Safety climate and the Theory of Planned Behavior: Towards the prediction of unsafe behavior[1]

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[Abstract] The present study is concerned with the human factors that contribute to violations in aviation maintenance. Much of our previous research in this area has been based on safety climate surveys and the analysis of relations among core dimensions of climate. In this study, we tap into mainstream psychological theory to help clarify the mechanisms underlying the links between climate and behavior. Specifically, we demonstrate the usefulness of Ajzen's (1991, 2001) Theory of Planned Behavior (TPB) to understanding violation behaviors in aircraft maintenance. A questionnaire was administered to 307 aircraft maintenance workers. Constructs measured by the survey included perceptions of management attitudes to safety, own attitudes to violations, intention to violate, group norms, workplace pressures, and violations. A model based on the TPB illustrated hypothetical connections among these variables. Path analyses using AMOS suggested some theoretically justifiable modifications to the model. Fit statistics of the revised model were excellent with intentions, group norms, and personal attitudes combining to explain 50% of the variance in self-reported violations. The model highlighted the importance of management attitudes and group norms as direct and indirect predictors of violation behavior. We conclude that the TPB is a useful tool for understanding the psychological background to the procedural violations so often associated with incidents and accidents.

1. Introduction

Traditionally, occupational health and safety interventions have centered on controlling the physical work environment and work procedures of employees in an effort to prevent errors and accidents. Examples include the documentation of detailed procedures designed to provide the safest way of completing tasks, procedures for handing over uncompleted tasks to colleagues, strict safety guidelines for the operation of machinery, and the wearing of personal protective equipment. A complementary approach to human error focuses on the human factors in work accidents. This approach takes into account the inevitability of human error and seeks to contextualise behavior so that a greater understanding can be realised. Where strict procedural guidelines attempt to mechanise and standardise behavior, a human factor perspective acknowledges individual differences and focuses on psychological pressures and factors that influence behavior. The present study is concerned with the human factors that contribute to violations in aviation maintenance. Much of the previous research in this area has been based on safety climate surveys and the analysis of relations among core dimensions of climate and safety outcomes (e.g., Mearns et al., 2003). In this study, we tap into mainstream psychological theory to help clarify the mechanisms underlying the links between climate and behavior. Specifically, it will be argued that Ajzen's (1991, 2001) Theory of Planned Behavior can be applied to unsafe behavior in the workplace. We will demonstrate the usefulness of this model by applying it to safety climate data derived from aircraft maintenance workers in the Australian Defence Force (ADF).

1.1. Models of unsafe behavior

The concept of safety climate refers to employees' perceptions of the relative emphasis placed by management on safety issues relative to other organisational concerns. Since the landmark paper on this topic by Zohar (1980) some 28 years ago, safety climate research has evolved to embrace a range of themes. An ongoing part of the research effort is devoted to improving measures of safety climate (e.g., Flin et al., 2000; Hahn and Murphy, 2008; Zohar and Luria, 2005) or adapting those measures to particular cultures (e.g., Lin et al., 2008). Other researchers have focused on identifying safety climate variables with the aim of constructing models to explain the interactions among the variables and their impact on safety performance (e.g., Fogarty, 2004, 2005; Hahn and Murphy, 2008). A further significant stream of research relates to the level at which safety climate variables exert an influence on safety outcomes with variables classified at either the organisational, group,

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or individual level. Thus, Zohar et al. (2007) described the way in which organisational policies in hospitals are interpreted differently at the individual nursing unit level and demonstrated how a poor hospital climate can be overcome by a good climate within a particular nursing unit. Like most other areas of psychology, safety climate research includes many examples of studies that have looked for moderation and mediation effects (e.g., Fogarty, 2005; McKeonet al., 2006; Zohar et al., 2007).Some studies have managed to combine a number of these research themes, using cross-lagged designs to demonstrate causal mediated relations between climate and safety performance (e.g., Neal and Griffin, 2006).[2]

