

The Impact of Pressure on Risk Evaluation in Decision-Making: A Case Study of Three Major Accidents

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Abstract. Decision-making is critical in organizational and managerial activities, and stress is an important factor influencing decision-making. This study examines how stress affects risk assessment and decision-making by analyzing three major accident cases (the Fukuchiyama Line derailment, the NASA Challenger STS-51L accident, and Boeing 737 Max 8 design problems). In the Fukuchiyama Line accident, the driver ignored the risk of speeding the train for fear of company penalties. In the Challenger accident, NASA ignored the risk of a leaking O-ring due to political, media, and internal cultural pressures. In the Boeing 737 Max 8 accident, Boeing ignored potential risks in the design of the MCAS system and a single sensor in an effort to catch up with competitor Airbus. This study points out that pressure can lead decision makers to ignore risks with disastrous consequences and suggests that the quality of decision making can be improved by information gathering, seeking expert advice and taking known issues seriously.

Keywords: Decision Making Under Pressure, Risk Evaluation, Organizational Accidents.

1. Introduction

Decisions arise from the need to solve a problem or the need for change, and they play an important role as they determine organizational and managerial activities [1]. Making wise decisions is important in solving a problem, and rational decision-making has become a pursuit for many individuals, organizations, and enterprises. However, making rational decisions in real-life situations is always difficult. A key factor that affects decisions is pressure. For individuals, pressures will make them nervous and sometimes blinded, resulting in an inaccurate judgment of their circumstances and the risk they face, affecting their final decision. For organizations and enterprises, pressures will cause arguments in management, and some valuable suggestions, perspectives, and risks will be neglected. Once the risk is overlooked, the decision may become too risky and cause negative effects.

However, under pressure, people's potential ability can be stimulated. In this situation, pressure can also catalyze new ideas, providing a more comprehensive perspective on the problem. Some hidden risks may be found in new perspectives and help make better decisions. For individuals, pressure can help them increase their working efficiency, including solving problems faster and creating more ideas. For organizations and enterprises, pressure may push them to search for new plans and solutions, which may help them deal with the risk properly and even create new chances for the organization or enterprise.

Although pressure may bring problems for risk evaluation and decision-making, there are certain ways to overcome the negative effects of pressure. For instance, searching for more information will help people understand the situation better, which will assist people in analyzing the risks and opportunities deeper and finally making a wise decision. In an organization or enterprise, encouraging staff to give more advice and discuss it before deciding is also useful for managers to expand their horizons, thoroughly understand the risks, and make thoughtful decisions. All these methods will help individuals, organizations, and enterprises enhance their risk evaluation and decision-making procedures.

This study will discuss how pressure influences risk evaluation in decision-making using examples from individuals, organizations, and enterprises. It will also suggest how decision-makers can use different methods to overcome the negative effect of pressure and evaluate the risk accurately to help them make decisions.

2. Case Study

This section will use three cases to analyze the effect of pressure on risk evaluation in decision-making. These cases are the derailment accident on the Fukuchiyama Line, the NASA Challenger STS-51L accident, and the Design problem in the Boeing 737 Max 8.

2.1. The derailment accident on the Fukuchiyama Line

On April 25th, 2005, a seven-car commuter train driving on the JR Fukuchiyama Line came off the tracks. The train entered a curve between Tsukaguchi Station and Amagasaki Station with a radius of 304m at a speed of 116km/h, much greater than the speed limit of 70km/h, resulting in the derailment of the first to the fifth train cars. The first and second cars collided with an apartment beside the curve. 106 passengers and the driver died in this accident, and 562 passengers were injured [2].

The driver's wrong judgment and decisions are the most likely reason for the accident. Before the accident, when the train passed through the Itami Station, the train didn't stop at the correct position. As a result, the driver needed to back up the train, which caused a 90-second delay in the schedule. In order to catch up with the schedule, the driver increased the train's speed. The train passed through Tsukaguchi Station at a 120km/h speed, and the delay was reduced to 60 seconds. He kept the speed until 4 seconds before he saw the curve [3].

