BALANCING GOAL TRADE-OFFS WHEN DEVELOPING RESILIENT SOLUTIONS: A CASE STUDY OF RE-PLANNING IN AIRLINE OPERATIONS CONTROL

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Abstract

The main question this paper aims to shed light on is how goal prioritizing and action planning are distributed across stakeholders over the re-planning process, and what mechanisms can contribute to arriving at integrated and resilient solutions when balancing trade-offs. This will be illustrated by examining a case study on the re-planning process during a safety related contingency event in a single Airline Operations Control Centre. Results show that goal prioritizing authority rotates during the re-planning process across two dominant stakeholders, who shift the dominant trade-off between the boundaries of safety, economics, and operational feasibility. Rotation of authority might have affected awareness of interdependencies between stakeholders, and increased shared situation awareness and maintaining common ground as perspectives broadened. Furthermore, despite time and effort needed to coordinate distributed activities, efficiency was gained by trading-off thoroughness on the least important boundary, and by using loose definitions of common goals. As this helped to balance fundamental trade-offs, tightly controlled operations close to the boundary of acceptable performance were successfully sustained.

1 INTRODUCTION

One of the most fundamental questions in the design of resilient solutions in the face of real world unexpected events, is how to cope with ill-structured and conflicting goals. Goal conflict does not need to be eliminated, instead organizations should be able to balance the various trade-offs across goals (Woods, Dekker, Cook, Johannesen & Sarter, 2010). This balancing act is never ending, as events unfold during the problem solving process and additional aspects of events are revealed and new goals emerge. This requires a continuous re-planning of actions (Klein, 2007). The need to manage conflicting and emergent goals is complicated further by the involvement of multiple stakeholders with different interests and responsibilities, especially when the organisational structure is at least partly based on a network instead of a hierarchy (De Bruijn & Heuvelhof, 2008). This requires additional coordination effort (Hoffman & Woods, 2011). The main question this paper focuses on is how goal prioritizing and action planning are distributed across stakeholders over the re-planning process, and what mechanisms can contribute to arriving at integrated and resilient solutions.

This paper seeks to advance our understanding of the development of resilient solutions across stakeholders who operate in a network. The aim is to look beyond the general control structure that is used to coordinate distributed activities. Rather, its first aim is to identify how goal prioritizing is managed within the process of developing solutions by multiple actors in different parts of an organisation during an unexpected event. Second, we aim to point out the possible consequences of the division of goal trade-off activities on the resilience position of the organisation. This will be illustrated by examining a case study on the re-planning process during a safety related contingency event in a single Airline Operations Control Centre (AOCC).

2 AIRLINE OPERATIONS CONTINGENCY PLANNING IN A NETWORK PERSPECTIVE

The airline under study uses a matrix organisation structure. Authority is divided vertically by functional area

and horizontally by cross-functional processes. Consequently, decision making at any time can both have hierarchical and network like characteristics. In an AOCC, network like decision making dynamics seem abundant, especially during large scale disruptions as multiple stakeholders are added to the decision process.

During daily operations in an AOCC, small scale disruptions happen relatively frequently. Disruptions will often lead to delays or cancellations (Thengvall, Bard & Yu, 2000), which can result in excessive delay costs (Wu, 2005). Although they can be complex, the overall impact and duration of this type of events is usually limited, and they are solved within the ongoing operational process. Decision authority is centred in the Operations Control department, where professionals are constantly challenged to make conflicting trade-offs between the main elements of an airline operation: passenger flows, aircraft and crew (Kohl, Larsen, Larsen, Ross & Tiourine, 2007). As such, their main responsibility is to balance the different interests across the departments that are represented in the AOCC, like crewing and maintenance.

Large scale disruptions on the other hand, can last over longer time periods. Often they extend beyond the boundaries of the AOCC departments. At the airline studied here, under such circumstances decision making is separated from the daily operation. An off-line decision process, led by a Contingency Team, is installed on a case-by-case basis. As additional stakeholders outside of the AOCC are involved as well, this raises the possibility of conflicting interests and makes solving these problems increasingly complex. Moreover, it amplifies the network dynamic of decision making.

