Development and evaluation of cabin crew expected safety behaviours

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Abstract

Within the airline industry, expected safety behaviours or non-technical skills, such as those developed through the JAR-TEL NOTECHS project or the behavioural markers used by the Line Operations Safety Audit (LOSA) program, are being increasingly used to assess or observe flight crew CRM performance. While safety and human factors programs are well established components of cabin crew training, airlines are yet to identify the non-technical skills required of cabin crew to successfully manage safety critical tasks and situations. In addition, there is a lack of data on how cabin crew avoid, recover and manage error. This paper describes a two-part research project being undertaken within Qantas Airways. Stage 1 involved the application of the Critical Decision Method protocol to identify successful decision making skills amongst experienced cabin crew. From a qualitative analysis of interviews with eighty Customer Service Managers (CSM’s), expected safety behaviours were identified, and grouped under the following seven elements: situational awareness, information feedback, self awareness and analysis, operational understanding, passenger and crew management, negotiation and influencing skills and workplace safety. The use of these expected safety behaviours in training and performance planning is discussed. Stage 2 of the project, which is still proposed, involves the implementation of the flight crew LOSA program within the Cabin Crew environment, utilising the expected safety behaviours developed in Stage 1. The applicability of LOSA for cabin crew operations as well as the logistical and practical challenges of planning and implementing normal operations monitoring for cabin crew is discussed. In addition, an outline of the expected benefits of this research to air operators and the wider aviation industry is provided.

Introduction

In recent years, human factors training programs have begun to develop more rigorous criteria for training and evaluation. Behavioural competencies are replacing the traditional approach to CRM, which has focused on attitude change (eg. van Amermaete & Krujisen, 1998). Behavioural marker systems are becoming increasingly accepted as a legitimate means of measuring individual and team performance in a range of high reliability contexts, most notably aviation (Flin & Martin, 2001), nuclear power (O’Connor, Flin & O’Dea, 2001) and medicine (Fletcher, McGeorge, Flin, Glavin & Maran, 2002).
Behavioural markers are generally thought of as observable, non-technical behaviours that contribute to effective or ineffective performance within a specific work environment. They are usually structured into a set of categories or elements and include sub components or anchors. A behavioural marker should describe an observable behaviour, not an attitude or personality trait, and demonstrate a causal relationship to performance outcome. Klampfer et al (2001) suggest the following uses for behavioural markers:

- To enable performance measurement for training and assessment;
- To highlight positive examples of performance; and
- To build performance databases to identify norms and prioritise training needs.

While behavioural marker systems can provide a focus for training goals and needs, they are limited in that they cannot capture every aspect of performance because of the infrequent occurrence of some behaviours (eg., sporadic behaviours such as aggression). Moreover, observers are constrained by their human performance capabilities and may miss specific behaviour due to distractions or overload. However, these limitations are minor, compared with the opportunity afforded by behavioural marker systems to gather more operationally meaningful data on transparent CRM behaviour.

In contrast to the initial development of CRM style programs, characterised by their wide variety, different assumptions, different training methods, and a lack of common content, the recent growth of behavioural human factors training has been accompanied by a shift toward standardised programs. In the aviation industry, three research groups have led the push for behavioural markers systems.
In Europe, the Joint Aviation Authority has produced the NOTECHS (Non-Technical Skills) framework, an amalgamation of existing airline behavioural markers systems, to measure non-technical skills. The NOTECHS project was motivated by Joint Aviation Requirements (JAR) which mandate the training and assessment of pilot’s CRM skills. NOTECHS defines non-technical skills as “attitudes and behaviours in the cockpit not directly related to aircraft control, system management, or standard operating procedures” (van Avermaete & Kruijisen, 1998). Non-technical skills are divided into four categories that are rated on a five-point scale:

1. Cooperation;
2. leadership and/or management skills;
3. situation awareness; and
4. decision making.

The NOTECHS system also includes five principles, which are intended to provide objective assessment. The first requirement is that only observable behaviour is assessed. Secondly, for behaviour to be rated unacceptable, it is a requirement that there be a threat to flight safety. The third requirement is that unacceptable behaviour must be repeated during a check to determine if there is a substantive problem. Fourthly, each behaviour must be rated as either acceptable or unacceptable. Finally, an explanation is required for each unacceptable rating. The NOTECHS system continues to be evaluated by the JAR-Tel project (Andlauer et al., in prep).