One feature of the safety climate approach is that it has become a research paradigm in its own right, reaching back into the literature on culture and climate and vigorously exploring themes within this paradigm, as illustrated above. What it has not done quite so well is drawn upon explanatory accounts of behavior developed within other areas of psychology, yet there are some points where connections can be made. Ajzen's (1991, 2001) Theory of Planned Behavior (TPB) appears well-suited to the explanation of the link between climate and particular types of workplace behaviors that are intentional but unsafe. These behaviors are traditionally referred to as violations, which involve the deliberate deviation from rules that describe the safe or approved method of performing a particular task or job; as opposed to errors, which refer to unintended outcomes caused by slips, lapses and mistakes made by individuals (Reason, 1990). Failure to follow procedures is a major contributor to errors (Lawton, 1998). Helmreich (2000) reported that over half the "errors" observed in a line safety operations audit were due to violations and that those who violated procedures were 1.4 times more likely to commit other types of errors. In fact, procedural violation is such an influential factor in accident causation that some researchers (e.g., Reason, 1990; Lawton and Parker, 1998) have suggested that it be treated as a safety outcome variable in its own right, rather than as just one of the predictors of error. Lawton and Parker further argued that the psychological pathways to violations and errors are different with the former being associated with social-psychological factors, such as attitudes and behaviours whilst the latter are more closely associated with deficiencies in skill or information processing. It is the strong link between attitudes, intentions, and behaviors that brings this aspect of safety behavior well within the scope of the TPB. A short introduction to this theory follows.

1.2. The Theory of Planned Behavior

The Theory of Reasoned Action (TRA: Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980) emerged from social psychology as an intention model that formed the theoretical basis for research on the determinants of user behavior. The TRA was designed to predict easily performed, volitional behaviors. This model was limited in its explanatory power, however, Ajzen (1991) extended it by including perceived behavior control to account for internal and external constraints on behavior. The Theory of Planned Behavior (TPB), as it then became known, is shown in Fig. 1.

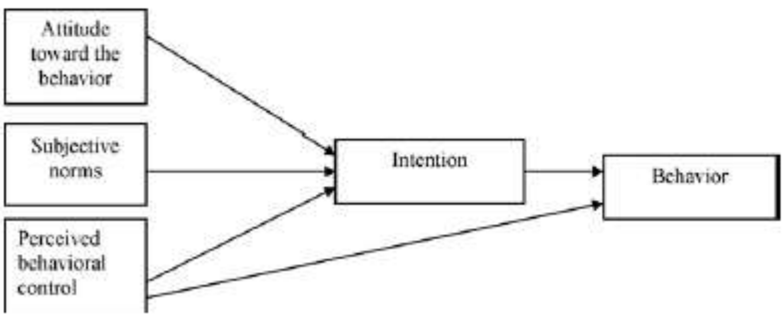

Fig. 1. The Theory of Planned Behavior (Ajzen, 1991, p. 182).

Ajzen hypothesised that attitudes often fail to exhibit strong correlations with behavior because of the large number of factors that potentially prevent the attitude from being converted to behavior. These factors and their inter-relationships are captured by the TPB model, the main components of which are a person's own attitudes, subjective norms, perceived behavioral control, intentions, and behavior (Ajzen, 1991, 2001). In descriptive terms, the TPB is based on the proposition that an individual's behavior is a direct function of behavior intention and perceived behavioral control Intentions are themselves shaped by attitudes, subjective norms, and perceived behavioral control. These determinants of behaviour intention are each based on an underlying belief structure.