Complicating the challenge to balance the interests of multiple stakeholders even further, are the complex interdependencies between the different departments (Abdelghany, Abdelghany & Ekollu, 2008; Clausen, Larsen, Larsen & Rezanova, 2010). Inevitably, this puts a strain on the airline's boundaries of acceptable performance. Over the past years, many airlines have been struggling to meet their economic targets, which can jeopardize safety awareness (Madsen, 2013). As slack between different system components decreases, safety can be compromised due to economic pressure, stimulating the tight coupling of systems to gain efficiency. These developments lead to an increasing risk of large scale accidents, and recovery from such accidents is harder (Cook & Rasmussen, 2005).

The case studied in this paper aims to show how, despite these challenges, several mechanisms could have contributed to sustain resilient performance during the airline's contingency re-planning process. As actions change based on goal prioritization and perception, so does the immediate resilience position of the organisation within its boundaries of acceptable performance (Rasmussen, 1997). Resilience is not just determined by an organisation's current position, but also by its propensity to "go solid" (Cook & Rasmussen, 2005). To gain a richer image of resilient performance, additionally the continuous effort across the re-planning process to balance the five fundamental trade-offs as identified by Hoffman and Woods (2011) is studied: respectively the optimality-resilience trade-off, the efficiency-thoroughness trade-off, the reflection-revelation trade-off, the acute versus chronic goals trade-off, and the concentrated-distributed action trade-off.

3 METHOD

The current study focuses on the re-planning process that was centred around the recovery from an incident in Nigeria, where flight operations temporarily came to a halt due to political unrest and fuel shortages that posed immediate threats to safety. Over the course of two weeks, approximately ten meetings were held, each lasting about an hour. Several different internal and external AOCC departments were involved in the decision making process: Operations Control (both operations personnel and management), Flight (representing cockpit crew), Inflight (representing cabin crew), Maintenance, Security Services, Outstations (representing local operations at the airport in Nigeria), Commercial (representing passenger interests), and Cargo. For the remainder of this paper, Flight and Inflight are subsumed under the heading of Flight, as their interests in this case were the same. The same goes for Commercial and Cargo, who are subsumed under the heading of Commercial. Central to these meetings was the question if and how operations to Nigeria should be sustained.

Analysis is based on data stemming from observations documented by the researcher during the contingency management process, retrospective interviews with all contingency team members, and policy documents, such as the contingency management master plan and official meeting reports. All documents and interview transcripts were coded to identify the actions taken and goals pursued by the different stakeholders. Statements related to the fundamental trade-offs were coded as well. They were linked to the inductively identified driving forces that seem to shape the decision making process.

4 DECISION POINTS

The entire contingency process revolved around three central decision points. First, a decision needed to be

made whether or not to evacuate the crew out of Nigeria. When crew was indeed evacuated, the next question was if and how alternative operations should be constructed. Finally, the moment to return to normal operations was decided on. Although official procedures provide clear demarcation between decision points that are embedded in the contingency management process, substantive decision points are subject to discretion of individual stakeholders. This includes, for example, the decision to call off a contingency: *"If circumstances are in agreement with one of the mentioned criteria, [the Duty Manager (DM)] will contact [Operations Control Management] in order to start the contingency management procedure. It is impossible to set hard limits for the specific circumstances and it is left to the discretion and professionalism of the DM."*

Results are presented for each decision point separately, showing how the decision making process and resilience position evolved over time. In general, throughout the entire process, goal prioritization centred around three main boundaries of performance: safety, operational feasibility, and economics. Operational feasibility includes all necessary flight operations logistics, such as ground handling and maintenance facilities.