In the United States, the University of Texas has been conducting work on the evaluation of CRM behaviours since the late 1980’s. Behavioural markers were first incorporated into a useable format via the Line/LOS checklist for conducting flight deck observations (Helmreich, Wilhelm, Gregorich, & Chidester, 1990). More recently the development of the
Line Operations Safety Audit (LOSA) program has provided a new platform to collect data on
albeit a smaller list of markers.

LOSA utilises trained observers to collect data about flight crew behaviour on normal flights
under non-jeopardy conditions. Observers record potential threats to safety and how the flight
crew manage errors. Information is collected based on three worksheets. The first worksheet
records a description of external threats (e.g., weather or ATC) that may influence crew
performance and how these threats are managed. The second worksheet describes the errors
made by the flight crew and what strategies were used to detect and recover from these errors.
The final worksheet records the behavioural markers based on three categories “Planning”,
“Execution” and “Review/Modify Plans”. The behavioural markers are used repeatedly for
every flight phase and rated on a four-point scale (poor – outstanding). The validation of the
LOSA program and the use of behavioural markers is ongoing (Helmreich, Klinect &
Wilhelm, in press).

The third research group examining behavioural marker systems is GIHRE (Group Interaction
in High Risk Environments), an interdisciplinary project that was launched by the Gottlieb
Daimler and Karl Benz Foundation in 1998. The interest of this group is to study the
management of high workload situations by professionals working in high-risk environments.
A subgroup is working on the GIHRE-aviation project, concerned with the validation of
existing behavioural markers for CRM assessment under conditions of high workload. The
intention is to compare the performance of crews in simulators using the NOTECHS and
LOSA behavioural markers. The project aims to identify which behavioural markers
differentiate best between effective and ineffective crews under high workload. To date, the
results of the project have not been published (Klampfer, Hausler, Fahnenbruck & Naef, in press).

In addition to the three projects described above, a number of airlines have developed their own behavioural marker systems for training and assessing flight crew skills (see Flin & Martin, 2001, for a review). For example, Qantas Airways have developed a framework for assessing CRM expected behaviours as part of their Advanced Proficiency Training (APT) project (Wood, 2001). These expected behaviours are used to assess flight crew during simulator and line flying.

However, methodological guidelines for the development of behavioural markers are lacking. The NOTECHS system has been developed based on an amalgamation of existing marker systems amongst various European carriers, rather than utilising any formal cognitive task analysis process. Consultation with a number of airlines, who have developed their own behavioural markers, has revealed the use of a variety of informal methods and techniques. It appears that studies using established, valid and reliable processes such as cognitive task analysis or critical decision techniques are required (eg., Hoffman, Crandall, & Shadbolt, 1998).

Furthermore, there does not appear to be any published research into the development of behavioural markers for cabin crew, despite the requirement for cabin crew CRM training in many countries since the early 1990’s. It has been well established that assertiveness and leadership behaviours have a direct influence on the evacuation rate of passengers in emergencies (Muir & Cobbett, 1996). Numerous accident and investigation reports repeatedly reinforce the need for cabin crew to take appropriate action to deal with situations involving
in-flight fire, ill or disruptive passengers, or passing on information to the flight crew about aircraft damage. The handling of such emergencies calls for knowledge, skills and abilities quite different from those associated with the provision of normal service duties.

While the duties and functions assigned to cabin crew in the interests of passenger safety are well established across the aviation industry, there is no consensus on which skills are needed for effective cabin crew CRM or how to train CRM behaviours (ICAO, 2002). There are a number of benefits for establishing behavioural marker systems for cabin crew, including the ability for air operators to more easily identify risks to the operation in order to target cabin crew training more effectively.

