Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Research and Analysis – AR-2006-156(1)
Final

Threat and Error Management

Attitudes towards training and applicability of TEM to general aviation and low capacity air transport operations

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Published by: Australian Transport Safety Bureau
Postal address: PO Box 967. Civic Square ACT 2608
Office location: 62 Northbourne Ave, Canberra City, Australian Capital Territory, 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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Threat and Error Management: Attitudes towards training and applicability of TEM to general aviation and low capacity air transport operations

Authors

Cheng, K.
Inglis, M.
Godley, S. T.

Prepared By

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

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Abstract

The threat and error management (TEM) model provides a non-technical tool to help pilots identify and manage threats (hazards) and errors during flight. In preparation for regulatory changes that come into effect in July 2009, the Guild of Air Pilots and Air Navigators (GAPAN) developed a TEM 'train-the-trainer' course for general aviation and low capacity air transport operations. Between August and October 2007, GAPAN conducted TEM training in 10 locations throughout Australia. Two surveys were administered to TEM course participants by the Australian Transport Safety Bureau: one immediately after the training session and the other about 8 months after the training.

The surveys were designed to elicit information on attitudes towards TEM, organisational safety strategies, and challenges and benefits of implementing TEM. The follow-up survey was constructed to explore whether TEM has been implemented, along with any challenges and benefits found where TEM had been implemented.

Overall, the responses regarding attitudes and intentions of implementing TEM were positive. Eight months after the training, most organisations had implemented TEM and incorporated it into their own training programs. Implementation of TEM into the respondents' organisation was generally considered easy and staff were receptive, with the greatest challenges being time and resources.

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EXECUTIVE SUMMARY

The threat and error management (TEM) model provides a non-technical tool to help pilots identify and manage threats (hazards) and errors during flight. Initially developed by researchers at the University of Texas, TEM research has primarily focused on multi-crew commercial airline operations. However, the principles behind TEM should also be applicable to many types of aviation, including general aviation and low capacity air transport operations. The Civil Aviation Safety Authority has followed the International Civil Aviation Organization's lead in mandating TEM in pilot licensing standards. From 1 July 2009, TEM will become a part of pilot licence testing in Australia. In preparation for these requirements, the Guild of Air Pilots and Air Navigators (GAPAN) developed a TEM 'train-the-trainer' course to support these regulatory changes.

Between August and October 2007, GAPAN conducted TEM training to participants in 10 locations throughout Australia. The aim of the training was to provide a training template for the concept of TEM for those in general aviation and low capacity air transport operations involved with pilot training. Subsequently, two surveys were administered to TEM course participants: one immediately after the training session (post-training survey); and the other about 8 months after the training (follow-up survey). The post-training survey and the follow-up survey were voluntary and had response rates of 68 per cent (212 responses) and 23 per cent (73 responses), respectively.

This report reviews the appraisals of participants of the GAPAN TEM course about the concept of TEM and investigates whether the course participants had implemented TEM training since the course and the reasons behind this.

The post-training survey found that 23 per cent of participants had no prior knowledge of TEM. Importantly, most participants indicated they believed that TEM will improve safety, and this was more likely among respondents in air transport category. While many benefits were identified with TEM, a lack of spare time and resistance to change were seen as the greatest challenges in implementing TEM.

For the follow-up survey, most respondents indicated they used TEM in their day-to-day activities. Although resistance to change was identified as a possible challenge to implementing TEM, the follow-up survey did not support this contention. Respondents said that implementation was easy and that staff were receptive, although the greatest challenges were time and resources. Moreover, the follow-up survey also showed that cost was not a major obstacle in implementing TEM. Where organisations did implement TEM, it was most frequently implemented as part of initial or recurrent crew resource management training. Organisations that intended to implement TEM in the future or did not intend to do so at all cited time and resource constraints. This reflects the predicted challenges highlighted in the post-training survey.

ABBREVIATIONS

ATPL	Air transport pilot licence
ATSB	Australian Transport Safety Bureau
CAAP	Civil Aviation Advisory Publications
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations
CRM	Crew resource management
CTL	Commercial pilot licence
GA	General aviation
GAPAN	Guild of Air Pilots and Air Navigators
GFA	Glider Federation of Australia
GFPT	General flying progress test
ICAO	International Civil Aviation Organization
LOSA	Line Operations Safety Audit
N	Number of respondents/responses
PPL	Private pilot licence
RA-Aus	Recreation Aviation Australia
RPT	Regular public transport
SD	Standard deviation
SMS	Safety management systems
SOP	Standard operating procedures
TEM	Threat and error management
VFR	Visual flight rules

1 INTRODUCTION

1.1 Threat and error management (TEM)

Threat and error management (TEM) is a method that can be used by flight crew to identify and mitigate risks and errors that may have an impact on safe flight. The concept of TEM was derived from the Line Operations Safety Audit (LOSA) program by researchers involved in the University of Texas Human Factors Research Project.

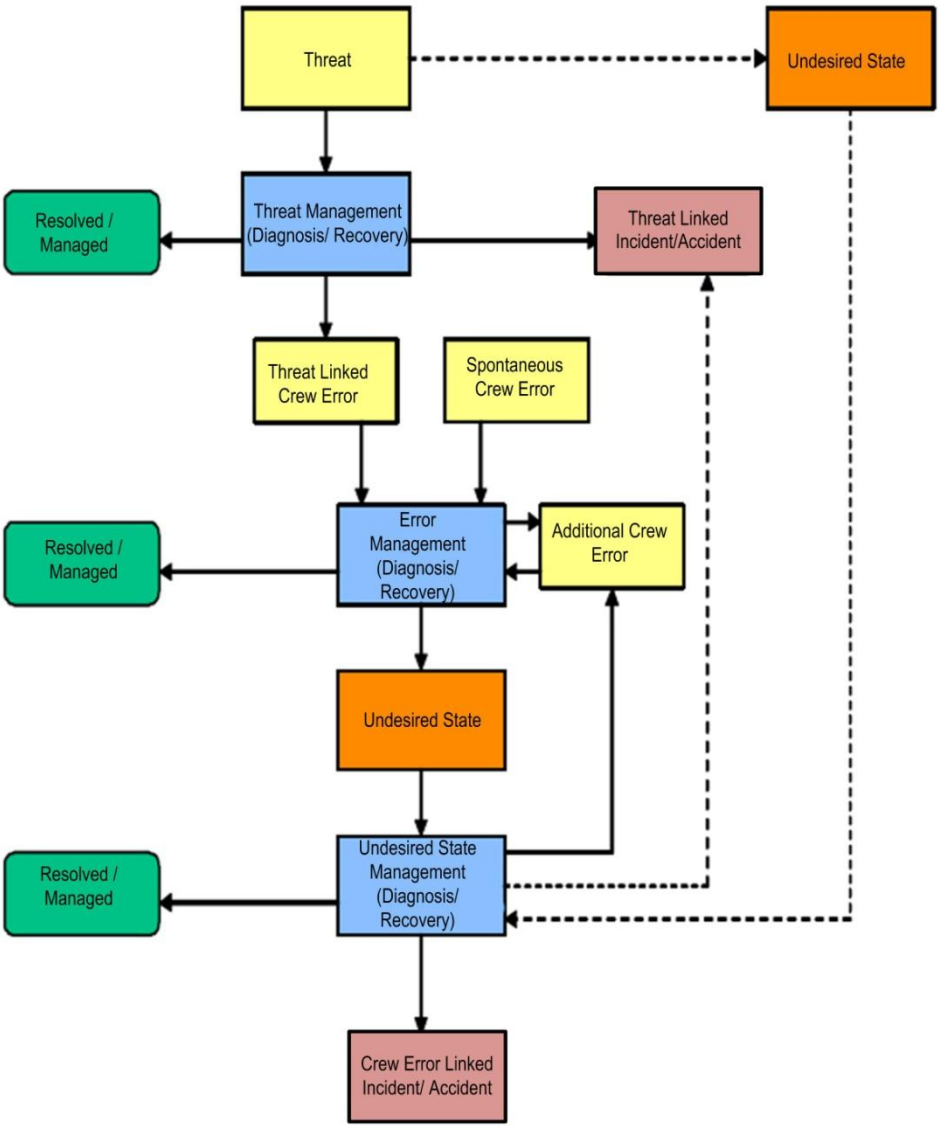
The LOSA program involves trained observers recording the non-technical aspects of crew performance from the flight deck observation seat. At the core of the LOSA process are the crew's identification and management of threats and errors. Observers record the various threats encountered by flight crew, the types of errors that occurred, and how flight crews managed those situations to maintain safety (University of Texas Human Factors Project, n.d.). Information on threats and errors and their management obtained through the audits can then be used to direct resources within an airline to enhance safety.

There are three basic components in the TEM model: threats, errors and undesired aircraft states.

- **Threats** are 'events or errors that occur beyond the influence of the flight crew, increase operational complexity, and which must be managed to maintain the margins of safety' (Maurino, 2005). When undetected, unmanaged or mismanaged, threats may lead to errors or even an undesired aircraft state.
- **Errors** are 'actions or inactions by the pilot that lead to deviations from organisational or pilot intentions or expectations' (Maurino, 2005). When undetected, unmanaged or mismanaged, errors may lead to undesired aircraft states.
- **Undesired aircraft states** are defined as 'an aircraft deviation or incorrect configuration associated with a clear reduction in safety margins' (Maurino, 2005). Undesired aircraft states are considered the last stage before an incident or accident (ICAO, 2005). Thus, the management of undesired aircraft states represents the last opportunity for flight crews to avoid an unsafe outcome, and hence maintain safety margins in flight operations (Maurino, 2005).

From a theoretical view point, Figure 1 shows how threats, errors, undesired aircraft states and consequences (accidents and incidents) are related. It shows that there is no linear relationship between threats, errors, and undesired aircraft states (or an incident or accident): not every threat leads to an error, and not every error leads to an undesired aircraft state. Likewise, an undesired aircraft state is not always preceded by an error, nor is every error preceded by a threat. However, threats that are not adequately managed can lead to errors, and errors that are not adequately managed often lead to undesired aircraft states. These in turn can lead to undesired consequences.

Figure 1: Threat and error management framework



Source: ICAO (2005)

The concept of TEM was originally developed for LOSA. However, airlines, the International Civil Aviation Organization (ICAO), and regulators have seen the potential safety benefit of developing the TEM concept further into a practical non-technical tool that can be used by pilots.

Maurino (2005) notes that slight modification to the definitions of threat, errors and undesired aircraft states may be required for different users of TEM, such as front-line personnel, flight operations, maintenance, or air traffic control. For example, definitions that are appropriate for LOSA observers may differ to definitions that would be appropriate for flight crew when using TEM to manage threats and errors in everyday operations.

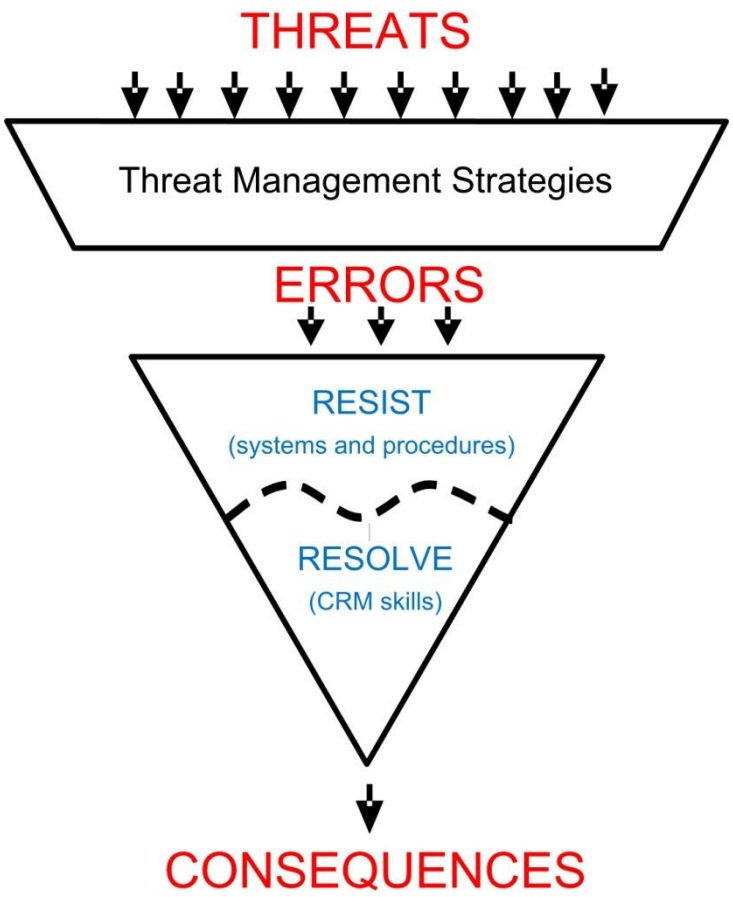
Threats and errors are part of everyday flight operations that must be managed by flight crews, since both threats and errors carry the potential to generate undesired aircraft states. The teaching of non-technical or crew resource management (CRM) skills, along with expected behaviour policies within airlines that include them,

have somewhat successfully addressed the intent of TEM over the past decade, in particular, error management. However, many threat and error management behaviours in the flight deck have remained informal and often internalised within individual crew members. This increases the chances of threats and errors remaining undetected by crew before an undesired aircraft state develops.

Therefore, the aim of using TEM on the flight deck is to ensure that threats are identified well in advance of them occurring so that threat management strategies can be put in place while all mitigation options are still available and there is enough time for proper consideration of all available options. All crew need to be involved in this decision making process to ensure shared mental models and adequate situational awareness. Mitigation strategies put in place need to be re-evaluated to determine whether they are working as planned. Likewise, errors and undesired aircraft states need to be identified as early as possible so that mitigation controls can be considered, chosen, acted upon, and evaluated.

Figure 2 is a common pictorial model used for training airline flight crews, and was originally developed by Continental Airlines. It shows how the three components of the TEM model fit together, and how they can lead to undesired aircraft states if not well managed. The number of arrows in the diagram represent the expected number of threats, errors and consequences (incidents and accidents), conveying the idea that crews will generally need to manage many more threats than errors, and likewise, manage more errors than consequences. The height of the diagram refers to time available before an occurrence occurs relative to when threats and errors usually appear. The width of the diagram represents the amount of resources available for crews to manage the situation. Generally, there are more resources available to manage threats when they first occur compared to later when these threats have already led to an error.