More specifically, a person's attitude (A) towards a behavior is determined by his or her salient beliefs (bi) about the consequence of the behavior multiplied by an evaluation of the desirability of the outcome for each belief (ei) (A =_biei). Subjective norms refer to an individual's perceptions of the beliefs and behaviors of significant others. In a work situation, the source of these norms is likely to include both managers and those co-workers who are closely associated with the individual. For example, if an employee does not believe that managers or colleagues are concerned with safety, then he or she is less likely to consider safety as important. Subjective norm (SN) is determined by multiplying an individual's normative belief (ni), that is, perceived expectations of important individuals or groups, and motivation to comply (mi) with these expectations (SN =_nimi) (Fishbein and Ajzen, 1975). The final determinant of behavior intention is perceived behavioral control (PBC), which refers to a person's perception of the ease or difficulty of performing the behavior. People often intend to perform certain behaviors, yet fail because of factors that fall outside their control. PBC is based on two components: control beliefs and perceived power (PBC =_cipi). Control beliefs (ci) refer to those internal and external factors that may impede performance and this first component is measured by self-efficacy, an individual's assessment of his or her ability to perform the behavior. Perceived power (pi) is the second component that reflects factors that may facilitate or inhibit performance of the behavior (Ajzen, 1991, 2001). According to the model, perceived behavioral control strengthens the relationship between intentions and behavior through its spurious association with both variables. In addition, it has a direct effect on behavior.

To a certain extent, the constructs included in the TPB mirror the individual, group, and organisational level variables measured in safety climate studies. Individual attitude towards safety is often used as a marker variable for safety climate (e.g., Mearns et al., 2001). Safety climate studies have also looked at the influence of subjective norms. Individuals in organisations tend to regard themselves as members of workgroups. The norms developed by these groups influence the behavior of employees who feel they are a part of any such group. The inclusion of group level factors in safety climate studies is supported by research that has looked at the role group norms play in safety behaviors (e.g., Hofmann and Stetzer, 1996; Zohar, 2000). Finally, perceived behavioral control suggests there are times when, despite their best intentions to act in a certain manner, individuals feel incapable of completing work tasks according to procedures and rules because of external factors that are beyond their direct control. Huang et al. (2006) demonstrated that a measure of safety control that has close parallels with the notion of perceived behavioral control mediates the effect of safety climate on self-reported injuries. Their measure of safety control assessed safety knowledge and feelings of being in control of personal safety. Our approach was different. We chose instead to construct items that reflected these external influences including such things as lack of equipment, lack of personnel, lack of time, and production pressures. In the safety literature these factors are often combined under the construct of workplace pressures, elements of work that are beyond the control of individual workers, yet likely to impact on their perceived ability to complete tasks in accordance with procedures (Fogarty, 2004, 2005). Consequently, we anticipated that workplace pressures would be associated with employee intentions to violate and actual violations of procedures.

In one of the few studies that has applied the TPB to safety related behaviors, Johnson and Hall (2005) found that the influence of attitudes on safe-lifting behavior was mediated by subjective norms and perceived behavioral control. The present study will extend the TPB by suggesting management attitude to safety is responsible for the correlations among attitude, subjective norms, and perceived behavioral, the three input variables to the TPB model whose relations are usually reported but not often analysed. The importance of management attitudes to safety is well-documented, indeed, it extends back to Zohar's (1980) initial study of safety climate. Zohar found that an employee's perception of his or her manager's attitudes towards safety was the most important predictor of safety climate. Since then, studies applying safety climate to mining accidents, the aviation industry, and construction workers have highlighted the important role played by management in ensuring the safety of organisations (Flin et al., 2000; Mearns et al., 2003). We suggest here that management attitudes will exert a direct influence on own attitudes, subjective norms, and perceived control. In the model shown in Fig. 2, it is proposed that the relations among these three variables can be explained by the spurious influence of management attitudes. In other respects, the model reflects the structure of the TPB where group safety norms are treated as the equivalent of the TPB's subjective norms and workplace pressures as the equivalent of perceived behavioral control.

The aim of the present study was to test this model on a set of data collected from aviation maintenance engineers.

2. Method

2.1. Participants

The 308 participants in this study were either enlisted maintenance personnel from the three services of the Australian Defence Force (Army, Air Force, and Navy) or civilian contractors working for the Australian Defence Force. The majority of the participants were aircraft maintainers (52%) or avionics maintainers (39%), whilst the remaining 9% were involved in other maintenance support roles. The respondents were almost all male with an average of 3.3 years experience (SD = 1.99) working on the aircraft type to which they were assigned at the time of the study.