A behavioural marker system for cabin crew is also on the regulatory agenda, at least in Australia. Unlike other countries such as the United States and in Europe, human factors training and assessment has not been mandatory for Australian air carriers. Recently the Civil Aviation Safety Authority (CASA) released a Discussion Paper for CASR 121A concerning commercial air transport operations in large aeroplanes. This discussion paper is largely based on the proposed JAA’s JAR-OPS 1 and therefore mirrors an international trend towards mandatory human factors training. More recently CASA has released an accompanying Advisory Circular to CASR 121A, which details a plan for regulating human factors training for flight and cabin crew based on a competency based framework. The Advisory Circular contains advice on the identification of competency standards and behavioural markers, the development of evaluation methodologies for training feedback and the integration of technical and non-technical training. However, CASA does not include specific guidance on how to develop behavioural markers. Therefore, the development of a behavioural marker system for
Qantas cabin crew training is expected to not only meet this requirement but lead the wider industry towards this type of program. For example, a practical methodology to identify and assess cabin crew behaviours would be of direct benefit to the wider industry in the form of guidance material.

Therefore, the aims of this study were:

1. To identify specific behaviours that are central to proficient cabin crew safety performance; and
2. To determine the best method for the assessment of identified safety behaviours during normal line operations.

Method

Participants

The participants consisted of eighty Customer Service Managers (CSMs). CSMs are the most senior cabin crew, and oversee cabin safety and management (known as Pursers or Cabin Supervisors in some airlines). The CSMs were a mixture of short haul (54%) and long haul (46%) from various bases across Australia. They had spent an average of 7.5 years operating as a CSM (range = 1-25yrs, s = 6.2yrs), and their mean age was 42 years (s = 7.0yrs).

The participants were recruited via posters placed around crew lounges and sign-on areas. The criteria for participation were that the person must be a CSM, and that they could discuss, in detail, a recent (within 18 months) safety-related event that was
challenging. CSMs were paid for the ground duty time they spent being interviewed (usually 1.5 – 2 hours).

The interviews were conducted by six interviewers, who were also CSMs. Although their main role was interviewing, these six team members also helped with data analysis and development of the safety behaviours, and acted as expert practitioners for the project. CSMs were used as interviewers because they are subject matter experts, with large domain knowledge of technical and safety-related cabin issues.

Design

The variables of home base location (Sydney, Melbourne, Brisbane, Perth) and operation type (short or long haul) were controlled to ensure the CSMs proportionally represented the Qantas operation.

The interview process was based on Klein’s Critical Decision Method (CDM) (Klein, Calderwood & McGregor, 1989), which is a variant of Flanagan’s (1954) Critical Incident Technique. Flanagan states that the Critical Incident Technique can be applied for a variety of situations and uses in aviation, including:

- Measuring typical performance - developing critical requirements for evaluating the typical safety behaviour of an operator;
- Measuring proficiency - providing a basis for evaluating proficiency in a check and training situation; and
- Measuring training effectiveness - providing an indication of the effectiveness of training programs.
These are three areas that the Expected Safety Behaviour project may eventually cover at Qantas.

The CDM is a retrospective interview strategy that applies a set of cognitive probes to non-routine incidents that requires expert (CSM) judgement or decision making (Klein et al., 1989). A semi-structured interview format is used to probe different aspects of the decision process.

The CDM is effective in revealing expert’s knowledge, especially tacit knowledge, reasoning and decision strategies. Compared to other methods of knowledge elicitation, the CDM yields more information, including a wider variety of specific cognitive details, more information about underlying causal linkages among core subjects, and the revelation of tacit knowledge (Hoffman, Shadbolt, Burton & Klein, 1995). The reliability of the procedure is based on the idea that experts have clear memories of salient or unusual safety-related incidents (Hoffman et al., 1995). This method of knowledge elicitation has been used successfully in naturalistic environments such as fire fighting (Taynor, Klein & Thordsen, 1987), para-medicine, nursing (Crandall & Gretchell-Reiter, 1993), helicopter flying (Thordsen, Klein & Wolf, 1992), and military command and control (Kaempf, Wolf, Thordsen & Klein, 1992). It is now established as a valid and reliable method of cognitive task analysis and knowledge elicitation (Hoffman, Crandall & Shadbolt, 1998; Taynor, Crandall & Wiggins, 1987).