Figure 2: Operations threat and error model



Source: Adopted from Continental Airlines

1.1.1 Pilot TEM requirements

In 2006, the ICAO adopted TEM in pilot licensing standards and recommended practices (ICAO, 2006). Further information on ICAOs TEM requirements for flight crew training and the flight crew licensing requirements are detailed in Annex 1, *Personnel Licensing*.

In line with ICAO, the Civil Aviation Safety Authority (CASA) has moved to include TEM in Australian flight crew licensing requirements. From March 2008, TEM has been incorporated into the Day Visual Flight Rules (VFR) syllabuses. From 1 July 2009, TEM will also be assessed on flight tests for the general flying progress test (GFPT), and private and commercial pilot licences. Additionally, TEM will be examined in all human factors aeronautical knowledge examinations for these licences from 1 July 2009 (CASA, 2008).

As a result, flight instructors will be required to teach TEM skills. To assist in meeting these requirements, CASA has produced an example of a training syllabus, Civil Aviation Advisory Publication (CAAP) 5.59-1, for teaching and assessing *Single Pilot Human Factors* and *TEM* modules.

1.1.2 TEM for general aviation and low capacity air transport operations?

Although TEM had initially been directed towards multi-crew commercial airline operations in terms of both LOSA and its subsequent development as a non-technical skill, its principles should nonetheless also be applicable to pilots in general aviation and low capacity[1] air transport operations.

However, the application of TEM will be different for small operators compared to high capacity airlines. This is due to differences in: crew numbers (both pilots and cabin crew); levels of experience of crew (such as flying training); the level of involvement by other personnel such as flight planners, dispatchers, loaders and maintenance support; aircraft systems and computerisation; the nature of operations and airspace operated in; and the types of interaction with air traffic control. As a result, although there will be some commonality, there will be different types of threats and errors, and different threat and error management strategies that will be appropriate. Therefore, a program developed for a large airline could not be used 'off the shelf' by GA or low capacity air transport operations[2].

Unlike high capacity airlines, smaller low capacity air transport and GA operators generally do not have the resources to develop company specific TEM programs. To assist these operators, as mentioned above, CASA has provided an advisory publication in October 2008 (CAAP 5.59-1) for guidance on teaching and assessing TEM.

However, prior to this, in light of the perceived safety benefits of TEM and the foreseeable changes to ICAO and CASA requirements, the Guild of Air Pilots and Air Navigators Training (GAPAN) embarked on a program to develop a training course in TEM principles for flight training professionals in general aviation and low capacity air transport.

1.2 Guild of Air Pilots and Air Navigators training

As part of its efforts to improve aviation safety, the Australian Transport Safety Bureau (ATSB) provided funding in 2005 to GAPAN to create and facilitate a TEM train-the-trainer course for general aviation and low capacity air transport operations. The course was aimed at instructors and training-and-checking pilots who would be required by CASA to teach TEM within their organisations. The objective of the training program was to introduce Australian pilots to TEM and to provide them with an understanding of the basic principles and practices of TEM, as well as the platform to build on these knowledge and skills.

The courses, which were free of charge, were conducted between August and October 2007 at 10 locations in Australia (locations listed in Appendix B). Two courses, each one day in length, were offered at each location. Course one was tailored for single-pilot operations and course two was tailored for multi-crew operations.

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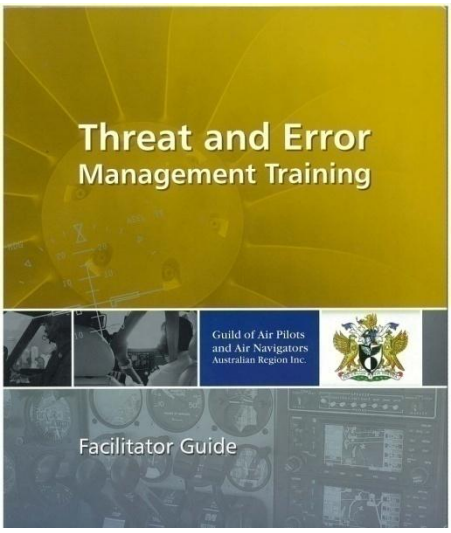
[1] A low capacity aircraft provides less than 38 passenger seats and a maximum payload no greater than 4,200 kg.

[2] Air transport operations refers to both regular public transport (RPT) and charter operations.

Participants were given a course manual including two DVDs containing training slides and video footage of in-flight scenarios, as well as a facilitator guide and a delegate's workbook (Figure 3). The course material, developed with assistance from the University of Texas Human Factors Research Project, focused on the theory of TEM and used case studies to illustrate TEM concepts.

Figure 3: GAPAN TEM course manual



For more information about the GAPAN TEM course or a copy of the course manual, contact GAPAN (details in Appendix C).

At the end of the course, participants were asked to complete a survey that aimed to evaluate various aspects of the course as well as their attitudes towards TEM.

1.3 Objectives

Much literature has concentrated on TEM as a concept in multi-crew commercial operations, but there is limited research into TEM and its implementation in general aviation and other flying categories. Thus, the over-arching aim of this report is to investigate the acceptance of TEM as a concept and its applicability in general aviation and low capacity air transport operations. The objectives are to:

- explore how participants of the GAPAN TEM training regard the concept of TEM and its usefulness and applicability in the Australian environment
- explore participant experiences in implementing TEM, or barriers for not implementing TEM.

To achieve these objectives, some evaluation of the GAPAN TEM training and training resources provided, from the perspective of their usefulness for future training, was also conducted.

Operators in general aviation and low capacity air transport will benefit from the insight into the attitudes and perceptions of respondents from a variety of organisational roles. Operators will also benefit from the experiences of those who have implemented TEM into their organisations.

2 METHODOLOGY

2.1 Data sources

The data contained in this report were derived from two surveys: one conducted immediately after training (post-training survey), and the other about 8 months after the training (follow-up survey).

The post-training survey was distributed to the course participants in a paper format at the end of the GAPAN TEM training course in 2007. The follow-up survey was sent to all course participants either in a paper (mail) or electronic (email) format.

Both surveys were completed on a voluntary basis. Personal details were not recorded on the surveys to ensure confidentiality and honest reporting. As no names or organisations were recorded, a coding system was included in the surveys to enable the two surveys to be linked by respondent.

Post-training survey

Part A of the post-training survey aimed to collect information about the respondent's attitudes and beliefs about the concept of TEM, its applicability and usefulness to their organisation, and the benefits and difficulties they expect to face if their organisation was to implement TEM training. The questions required a combination of forced-choice answers and open-ended answers. Part B contained ratings of the safety of their flying category and common risks that were duplicated from an earlier ATSB safety climate survey (ATSB, 2005). Along with two Part A open-ended questions, which asked participants to list the most common threats and errors faced in their industry, the analysis of Part B questions will be reported in a separate ATSB research report. Part C contained demographic information questions. The survey contained 27 questions. The survey questions are included in Appendix D.

Follow-up survey

The follow-up survey investigated whether the resources and materials provided by GAPAN were considered useful for teaching TEM in the participants' organisations. It also examined the experiences of organisations that have implemented TEM training, reasons why some organisations have not implemented TEM, and why some organisations do not intend to implement TEM in the near future.

The follow-up survey was divided into four sections. All respondents were asked to complete Section A. Respondents whose organisation implemented TEM training were asked to complete Section B, while Section C was applicable to respondents whose organisation intended to implement TEM training in the future. Section D was completed by respondents whose organisation was not intending to train staff in TEM. The survey can be seen in Appendix E.

2.2 Population and sample

The Guild of Air Pilots and Air Navigators advertised the TEM course in their newsletter and sent invitations to regional airlines, charter operations and flying schools to attract participants to the free course. Course participants were self selected.

A total of 212 participants, out of approximately 312 who attended the training, responded to the post-training survey, yielding a response rate of 68 per cent. A detailed description of the respondents can be found in Section 3.1.

Of the 312 participants, 73 completed the follow-up survey. The response rate for this survey was 23 per cent. Of the 73 respondents, only 45 had also completed the post-training survey. A detailed description of the respondents can be found in Section 4.1.

2.3 Method of analysis

The majority of the analyses conducted in this paper are descriptive and, where appropriate, inferential statistics using chi-square (χ^2) analyses were conducted to test for statistically significant associations. The type 1 error rate was set at $\alpha = 0.1$. Where the test for association was statistically significant, an odds ratio analysis[3] was conducted, showing 90% confidence intervals[4], to identify the strength of association between variables.

The total number of responses for each question in the survey is recorded as N. In many cases, N may be less than the number of respondents who completed the survey as not all respondents answered every question. Some questions asked respondents to provide more than one answer (multiple response questions), therefore, the total number of responses may be greater than the total number of respondents.

Coding

For multiple response questions, the data were coded independently by two ATSB researchers. Any discrepancies were discussed and resolved. These responses were then analysed using the multiple response function in the statistical software package SPSS.

The survey collected demographic information including the flying category in which the respondent spent most of their flying time. As some flying categories, such as surveying and spotting, had too few respondents to produce meaningful comparisons, the flying categories were coded into larger groups. Thus, flying categories were coded in the following ways:

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[3] An odds ratio presents the proportion of people with a variable of interest present to those where the variable is absent.

[4] Confidence intervals present a range where the true magnitude of an effect lies. Wide confidence intervals show greater variability in a sample, which can be a result of small samples.

- air transport – included low capacity regular public transport (RPT), passenger charter, and other charter;
- aerial work - included emergency services, agriculture, surveying or spotting, and other aerial work;
- flying training; and
- private/business.

Note that aerial work, flying training and private/business flying categories are collectively referred to in this report as general aviation (GA).

Excluded data

The post-training survey asked respondents to indicate one flying category where they spent most of their flying time in the past 12 months and to indicate the primary role they held in their organisation. Twenty-six respondents of 212 (12 per cent) indicated they belonged to more than one flying category. Similarly, 28 respondents (13 per cent) indicated that they had more than one primary role in their organisation. Since it was not possible to determine whether respondents who selected only one flying category or primary role in the survey actually also belonged to more than one flying category or held more than one primary role, analyses involving these variables excluded responses from respondents who indicated more than one category. The exception to this rule was applied to the four respondents (out of the 26 respondents mentioned above) who indicated they belonged to both regular public transport (low capacity) and charter passenger categories. Since those categories form the air transport category, the four respondents were not excluded from the analyses. The deletions did not skew the distribution of results.

Completion of both surveys

Forty five respondents completed both the post-training and follow-up surveys. While it would have been valuable to correlate the responses from both surveys to examine how the GAPAN TEM training may have influenced respondents in general aviation and low capacity air transport operations, the sample size was too small to perform meaningful quantitative analyses.

3 POST-TRAINING SURVEY: RESULTS AND DISCUSSION

This section reports the results from the post-training survey, which had 212 respondents. Results from the follow-up survey are found in Chapter 4. The results from the post-training survey are organised by demographic information, by their attitudes and perceptions towards threat and error management (TEM) and safety, and by their perceptions about implementing TEM.

3.1 Demographics

3.1.1 Flying categories

A detailed breakdown of respondents by the flying category in which the respondent most frequently operated during the past 12 months can be found in Table 1.

Table 1: Respondents by type of flying (Post-training survey)

	Frequency	Per cent
Flying training	90	49.5
Charter – passenger	34	18.7
Regular public transport	18	9.9
Private	11	6.0
Emergency or medical services	10	5.5
Aerial work – other	6	3.3
Surveying or spotting	6	3.3
Business	4	2.2
Charter – freight	3	1.6
Total number of respondents	182	100
Number of non-responses	30	

As some flying categories, such as surveying or spotting, had too few respondents for meaningful comparisons, certain flying categories were grouped together for the purpose of analyses (Table 2). The methodology for this process was described in Section 2.3. Of the 182 respondents who recorded their flying activity, 8 per cent were from the private/business flying category, while 12 per cent performed aerial work. All respondents from regular public transport (RPT) operated in low capacity RPT. This group, together with charter passenger and other charter, made up 30 per cent of all respondents.

Table 2: Respondents by combined flying categories (N=181)

	Frequency	Per cent	Categories included
Flying training	90	49.5	Flying training
Air transport	55	30.2	Regular public transport; charter passenger; other charter
Aerial work	22	12.1	Emergency services; agriculture; surveying or spotting; other aerial work
Private/business	15	8.2	Private and business
Total number of respondents	182	100	

3.1.2 Crew operation

Out of the 209 respondents, 74 per cent were from single pilot operations and 23 per cent were from multi-crew operations (Table 3).

Table 3: Respondents by crew operation (N=209)

	Frequency	Per cent
Single pilot	154	73.7
Multi-crew	48	23.0
Both single pilot and multi-crew	7	3.3
Total number of respondents	209	100
Number of non-responses	3	

Table 4 shows the breakdown of respondents in each operational category by the type of crew operation. As expected, the majority of respondents in general aviation operated as single pilot, while multi-crew operations were more likely to be found in (low capacity) air transport operations.

Table 4: Respondents by flying category and type of crew operation (N= 181)

	Category of flying				
	Air transport	**Aerial work**	**Flying training**	**Private/ business**	**Total**
Single pilot	29	17	80	10	136
Multi-crew	23	3	9	5	40
Half single, half multi-crew	2	2	1	0	5
Total number of respondents	54	22	90	15	181
Number of non-responses					31

3.1.3 Primary organisational role

Flight instructors represented the greatest proportion of respondents, making up 29 per cent. This was followed by chief pilots, pilots, check and training pilots and chief flying instructors (Table 5). Ten per cent of respondents indicated that they held a role other than those listed. Many were managers, for example, training, safety, and chief executive officers. It is not surprising that the most common specified 'other' role was the role of safety manager since the GAPAN course focused on improving safety using TEM.

Table 5: Respondents by primary role (N=184)

	Frequency	**Per cent**
Instructor	53	28.8
Chief pilot	32	17.2
Pilot	29	15.8
Check and training	27	14.7
Chief flying instructor	22	12.0
Other	21	10.0
Total number of respondents	184	100
Number of non-responses	28	

Table 6 depicts the breakdown of respondents' demographics by their primary role in their organisation and by their category of flying. Instructors from the air transport category were not represented in the post-training survey. As chief flying instructor is not a role used in aerial work and private/ business, they were not represented in these flying categories.