The driver increased the speed beyond the limit because he needed to catch up with the schedule to avoid punishment for the mistakes he made before the accident. The punctuality rule in the railway company, JR West, is very strict [4]. That is because of the tight timetable of the train, and as a result, even a small delay in the schedule will heavily affect the timeframe for the rest of the day. Ten months before the accident, the driver was punished by JR West because he overshot a station platform by 100 meters. JR West drivers would face financial penalties and accept a harsh retraining program called "nikkin kyōiku", which means dayshift education. This program consisted of severe verbal abuse, forcing the employees to repent by writing extensive reports. When the driver made mistakes again on April 25th, 2005, he feared being punished again by the company. As a result, he may keep thinking about the punishment a few minutes before the accident and not focusing on driving the train. In the final report, the retraining system is also concluded as a factor causing the accident [5].

In this accident, the pressure on the driver is the punishment from the JR West Company. The last time he made serious mistakes, he had already faced the humiliating "nikkin kyōiku", which may create fears about the program in the driver's mind. As a result, he naturally wanted to escape from the punishment, and this thought made him underestimate the risk of increasing the speed. It's clear that the train's speed is much higher than the limited speed of the train, which is very dangerous, especially in the curve; high speed will create a huge centrifugal force, which will cause derailment. The driver didn't pay enough attention to the risk in his decision. Hence, his decision at that moment seemed right and wise for him: he could avoid punishment from the company, and the train could catch up with the timetable, but in fact, the high risk behind the decision would cause devastating results: the derailment of the train.

2.2. The NASA Challenger STS-51L accident

On January 28th, 1986, 73 seconds after the Space Shuttle Challenger started its flight mission STS-51-L, the space shuttle disintegrated (at 16:39 UTC), and all seven crew members aboard died in the accident. The cause of the disaster was an O-ring seal failure in its right solid rocket booster. This allowed hot gases to leak and damage the external fuel tank, disintegrating the shuttle. The O-ring failure was due to extremely cold temperatures on the morning of the launch, which compromised the seal's integrity [6]. Although it seemed that design problems caused the accident, NASA did neglect the issue before the flight because of the pressure surrounding them.

Political pressure. NASA was under significant political pressure to demonstrate the success and reliability of the Space Shuttle program. From the inception of the Shuttle, NASA had been

advertising a vehicle that would make space operations “routine and economical”. It had become a symbol of American technology during the Cold War. As a result, they were forced to keep a high launch frequency to justify the program’s costs and reach the expectations of NASA and the American People. This political background created an environment where delays were seen as failures, asking NASA to follow the timetable without delay.

Media pressure. In mission STS 51-L, the Teacher in Space program was started, and the teacher, Christa McAuliffe, was planned to be sent into space in this mission by Space Shuttle Challenger. NASA wanted to gain public interest and support for the Space Shuttle Program, so this mission was highly publicized. Millions of people, including students, teachers, and media, would watch live. The pressure to avoid disappointing the public affected the final decision to keep launching despite the existing risks.

Organizational Pressure (Internal culture). NASA’s culture at that time was focused on meeting schedules. To follow the culture, managers will weaken the effect of risk on decisions about delay. In the final report, it is mentioned that the O-Ring problem has existed since mission STS-2. However, the former problem didn’t affect the launch of previous missions, so the presence of minor problems was accepted as normal. The pressure to maintain the launch schedule overshadowed the need to address these safety concerns. In the STS 51-L mission, NASA neglected the O-Ring problem, which caused the disaster [7].

Engineers at Morton Thiokol, the contractor responsible for the solid rocket boosters, had serious concerns about the O-rings’ performance in cold temperatures. In a teleconference with NASA before the launch of STS 51-L, they mentioned their worries about launching under low temperatures, suspecting there would be problems on O-Ring, and tried to convince NASA to stop launching that day. However, due to NASA's pressure, the NASA managers who took part in this teleconference refused to delay it and neglected the opinions of Morton Thiokol Engineers [8].