**Procedure**

The basic procedure for employing CDM is well documented (Klein et al., 1989; Hoffman et al., 1998). There were several steps used in the interviewing process:
1. Incident selection - CSMs select a recent, non-routine incident that was challenging;
2. The interviewer obtains an unstructured recall of the event;
3. With the aid of the participant, the interviewer establishes the sequence of decision events and constructs a time line;
4. Decision point identification – the interviewer identifies specific decisions that were made;
5. Decision point probing – the interviewer utilises probing/questioning techniques to identify effective decisions and resultant behaviours (see Table 1 for examples of the probes)
6. Hypotheticals and ‘what if’s’? The interviewer chooses several decision points, and asks hypothetical questions based upon different event outcomes (eg., what would you do if the Captain didn’t take your request seriously?). These queries serve to identify potential errors, alternative decision-action paths, and expert/novice differences (Hoffman et al., 1998)
7. Standard case study - CSMs are provided with a standard case study\(^1\) and repeat steps three to six as if they were the CSM on-board that aircraft.

<table>
<thead>
<tr>
<th>Table 1. A Sample of CDM Probe Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Type</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Cues</td>
</tr>
<tr>
<td>Knowledge</td>
</tr>
<tr>
<td>Analogues</td>
</tr>
<tr>
<td>Standard scenarios</td>
</tr>
<tr>
<td>Goals</td>
</tr>
</tbody>
</table>

\(^{1}\) The standard case study was a real Qantas incident on-board a B737. It involved smoke and fumes in the cabin, with many CRM issues and problems.
Options | What other courses of action were considered or were available?
---|---
Mental models | Did you imagine the possible consequences of your action?
Experience | What specific training, experience or knowledge was necessary?
Decision making | Was there any time pressure? How long did it take to make the decision?
Aiding | What training, knowledge or experience could have helped you?
Errors | What mistakes are common at this point? How might a novice act?

Adapted from Hoffman et al. (1998)

Participants were informed that the interviews were anonymous, and the only identifying information collected was age, years operating as CSM, home base, and operation type (long/short haul). Interviews were conducted in a quiet office environment and tape-recorded (if permission was granted). Most interviews lasted for 1.5 – 2 hours; requiring at least one hour for the first critical incident, and half to one hour for the repeated case-study incident. Verbatim transcripts were made from the tapes.

The second stage of the study involved the coding of the interviews and development of the Expected Safety Behaviours. The procedure consisted of a number of stages (only stage 1 and 2 have been completed):

1. Initial coding of the transcripts to develop behavioural markers;
2. Improve code structure and markers with feedback from cabin crew subject matter experts;
3. Analysis of survey data and behavioural markers by general CSM population. The project results and behavioural markers will be sent to the CSM population for comment and feedback. This also includes CSMs rating the importance of each behavioural marker;
4. Attain a frequency count of behavioural marker elements/behaviours occurring in each incident;

5. Construct a risk matrix of behavioural markers (frequency occurring vs importance).
   This is based upon the results from steps 3 and 4; and

6. Produce a master list of Expected Safety Behaviours.

**Results and Discussion**

The following results are only preliminary, and are subject to change and development as the project progresses. Three interviews could not be used due to failed or poor quality tape recording. Currently, two more have been discarded due to unsuitability of the incident or lack of decision probing.

The majority of critical incidents recalled by CSMs were categorised under seven headings (see Fig 1). Almost half of these incidents were related to disruptive or drunk passengers (20%), in-flight medical emergencies (17%), or security/terrorism threats (12%). The large number of security/terrorism threats has only occurred since Sept 11th. It is interesting to note that so many safety issues revolve around aircraft door and slide issues (10%). Aircraft Technical issues (8%) refer to problems such as aborted take-offs, engine problems, and cockpit and cabin equipment malfunctions.