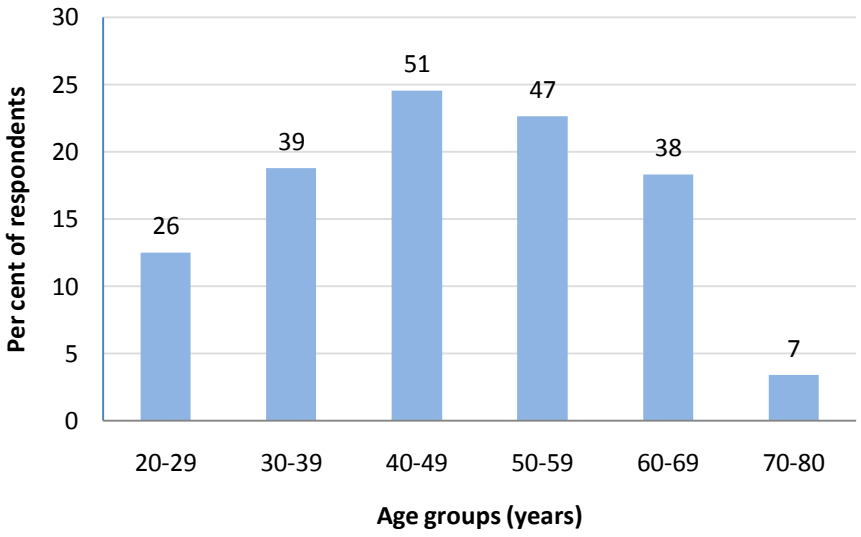
Table 6: Respondents by primary role in the organisation and flying category (N = 164)

Primary role	Flying category				
	Air transport	Aerial work	Flying training	Private/business	Total
Instructor	0	1	46	3	50
Chief pilot	21	6	1	2	30
Check and training	10	7	6	1	24
Pilot	16	6	N/A	1	23
Chief flying instructor	2	0	19	0	21
Other	3	1	5	7	16
Total number of respondents	52	21	77	14	164
Number of non-responses					48

3.1.4 Age

The minimum age of respondents was 20 years and the maximum was 80 years. The average age of respondents was 47 years (SD[5] = 13.6, median = 46.5). Figure 4 shows those aged between 40 and 59 years formed about half of the respondents.

Figure 4: Respondents by age groups (N = 208)[6]



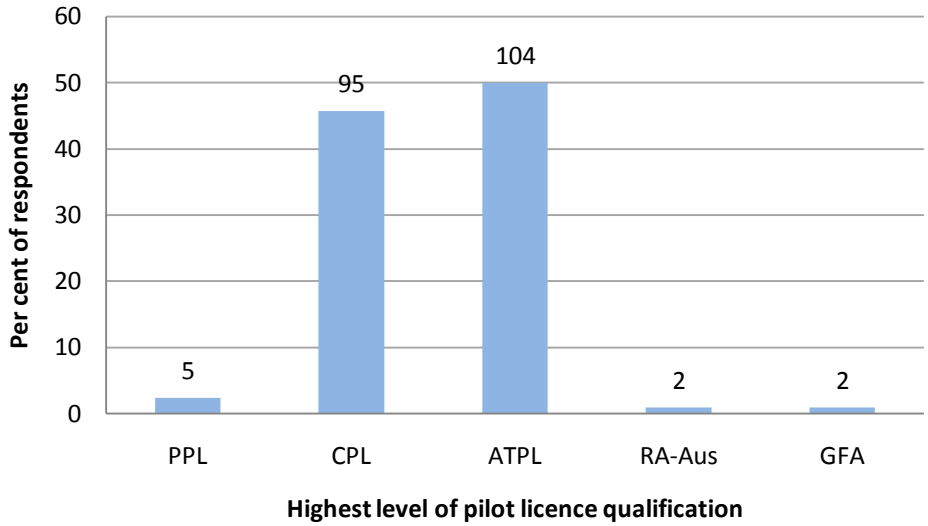
[5] Standard deviation (SD) is a statistical measurement of dispersion around an average or mean. For observations with a normal distribution, about 68 per cent of the observations fall within 1 SD around the average, about 95 per cent of observations fall within 2 SD around the average, and about 99.7 per cent of observations fall within 3 SD around the average (Moore & McCabe, 2006).

[6] Numbers on bars in all graphs indicate the number of respondents while the vertical axis refers to the percentage of the sample.

3.1.5 Licence and recent flying experience

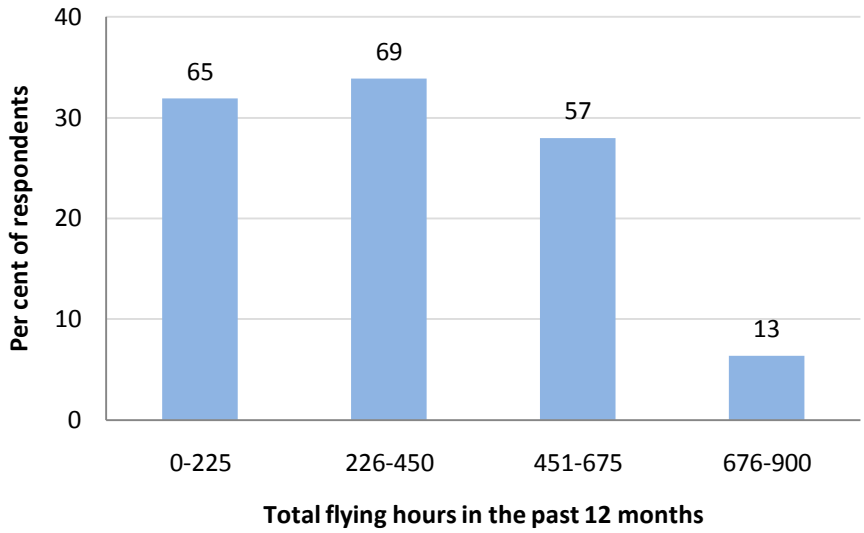
Ninety-eight per cent of respondents held either an air transport pilot licence (ATPL, 51 per cent) or a commercial pilot licence (CPL, 47 per cent) as their highest pilot licence. Five pilots (2 per cent) had a private pilot licence (PPL). Two respondents held a Recreation Aviation Australia (RA-Aus) licence and two held a Glider Federation Australia (GFA) licence (Figure 5). These two licences are not issued by the Civil Aviation Safety Authority (CASA), but by the respective organisations.

Figure 5: Respondents by highest pilot licence (N = 203)



The average time participants had held their licence was 16 years, ranging from 6 months to 54 years (SD = 12.28, median = 15). The hours flown in the last 12 months (at the time of the survey) ranged from 0 to 890 hours, with an average of 359 hours (SD = 204.37, median = 350). Figure 6 shows that the majority of respondents (66 per cent) had less than 450 hours flying time in the past 12 months at the time of the survey.

Figure 6: Respondents by recent flying experience (N=204)



No statistically significant differences were found in the average flying times between respondents who had held a PPL, CPL, or an ATPL as their highest level of licence (Table 7).

Table 7: Hours flown in past 12 months by highest licence attained

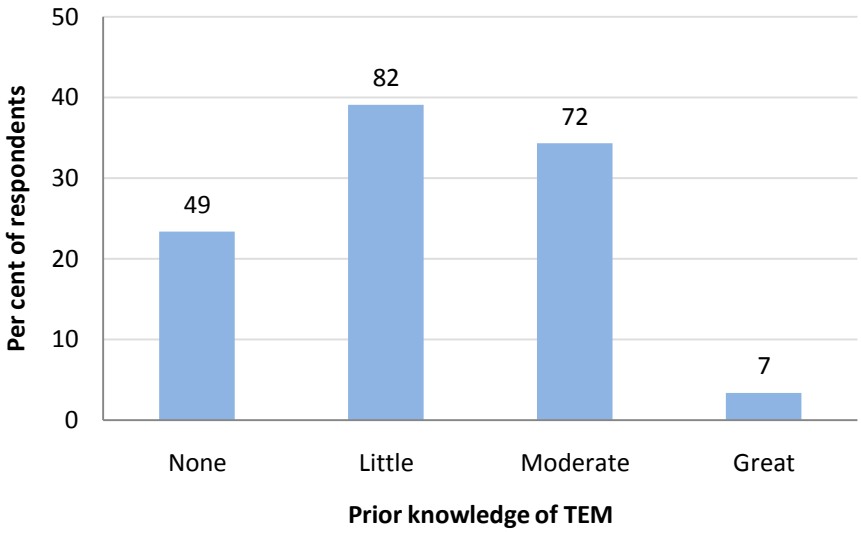
	Average	Standard Deviation	Minimum	Maximum
PPL	395.2	175.9	50	800
CPL	332.0	227.0	4	840
ATPL	397.7	160.6	100	720

3.2 Attitudes and perceptions towards TEM

3.2.1 Knowledge of TEM

Figure 7 shows that the majority of respondents had either little or moderate knowledge of TEM prior to attending the training course. Seven out of 210 respondents felt they had a great amount of prior knowledge.

Figure 7: Respondents' prior knowledge of TEM (N = 210)



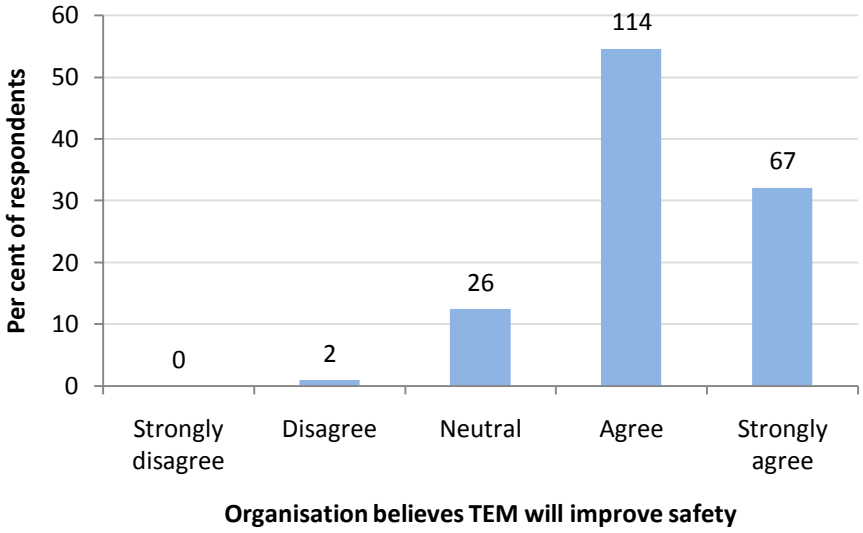
When respondents' prior knowledge of TEM were analysed by their demographics (such as their flying category, their primary role in the organisation, the type of crew operations, etc), no statistically significant differences were found. That is, their prior knowledge of TEM was independent of their demographics.

About half of the respondents in aerial work and in the private/ business flying category indicated they had a moderate level of prior TEM knowledge. About 40 per cent of those in air transport, private/ business, and flying training categories indicated they had little prior knowledge of TEM. Further details of respondents' prior knowledge of TEM are shown in Appendix F, Table F.1.

3.2.2 Improving safety and TEM

Eighty-seven per cent of respondents either agreed or strongly agreed that TEM would improve safety in their organisation, while only two respondents out of 209 disagreed. Those two respondents were from the aerial work category. No respondents strongly disagreed with the statement (Figure 8).

Figure 8: Respondents' perceptions about organisation safety and TEM (N = 209)



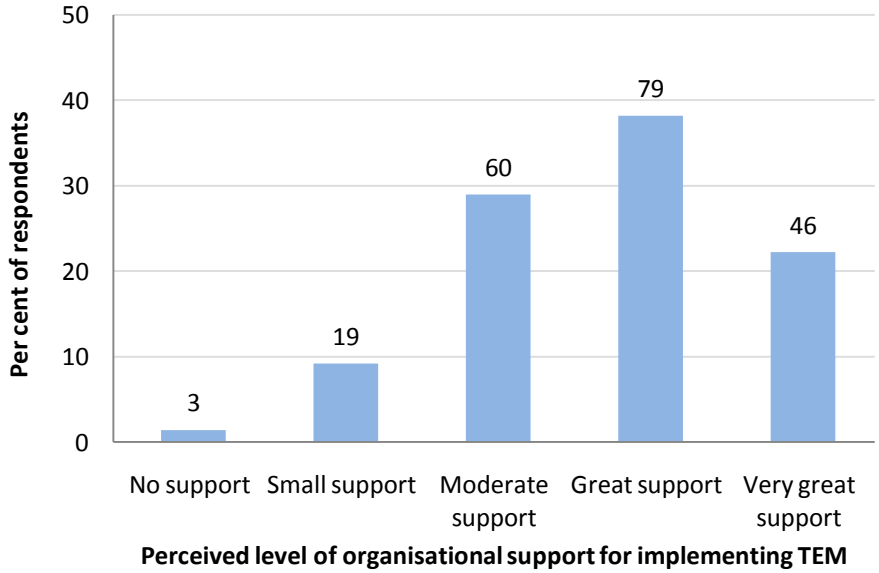
Most respondents (84 per cent) felt that there were organisational problems or issues that would be improved by introducing TEM. Furthermore, statistically significant differences were found when comparing responses from different flying categories ($\chi^2 = 8.614$, $p = 0.035$). This showed that, compared to respondents from other flying categories, respondents from air transport were more likely to believe that the introduction of TEM would improve organisational issues. Table F.2 in Appendix F contains more details of the statistical comparisons.

3.2.3 Organisational support for TEM

Of the 207 respondents, 68 per cent said they would be responsible for implementing TEM training. Also, about 40 per cent of respondents felt they would receive a great level of support from their organisation if they tried to implement TEM (Figure 9).

As with their prior knowledge of TEM, their perceived level of organisational support was not influenced by their demographics. Detailed information on the breakdown of perceived organisational support for implementing TEM by the respondent's primary role can be found in Table F.3, Appendix F.

Figure 9: Perceived level of organisational support for implementing TEM (N=207)



Seventy-eight per cent of respondents, out of 208, stated that their organisation has a nominated staff member who was responsible for safety training.