4.1 Decision Point 1: Crew Evacuation

Flight operations to destinations in unstable countries are monitored tightly by the airline's Security Services department. Findings are discussed routinely in the Security Committee, in which Security Services and several AOCC stakeholders are represented (including Operations Control and Flight). Most representatives are operations staff, but due to the nature of the case at hand, Flight was also represented by high level executives.

The case studied here centres around local uproar in Nigeria. Although political unrest in this country is not uncommon, tensions were growing alarmingly fast due to local strikes over fuel prices. These strikes created problems for both fuel availability and safety. With Nigeria being a long-haul destination, the flight crew on the outbound journey does not operate the immediate inbound return flight, but overnights in a local hotel. For several days, operations had already come to a halt as crew was kept inside the hotel for safety reasons, since traveling between the crew hotel and the airport was considered to be problematic. Ultimately, the decision was made in the Security Committee to evacuate the crew out of Nigeria entirely. It was not until this moment that Operations Control officially called off a contingency.

Prioritizing goals

Based on their hierarchical position, at this point in the decision process, Flight was the stakeholder in charge of prioritizing goals. Effectively, they decided to trade-off safety over economics. Although officially Security Services does not have decision making authority, they weigh in heavily on this decision by signalling that the score of safety threatens to become unacceptable. Moreover, in expectation of the upcoming decision by Flight, Security Services has already taken into account the economic consequences that giving off this signal might have: *"From a security perspective […] it is easy to say we need to cease operations, but that will cost the airline a lot of money, so we think twice before saying anything like that"*. Security Services also prioritizes safety over operational feasibility: "*Is logistics or safety the main concern? Security Services, whose opinion I value highly, strongly suggested safety*". Hence, goal prioritization was influenced mainly horizontally by one stakeholder, even though authoritative power for the final decision is organised vertically.

Balancing trade-offs

The first difficult trade-off was choosing between different perspectives on the safety status, as these varied widely. Local Security Services contacts signalled that things were taking a turn for the worse, but on the other hand this was contradicted by observations from the airline's local outstations organisation. Moreover, other airlines also seemed to be divided on the subject, as some had halted their operations, but others had not. However, this contrast of perspectives was not considered problematic. Seeking out different perspectives is even encouraged, because it helps to create shared situation awareness: *"Not everybody perceived the same urgency […] but that's a good thing, because otherwise you never have the constructive discussion which is needed to come to the right decisions"*.

Operations in unstable countries always operate closer to the boundary of acceptable performance. This is acceptable, as long as movement is restricted and brittleness is minimized. The actions taken were a direct result of the perceived increase in the brittleness of the system: *"in general the situation was just very unstable and dangerous, aggressive […] you know things can get out of hand any moment."* The negative balance on this optimality-resilience trade-off impacts the balance on the thoroughness-efficiency trade-off. Instead of more thoroughly analysing the situation to get a better grip on the differing perspectives, crew is evacuated when an opportunity comes along to evacuate on a different airline: *"All of a sudden there was an opportunity. […] Another airline who was evacuating its crew offered to take our crew as well."*

Evacuating the crew had a short term decreasing impact on safety (as crew transport was evidently more

dangerous than staying inside the hotel), but long term safety and other chronic goals, such as professionalism, were considered to be more important: *"We want to be able to say we have stepped in, and have stepped in in time. Which also enhances long term faith in our company. So it's also a strategic choice."* Summarizing, it seems that based on an unbalance on trade-offs regarding brittleness and a multitude of perspectives, an efficient, opportunistic but conservative approach is taken as chronic goals are considered most important.

Re-planning activities in the Security Committee are clearly distributed. Security Services weighs information, but taking action is a local responsibility. Because of close interdependencies, actions of one department always affect others. Flight, as the dominant decision maker, is aware of this. They balance the distribution of their decision making authority by making additional coordination effort through ensuring decision support by consulting in advance on an operational level with various other AOCC stakeholders about possible alternatives: *"You have to take the perspective of the AOCC organisation into account"*.