The break down of all reported cabin safety incidents for the one year period Jan 2001 to Feb 2002 is proportionally similar to those of this study. For example, the main reported incidents were passenger behaviour (24%), medical (16%), door/slide issues (5%), smoke/fumes (18%), and turbulence (1%) (Qantas, 2002).
Figure 1. Type of Critical Incidents Recalled

The initial coding of interviews has revealed seven Expected Safety Behaviour categories, each with multiple Expected Safety Behaviour elements and behaviours. These are listed in Table 2. While the Expected Safety Behavioural categories are fairly stable, the elements and behaviours are only preliminary and are subject to further refinement and development.

Table 2. Preliminary Expected Safety Behaviour Markers and Elements

<table>
<thead>
<tr>
<th>Expected Safety Behaviour Category</th>
<th>Expected Safety Behaviour Element / Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situation Awareness</td>
<td>• Demonstrates awareness of flight phase</td>
</tr>
<tr>
<td></td>
<td>• Considers political/social/cultural situations</td>
</tr>
<tr>
<td></td>
<td>• Considers time constraint</td>
</tr>
<tr>
<td></td>
<td>• Recognises higher safety goals and priorities</td>
</tr>
<tr>
<td></td>
<td>• Anticipates outcomes consequences</td>
</tr>
<tr>
<td></td>
<td>• Develops contingency plans</td>
</tr>
<tr>
<td></td>
<td>• Monitoring potentially threatening work conditions</td>
</tr>
<tr>
<td>Information Feedback</td>
<td>• Confirms common understanding of information</td>
</tr>
<tr>
<td></td>
<td>• Critically analyses information</td>
</tr>
<tr>
<td></td>
<td>• Provides timely feedback to Cabin/Tech Crew &amp; Pax</td>
</tr>
<tr>
<td></td>
<td>• Feeds-forward info to those that need to know (info dissemination)</td>
</tr>
<tr>
<td>Self awareness &amp; analysis</td>
<td>• Understands personal limitations (can be physical, skill/knowledge)</td>
</tr>
<tr>
<td></td>
<td>• Recognises when to seek professional/technical advice</td>
</tr>
</tbody>
</table>
| Operational Understanding | • Considers impact of life-events or personal situation on performance  
  • Understands roles/responsibilities – flight ground  
  • Demonstrates knowledge of BAK  
  • Understands CSM authority/duty  
  • Recognises when to relegate control  
  | Passenger & Crew Management | • Assesses pax (boarding or in-flight)  
  • Monitors potentially threatening pax behaviour  
  • Monitors potentially unsafe crew performance  
  • Allows and provides on-board coaching and training  
  • Considers pax welfare  
  • Considers crew welfare  
  • Diffuses situation (non-confronting)  
  • Presents a calm/controlled image  
  • Minimises cabin disruption  
  • Allows and provides crew debrief  
  | Negotiation & Influencing skills | • Consults with pilots to gain support  
  • Manages upwards – identifies problem  
  • Manages upwards - expresses concern  
  • Manages upwards - provides options  
  • Manages upwards - uses emergency language  
  | Workplace Safety | • Personal safety  
  • Hazard awareness  
  |

Figure 2 is a representation of how such Expected Safety Behaviours may look when they have been transferred to a Qantas in-flight observation form. This is based on a version currently in use with Qantas flight crew. The back of such a form would contain the full list of behaviours/elements (as listed in Table 2) for reference.

