Learning from Aviation Project Resource Management to avoid Project Failure

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Abstract

In aviation it has long been established that based on technical advances alone airlines would not achieve acceptable flight safety standards. As a consequence, the industry invested heavily in understanding and coping with so called human factors. An integrated and comprehensive approach to training called Crew Resource Management was developed. This was initiated after the Tenerife Airport disaster in 1977, the, until today, deadliest accident in aviation history. This article reviews the case of Tenerife and compares it with the case of the construction project of Berlin Brandenburg airport, one of the most prominent contemporary failures in the project management arena. The analysis shows that in Berlin and in Tenerife similar patterns of behavior significantly contributed to undesirable outcomes. It is suggested for project organizations to consider learning from aviation and to derive an approach for Project Resource Management from the established Crew Resource Management methodology.

Key words: project management, project failure, human factors, Crew Resource Management (CRM), risk management

Introduction

Projects often do not reach their objectives. Irrespective of the industry or even the sector concerned, they fail in the sense that they do not meet their schedule, cost and scope respectively quality objectives (Flyvbjerg et al., 2002; Altshuler/ Luberoff, 2003; Priemus et al., 2008). It is widely accepted that project failure can be traced back to technical, psychological and political-economic reasons (Flyvbjerg, 2009). Empirical evidence suggests that technical causes are less relevant than causes that are rooted in behaviors and interactions of humans involved in the management of projects (PMI, 2016). In such a context, it is not surprising that project management emerged as a dedicated discipline. Yet, limited project success rates in times of accelerated projectification of business and social life call for an ongoing search of improved and better practices, also outside the own profession.

Below, the case is made for learning from aviation. In aviation it has long been established that based on technical advances alone airlines would not achieve acceptable flight safety standards. As a consequence, the industry invested heavily in understanding and coping with so called human factors. It all started in 1977 with the, until today, deadliest accident in aviation history, the Tenerife Airport disaster. Following the Tenerife accident, the aviation industry identified a need for the development of skills and managerial techniques. An approach today known as Crew Resource Management (Kanki et al., 2010) was developed. The case analysis is used to reflect how the discipline of project management can learn from the aviation industries Crew Resource Management (CRM) methodology.

For the purpose of this case study, the causes of the well documented and researched Tenerife accident are compared with one of the most significant contemporary and thus also well documented disasters in project management, the endeavor to build a new airport for Germany's capital Berlin, Flughafen Berlin Brandenburg "Willy Brandt" (BER).

The Tenerife airport disaster[1]

On 27 March 1977 two Boeing 747 jumbo jets collided on the runway of Tenerife airport, killing 583 people. At the time of the accident, Los Rodeos airport is surrounded by fog. But this turns out to be only one of many contributing factors to a catastrophic outcome. The two planes involved are on an unplanned stopover at Tenerife as a bomb alarm at their original destination, Gran Canaria airport, prevented them from landing there. Due to the situation at Gran Canaria, Los Rodeos airport is extremely busy with grounded airliners. Even the taxiways to the runways are used to park airplanes. Only two air traffic controllers are on duty to handle the crowded situation. KLM flight 4805 and Pan Am flight 1736 have been waiting at Tenerife for more than three hours. They are under time pressure to leave as the crews approach the regulatory cap for maximum flight and duty time.

When Gran Canaria reopens, both, the KLM and the Pan Am 747 jumbo jets have to taxi on the runway to get into position for takeoff. Visibility on the runway is very bad due to layers of low laying clouds. The airplanes' crews cannot see each other. KLM 4805 is the first to be ready for takeoff, whilst in the fog Pan Am 1736 misses an exit to clear the runway.

The pilot aboard the KLM 747, captain Jacob Veldhuyzen van Zanten (50) is very experienced and a senior member of staff at the airline. In addition to his duties as pilot he is head of the airline's flight training department. On the runway he opens the throttles and the jumbo jet slightly moves forward when his co-pilot, Klaas Meurs (32), says "Wait a minute, we don't have an ATC clearance" to which the captain replies "No, I know that, go ahead, ask."