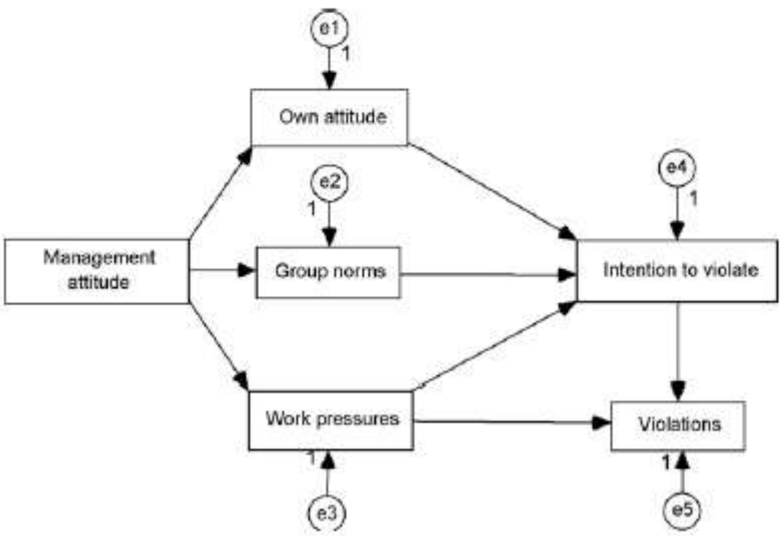

Fig. 2. Model of safety behavior based on the Theory of Planned Behavior.

2.2. Materials

Scales needed to obtain measures of variables found in Fig. 2 were embedded within a much larger instrument constructed by the authors and military staff to measure safety climate within the ADF aviation maintenance environment. The relevant scales are described below. Internal consistency estimates of reliability (Cronbach's alpha) obtained in this study are shown in brackets. All items employed a five-point Likert-style response format. For the management attitude to safety, attitudes to violations, and intention to violate scales, possible responses ranged from 1 (Strongly Agree) to 5 (Strongly Disagree). Other scales used responses ranging from 1 (Always) to 5 (Never). The dependent variable for all scales was the total score divided by the number of items in the scale.

Management attitude to safety was measured by seven items representing participants' perceptions of management beliefs and actions about safety topics and situations. For example: "Managers turn a blind eye to risk taking by supervisors if the flying programme or task deadline is met." (α = .86).

Own attitude to violations was measured by nine items covering attitudes to shortcuts and reporting of procedural violations. For example: "There are better ways of performing a task that those described in the publications and manuals." (α = .73).

Group norms were measured by seven items chosen to represent participants' perceptions of group safety norms. These questions focused on the respondents' beliefs about usual group practices in relation to violations. For example: "Other people in my workplace violate procedures." (α = .78).

Workplace pressures. Eight items were chosen to represent participants' perceptions of workplace pressures. These questions focused on the extent to which respondents felt they were under pressure to complete tasks. For example: "Adequate time is allocated to complete assigned tasks." (α = .84).

Intention to violate. This scale contained five items. For example: "I am prepared to take short cuts to get a task done." (α = .74).

Violations were measured by a four-item scale. For example: "When given a task, I ensure that approved procedures are followed." (NB. reverse-scored item) (α = .72).

2.3. Procedure

Surveys were administered and collected by psychologists from the ADF who travelled to the military bases of the units taking part in the survey. All members of the units who were available at the time participated in the survey. Because of work shift work arrangements, the number of participants represented approximately 75% of the members of each unit. The full survey took approximately 30–45 min to complete.

3. Results

3.1. Correlations

As specified by the model, the correlations among the variables were all significant at the p < .01 level. The descriptive statistics and correlations are presented in Table 1.

Table 1
Correlation matrix for all variables (*N* = 308).