<table>
<thead>
<tr>
<th>CSM: Cabin Crew</th>
<th>Sector:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective</td>
<td>Marginal</td>
<td>Effective</td>
</tr>
<tr>
<td>1</td>
<td>Situation awareness</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Information feedback</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Self-awareness &amp; analysis</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Operational understanding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pax &amp; crew management</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Negotiation &amp; influencing skills</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Workplace Safety</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ineffective</th>
<th>Marginal</th>
<th>Effective</th>
<th>Highly Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>This is a behaviour which:</td>
<td>This is a behaviour which:</td>
<td>This is a behaviour which:</td>
<td>This is a behaviour which:</td>
</tr>
<tr>
<td>• May contribute to an uncorrected error</td>
<td>• May impair crew from completing a task, but is unlikely to contribute to uncorrected error</td>
<td>• Facilitated the effective completion tasks free of significant error</td>
<td>• Facilitated the completion of tasks with more efficiency than is normally required</td>
</tr>
<tr>
<td>• Immediate improvement is required in this area</td>
<td>• Crew members will benefit from further training or self-improvement</td>
<td>• Demonstrates an example of CRM that crew members should achieve in line operations</td>
<td>• Demonstrates an example of CRM that all crew members should strive to achieve</td>
</tr>
</tbody>
</table>

**Figure 2. Mock-up of Cabin Crew Safety Behaviour Evaluation Form**

*Future Stages - Stage 1*

The main product to be developed from the cabin crew expected safety behaviours project is a master list of Expected Safety Behaviours (as per Table 2). These are to be used in the training of cabin crew, and for the evaluation of non-technical skills (human factors and CRM skills).

In the short term the interview transcripts can also be used as training aids. There are now eighty Qantas-specific incidents that can be used as case studies and examples for cabin crew training and education. Because the incidents focus on the cognitive aspects of the situation, they are an excellent training aid for teaching expert skills and behaviours to novices. Given the similarity between the proportion and type of actual reported cabin safety incidents (Qantas, 2002) and those attained in this study, the incidents attained will be highly useful for training as they cover most incident types occurring.
Finally, the safety behaviours could also be used in the recruitment of cabin crew.

Potential staff could be recruited against the actual safety behaviours and skills required by Qantas cabin crew, rather than against generic industry requirements. The recruitment process could be refined to include more targeted safety requirements, as well as the essential, established service skills, ensuring that only the most suitable applicants are selected.

*Future stages - Stage 2*

In the longer term the expected safety behaviours can be used in a similar manner to the way in which they are used for cockpit crew – the evaluation of CRM and non-technical skills in training.

However, the greatest challenge is moving the evaluation and observation of safety behaviours out of the training environment and into normal line operations, in the form of a cabin crew LOSA program. There are many issues and problems to overcome before in-flight cabin observations can take place. Such problems include:

- Cabin environment is not as contained as the cockpit.
- Double deck aircraft.
- Multiple crew to observe (up to 15 on B744).
- All information goes through CSM.
- Observers are more obtrusive in cabin.
- Errors tend to be less consequential in the cabin.
- Impact on customers.
- Cabin crew are less familiar with CRM than pilots.
- Less external threats to cabin safety in-flight than in the cockpit.
Many of these issues are not relevant to the cockpit, where check and training for technical skills has been an accepted practice for decades. Further, CRM and non-technical skills audit and evaluation is gaining acceptance in the cockpit, and a cockpit LOSA program is running at Qantas. As yet, no airline has committed to LOSA style programs for cabin crew, and to our knowledge, the proposed Qantas project is the first attempt to apply this program within the cabin environment.

**Summary and Conclusion**

Expected safety behaviours or non-technical skills are being increasingly used to assess or observe flight crew CRM performance. Safety and human factors programs are well established components of cabin crew training, but the non-technical skills required to successfully manage safety critical tasks and situations have not yet been identified.

This paper described a two-part research project being undertaken within Qantas Airways to address these issues. Stage 1 involved the application of the Critical Decision Method protocol to identify successful decision making skills and expected safety behaviours amongst experienced cabin crew (CSMs). Seven main categories were developed. These expected safety behaviours can also be used to improve the future recruitment of cabin crew. Stage 2 of the project, which has not been completed, involves the implementation of the flight crew LOSA program within the Cabin Crew environment, utilising the expected safety behaviours developed in Stage 1. The applicability of LOSA for cabin crew operations as well as the logistical and practical challenges of planning and implementing normal operations monitoring for cabin crew are still major issues to be resolved.
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