3.2.4 Safety strategies

At the time of the survey, less than half of the organisations had introduced formal safety strategies or programs in the past 12 months. It is important to note that organisations may have working safety systems which were introduced earlier than 12 months ago.

The types of safety strategies introduced by organisations are reported in Table 8. Of the 85 respondents whose organisations had introduced formal safety strategies, the majority of those involved the appointment of a safety manager, the implementation of safety management systems (SMS), or both. The commonality of SMS implementation can perhaps be explained by Civil Aviation Safety Authority's (CASA) strong encouragement for operators to implement SMS along with the planned introduction of Civil Aviation Safety Regulation 119, which was to make SMS mandatory for all air transport operations (RPT and passenger charter)[7] (CASA, 2002).

Threat and error management was one of the least common safety strategies implemented in the 12 months prior to the training (less than 5 per cent of responses) perhaps because the concept was still new to the general aviation and low capacity air transport sectors of the industry at the time of the survey. It is expected that more operations will adopt TEM training closer to 1 July 2009 when the requirement for TEM to be included in Australian flight crew licensing comes into force.

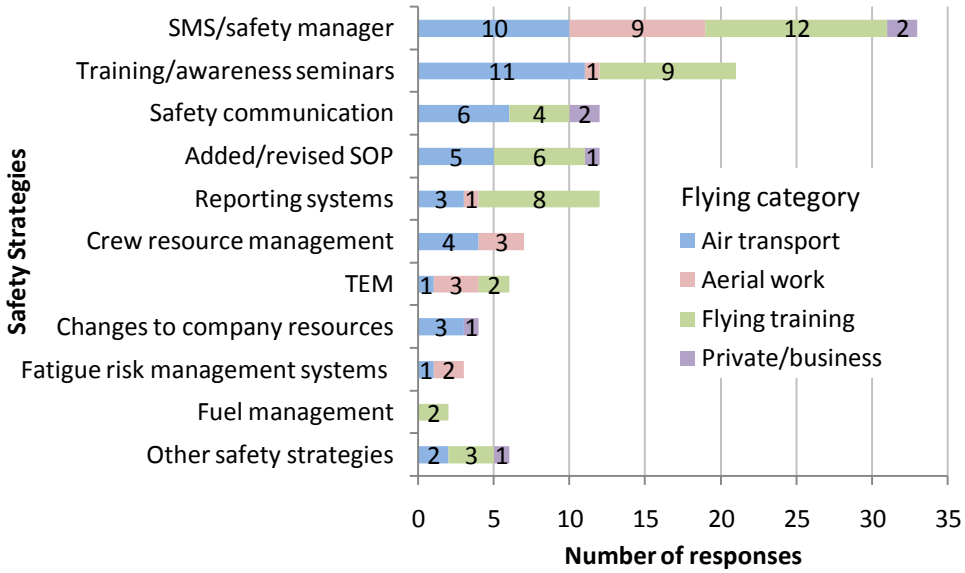
[7] At the time of publication, CASR 119 had not been implemented. However, as an interim measure, CASA amended Civil Aviation Orders 83.3 and 83.5 on 3 February 2009 to require regular public transport operators to have a safety management system in place by 1 February 2010.

Table 8: Examples of safety strategies introduced in the past 12 months

Safety strategies	Number of responses	Example
SMS/safety manager	38	'SMS implemented and appointed an SMS officer'
Training/awareness seminars	25	'attendance at CASA safety briefings'
Added/revised SOP	13	'expansion of SOPs'
Safety communication	12	'safety notices for all flight crews' 'regular staff meetings with safety as a compulsory item'
Reporting systems	12	'standardised and anonymous electronic means of notifying accidents/ incidents for review by committee'
Crew resource management	10	'formal CRM training'
TEM	6	'TEM seminar'
Changes to company resources	6	'rearrangement of safety group'
Fuel management	4	'implementing fuel planning systems'
Fatigue risk management systems	4	'introducing FRMS relevant to our operations'
Other safety strategies	8	'Implementing 'no blame' culture; OH&S'
Total responses	138	

The distribution of safety strategies that were introduced by the different types of flying categories is shown in Figure 10. The safety strategies in Figure 10 are placed in order of most common to least common.

Figure 10: Safety strategies implemented by flying categories (N = 74)



3.3 Perceptions about implementing TEM

3.3.1 Expected benefits of implementing TEM

Respondents were asked to describe any envisaged benefits, difficulties or challenges if they tried to implement TEM in their organisation.

Table 9 shows some predicted benefits of implementing TEM in their organisation. It shows that respondents believed the majority of benefits were increases in safety (32 per cent), followed by increases in TEM knowledge which would encourage proactive approaches to safety (18 per cent). A small number of responses stated that TEM creates awareness that everyone makes errors. Table 9 also provides some examples of benefits of implementing TEM given by the respondents.

Figure 11 depicts the breakdown of the expected benefits by the respondent's flying category. For respondents in the aerial work category, increases in piloting skills, increases in safety awareness, and the awareness that people make mistakes were not considered to be benefits of implementing TEM. Two of those respondents also indicted that the implementation of TEM adds little benefit. Respondents from all flying categories indicated that increases in safety; providing TEM knowledge, encouraging a proactive approach to safety; crew resource management (CRM) behaviours; benefits to the company; the reduction in threat and error; and the standardisation or formalisation of TEM, were predicted benefits.

Figure 12 depicts the breakdown of the expected benefits by the respondent's type of crew operation. Note that the benefits presented in Figure 12 are not in rank order, but instead presented in the same order as Figure 11 to allow for easy comparisons between the two figures. For single-pilot and multi-crew operations, the three most common expected benefits of implementing TEM, in order of most to least common response, were: increase in safety; knowledge in TEM may encourage a proactive approach to safety; and CRM behaviours. Also, benefits to the company were cited by respondents from single pilot operations as being one of the top three ranking benefits (Figure 12). No respondents from multi-crew

operations expected that TEM would benefit users by making them aware that everyone makes mistakes.

Table 9: Sample responses to benefits of implementing TEM

Benefit	Number of responses	Sample responses
Increases safety	95	'reducing incidents and accidents'
TEM knowledge/ Proactive to safety	54	'a greater awareness of the process in identifying threats and errors'
CRM behaviours	28	'increased awareness of the CRM skills/ behaviours that contribute to effective TEM'
Benefits to company	20	'improve operational effectiveness'
Reduce threats and errors	19	'tools to deal with threats and errors'
Standardises or formalises TEM	17	'consistent approach to managing threats and errors'
Improves safety culture/ culture change	15	'encourage a safety culture'
Increases piloting skills	15	'better airmanship developed in all pilots, esp. young inexperienced pilots'
Increases safety awareness	12	'better awareness of safety issues'
Increases morale/ improves attitudes	5	'reduce ego' 'will address potential destructive attitudes towards the job'
Awareness that people make mistakes	4	'taking the negativity out of making mistakes'
Adds little benefits	3	'frankly I believe I have been implementing 'TEM' ever since I started flying- putting a name to it serves little purpose in my opinion'
Other benefits	7	'better service to trainee pilots' 'more thorough understanding of technical data and procedures'
Total responses	294	

Figure 11: Benefits of implementing TEM by flying category (N = 163)

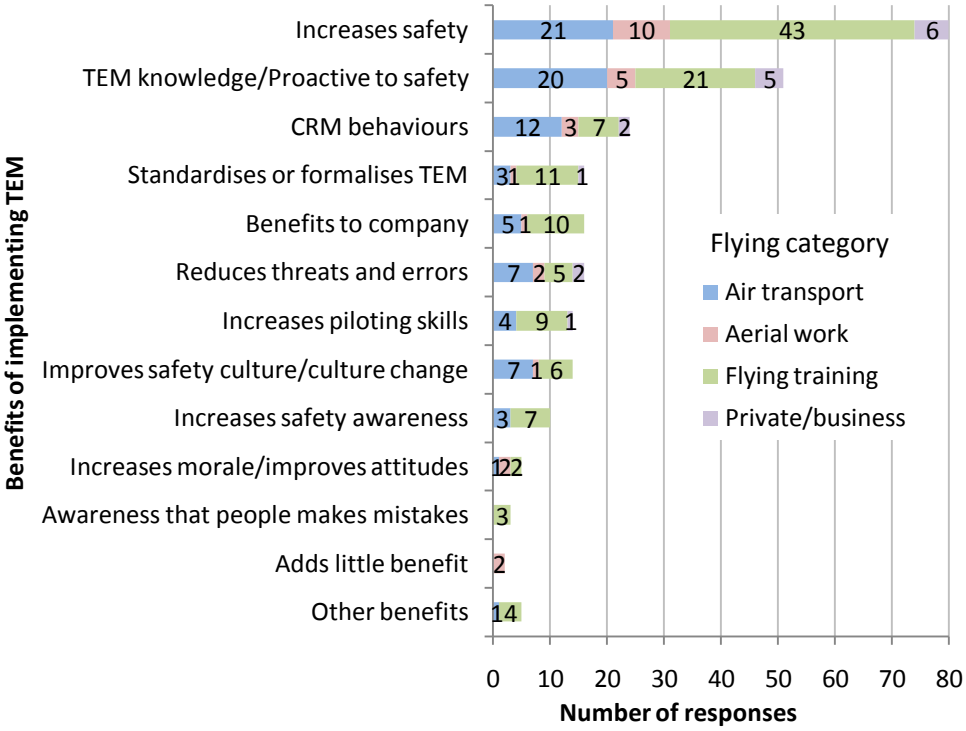
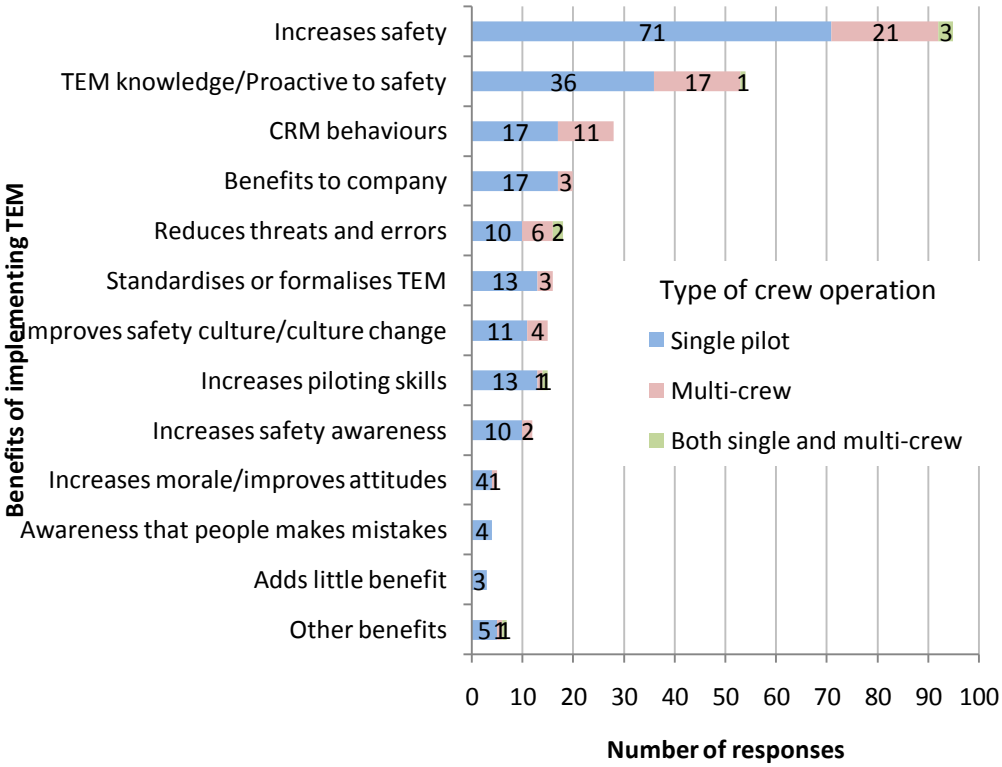


Figure 12: Benefits of implementing TEM by type of crew operation (N = 187)



3.3.2 Perceived challenges implementing TEM

The difficulties or challenges expected by the 190 respondents (Table 10) were more evenly spread compared with the benefits predicted. Participants expected to encounter difficulties associated with a lack of time and a resistance to change. The table below samples some of the difficulties or challenges in implementing TEM expected by the respondents.

Table 10: Sample responses of difficulties or challenges of implementing TEM

Difficulties/ Challenges	Number of responses	Sample responses
Lack of time	43	'finding the time to train' 'time to set up the system'
Resistance to change/ culture	38	'need to change the culture' 'acceptance'
Coordinating training and staff	36	'organising time and staff together at the same time to present TEM seminar'
Lack of money or resources	25	'commercial pressure' 'resource constraints'
Usability or relevance issues	24	'I believe we still have not reached the point where TEM can be effectively transferred to the flight deck from the ground school'
Training issues	23	'course development with current program'
Management	15	'getting senior management to accept the principles'
Lack of belief in TEM	13	'convincing crew they need it'
Standardising behaviour	7	'including TEM in ops manual/ check and training manual'
High staff turnover	4	'high turnover of pilots'
Other difficulties	13	'personal' 'not yet a requirement'
Total responses	241	

Respondents in the private/ business flying category did not indicate that establishing procedures to standardise behaviour or the high turnover in staff would lead to difficulties or challenges in implementing TEM (Figure 13).

The expected difficulties in Figure 14 are presented in the same order as those in Figure 13 for the purpose of easy comparison between the two figures. In relation to single pilot operations, Figure 14 shows the three most commonly anticipated difficulties associated with implementing TEM. These were lack of time, resistance to change, and difficulties in coordinating training, and arranging for staff to be available to attend training. For operations that are mostly multi-crew, the responses were more evenly distributed.