The political, public, and organizational pressures faced by NASA led to a series of flawed decisions that resulted in the Space Shuttle Challenger accident and the loss of seven lives. Every small space shuttle problem is worth taking seriously, as they may cause serious consequences. The O-Ring problem has existed for a long time and has been mentioned by many people during the past few years before the accident. However, the pressure of following the timetable caused NASA to neglect them repeatedly and finally caused the tragedy.

2.3. The Design Problem on Boeing 737 Max 8

In 2010, one of the biggest aircraft manufacturers in the world, Airbus, launched their new generation narrow-body aircraft: Airbus A320neo. It can bring 20% fuel savings compared to the previous generation of Airbus aircraft and 10%~15% fuel savings compared to Boeing’s previous generation model: 737NG [9]. In order to compete with Airbus and get back its market share in the narrow-body aircraft market, Boeing announced their new generation of narrow-body aircraft: the 737 Max. Boeing put larger and more efficient engines on the 737 Max 8 to improve its fuel efficiency, however, as the 737’s landing gear is short, putting new engines in the previous position will result in friction with the ground. To solve the problem, the engine was placed in a forward and higher position on the aircraft, creating an aerodynamic effect that made the plane pitch up. To prevent stalls caused by this aerodynamic effect, Boeing equipped the MCAS (Manoeuvring Characteristics Augmentation System) system on the 737 Max 8, which has the purpose of controlling and stabilizing the plane when it pitched up at a high angle of attack so that the plane will not stall. However, even though the MCAS system was a huge amendment to 737’s system and design, Boeing chose not to put it in the operations manual of 737 Max 8. The possible reason for Boeing’s decision was to save time and cost. If MCAS didn’t count as a major amendment to 737’s design, pilots for 737NG didn’t need to be retrained. The retraining process was expensive and time-consuming, and by eliminating this step, airlines can save money and time, which will help them to put the 737 Max 8 into use quickly. This will also help Boeing get the certification of the 737 Max 8 from the FAA quickly, as there’s no major change to the 737 Max 8’s new system. These procedures created risks as pilots

didn't know the MCAS system, and when accidents happened, they didn't know how to properly use or deal with the MCAS system [10].

Besides that, the design of the MCAS system was defective. As the MCAS system relies on the detection of the angle of attack (AoA), two AoA sensors should both be connected to the system to maintain redundancy, so that when there's a problem on one sensor, the MCAS system wouldn't work due to the "AoA Disagreement". Surprisingly, Boeing only connected the MCAS system with one of the sensors, which created risks for sensor failure, and the MCAS system will fail with that. In addition, when designing the MCAS system, Boeing prioritizes the MCAS system permissions over pilot permissions, and pilots need to do a complex procedure to turn the MCAS system off; however, in accidents, pilots usually didn't have enough time to deal with these procedures [9].

On October 29th, 2018, flight JT610, which was a flight operated by 737 Max 8, crashed into the Java Sea, and no one on the board was alive. The MCAS system was wrongly triggered due to inaccurate AoA sensor data. On March 10th, 2019, another 737 Max 8 operated flight ET302 crashed in Ethiopia. The MCAS system was triggered and activated because of the AoA sensor alarm caused by a false reading. These two accidents proved that the design of the MCAS system was flawed. As a result, Boeing suffered huge losses and was forced to change the design of the MCAS system [11].

Throughout the design and manufacturing process, Boeing faced pressure from their competitor's product, Airbus A320neo, and financial drivers put Boeing's employees under too much pressure. For instance, it is said that Boeing management rejected any suggestions that required additional pilot training and time for getting certification, as Boeing needed to catch up with the A320neo as soon as possible. Also, in 2015, an unnamed Boeing Engineer raised the issue of relying on a single AoA sensor in an email. Although there are so many disagreements about the design of the MCAS system, under the pressure of competing with Airbus, Boeing "minimized" the impact of the risks to the design, which finally resulted in the crashes of the Boeing 737 Max 8.