Subsequently, KLM 4805 receives air traffic control (ATC) clearance for the route to take but not yet a clearance for take-off. The co-pilot reads back the instructions received and adds "We are now at takeoff". The captain immediately says "Let's go….check thrust" even before air traffic control replies to the co-pilot "O.K….stand by for takeoff….I will call you." Obviously, the tower interprets the co-pilot's sentence to be "We are now at takeoff [position]" but not as "We are now taking-off".

At the same time inside the other Boeing 747, the Pan Am crew listens to the beginning of the radio conversation between the KLM and the tower and as a

[1] The summary provided is based on the official reports by the Netherlands Aviation Safety Board (1977), the Spanish government (Ministerio de Transportes y Comuniciacones, 1978) and by Roitsch et al. (1979) on behalf of the Airline Pilots Association (ALPA).

reaction reports to the controller “We are still taxiing down the runway”. This radio message overlaps with the radio message from the tower to the KLM and causes a shrill noise in the KLM cockpit right after the “O.K.…” they hear from the controller. Interpreting the “O.K” as clearance for takeoff, captain van Zanten accelerates with no further intervention from his co-pilot.

After the incident, the voice recorder unveils a last conversation from the cockpit where the third crew member, flight engineer Willem Schreuder (48), reluctantly questions about the Pan Am jumbo on the runway: “Is he not clear that Pan American?” and van Zanten empathically replied “Oh, yes”.

A few seconds later and with increasing speed, the nose of the KLM points up when the crew recognizes the Pan Am 747 as an obstacle on the runway. Less than ten seconds after Willem Schreuder’s question, the impact takes place, the planes collide and burst into flames. 583 people die. Only 63 people situated in the front of the Pan Am jumbo jet survive the accident.

The opportunity to learn from aviation

As the Tenerife case illustrates, aviation incidents may arise out of complex settings. Yet, in retrospective it is regularly possible to gain an almost full understanding of the causes and effects of an incident. Several factors facilitate such a comprehensive understanding: The number of relevant actors involved is small. The technology in use is highly specified and well known. Processes are highly standardized and tightly regulated. Relevant events take place in a relatively short time-frame. Human actors, technology as well as many environmental factors are monitored and recorded.

In comparison, project management settings are, even in retrospective, by far less specifiable. Compared to cockpit situations, already small projects appear to be extremely vague and diverse with many more or less involved actors as well as other influences which are difficult to oversee. Events which contribute to project success or failure may take place in close geographical proximity or at long distance. They may occur as a tight sequence of events or in disjoint time intervals.

The investigations into the Tenerife airport disaster came to the conclusion that “significant human aspects and system aspects, led, step by step, toward tragic human error, and then neutralized the opportunities for reversal of the final outcome” (Roitsch et al., 1979). Exactly such meanwhile scientifically so called “human factors” (Badke-Schaub et al., 2012) turn comprehensively investigated and documented aviation incidents into a source of learning for other contexts where human decision makers act for the better or the worse. Hagen (2013) proposes that all kind of organizations can avoid error and failure by learning from experience made in aviation. Put more concretely, what took place at Tenerife airport appears to show patterns of human behavior and interaction that are familiar also in other contexts like for example industrial, construction or software projects. The research proposition of this case study is that the detailed insights from the incident in Tenerife can be matched with observations made in project management environments. To review this proposition, the causes and contributing factors of the Tenerife accident are outlined below and related to factors that have been found to contribute to the failure of building the airport Berlin-Brandenburg (BER) on time, on budget and on scope.

BER can be classified as the most significant failed public construction project in Germany in the last decade. At the current stage the new airport exceeds the budget communicated at the beginning of the construction works in 2007 of € 2 billion by € 4 billion and will thus incur total costs of circa € 6 billion. The airport was scheduled to be completed in 2012 but it will not be operational before autumn 2017 which means that it is half a decade late. In total, more than 125.000 relevant construction defects have been counted, a range of fraudulent activities have been unveiled and at least four fatal accidents occurred (Fuchs et al., 2015; Deutscher Bundestag, 2014; Abgeordnetenhaus Berlin, 2012). The following analysis draws on a preceding review undertaken by Wagner (2016).