Figure 13: Difficulties or challenges of implementing TEM by flight category (N = 136)

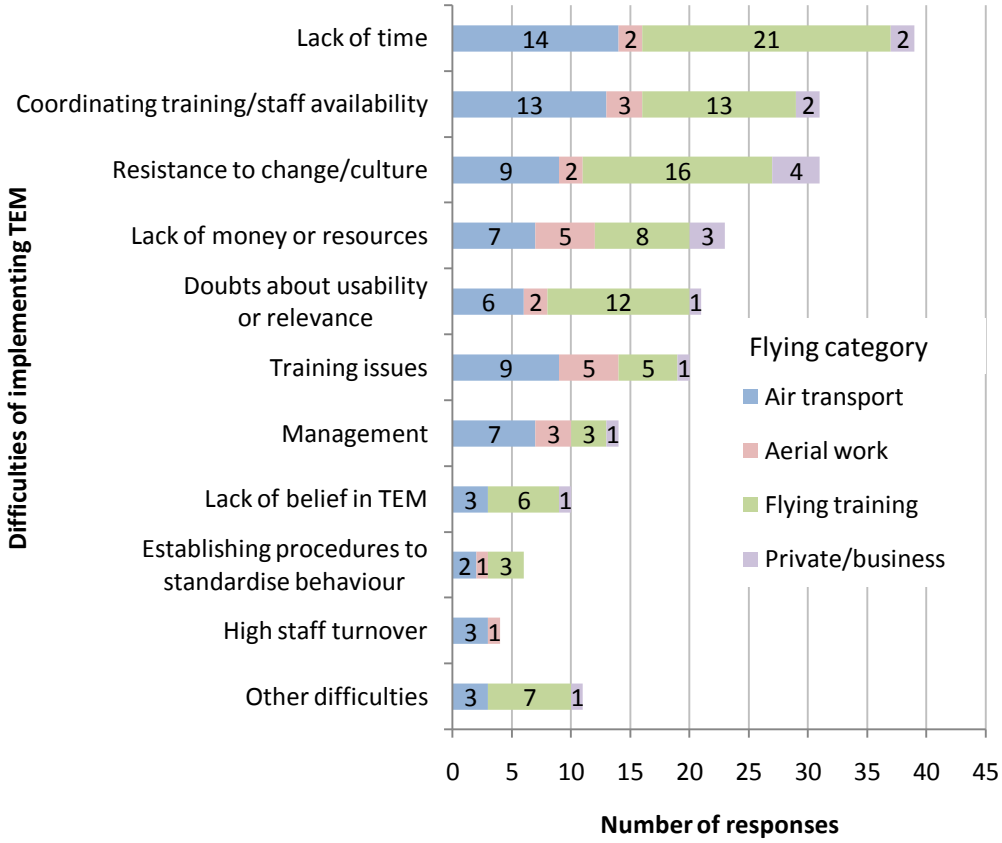
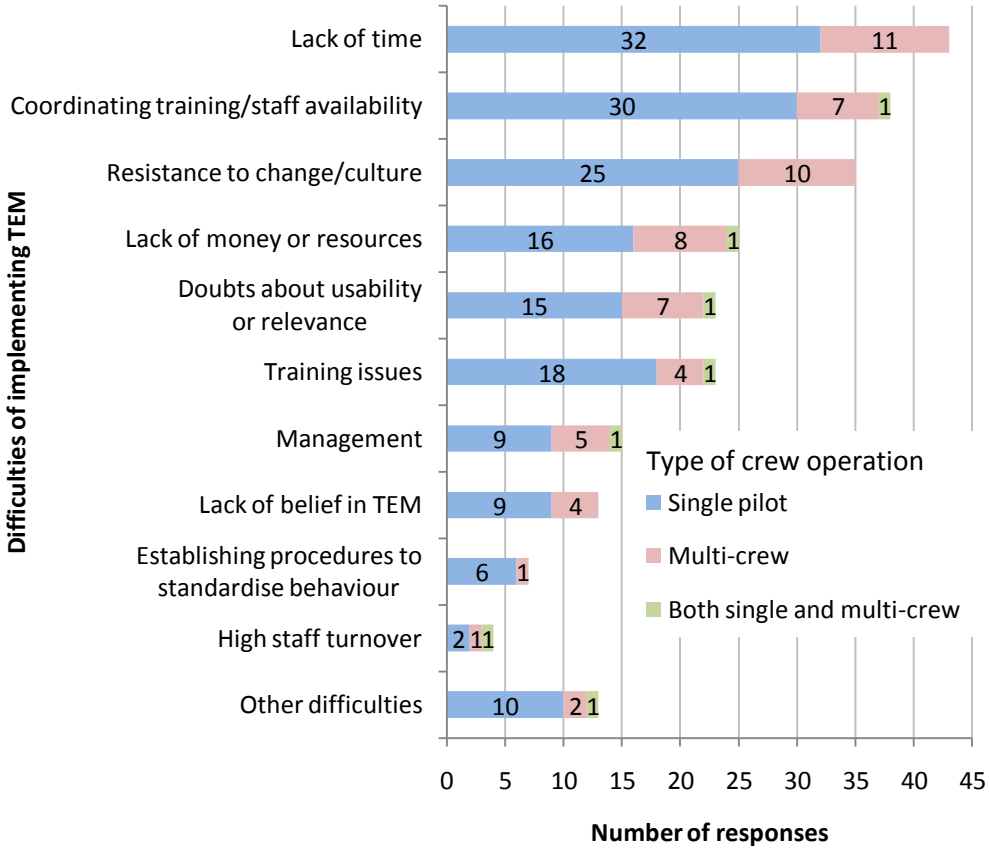


Figure 14: Difficulties or challenges of implementing TEM by type of crew operations (N = 153)



4 FOLLOW-UP SURVEY - RESULTS AND DISCUSSION

Chapter 4 explores the responses of the follow-up survey that was sent to participants of the GAPAN TEM 'train-the-trainer' course about 8 months after the training. The following is a discussion of the usefulness of TEM in the respondents' current work environment, perceptions about using TEM, and feedback on GAPAN training. It also explores characteristics of organisations which have implemented TEM, intend to implement TEM, and those who do not intend to implement TEM.

4.1 Demographics

There were 73 respondents who completed the follow-up survey, 45 of which had completed the post-training survey. The demographic information sought in this follow-up survey was limited to the respondent's flying category and their primary role in their organisation. As some respondents did not answer every question in the follow-up survey, not all questions would have a total number of respondents (N) equalling 73. Therefore, the total number of respondents changes for every question.

4.1.1 Flying categories

Table 11 shows the respondents' main categories of flying. As with the post-training survey, the most common flying category was flying training, followed by charter operations and low capacity regular public transport.

Table 11: Respondents by type of flying (Follow-up survey)

	Frequency	Per cent
Flying training	28	38.4
Charter - passenger	19	26
Regular public transport	9	12.3
Aerial work - other	5	6.8
Emergency or medical services	4	5.5
Private	3	4.1
Surveying or spotting	2	2.7
Charter - freight	2	2.7
Business	1	1.4
Agriculture	0	0
Total number of respondents	73	100
Number of non-responses	0	

Similar to the analyses for the post-training survey, these flying categories were grouped for further analyses. Table 12 lists the respondents' flying categories that were used for survey analysis. Compared with the first (post-training) survey, there was a lower proportion of respondents in flying training and more in air transport proportions by an order of about 10 per cent.

Table 12: Responses to flying category

	Frequency	Per cent
Air transport	30	41.1
Flying training	28	38.4
Aerial work	11	15.1
Private/business	4	5.5
Total number of respondents	73	

4.1.2 Representation by primary role in organisation

Table 13 depicts the distribution of respondents by their primary role at the time of the follow-up survey. Note that 27 per cent of respondents stated that they had changed roles since attending the GAPAN TEM training.

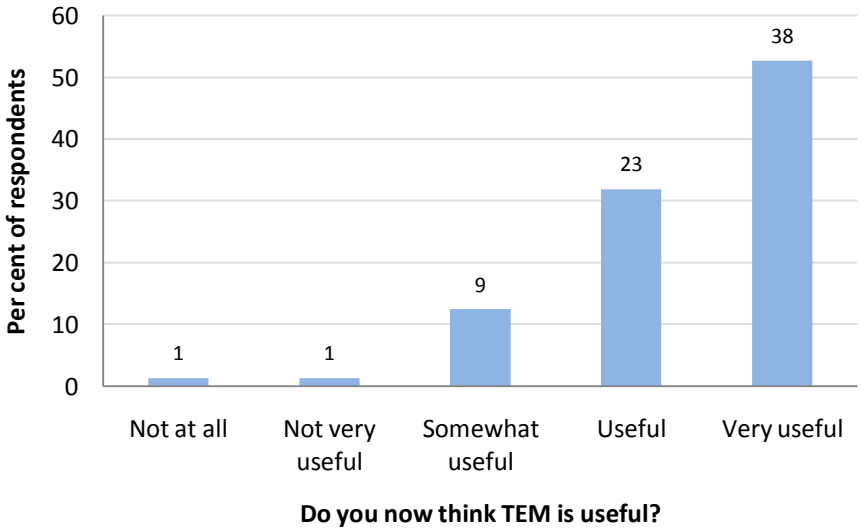
Table 13: Respondents by primary role

	Frequency	Per cent
Instructor	16	21.9
Chief pilot	12	16.4
Chief flying instructor	11	15.1
Check and training	11	15.1
Pilot	10	13.7
Other	13	17.8
Total number of respondents	73	100
Number of non-responses	0	

4.2 Follow-up attitudes towards TEM

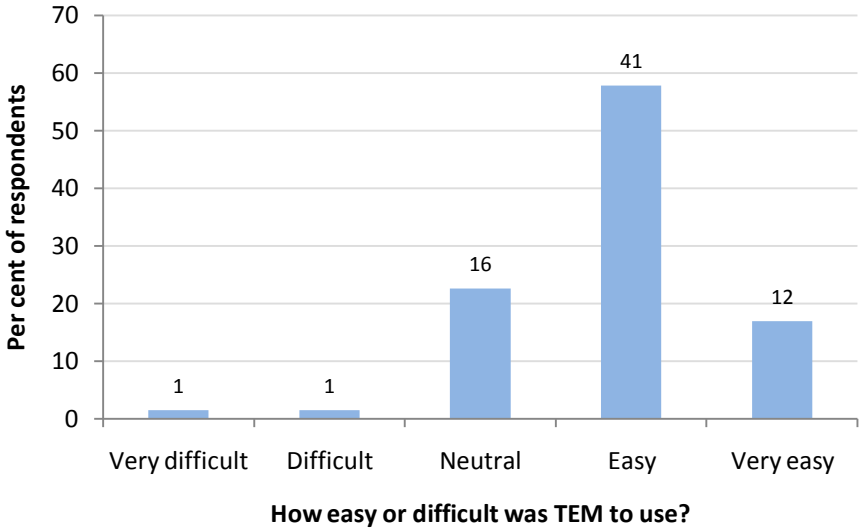
The follow-up survey revealed that just over half of the respondents felt that TEM was very useful in their current type of flying operation. Only one respondent, who was from flying training, felt that TEM was not useful at all (Figure 15). Another respondent, from air transport, felt that TEM was not very useful.

Figure 15: Usefulness of TEM (N = 72)



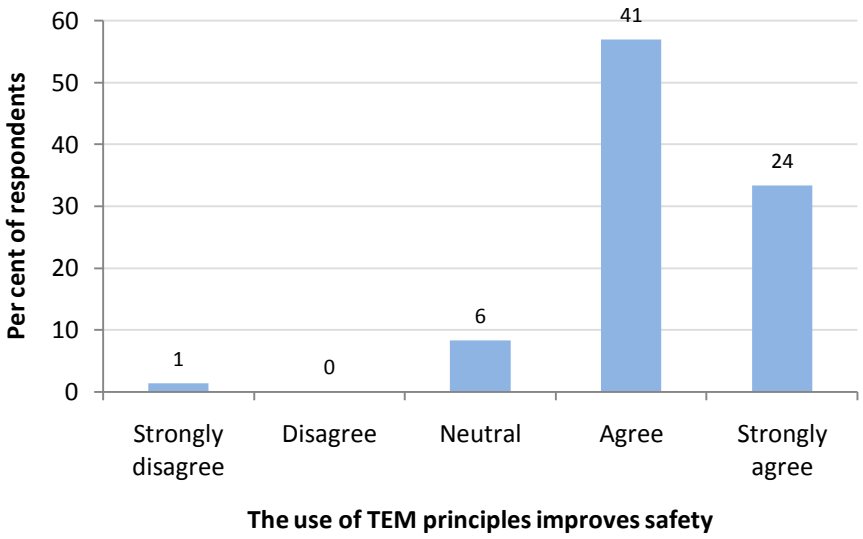
Around 75 per cent of respondents felt that TEM was either easy or very easy to use. A respondent from the aerial work category found TEM very difficult to use and a respondent from flying training felt that it was difficult to use. These respondents made up 3 per cent of the total respondents (Figure 16).

Figure 16: How easy or difficult is TEM to use? (N = 71)



When asked if they now felt the use of TEM principles improved safety, a third of respondents strongly agreed and about 10 per cent were neutral (Figure 17). One respondent, from the aerial work category, strongly disagreed (1.4 per cent).

Figure 17: The use of TEM principles improves safety (N = 72)

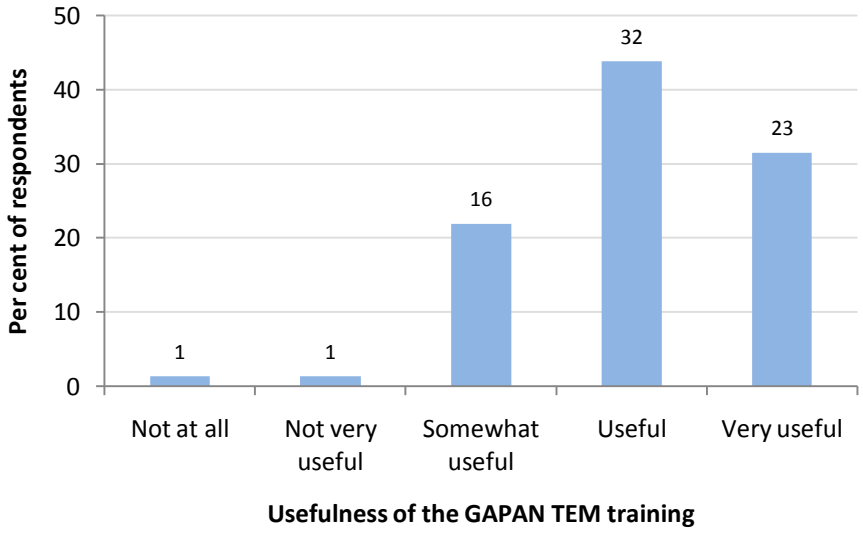


The survey shows that there is positive support for TEM: not only did the majority of respondents indicate that TEM is useful, easy to use, and will improve safety, the majority (94 per cent) of the 72 respondents also indicated they used TEM principles in their day-to-day flying. Furthermore, all of the 71 respondents who answered the question said they would recommend the use of TEM principles to other pilots.