Variable	*M*	SD	1	2	3	4	5
1. Management attitude	3.58	.72	1.00				
2. Own attitude	4.47	.45	.44	1.00			
3. Group norms	3.86	.59	.61	.50	1.00		
4. Workplace pressures	3.76	.56	.57	.38	.55	1.00	
5. Intention to violate	3.81	.70	.42	.58	.60	.44	1.00
6. Violations	3.82	.66	.45	.53	.65	.45	.60

Note: All correlations are significant at the .01 level.

3.2. Path analysis

Maximum likelihood procedures from AMOS 7.0 were used to test the fit of the path model shown in Fig. 2 to the covariance matrix generated from the set of six variables. Three indices of model fit were used. The first index was the traditional Chi-square value indicating the goodness of fit of the model to the data. One incremental fit index was used; the comparative fit index (CFI) which is considered to be reasonably robust against violations of assumptions and where a value above .95 was considered to indicate satisfactory fit (Hu and Bentler, 1999). The third index used was the root mean square error of approximation (RMSEA), which indicates the mean discrepancy between the observed covariances and those implied by the model per degree of freedom, and therefore has the advantage of being sensitive to model complexity. A value of .05 or lower indicates a good fit and values up to .08 indicate an acceptable fit (Kline, 2005).

Initial fit statistics were unsatisfactory: _2 (7, N= 308) = 133.4, p = .00; TLI = .66; CFI = .84; RMSEA= .24. Revisions were made on the basis of modification indices and theoretical considerations. The first change was to the section of the model dealing with the relationships among own attitudes, group norms, and work pressures; where significant residual covariances remained between group norms and own attitude and between group norms and workplace pressures after taking into consideration the spurious influence of management attitude. Drawing upon the safety literature, the most plausible additional pathways in this section of the model are from workplace pressures to group norms and from group norms to own attitudes. Thus, workplace pressures have an influence on group norms, which in turn help to shape individual worker's attitudes to safety standards. This re-conceptualisation of the model retains the spurious influence of management attitude but acknowledges that other pathways are also needed to explain the covariances among own attitudes, group norms, and workplace pressures.

A second change to the model shown in Fig. 2 included the fitting of direct pathways between own attitude and violations and also group norms and violations, both of which were only partially mediated by intention to violate. A third change involved the deletion of the direct pathway from management attitude to violations, suggesting that this relationship is entirely mediated by intention to violate. The resulting model is shown in Fig. 3.

Fit statistics for this model were excellent: _2 (4, N= 308) = 3.40, p = .49; TLI = 1.00; CFI = 1.00; RMSEA= .00 and all pathways were significant. The model accounted for 50% of the variance in violations, 47% of the variance in intention to violate, and a substantial proportion of the variance of the mediating variables.

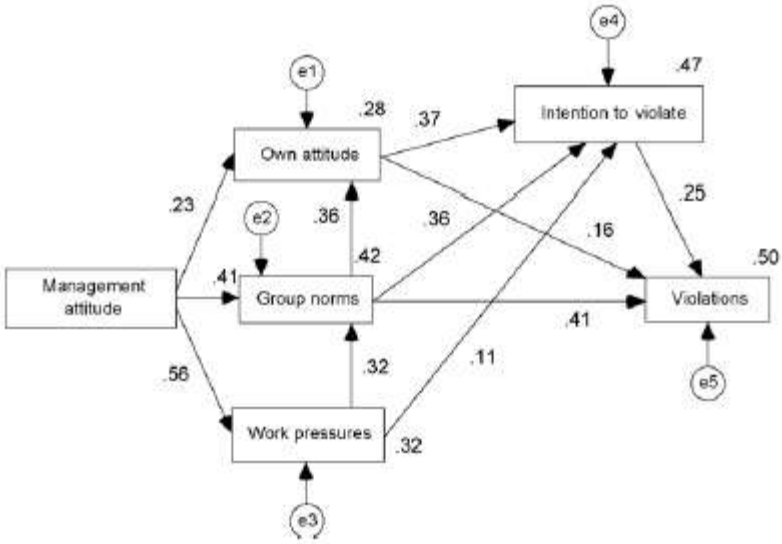

Fig. 3. Revised path model showing direct and mediated pathways to violation behaviors.

