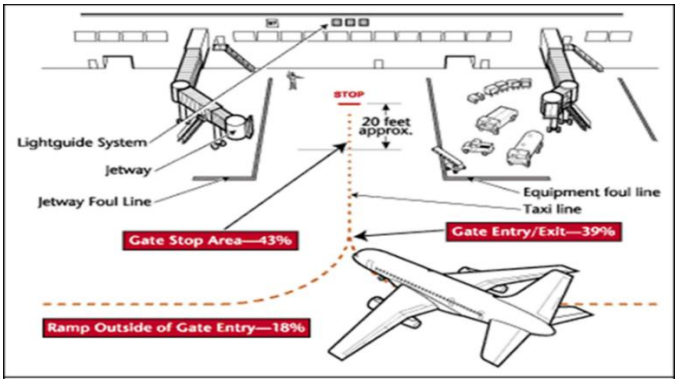

Figure 2. Ramp operations areas and percentage of incident locations

This diagram illustrates key zones at an airport apron, identifying the Gate Stop Area (43%), Gate Entry/Exit (39%), and Ramp Outside of Gate Entry (18%) as critical areas for incident occurrence. It shows spatial layout, jetways, equipment lines, and movement paths to highlight safety and operational considerations in apron management.

Ramp operations areas and percentage of incident locations (Source: Koscak et al., 2018)

Problem Recognition

The above discussion related to Human Factors in Aviation, the problems cropping up have been identified in detail. The errors recognised above, constitute the major cause for occurrence of accidents and incidents in Aviation Sector of India. The data collected from the D G C A, and other related agencies including airlines, the quantum of such Aviation accidents is about 80 percent of the total of the total accidents taking place. In Indian Aviation scenario as per figures available, the Human Error alone is responsible for not only loss of human lives but causes a Hugh financial loss as well. Loss of Human lives is about 80 percent of the total deaths taking place in Air accidents. According to the reports available Human Factors are the major cause of aviation accidents and incidents in India. According to figures available Human Factors are cause for occurrence of 80 percent of them for up to 80% of them.

Based on the assessments made by the Aviation experts, following sub-categories of Aviation accident or incidents have been recognised.

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1. **Pilot Error, 73 % (ii)Special Disorientationn,16% (iii) Health Problem, 5% (iv) Deliberate Crash,1% (v) Accidental ejection on ground, 2% (vi) Lack of Maintenance, 1%**
2. **Pilot errors**

In aviation, pilot error generally refers to an action or decision made by a pilot that that substantially contributes toward accruing of an aviation accident. It includes a pilot's failure to make a correct decision and taking proper actions for controlling the flight.

Generally, pilot error occurs during landing and taking-off.

This may be due to A physiological state of reduced mental or physical performance capability resulting from sleep loss, extended wakefulness, excessive workload, etc.

3. **Cause and Effect of Fatigue and Its Contributing Factors in Aviation**

Fatigue may impact pilots, leading to impaired attention, sleepiness, and short bouts of sleep during flights. These factors may impact the pilot's responsiveness and attentiveness.

Cognitive functions like sustained attention, and memory are affected badly due to reduced performance, resulting into to increased errors, and reduced situational awareness.

Fatigue may also lead to long-term health problems including reduced productivity, depression, anxiety. There is a possibility of acquiring conditions such as obesity, diabetes, hypertension, and certain cancers.

Adequate rest, strategic scheduling, and promoting conducive sleep environments are essential in fighting fatigue in aviation.

4. **Special Disorientation**

spatial disorientation, the inability of a person to determine his true body position, motion, and altitude relative to the earth or his surroundings. Both airplane pilots and underwater divers encounter the phenomenon.

5. **Health problem**

These medical conditions include a personality disorder manifested by overt acts, a psychosis, alcoholism, drug dependence, epilepsy, an unexplained disturbance of consciousness, myocardial infarction, angina pectoris, and diabetes requiring medication for its control.