4.3 Feedback on GAPAN TEM training

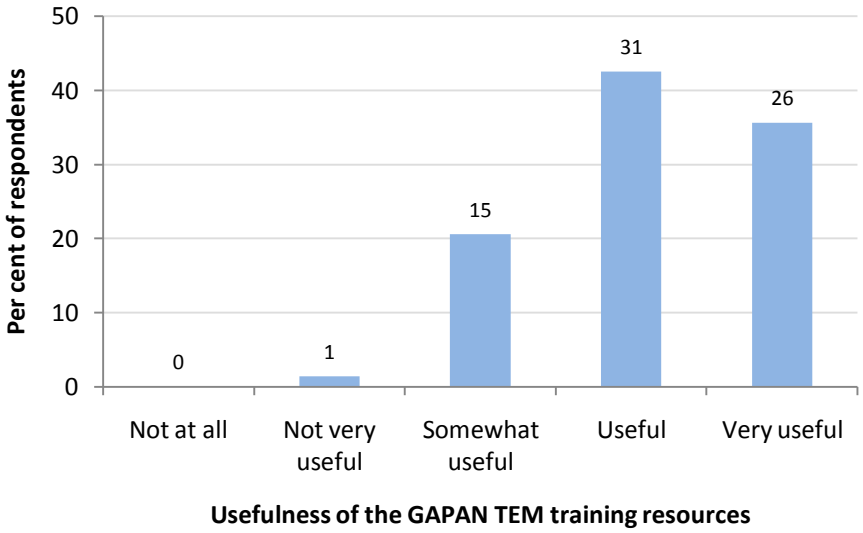
On a scale ranging from 'not at all useful' to 'very useful', just under half of the respondents (44 per cent) indicated that the GAPAN TEM training was useful in preparing them to teach TEM to others. Only one out of 73 respondents indicated the GAPAN training was not useful at all (Figure 18). This respondent was from the flying training category. Another, from the aerial work category, indicated that the training was not very useful.

Figure 18: Usefulness of the GAPAN TEM training (N = 73)



Just under half of the respondents (43 per cent) also indicated that the resources provided at the training were useful for learning and teaching TEM. Just over a third of respondents indicated that the resources were very useful (Figure 19). A respondent from flying training felt that the resources provided were not useful for future training. Although one respondent thought that the GAPAN TEM training was not at all useful, this respondent indicated that the resources provided were useful.

Figure 19: Usefulness of GAPAN TEM training resources (N = 73)



When asked about what they thought was the most useful part of the GAPAN TEM training, 31 per cent of respondents pointed to the case studies, examples and exercises used. Two respondents stated that an insight into the ICAO requirements for TEM training was the most useful part of the course. Another two respondents

felt that the most useful part was the message that everyone in the organisation is responsible for TEM, not just the pilots (Figure 20).

The most common suggestion (20 per cent) regarding how to improve GAPAN TEM training was to devote more time to teaching. A little over 15 per cent of responses indicated that the exercises, case studies and/or examples could be improved. An equal proportion also stated that the course needed to include more TEM content on general aviation and/or helicopter operations (Figure 21). However, one respondent commented that

> ...because of the diverse nature of the industry, GAPAN TEM training must remain a generic course. It is up to individual organisations to tailor the GAPAN TEM principles to fit their specific circumstances.

In addition, a small number of respondents (3 out of 44) felt that the GAPAN TEM workbook or materials provided could be improved, and two responses mentioned that the course could be expanded to other, non-pilot crews. Table 14 records some responses to how the GAPAN TEM training could be improved.

Table 14: Sample responses of how the GAPAN TEM training course can be improved

Improvements	Sample responses
More time	'a little more time in general, so we have more time to absorb TEM'
Less theory/ terminology, more implementation	'it seemed to focus on working backward from accidents to achieve knowledge, but gave little time to implementation of acquired knowledge' 'perhaps some reduction in the focus on terminology'
Examples, case studies, exercises	'some role play scenarios'
More general aviation and helicopter content	'more specific information for single pilot ops, especially small GA and rotary wing ops'
Evolve training course	'continue to provide on-going training. Ideas and techniques may change over time'
Workbook and materials	'better harmonise facilitator's guide to the Power Point slides'
CRM issues	'the TEM components mirrored or fit into components of the CRM course, we found it difficult to incorporate the TEM components, without using the entire TEM course as it was designed to flow from start to finish. The effect was a disjointed CRM course'
Expand to other crews	'we need to expand TEM into the cabin crew, ground handling and engineering/ maintenance arenas'

Figure 20: The most useful part of the GAPAN TEM training course (N = 76)

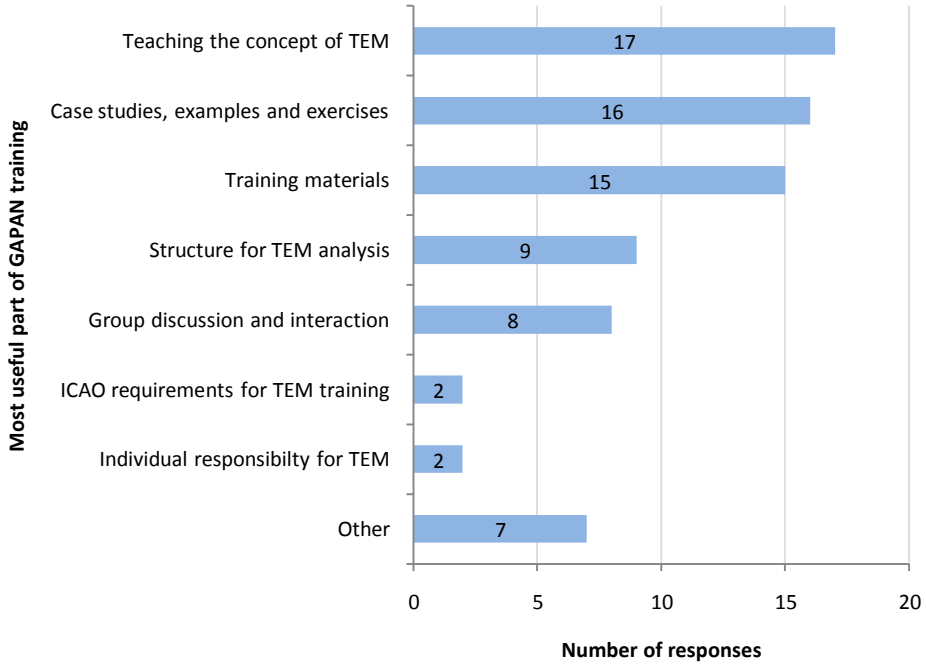
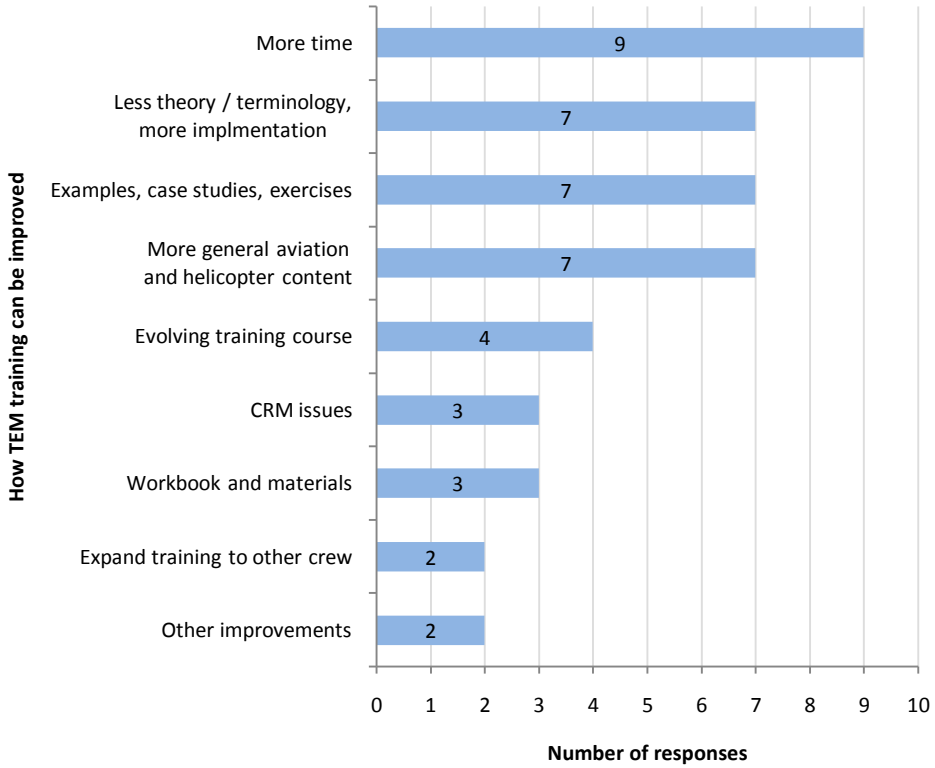


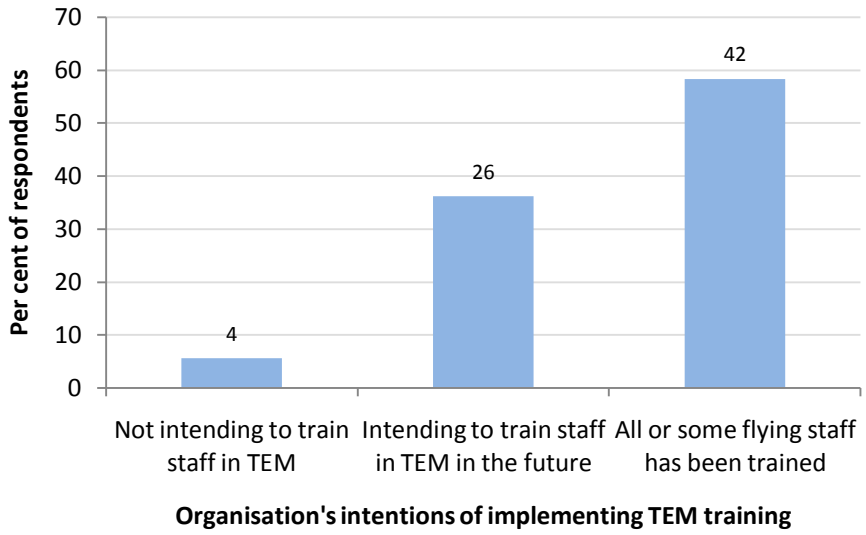
Figure 21: How the GAPAN TEM training can be improved (N = 44)



4.4 Implementation of TEM training

The latter section of the follow-up survey aimed to gauge the status of TEM training in organisations 8 months after GAPAN TEM training course. About 60 per cent of respondents indicated that their organisation had trained all or some of their staff in TEM, while 36 per cent indicated they were intending to train staff in the future. Five per cent said that their organisation was not intending to train staff in TEM (Figure 22).

Figure 22: Organisation's intentions of implementing TEM training (N = 72)

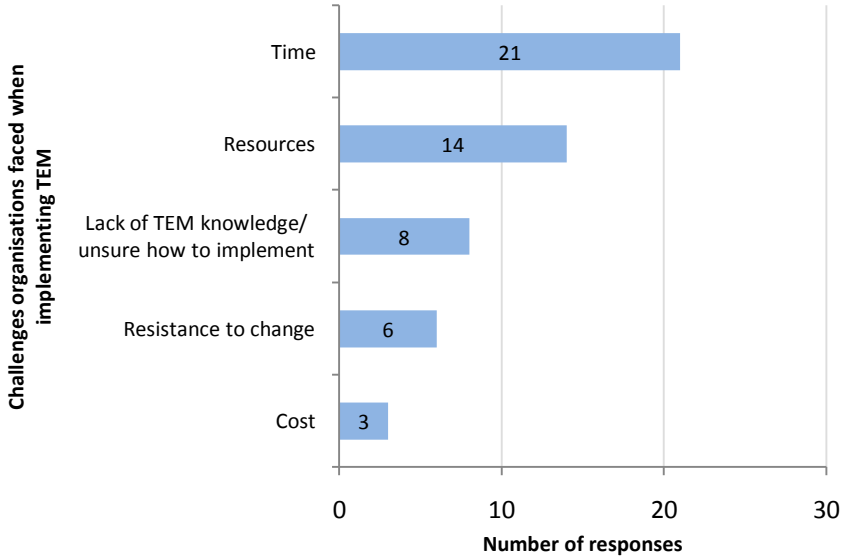


As the number of respondents who completed *both* the post-training and the follow-up survey was low (there were 45 respondents in total), further analyses to link the responses from those surveys were not conducted.

4.4.1 Organisations that have implemented TEM training

Out of the 42 organisations that implemented TEM training, one declined to comment on their organisation's experience. The expected difficulties or challenges of implementing TEM identified in the post-training survey were confirmed in the follow-up survey as time and resource issues (Figure 23). Cost to implement TEM training was not considered a major obstacle.

Figure 23: Challenges organisations faced when implementing TEM (N = 58)



Despite having attended the GAPAN TEM 'train-the-trainer' course, over half of the respondents (59 per cent) indicated that they did not teach TEM to staff themselves, with some indicating that they outsourced the training. Forty-one per cent (out of 39 respondents) indicated that they trained the staff themselves.

Forty-six per cent of the respondents indicated that their organisation did not develop their own resources and/or methods for TEM training. Table 15 shows that 21 respondents (54 per cent) said their organisation developed their own resources and/or methods. However, despite having developed their own resources, GAPAN resources were used to some extent. For example, 12 out of the 21 respondents revealed that their organisation, which developed their own training resources, had used an equal share of GAPAN and their own resources, or mostly used GAPAN resources. Similarly, those that did not develop their own resources also used the GAPAN resources to some extent.