3. Suggestions

Firstly, decision-makers should collect as much information as possible before they make decisions. Information will help them evaluate the present situation more comprehensively, and the more information decision-makers have, the fewer possibilities that they will underestimate the dangers of risks. In the Fukuchiyama Line derailment accident, the driver decided to increase the speed blindly because he didn't know there was a curve ahead, which would create risks. If he had known the information, he would have made wise decisions, such as giving up increasing speed or reducing it before they reached the curve. Although the situation is complex and it's hard for the driver to get enough information, he could check the railway map or ask the train dispatcher about the railway conditions. For individuals' decision-making in daily life, if the time is enough for collecting information, it's always necessary to collect information and evaluate the risks before making decisions, reducing the probability of ignoring risks greatly.

Secondly, for the decision-making in an organization or a company, the decision-maker should ask for advice from people, especially those experienced in these areas. These people's suggestions may be useful, deeply, and provide perspectives from another viewpoint, which will help decision-makers to find hidden risks and solve them. In NASA's Challenger Case, the engineers from Morton Thiokol had already predicted the risks of the O-Ring performance under low temperatures and the possibility of the O-Ring leaking. However, NASA managers were too confident about their judgment and relied too much on their experience in this program. The problem of O-Ring had existed for a long time and had been identified by different sources. For example, the field joint had been listed as a criticality 1 item (no redundancy) since 1982, but in the past launches, there had never been a serious consequence caused by the O-Ring system, so NASA's managers thought that there were not going to have a problem in STS 51-L mission. The managers ignored the extremely low temperature, which had never existed in past launches, on the STS 51-L launch date, but Morton Thiokol's engineers had proposed this problem. The overconfidence made the managers underestimate the risks of O-Ring,

and the pressure of launching made them neglect this “slight” problem. If NASA’s managers had accepted Morton Thiokol engineers’ suggestions and put off the launch, the accident may not have happened. This has proved that decision-makers should always consult other people before making the final decisions so that they can see the problem from a different perspective.

Finally, when there’s a known problem, decision-makers should consider it seriously instead of neglecting it, even if it seems like a slight problem. Sometimes, the problem doesn’t seem serious because there’s a lack of information, and people cannot see the risks behind the mist, so they may underestimate the magnitude of the problem, resulting in disastrous consequences. In Boeing’s 737 Max 8 case, the engineers at Boeing had already identified the problem and risks with a single AoA sensor before it got certification and was put into operation, but the problem had never been paid attention to by the management, as their most important mission is to finish the design and production of the plane so that they can compete with Airbus. Under these circumstances, safety wasn’t put in the first place; instead, they put efficiency at the most important position, so they weakened the effect of the defective MCAS system on the company’s decision, although they already knew the problem. This gives us an important lesson: every known problem should be considered and tried to solve before deciding to minimize the possible risks created by these problems.

4. Conclusion

This study has looked at the derailment accident on the Fukuchiyama Line, the NASA Challenger STS-51L accident, and the Boeing 737 Max 8’s design problems, and discussed the factors that caused these accidents: fear of the company’s punishments (“nikkin kyōiku”) in Fukuchiyama Line’s accident, political pressure (demonstrate the success of the program), media pressure (Teacher in Space Programme), and organizational pressure (internal culture of meeting the schedule) in NASA Challenger accident, and the pressure from the competitor Airbus A320neo in the Boeing 737 max 8 cases. The cause of these accidents is the ignorance of risks when making important decisions: the driver neglected the risk of derailment of the train when entering a curve with high speed, NASA ignored the risk of O-Ring leaking despite the reminder from Morton Thiokol’s engineers, and Boeing ignored the risk of single AoA sensor failure, although there had been internal discussions and past accidents proving the high risks around the design of single AoA sensor. The pressures forced them to make decisions quickly, meaning they must eliminate some steps in decision-making procedures to go through them faster. However, the negative effect is that some risks may be ignored, as there are no steps for considering these risks or there’s not enough time for decision-makers to consider them. Although these risks may not seem serious or are just small risks with only a small possibility of happening, the accumulation of risks will eventually lead to problems.

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