4.2 Decision Point 2: Establishing an Alternative Operation

After crew evacuation and calling of a contingency, the second decision point revolved around whether or not to establish an alternative type of operation. Once Flight determined that continuing operations in their current form was no longer an option, authoritative power shifted to Operations Control. Several Contingency Team meetings followed, in which the same AOCC departments were represented as in the Security Council. Additionally, Security Services was added, as were the two Commercial departments. An operational level AOCC planning team was instructed to start searching for alternatives. Very early on in this process, a dominant option surfaced and was selected. It was decided to continue operations, but with a crew slip in a different location. Effectively, this means that a third stop was added to the original flight schedule.

Prioritizing goals

Goal prioritizing authority shifted to higher level management Operations Control. The prevalence of safety did not change, and the option of reinstating normal operations at this point was excluded. Although the addition of Commercial to the decision making process would seem to signal the increasing importance of the economic boundary, operational feasibility was given priority over economics: *"Safety first, then operational feasibility, then economics"*, *"Economics are less important. It is more important to be able to transport everything logistically"*. Moreover, Commercial stakeholders indicated that their main task during the contingency meetings is not to deliver input, but to gain information based on which they can stop or continue to sell flights to customers. Hence, like many of the other AOCC stakeholders, they are treated as a resource department.

Balancing trade-offs

After crew evacuation, direct brittleness of the system was greatly reduced. However, not operating at all over the long term was also seen as brittle, as this would lead to a slow migration of the systems towards the economic boundary. To improve resilience, Operations Control decided to trade-off some of the regained safety in favour of an improved economic position. However, the importance of safety as the number one priority did not change, which was exemplified by the development of a fall back scenario that would have been enacted in case safety would have become problematic during alternative operations. Hence, although the system moved back towards the safety boundary, operations were tightly controlled, decreasing overall brittleness and sustaining resilient performance.

Perspectives on the safety situation still varied. This became especially apparent when Outstations decided to keep expats stationed locally in Nigeria, despite advice of Security Services to move to the compound. This also reflects the distributed authority of stakeholders where their own resources are concerned: *"Everyone knows in his role what to do"*, *"I'm not responsible for fuel. I'm not responsible for the station facilities, […] I want to know that the hotel for my crew is good enough"*. This modularity of activities helps to reduce complexity, and most stakeholders find this combination of differing perspectives and distribution of activity very useful and constructive: *"We respect each other's decisions […] We hold meetings to listen to each other's judgment. To me that's crucial. But of course we can question each other."* Here, the risk of fragmentation due to different perceptions and distribution of activities is likely counterbalanced by maintaining common ground: *"The entire contingency team helps to solve each other's problems."* Moreover, all stakeholders carry out their tasks with one shared purpose in mind: *"keep the operation going"*. Interesting to note however, is that definitions of what this exactly entails varied from acute economic or passenger goals, to chronic strategic goals.

Another way to balance effectiveness of the decision process despite distribution of authority, was limiting the range of options that were considered. Although several options were available, such as other crew slip locations or even rebooking passengers on flights of other airlines, these were not considered. *"From a pragmatic perspective you immediately search for a solution to start operations as soon as possible"*, *"We have*

jumped on the first opportunity to restart operations with an alternate crew slip". This satisficing behaviour was largely based on past operations and on actions of partner airlines. Although it is highly efficient, corners were cut on thoroughness. Moreover, it mostly discounts the economic perspective: *"It is not about economics* […] *it is really all about recovery speed."* This seems to emphasize that acute economic goals are not seen as very important. The lack of thoroughness, mainly at the cost of economics, seemed acceptable based on the short term focus of the solution: *"This solution will work for days, not weeks"*, *"First let's make sure we offer an alternative. Phase two is focusing on what we actually want."*

4.3 DP 3: Return to Normal Operation

After start-up of the alternative operation, the Contingency Team's main task was monitoring that operation. At the same time, the Planning Team was asked to continue to look for other options, because the current alternative would not be not sustainable in the long run. However, after a few days local circumstances in Nigeria changed, and the decision was taken to return operations back to the original schedule.