Causes for the Tenerife accident and comparable patterns in Berlin

The investigations into the Tenerife accident came to the straightforward conclusion that the fundamental cause of the accident was the fact that the KLM captain took off without clearance. Neither did he obey the “stand by for takeoff” by the tower, nor did he interrupt the takeoff when Pan Am reported they were still on the runway.
With the aim to explain why an experienced pilot supported by a qualified crew committed such a basic error, the authorities identified a number of contributing behavioral factors:

1. **Time-pressure**: The limitations of duty time put the crew under time pressure to either take off soon or to interrupt the flight. An interruption of the flight would have meant additional costs and organizational complications for the airline as well as further inconvenience for the passengers.

   Real or created time-pressure is a regular phenomenon on projects of all kinds. Berlin airport is a particularly extreme example. Early plans targeted for the airport to be put into operation as early as 2007. As the construction works began only in 2008, time-pressure existed from the very beginning on. Subsequently, repeatedly revised opening dates were put forward, debated, cancelled and rescheduled. The management team, main contractors and subcontractors were put under pressure to meet the schedule prescribed at a given time. Costly trade-offs with respect to acceleration costs, non-compliance with regulations or quality standards were made to meet unrealistic schedules which later had to be dropped. According to the investigations by different commissions of inquiry, assurance of schedules had absolute priority which led to dubious claim management processes (Abgeordnetenhaus Berlin, 2016; Deutscher Bundestag, 2014; Amann/Scherff, 2013).

2. **Emotions and post-factual behavior**: Potentially caused by the felt time-pressure, the impatient mood of the KLM captain and a “desire to be airborne” (Ministerio de Transportes y Comuniciacones, 1978) influenced how facts were dealt with and how decision making in the cockpit proceeded.

A "desire to be airborne" can also be detected at Berlin airport. It is common knowledge in the construction industry that incomplete planning, especially of technical building infrastructure, is a notorious weak spot of new-build projects. Nevertheless, management decided to move into implementation phase based on insufficient and deficient initial planning (Siegle, 2014). Despite obvious awareness of considerable risks and in ignorance of relevant facts, management did not give up the opening date targeted for autumn 2012 until only three weeks before the planned ceremony. The investigation report presented to Berlin parliament concluded that "a collective loss of reality" descended on the involved actors (Abgeordnetenhaus Berlin, 2016).

3. **Imprecise communication and confirmation bias**: At Los Rodeos various factors resulted in imprecise communication. The air traffic controller spoke with a heavy Spanish accent and was difficult to understand for the crew members. Then, technically, the two overlapping radio transmissions resulted in a disturbing whistling sound and loss of clarity. Even more importantly, inadequate language was used, especially when the KLM's co-pilot read back the ATC clearance and added "we are now at takeoff" and the tower replied commencing with "OK…" At this stage, the KLM crew was already in a confirmation bias mode where they only heard what they wanted to hear.

   On large projects like BER the potential for imprecise communication is disproportionately greater than on the runway. With numerous companies meeting at the workface it is difficult to establish one corporate language with one standard terminology. Communication at the interface between the business and the supervising political sphere also turns out to be a challenge.

   The government inquiry into the sudden cancellation of the planned opening in 2012 identified problematic communication behavior by various parties. The managing director for example requested for minutes of meeting to be disarmed by taking out the word "extremely" when referring to the critical paths of the project. Another example is provided by the controlling reports which used a traffic light system to highlight problems. Already half a year before the unexpected cancellation, critical actions showed red evaluations but the overall evaluation remained yellow. Asked for explanation in a supervisory board meeting, project management commented that the intention was not to undermine the pressure to complete the works by sending negative (red) signals. The report concluded that there was a lack of adequate communication and a lack of realistic assessment of risks (Abgeordnetenhaus Berlin, 2016).

4. **Steep authority gradient**: In the 1970s the flight captain on board of an airliner was regularly perceived as a 'Master of the Skies' whose decisions were not to be questioned. On KLM flight 4805 co-pilot Klaas Meurs dared to intervene once when there was no ATC clearance but kept quiet afterwards. Flight engineer Schreuder's shy question about the Pan Am on the runway was empathically pushed aside by the captain.