Table 15: Extent to which GAPAN resources were used by organisations

	Did not develop own TEM resources	Developed own TEM resources	Total
No GAPAN resources used	2	3	5
Mostly own resources used	2	6	8
Equal share of GAPAN and own resources	3	6	9
Mostly GAPAN resources used	6	6	12
Only GAPAN resources used	5	0	5
Total no. of respondents	18	21	39

Ten per cent of respondents thought that their organisation found it difficult to introduce staff to TEM (one each from the air transport and flying training categories and two from the aerial work category), while 60 per cent thought their organisation found the experience easy (Figure 24).

Figure 24: How easy or difficult was it to introduce TEM? (N = 41)

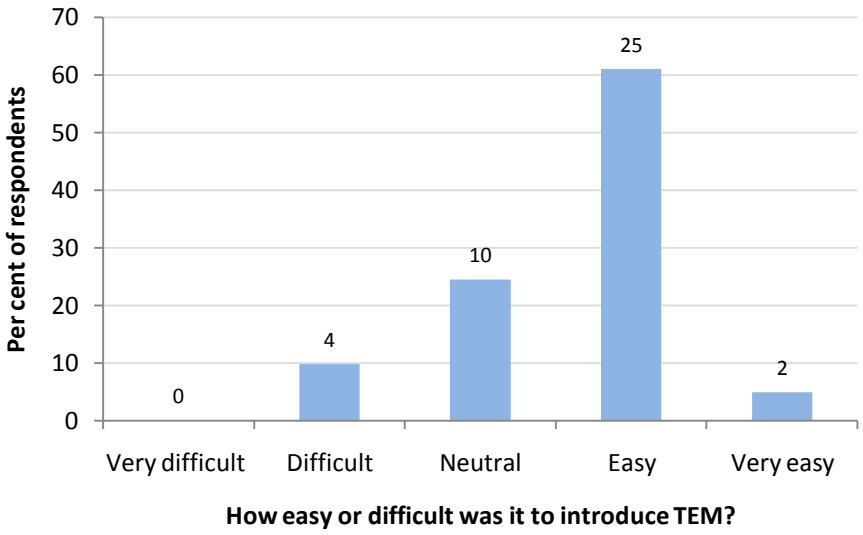


Figure 25 shows that all respondents whose organisation had introduced TEM training found staff receptiveness ranged from somewhat receptive to very receptive. This would explain why resistance to change was not a challenge to implementing TEM for most organisations, despite this being the second most predicted challenge in the post-training survey.

Figure 25: Level of staff receptiveness to TEM (N = 40)

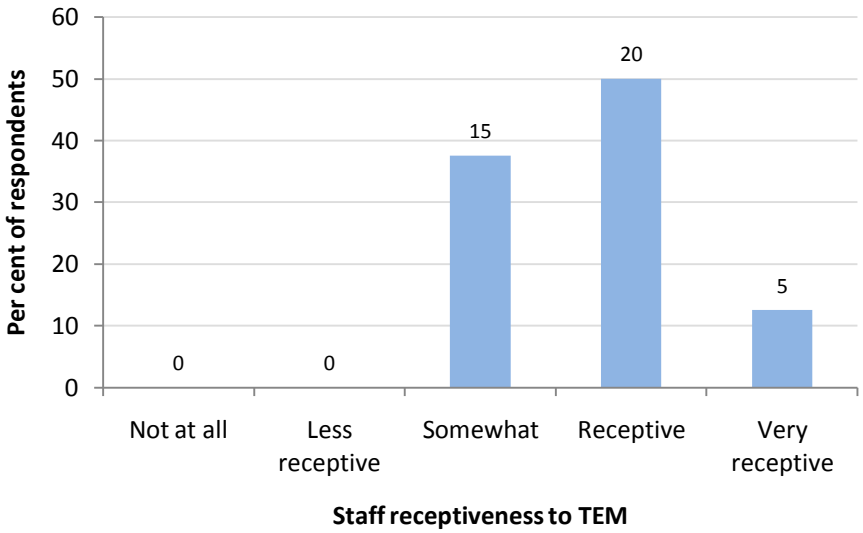
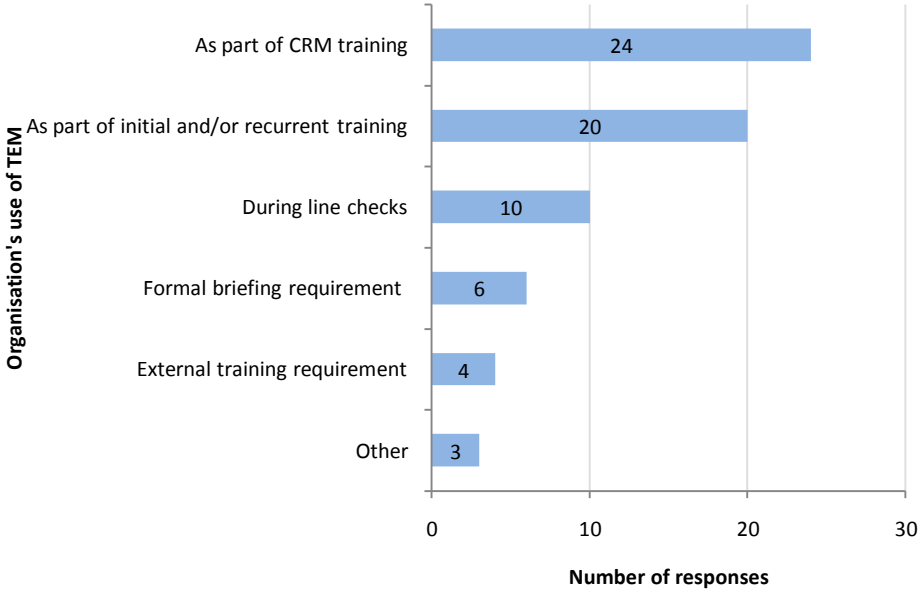


Figure 26 shows that for the majority of respondents, the most common way TEM was implemented in their organisation was to incorporate it as part of CRM training, followed by incorporating it into initial and/or recurrent training.

Figure 26: Organisation's use of TEM (N = 67)



4.4.2 Organisations intending to implement TEM and train staff

Twenty-six out of the 72 respondents who answered the follow-up survey, indicated that their organisation had not yet implemented TEM training but were intending to.

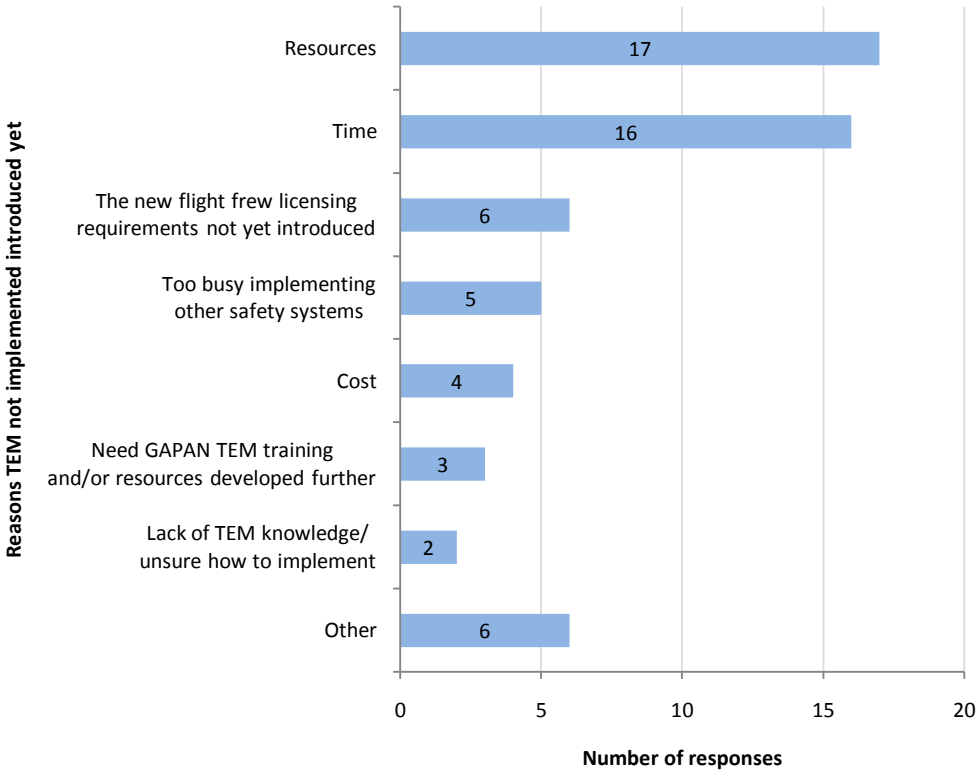
Half of the respondents indicated that their organisation intended to implement TEM within 6-12 months from the time of the follow-up survey, while 27 per cent intended to take over 12 months. The rest were going to introduce TEM training within 3-6 months.

The top reason why TEM had yet to be introduced was because of resources and time (Figure 27) as reflected in the predicted challenges of implementing TEM. Cost was a factor for the delay for four respondents.

In addition, out of 25 respondents, 60 per cent of respondents revealed that they will be the one training other staff or pilots in TEM. Forty per cent indicated that they will either be part of a training team or were not sure of the future arrangements, while not one respondent said they will not be the one to train staff in TEM.

In relation to whether those organisations were thinking about developing their own TEM resources and/or methods, 17 respondents chose not to answer this question. Of the 10 respondents that answered this question, the responses were equally split.

Figure 27: Reasons for not yet implementing TEM training (N = 61)



4.4.3 Organisations with no intention to implement TEM or train staff

Four out of 72 respondents pointed out that their organisation had no intention to train staff in TEM. Respondents were given a list of reasons for not implementing TEM and were asked to indicate all that applied. Only one respondent indicated that cost was a factor in their organisation's decision not to implement TEM training. Despite 'lack of time' being the greatest expected challenge of implementing TEM, as indicated in the post-training survey, the same respondent (and the only one) stated that time was a factor in not implementing TEM training.

Resistance to change and issues with resources were not factors that influenced those organisations' intentions. Rather, one organisation was too busy implementing other safety systems, while another indicated that TEM training was not appropriate or adequate for their company. Another felt that the GAPAN TEM training and/or resources needed to be developed further before their organisation would consider implementing TEM training. Another respondent stated that TEM was not useful and because TEM training is not a Civil Aviation Safety Authority (CASA) requirement yet, their organisation was not intending to implement this training. In addition, this respondent felt that their organisation was unsure of how to implement TEM training, perhaps due to a limited knowledge in TEM.

5 CONCLUSIONS

Threat and error management (TEM) originated in line operations safety audits in high capacity regular public transport (RPT). Since this time, it has evolved in to a non-technical tool for pilots. Most of the development and literature has concentrated on TEM in the high capacity air transport. Little, if any, research has been conducted into the acceptance or the implementation of TEM in low capacity air transport operations and general aviation. To address this short fall, the Guild of Air Pilots and Air Navigators Training (GAPAN) embarked on a program to develop a training course in TEM principles for flight training professionals in general aviation and low capacity air transport.

This report has revealed the perceptions of people in general aviation and low capacity air transport operations who have received the GAPAN training in TEM. Overall, the responses to implementing TEM into these operations were positive. At the end of training, respondents felt that their organisation would benefit from implementing TEM concepts into their operations. They also felt that their organisation would provide them with the support to implement TEM. Data in this report shows there was very little knowledge of TEM and that certain challenges were expected to be encountered in implementing TEM. Those challenges included issues relating to time and resources. Importantly, it shows that many people have successfully applied TEM to their everyday operations.

The follow-up survey, conducted about 8 months after the training, found that most organisations had implemented TEM and incorporated it into their own training programs. Respondents said that implementation was easy and that staff were receptive, although the greatest challenges were time and resources. Organisations that intend to implement TEM in the future or did not intend to do so at all also cited time and resources as difficulties in implementing TEM. Those responses confirmed the predicted challenges highlighted in the post-training survey.

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7 APPENDICES

7.1 Appendix A – Sources and submissions

7.1.1 Sources of information

The primary sources of information used during this research were:

- the data collected from the post-training and follow-up surveys
- the Guild of Air Pilots and Air Navigators threat and error management course manual
- literature on treat and error management .
- A full list of data sources is provided in the Methodology (Chapter 2) and References (Chapter 6).

7.1.2 Submissions

A draft of this report was provided to the Civil Aviation Safety Authority and Guild of Air Pilots and Air Navigators.

Submissions were received from the Civil Aviation Safety Authority and Guild of Air Pilots and Air Navigators.

7.2 Appendix B - GAPAN TEM training locations

City	Seminar	Date
Adelaide	GA (Single pilot)	17 September 2007
	Multi-crew	16 September 2007
Alice Springs	GA (Single pilot)	7 September 2007
	Multi-crew	8 September 2007
Brisbane	GA (Single pilot)	30 August 2007
	Multi-crew	29 August 2007
Cairns	GA (Single pilot)	4 September 2007
	Multi-crew	3 September 2007
Canberra	GA (Single pilot)	24 August 2007
	Multi-crew	25 August 2007
Darwin	GA (Single pilot)	6 September 2007
	Multi-crew	5 September 2007
Hobart	GA (Single pilot)	14 September 2007
	Multi-crew	15 September 2007
Melbourne	GA (Single pilot)	13 September 2007
	Multi-crew	12 September 2007
Perth	GA (Single pilot)	24 September 2007
	Multi-crew	25 September 2007
Sydney	GA (Single pilot)	28 August 2007
	Multi-crew	27 August 2007

7.3 Appendix C - Guild of Air Pilots and Air Navigators

Contact details:

The Guild of Air Pilots and Air Navigators (Australian Region) Incorporated,
ABN 43 761 679 349

PO Box A2270
Sydney South
NSW 1235
Australia

Telephone: 02 9267 7538

Facsimile: 02 9264 4738

Email: *admin@gapan.org.au* or *tem@gapan.org.au*

Website: *www.gapan.org.au*

7.4 Appendix D - Post-training survey questions

Instructions

Some of the questions in this survey use a rating scale. These ratings may differ across questions so please read the scale carefully before you mark your response. Please circle a number on the scale to record your opinion.

PART A
Please respond to the following statements in terms of your role as a company pilot/member as they apply to the company you worked most for in the last 12 months.