Prioritizing goals

The decision to reverse the alternative operations was enabled by the positive judgment of safety by Security Services, in consultation with Flight. Again, safety is given the highest priority. Although the original decision to halt operations was made solely by Flight, the final decision to reverse operations was made together with Operations Control, as they have final authority over operational feasibility.

Balancing trade-offs

The risk of brittleness was minimized by the continued close monitoring of the security status and the running alternative operation. Once Security Services reported that safety started to improve, operations were not directly reinstated. Flights were scheduled up to three days ahead, creating slack that allowed the Contingency Team to await if stability would persist. This also allowed for integration of all the different perspectives within the team, as other airlines started operating again as well, and outstation reports were okay.

Although efficiency seemed to be favoured during setting up the alternative operation, thoroughness prevailed here: *"Triple check if there is fuel available, because I want to make sure we can leave there."* Still, many stakeholders felt that the return to normal operations did not take too long and was relatively efficient. Moreover, it again shows an opportunistic but conservative approach and a focus on chronic safety goals.

5 DISCUSSION

This paper attempts to show what mechanisms seem to play a role in maintaining resilient performance in a network environment where responsibilities and activities are distributed across multiple stakeholders during re-planning of operations. Despite the involvement of higher level executives for Flight and Operations Control, the rotation of decision making authority gives the decision making process a network dynamic. During the search for an alternative operational mode, each of the resource departments maintains its authority to block the decision making process. This exemplifies the horizontal distribution of autonomy over resources.

The distribution of activities across stakeholders likely has contributed to the multitude of perspectives that existed over the first two decision points. Diversity of perspectives is important to ensure timely identification of safety issues (Hayes, 2012). Moreover, discussing these perspectives helped to create shared situation awareness and common ground, helping to improve resilient performance (Gomes, Borges, Huber & Carvalho, 2014; Vidal, 2009). However, coordination of activities and integration of perspectives requires considerable time and effort, which are usually in short supply in AOCC environments (Igbo, Higgins, Dunstall & Bruce, 2013).

Several dynamics could have balanced this issue. First, efficiency was sometimes traded off in favour of thoroughness, but only where the least important, economic goal was concerned. Although decision making authority rotates, goal priorities throughout the development of this case are fixed: safety comes first, operational feasibility second, and economics third. The dominant trade-off does shift over time as the system moves back and forth between boundaries, but as safety is always given highest priority, marginal boundaries are relatively fixed. Moreover, operating close to this boundary is only acceptable when the position can be tightly controlled, which is typical for a high reliability organization (Cook & Rasmussen, 2005). The marginal boundary on operational feasibility on the other hand, is more flexible. Most flexible and least important, at least for a contingency during a relatively short time frame, is the economic boundary. Compromising thoroughness mostly on this boundary helped to maintain focus on chronic goals.

Second, maintaining common ground was based on a very vaguely defined common goal, in this case 'continuing some form of operation'. Using a loose definition could have helped to sustain resilient

performance, as such 'constructive ambiguity' offers stakeholders room for adjusting actions to their own objectives (De Bruijn & Heuvelhof, 2008). Using a loose definition also prevents having to take into account a large number of decision making variables, which reduces complexity (Kontogiannis & Malakis, 2013).

6 CONCLUSION

The main question this paper focused on is how goal prioritizing and action planning are distributed across stakeholders over the re-planning process, and what mechanisms can contribute to arriving at integrated and resilient solutions. Results have shown that goal prioritizing authority rotates during the re-planning process across two dominant actors. Rotation of authority might have affected awareness of interdependencies between stakeholders, and increased shared situation awareness and maintaining common ground as perspectives broadened. Furthermore, despite time and effort needed to coordinate distributed activities, efficiency was gained by trading-off thoroughness on the least important boundary, and by using loose definitions of common goals.

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