> On the Berlin airport project many indicators point towards steep authority gradients. Repeatedly, unrealistic project plans and budgets were followed. Problems were not reported or not escalated, or both. The airport's failure to identify and mitigate problems with the preventive fire protection system became a symbol for dysfunctional management structures on the project (Amann/Scherff, 2013). When the numerous problems at BER escalated a decision was made to get more of the same: Hartmut Mehdorn, a top-manager known for his direct and authoritarian leadership-style, was appointed as a new CEO in 2013 and later criticized by the supervisory board for nurturing a climate of fear (Beikler, 2014). In 2014 a government enquiry brought to light that the volume of change orders had reached a value of € 1.4 billion. By the airport's management this was framed as "normal project business" (Deutscher Bundestag, 2014; F.A.Z, 2014). In fact, the sum equaled a remarkable 70% of the original budget. This reminds of captain van Zanten's "Oh yes" and shows that even when it is already too late, authority may still be used to ignore or mask facts.

Very different from Tenerife, in the government inquiry in Berlin concludes that there does not exist one fundamental cause for the disaster (Abgeordnetenhaus Berlin, 2016). But although the challenges of safely conducting civil aviation and completing a major new-build project are very different from each other, comparable patterns of underlying human factors seem to have undesirable impact.

Crew Resource Management as an answer

The investigations into the Tenerife accident and into a United Airlines crash a few months later in 1978 led to recommendations for new, innovative forms of training to cope with human error. What started out as Cockpit Resource Management training was soon expanded to all crew members of an aircraft and thus became Crew Resource Management (Kanki et al., 2010; Hagen, 2013).

CRM training is designed to avoid crisis situations and to improve the competencies of whole teams to cope with a crisis (Badke-Schaub et al., 2010). As such, it is supposed to help avoiding, identifying and addressing human errors. In its standardized form, the training goes through three phases: 1. Initial awareness training to convey the essentials of human factors concepts and know-how. 2. Exercises and feedback in realistic settings for complete crews. 3. Refresher trainings in regular intervals based on various methods (Federal Aviation Administration, 2004; Kanki et al., 2010). CRM training is regularly composed of but not limited to the following building blocks:[2]

Situational Awareness: To comprehend current system and environmental conditions, anticipate future changes. To consciously avoid complacency and to

[2] Worldwide, a variety of different approaches and CRM trainings designed to meet the needs of the individual organization concerned exist. The following summary is intended to be illustrative rather than comprehensive with the intention to be insightful from a project management perspective. It is based on ICAO (1998), Federal Aviation Administration (2004), Kanki et al. (2010) and Scheiderer/Ebermann (2010).

watch over system and environment changes, informing other team members of potential threats and errors.

Workload Management: To ensure good preparation and sufficient planning including relevant communication. To prioritize and delegate effectively to maintain focus on primary tasks. To continuously monitor progress, avoid distraction, remain vigilant and, if necessary, respond without undue delay.

Human Error: To know about the origins of error and to differentiate types of error. To understand concurrent failures and chains of errors as well as available resources and redundancies when dealing with threats and errors in order to enhance the competency to manage errors (error prevention, resistance, detection and recovery).

Communication: To enable free and open communication with active participation of all team members at the appropriate time. To use clear and effective language and to become responsive to feedback. To ensure interactive exchange of information and an environment where plans are stated and ambiguities resolved.

Decision Making: To detect deviations from desired states, assess problems, generate alternative actions, identify risks and select the best course of action, which is subsequently reviewed for the purpose of learning and necessary adaptation.

Leadership & Teamwork: To use appropriate authority in order to ensure a focus on task and crew member concerns and to support others in completing tasks. To establish task priorities and to utilize team resources to achieve objectives whilst contributing to the improvement of team interpersonal relations.

Stress & Fatigue: To know about the origins and the effects of stress and fatigue which enables team members to recognize and to manage stress and fatigue. To exercise personal responsibility with regard to factors of stress and fatigue.