4. Discussion

The importance of management attitudes is again highlighted in this study, justifying the importance attached to it by other researchers (e.g., Mearns et al., 2001, 2003). Either directly, or indirectly, it influenced every variable in the model. To spell out its influence in more detail, perceptions of management attitudes had a direct effect on the shaping of a worker's own attitudes and also on group norms. It also had a direct effect on work pressures. This last connection may not appear obvious from a logical point of view but the fact is that workers see managers as exerting control over the quality of their work through the relative emphasis managers place on such things as quality versus production, working safe versus working quickly (the old saying: "Safety works until we are busy"), and the attitude of management to errors and violations. Group norms is another key variable in our model, again justifying the emphasis placed on it by previous researchers (Hofmann and Stetzer, 1996; Zohar, 2000). In this study, group norms had a strong influence on individual attitudes, violation intentions, and actual violation. The importance of group norms is shown in the correlation matrix itself where its relationship with violations is equivalent to the relationship between intention to violate and violations. The strength of these relations involving group norms is above that normally reported in TPB studies, where the subjective norms construct is generally found to be a weak predictor of intentions (Armitage and Connor, 2001).

The only pathway in the model that had to be discarded was the direct link from workplace pressures to violations. The TPB (Ajzen, 1991) and meta-analytic reviews (Armitage and Connor, 2001) suggest this link should be present but our own data lead us to conclude that its influence is indirect and rather weak. A likely explanation is that the work pressures construct used here representing time and resource shortages was not an adequate substitute for the perceived behavior control variable found in the TPB. A more general attitudinal measure, such as the safety control measure used by Huang et al. (2006), may be preferable.

In summary, the Theory of Planned Behavior has been helpful in refining a model that can be used to explain variance in this aspect of safety behavior. The theory does not lend itself to the analysis of errors because these are—by definition—unintentional behaviors. The TPB draws our attention to the role of subjective norms and the mediating construct of intentions, both of which are useful additions to the network of variables that interact to influence safety behaviors. The role played by management, on the other hand, is not something that was suggested by the TPB, which has recourse to belief systems as the precursors to attitudes, norms, and perceived behavioral control. Rather, it was suggested by previous research on safety climate. The practical implications of safety climate research are predominantly concerned with highlighting courses of action that can be followed by organisations to reduce the risk of accidents.

Because managers are viewed as the vehicle through which organisations influence the workforce, management behaviors and attitudes are usually of particular interest. Our findings highlight the pervasiveness of management influence in all aspects of safety behaviors. For these reasons, it is suggested that the manner in which management variables influence safety behaviors within organisations should be of prime interest to researchers and practitioners in the immediate future. In a similar vein, the influence of group norms on safety behavior should also be emphasised. Our data suggest that behavior intentions are shaped to an equal extent by attitudes and norms, and to a lesser extent by work pressures. Workplace interventions designed to improve safety performance should include components that are designed to overcome the pervasive influence of sub-standard work practices that have become part of “the way things are done around here”.

In closing, it is important to draw attention to methodological weaknesses in the present study that suggest the need for replication following design improvements. The measures used were all self-report and taken at the same time using the same response formats. Armitage and Connor (2001) estimated that self-report measures inflated TPB R-square values by approximately .11, so this criticism can be overcome somewhat by acknowledging that the effect sizes reported here are likely to be overestimates of the true values. The criticism relating to a cross-sectional survey methodology is more difficult to overcome. There is no doubt that, provided adequate sample sizes are obtained, time-lagged studies of the type used by Neal and Griffin (2006) offer a sounder basis for inferring causality. As industries establish better safety performance databases and become more accustomed to sharing sensitive information with researchers, it is almost certain that safety climate studies will not only embrace more theories from other areas of psychology—as we have done here with our application of the Theory of Planned Behavior—but also succeed in linking psychological constructs with data obtained over long time periods from actual workplace settings.

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