Problem Formulation

The Analytic Hierarchy Process (AHP) is a decision-making tool that uses a structured approach to analyse complex problems with multiple criteria. The AHP process involves the following steps:

Define goals: Understand the goal of the decision-making process

Identify the problem: Define the problem to be solved

Structure criteria: Organize criteria into matrices

Estimate criteria importance: Use expert judgments to estimate the importance and weight of each criterion

Analyse and select: Analyse the criteria and select the best option

The Analytic Hierarchy Process (AHP) has been developed by T. Saaty (1977, 1980, 1988, 1995) and is one of the best known and most widely used MCA approaches. It allows users to assess the relative weight of multiple criteria or multiple options against given criteria in an intuitive manner.

The essence of the process is decomposition of a complex problem into a hierarchy with goal (objective) at the top of the hierarchy, criterions and sub-criterions at levels and sub-levels of the hierarchy, and decision alternatives at the bottom of the hierarchy.

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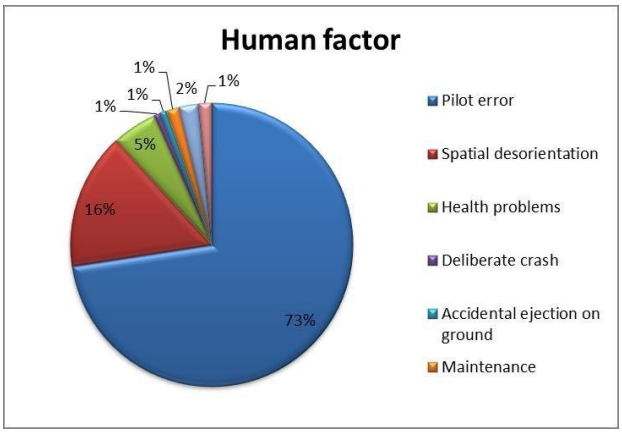

Figure 3. Human Factors in Aviation Accidents

This figure represents the proportional distribution of human factors contributing to aviation accidents, visualized through a pie chart. It highlights the major causes:

1. Pilot error (73%)
2. Spatial disorientation (16%)
3. Health problems (5%)
4. Deliberate crash (2%)
5. Accidental ejection on ground (1%)
6. Maintenance issues (1%)

The chart emphasizes the predominance of pilot error in aviation accidents. Let me know if you want a formal caption or detailed explanation added!

AHP TABLE 1

Table 2. Human Factors ("Dirty Dozen") in Aviation Accidents

Human Factors	Pilot error	Spatial disorientation	Health problem	Deliberate crash	Accidental ejection on ground	Maintenance	Eigen Vector	L/EV(A)	λ MAX
Pilot error	1	8	5	1.5	1.5	2	0.3278	3.36916	
Spatial disorientation	0.125	1	2	2.5	3	7	0.2119	7.88132	
Health problem	0.2	0.5	1	3	5	3	0.1773	5.39433	
Deliberate crash	0.6666	0.4	0.3333	1	2	4	0.1303	1.14324	
Accidental ejection	0.6666	0.3333	0.2	0.5	1	2	0.0821	0.27824	
Maintenance	0.5	0.1428	0.3333	0.25	3	1	0.0705	0.17807	
							1		**7.88132**

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Result of First Run of AHP

1. Eigen vectors in the first run have been calculated
2. The value of sum of eigen vectors is =1
3. Lemda max have been calculated

Inference

Pilot error has highest value.