1. Please rate your knowledge of Threat and Error Management (TEM) prior to this training session?

No knowledge	Small knowledge	Moderate knowledge	Great knowledge	Very great knowledge
1	2	3	4	5

2. Over the last 12 months, list the five (5) most common **threats** to safety in your flying operation.

_____

_____

_____

_____

_____

3. Over the last 12 months, list the five (5) most common **errors** committed in your flying operation.

_____

_____

_____

_____

_____

4. Would you say your organisation believes TEM will improve safety?

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

5. Please describe what you think are the difficulties or challenges, if any, of implementing TEM in your organisation

6. Please describe what you think are the benefits, if any, of implementing TEM in your organisation

7. Are their any problems or issues in your organisation that would be improved by introducing TEM?

- ❑ Yes
- ❑ No

8. Does your company have a nominated staff member who is responsible for implementing safety training?

- ❑ Yes
- ❑ No

9. Will you be responsible for implementing TEM in your organisation?

- ❑ Yes
- ❑ No

10. Please rate how much support you will have from your organisation if you try to implement TEM

No support	Small support	Moderate support	Great support	Very great support
1	2	3	4	5

11. Over the last 12 months has your company introduced any formal safety strategies or programs?

Yes ❑ go to 11a, then continue to question 12

No ❑ go to question 12

11a. Please briefly describe this strategy

_____

_____

_____

_____

_____

PART B

Please respond to the following questions in terms of your flying experience in the last 12 months.

12. How often did you personally see the following influences negatively affect flight safety in Australia in the last 12 months?

	Very often	Often	Sometimes	Rarely	Never
a) Lack of pilot skill, knowledge or experience	1	2	3	4	5
b) Fatigue	1	2	3	4	5
c) Alcohol, drugs or prescribed medication use	1	2	3	4	5
d) Medical conditions	1	2	3	4	5
e) Personal stress	1	2	3	4	5

13. How often did you personally encounter significant safety deficiencies in the following areas in Australia in the last 12 months?

	Very often	Often	Sometimes	Rarely	Never
a) Air traffic control	1	2	3	4	5
b) Meteorological information	1	2	3	4	5
c) Aircraft maintenance	1	2	3	4	5
d) Aircraft weight and balance	1	2	3	4	5
e) Runways and runway facilities (lights, signs etc)	1	2	3	4	5
f) Aircraft airworthiness	1	2	3	4	5
g) Aircraft to aircraft communications	1	2	3	4	5

14. Over the last 12 months, how safe do you think flying was in your category of flying? (RPT, charter, agricultural, training, private etc)

Very unsafe	Unsafe	Neutral	Safe	Very safe
1	2	3	4	5

15. Over the last 12 months, how has the overall level of safety in your category of flying changed? (RPT, charter, agricultural, training, private etc)

Very much deteriorated	Deteriorated	Unchanged	Improved	Very much improved
1	2	3	4	5

PART C
The following information will assist in interpreting the data gathered in the survey. It will be analysed in groups and individual responses will remain confidential.

16. What is your age? ……years

17. What is the highest level of pilot licence qualification you hold now (Please circle)

a) PPL CPL ATPL

b) Approximately how long have you held this licence? ……years

c) If you hold a CPL or ATPL, how long have you held your PPL? ……years

18. Approximately how many hours of flying did you do, in the last 12 months?

.....hours

19. What category of flying did you do most of the time in the last 12 months? (Please tick one only)

- ❑ Regular Public Transport
- ❑ Charter - passenger
- ❑ Charter - other
- ❑ Aerial work – emergency or medical services
- ❑ Aerial work – agriculture
- ❑ Aerial work – surveying or spotting
- ❑ Aerial work – flying training
- ❑ Aerial work – other Please specify
- ❑ Business
- ❑ Private

Thinking about the company you worked <u>most</u> for in the last 12 months

20. What is your primary role in that organisation?

- ❑ Chief flying instructor
- ❑ Instructor
- ❑ Chief pilot
- ❑ Pilot
- ❑ Check and training
- ❑ Other (Please specify) ……

21. Approximately how long have you worked or did you work as a pilot for this company in total? .....years

22. Approximately how many full-time equivalent pilots were employed in the company in the last 12 months?

- ❑ 1-4
- ❑ 5-10
- ❑ 11-20
- ❑ 21-50
- ❑ More than 50

23. Approximately how many full-time equivalent non-flying positions existed in the company in the last 12 months?

- ❑ 1-4
- ❑ 5-10
- ❑ 11-20
- ❑ 21-50
- ❑ More than 50

24. Are your organisation's flying operations primarily single pilot or multi-crew operations?

- ❑ Mostly single pilot
- ❑ Mostly multi-crew
- ❑ Other (Please specify) .....

25. Approximately how many aircraft did your flying organisation own/lease in the last 12 months?

- ❑ 1
- ❑ 2-4
- ❑ 5-10
- ❑ 11-20
- ❑ 21-50

26. How many different aircraft types (eg Piper Navajo, Beech Duchess, Cessna 210) did your company operate in the last 12 months? .....aircraft types.

27. Please estimate how long this survey took you to complete .....minutes

Thank you for your time completing this survey.

Please give this form to your course trainer.

7.5 Appendix E - Follow-up survey questions

Page 2

Section A - All to complete

Q1. How useful was the Guild of Air Pilots and Air Navigators (GAPAN) Threat and Error Management (TEM) training in preparing you to teach TEM to others?

1	2	3	4	5
○	○	○	○	○
Not at all		Somewhat useful		Very useful

Q2. How useful were the GAPAN TEM resources for learning and teaching TEM?

1	2	3	4	5
○	○	○	○	○
Not at all		Somewhat useful		Very useful

Q3. What do you now think was the most useful part of the GAPAN TEM training?

Q4. How do you now think the GAPAN TEM training could be improved? Please specify anything that you think should have been included in the training.

Q5. Have you changed companies or roles since attending the GAPAN TEM training?

- ○ Yes
- ○ No

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Q6. What is your **main** category of flying and **primary** role in your current position?
(**Please select one only in each column**)

Category of flying

- ○ Regular Public Transport
- ○ Charter - passenger
- ○ Charter - other
- ○ Business
- ○ Private
- ○ Aerial work - emergency or medical services
- ○ Aerial work - agriculture
- ○ Aerial work - surveying or spotting
- ○ Aerial work - flying training
- ○ Aerial work - other (please specify below)

Primary role

- ○ Chief flying instructor
- ○ Instructor
- ○ Chief pilot
- ○ Pilot
- ○ Check and training
- ○ Other (please specify below)

Q7. Do you now think TEM is useful in your current type of flying operation?

1	2	3	4	5
○	○	○	○	○
Not at all		Somewhat useful		Very useful

Q8. Would you now say that the use of TEM principles will improve safety?

1	2	3	4	5
○	○	○	○	○
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Q9. Do you use TEM principles in your day to day flying?

- ○ Yes
- ○ No

If no, please explain why:

Page 3

Q10. How easy or difficult is TEM to use in everyday operations?

1	2	3	4	5
○	○	○	○	○
Very difficult	Difficult	Neutral	Easy	Very easy

Q11. Would you recommend the use of TEM principles to another pilot?

- ○ Yes
- ○ No

If no, please explain why:

Q12. Which scenario best describes your company's use of TEM?

- ○ All or some flying staff has been trained in TEM → Continue to Section B
- ○ My company is intending to train staff in TEM in the future → Continue to Section C
- ○ My company is NOT intending to train staff in TEM → Continue to Section D

End of Section A

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Section B - All or some flying staff has been trained in TEM

Q13. How has TEM training been included in your company? (**Tick all that apply**)

- ☐ As a formal briefing requirement
- ☐ As part of initial and/or recurrent training
- ☐ During line checks
- ☐ As an external training requirement
- ☐ As part of Crew Resource Management (CRM) training
- ☐ Other (please specify):

Q14. How easy or difficult was it to introduce TEM?

1	2	3	4	5
○	○	○	○	○
Very difficult	Difficult	Neutral	Easy	Very easy

Q15. How receptive were staff to the introduction of TEM?

1	2	3	4	5
○	○	○	○	○
Not at all		Somewhat		Very receptive

Q16. What were the greatest challenges, if any, of implementing TEM? (**Tick all that apply**)

- ☐ Cost
- ☐ Time
- ☐ Resources
- ☐ Resistance to change
- ☐ Lack of TEM knowledge / unsure how to implement
- ☐ Other (please specify):

Q17. Please explain why you think your company introduced TEM:

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Q18. Were you the person that trained your company's pilots/staff in TEM?

- ○ Yes
- ○ No
- ○ Other (please specify):

Q19. To what extent were the GAPAN TEM resources used in your company's TEM training?

1	2	3	4	5
○	○	○	○	○
No GAPAN resources used	Mostly own resources used	Equal share of GAPAN and own resources	Mostly GAPAN resources used	Only used GAPAN resources

Q20. Did your company develop their own resources and/or methods for TEM training?

- ○ Yes
- ○ No

If yes, please describe the resources or method developed:

Any other comments?

End of Section B

Please continue to Page 10

Section C - My company is intending to train staff in TEM in the future

Q21. Why hasn't TEM been introduced yet? (**Tick all that apply**)

- ☐ Cost
- ☐ Time
- ☐ Resources
- ☐ Resistance to change
- ☐ The new Flight Crew Licensing requirements not yet introduced
- ☐ Too busy implementing other safety systems
- ☐ Does not think TEM will be very useful
- ☐ Lack of TEM knowledge and/or unsure how to implement
- ☐ GAPAN TEM training and/or resources need to be developed further
- ☐ Other (please specify):

Q22. When do you think your company will begin to introduce TEM training?

1	2	3	4	5
○	○	○	○	○
Never	Over a year	6 - 12 months	3 - 6 months	< 3 months

Q23. Please explain why you think your company intends to introduce TEM:

Q24. Will you be the person that trains your company's pilots/staff in TEM?

- ○ Yes
- ○ No
- ○ Other (please specify):

Q25. Is your company developing its own resources and/or methods for TEM training?

- ○ Yes
- ○ No

If yes, please describe the resources or method developed:

Any other comments?

End of Section C

Please continue to Page 10

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Section D - My company is NOT intending to train staff in TEM

Q26. What do you think are your company's reasons for not training staff in TEM? (**Tick all that apply**)

- ☐ Cost
- ☐ Time
- ☐ Resources
- ☐ Resistance to change
- ☐ The new Flight Crew Licensing requirements not yet introduced
- ☐ Too busy implementing other safety systems
- ☐ Does not think TEM will be very useful
- ☐ Lack of TEM knowledge and/or unsure how to implement
- ☐ GAPAN TEM training was not adequate/appropriate for the company
- ☐ Other (please specify):

Any other comments?

End of Section D

Please continue to Page 10

Thank you for completing this survey

To submit this survey, press the "Submit Survey" button below (preferred method).

Please ensure you have filled out your Reponse Code, all of Section A, and any other sections that apply to you.

If you would like to mail this survey, print the form and mail to:

Australian Transport Safety Bureau
Aviation Safety Research and Analysis Section
Reply Paid 967
Civic Square
ACT 2608

When submitted, the "Reset Survey" button can be pressed so that another person can fill in the survey. To ensure you do not lose any data, you may wish to save this survey on your computer before resetting your answers. Save each person's survey under a different filename.

Submit by Email | Print Survey | Reset Survey

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7.6 Appendix F – Results

Table F.1: Prior knowledge by demographics

		Prior knowledge of TEM				
		No knowledge	Small knowledge	Moderate knowledge	Great knowledge	Total
Primary role in organisation						
Instructor	N	15 (29.4%)	19 (37.3%)	15 (29.4%)	2 (3.9%)	51
Chief pilot	N	8 (25%)	13 (40.6%)	11 (34.4%)	0 (0%)	32
Pilot	N	7 (24.1%)	12 (41.4%)	7 (24.1%)	3 (10.3)	29
Check and training	N	5 (18.5%)	8 (29.6%)	13 (48.1%)	1 (3.7%)	27
Chief flying instructor	N	6 (27.3%)	11 (50%)	5 (22.7%)	0 (0%)	22
Other	N	4 (19%)	4 (19%)	13 (61.9%)	0 (0%)	21
Total	N	45	67	64	6	182
Highest level of pilot licence qualification						
PPL	N	1 (20%)	1 (20%)	3 (60%)	0 (0%)	5
CPL	N	23 (24.7%)	44 (47.3%)	24 (25.8%)	2 (2.2%)	93
ATPL	N	23 (22.1%)	37 (35.6%)	40 (38.5%)	4 (3.6%)	104
RAA	N	0 (0%)	0 (0%)	2 (100%)	0 (0%)	2
GFA	N	0 (0%)	0 (0%)	2 (100%)	0 (0%)	2
Total	N	47	82	71	6	206
Flying Categories						
Flying training	N	24 (27%)	37 (41.6%)	26 (29.2%)	2 (2.2%)	89
Air transport	N	13 (23.6%)	24 (43.6%)	16 (29.1%)	2 (3.6%)	55
Aerial work	N	3 (13.6%)	6 (27.3%)	12 (54.5%)	1 (4.5%)	22
Private/ business	N	1 (7.1%)	6 (42.9%)	7 (50%)	0 (0%)	14
Total	N	41	73	61	5	180

Table F.2: Relationship between flying category and perception of TEM effectiveness

		Confidence Interval	
	Odds ratio	Lower bound	Upper bound
Flying training	1		
Air transport	1.833	0.743	4.524
Aerial work	0.611	0.25	1.494
Private/ business	0.267	0.093	0.763

Table F.3: Perceived level of organisational support for implementing TEM by primary role in organisation

		Perceived level of organisational support for implementing TEM					
		No support	Small support	Moderate support	Great support	Very great support	Total
Primary role in organisation							
Instructor	N	0 (0%)	10 (19.6%)	15 (29.4%)	19 (37.3%)	7 (13.7%)	51
Chief pilot	N	2 (6.3%)	1 (3.1%)	9 (28.1%)	10 (31.3%)	10 (31.3%)	32
Pilot	N	0 (0%)	3 (10.3%)	12 (41.4%)	9 (31%)	5 (17.2%)	29
Check and training	N	0 (0%)	3 (11.1%)	6 (22.2%)	13 (48.1%)	5 (18.5%)	27
Chief flying instructor	N	1 (4.5%)	0 (0%)	6 (27.3%)	8 (36.4%)	7 (31.8%)	22
Other	N	0 (0%)	1 (5%)	7 (35%)	7 (35%)	5 (25%)	20
Total	N	3	18	55	66	39	181