In aviation, continued and ongoing training of all crew members is geared to create a system that makes best possible use of the resources available on board of an aircraft to promote safety and enhance efficiency. Despite all efforts, for many years crews and pilots in particular had been reluctant to accept the new approach (Hagen, 2013). It took a decade until another flight incident turned out to be a breakthrough event for CRM: In 1989 the crew of United Airlines (UAL) flight 811 from Honolulu to Sidney managed to safely land a fully loaded Boeing 747 after a cargo door failed and an explosive decompression blew out several rows of seats through a massive hole in the body of the aircraft. Almost as remarkable as the safe landing was that the crew publicly emphasized that their CRM training was an important enabler to rescue the plane, its passengers and the crew (National Transportation Safety Board, 1992). In his review of the incident, Hagen (2013) shows how the men in the UAL cockpit interact much more constructively than the KLM crew in Tenerife where van Zanten, Meurs and Schreuder remained in tragic inner isolation.

In the 1990's, CRM became a mandatory training requirement under most regulatory bodies for aviation worldwide and the idea spread into many other high risk industries like health care, fire-fighting or oil & gas.

Project Resource Management as a perspective

Behind the mostly glamorous and rarely catastrophic façade of a high tech driven aviation industry, Crew Resources Management training has made a quiet but extremely effective career. Its origins benefited from forensic root cause analyses of flight incidents. The training modules tackle individual sources of human error and systematically integrate to deliver synergies not only for the trained individual but also between the participants as every crew member knows what his or her colleagues know and how they are trained and requested to act. Therefore, CRM over the years has had a significant influence on the professional culture on board of aircrafts. Today, many of the contents of CRM-training can also be found to be part of the curriculum of more general leadership programs or project-management trainings. However, it is the focus on human error combined with the systematic roll-out of the training to all relevant actors which make the approach unique (figure 1.).

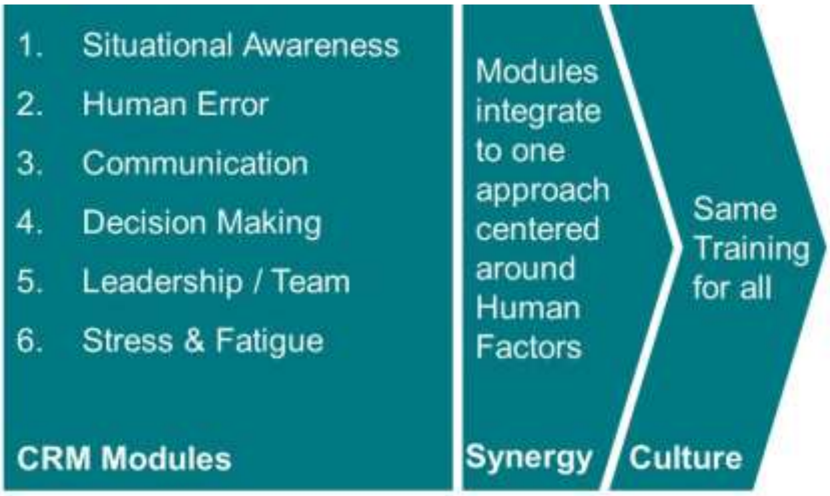

Figure 1. The logic of Crew Resource Management

The reasons why projects fail often remain manifold and ambiguous. However, the combination of the cases of Tenerife and the Berlin presented above, suggests that typically human but avoidable behaviors contribute errors and unfold dynamics (see also Wagner, 2016) which lead to error chains that play a significant role for undesired outcomes. It is a long way to go from such an insight to the implementation of what may be called Project Resource Management or Company Resource Management. But for organizations involved in project business it can be worthwhile asking how valuable it can turn out to be if

- all involved in a project would be able to better recognize errors
- all involved in a project would know about the logic of error chains
- precise and courageous communication would be requested from all hierarchy levels on a project

- universal decision making models would be commonly known and could be requested to be put to use by anyone on a project
- problems could be openly addressed, irrespective of a person's formal role or position
- physical and psychological personal limitations would be actively considered on an individual basis

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