Table 3. (Sensitivity Analysis)

Factor	Pilot error	Spatial disorientation	Health problem	Deliberate crash	Accidental ejection on ground	Maintenance	Eigen Vector	L/EV(A)	λ MAX
Pilot error	1	8	3	1.5	1.5	2	0.3094	3.069995 2	
Spatial disorientation	0.125	1	2	2.5	3	7	0.2177	7.905505 08	
Health problem	0.2	0.5	1	3	5	3	0.1821	5.405172 1	
Deliberate crash	0.6666	0.4	0.3333	1	2	4	0.1339	1.417 7174	
Accidental ejection	0.6666	0.3333	0.2	0.5	1	2	0.0984	0.280394 4	
Maintenance	0.5	0.1428	0.3333	0.25	3	1	0.0725	0.179 035	
							1		**7.905505 08**

Old Write-Up

Manpower

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This table presents the Analytic Hierarchy Process (AHP) pairwise comparison matrix for the Dirty Dozen human factors in aviation accidents. It displays the relative importance (comparison values) between the factors, where "1" denotes equal importance, based on expert judgment. The table highlights the subjective relationships between factors such as Fatigue, Lack of Communication, Complacency, and others in contributing to aviation accidents.

Table 4. Human Factors ("Dirty Dozen") in Aviation Accidents

Human Factors	Lack of Communication	Distraction	Stress	Complacency	Lack of Teamwork	Fatigue	Lack of Assertiveness	Lack of Awareness	Eigen Vector
Lack of Communication	1	4	0.3333	0.2	0.1666	0.1428	0.2	0.25	0.03714
Distraction	0.25	1	5	3	8	4	5	2	0.2467
Stress	3	0.2	1	4	5	2	7	1.25	0.1212
Complacency	5	0.033	0.25	1	4	3	7	4	0.1883
Lack of Teamwork	6	0.125	0.2	0.25	1	2	4	3	0.1003
Fatigue	7	0.125	0.2	0.3333	0.5	1	1	1	0.0972
Lack of Assertiveness	5	0.2	0.25	0.1428	0.25	0.1666	1	6	0.0564
Lack of Awareness	4	0.5	0.666	0.25	0.6666	0.5	0.1666	1	0.0617

Table 5. AHP Pairwise Comparison Matrix for Human Factors in Aviation Accidents (Dirty Dozen Model)

Variables	Lack of Communication	Distraction	Stress	Complacency	Lack of Teamwork	Fatigue	Lack of Assertiveness	Lack of Awareness	Eigen Vector
Lack of Communication	1	4	0.3333	0.2	0.1666	0.1818	0.2	0.25	0.038436925
Distraction	0.25	1	5	3	8	4	5	2	0.247671352

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Stress	3	0.2	1	4	5	4	5	1.5	0.213066873
Complacency	5	0.33	0.25	1	4	3	7	4	0.189103045
Lack of Teamwork	6	0.125	0.2	0.25	1	2	4	3	0.100753104
Fatigue (highlighted)	4.5	0.25	0.2	0.333	0.5	1	6	2	0.092379449
Lack of Assertiveness	5	0.2	0.25	0.1428	0.25	0.1666	1	6	0.065595959
Lack of Awareness	4	0.5	0.666	0.25	0.6666	0.5	0.1666	1	0.061996 83

Table 6. AHP Pairwise Comparison Matrix for Human Factors (Dirty Dozen Model) in Aviation Accidents

Variables	**Lack of Communication**	**Distraction**	**Stress**	**Complacency**	**Lack of Teamwork**	**Fatigue**	**Lack of Assertiveness**	**Lack of Awareness**	**Eigen Vector**
Lack of Communication	1	2	0.3333	0.2	0.1666	0.1818	0.2	0.25	0.034581941
Distraction (2)	0.5	1	5	3	8	4	5	2	0.264992757
Stress	3	0.2	1	4	5	4	5	1.5	0.209047708
Complacency	5	0.33	0.25	1	4	3	7	4	0.18553592
Lack of Teamwork	6	0.125	0.2	0.25	1	2	4	3	0.098852558
Fatigue (1) (highlighted)	4.5	0.25	0.2	0.333	0.5	1	6	2	0.090636859
Lack of Assertiveness	5	0.2	0.25	0.1428	0.25	0.1666	1	6	0.055527984
Lack of Awareness	4	0.5	0.666	0.25	0.6666	0.5	0.1666	1	0.060824272

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