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The Impact of Line Maintenance Mechanics' Attitude, Behavioural Intentions, and Behaviour on Aircraft Safety: A Study of Two Aircraft Maintenance Companies in Hong Kong

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Abstract

This research examined the impact of attitude, behavioural intentions and actual behaviour on aircraft safety amongst by analyzing data collected from aircraft line maintenance mechanics in Hong Kong. The research used two conceptual framework models and structural equation modeling to compare two aircraft maintenance companies and was based on the theory of reasoned action and the theory of planned behaviour. It was hypothesized that attitude affects behavioural intentions and that behavioural intentions in turn affect actual behaviour; that behaviour then impacts aircraft safety. Data were collected through a questionnaire survey from 380 line maintenance mechanics in two aircraft maintenance companies located in Hong Kong. The survey produced 262 valid responses of which 129 came from company A and 133 came from company B. Principal component analysis and structural equation modeling were used to analyze the data in order to extract common factors underlying attitude and behavioural intentions, determine the relationships between the dimensions of safety attitude and behavioural intentions, and compare the differences between the two companies. Reliability and validity of the data was found to be within acceptable limits. Results indicate that there is relationship between attitude, behavioural intentions and behaviour in accordance with the theory of reasoned action and the theory of planned behaviour. The hypothesis is supported by the study's conclusion that maintenance mechanics' attitude will predict their behavioural intentions as well as their safety behaviour and that this will indirectly affect aircraft safety.

Keywords: Attitude, Behaviour Intention, Safety, Hong Kong

1. Introduction

The research was based on two aircraft maintenance companies located in Hong Kong, herein named company A and company B, with a total population of 380 mechanics working in line maintenance. The population of line maintenance mechanic for company A was 200 and for company B it was 180. Both companies were major competitors in Hong Kong. They occupied more than 95 percent of the ramp activities at Hong Kong International Airport. Company A was established in 1950 while company B was founded in 1995. Both companies provide aircraft maintenance, cabin cleaning and ramp services for all transit aircraft operating within Hong Kong.

1.1 Background of the Study

Aircraft maintenance is critical for maintaining aviation safety. According to Marx and Graeber (1994), twelve percent of major aviation accidents were caused by maintenance and inspection deficiencies. It has also been reported that the number of maintenance related accidents has been increasing over the past ten years with the number of flights increasing by 55% and the number of maintenance concerned accidents increasing by 100% (King 1998). According to Hobbs and Williamson (2002), 619 safety incidents involving maintenance deficiencies of which 96% were related to maintenance personnel.

Human factors play a major role in accidents (Denis, 2000; Fogarty and Shaw, 2003; Hobbs and Williamson, 2002; John, 2004). Sabey and Taylor (1980) contended that human factors are the main contributing elements in accidents. The cause of accidents are lack of communication, lack of resources, lack of knowledge, lack of awareness, pressure, stress, and fatigue. Human error is a causal factor in most transport and industrial accidents (Hale and Glendon, 1987; Maurino, Reason, Johnston and Lee, 1995; Rasmussen, 1981; Reason, 1990; Taylor and Lucas, 1991). In order to prevent or minimize the occurrence of accidents in aircraft maintenance, it is important to understand the unsafe behaviours that contribute to accidents.

It is clear that unsafe behaviour in a safety-critical environment occurs not only because of failures of information processing and action execution, but also because of deviations from regulations and procedures. Mason (1997) reported that deliberate deviations from recommended safe behaviour may be the cause of 70% of industrial accidents. An intention not to comply with procedures is a significant problem in oil production, rail transport, and medical fields (Reason, Parker and Lawton (1998). Given that deliberate rule violations occur in a diverse range of safety environments, it is apparent that models of unsafe behaviour must not only take cognitive violations into account but also the attitude that lead to them. The attitude of aircraft mechanics is important because it is directly related to resolving maintenance problems. Mistakes or errors committed by these mechanics will inevitably degrade standards and eventually cause accidents.

2. Literature Review and Hypotheses Development

This research applied the theory of reasoned action (Redding et al., 2000) to the behavioural intentions and behaviour of mechanics toward aircraft safety maintenance and accident prevention by analyzing responses to questions concerning aircraft safety maintenance.

2.1 Relationship between Attitude and Behaviour

Allport (1935) defined attitude as "a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related." In the classic article by Doob (1947), attitude is defined as "an implicit, drive-producing response considered socially significant in the individual's society." This definition means that attitude is a response to exogenous stimulus, which occurs within individuals and which can induce overt behaviour; in other words, attitude can predict and determine overt behaviour. Since the introduction of the concept of attitude over 40 years ago, there have been controversial challenges to this concept by suggestions of low and non-significant attitude-behaviour relations (Ajzen and Fishbein, 1977). The findings at that time led to a false belief that attitude cannot be used to predict overt behaviour (Ajzen and Fishnein, 1973, 1977; Ajzen, Timko and White, 1982; Calder and Ross, 1973; Campbell, 1963; DeFleur and Westie, 1963; Ehrlich, 1969; Kelman, 1974; Rokeah, 1967; Schwartz and Tessler, 1972; Tittle and Hill, 1967). The consequent re-evaluation of the role of attitude led to an assertion that attitude was only one of many factors that determined behaviour and that its relationship to behaviour was moderated by other variables (Brannon, 1976; Liska, 1975; Schneider, 1976; Schuman and Johnson, 1976). These moderating variables included multidimensional attitude (Rosenberg and Hovland, 1960) and Rokeah (1967) asserted that at least two attitude are required to make a correct prediction of behaviour. The variables included social and psychological variables that intervene between attitude and behaviour (Ehrlich, 1969) and direct experience with the attitude object or with the behaviour (Fazio and Zanna, 1978a; Regan and Fazio, 1977). Other variables included the confidence level of holding the attitude (Fazio and Zanna, 1978b), the internal consistency of the attitude (Norman, 1975), and self-consciousness (Scheier, 1980).

2.2 Interaction between Emotion and Cognition

Attitude is traditionally conceptualized as a combination of cognition (thinking), affection (feeling and emotion), and conation (motivation and action) (Hilgard, 1980; Rosenberg and Hovland, 1960). This tripartite of conceptualization proposes that behaviour is a result of interaction amongst these three spheres. This means that a thought in the cognitive domain will influence thinking, feeling, and action, as likewise, an emotion or feeling will influence thinking, feeling or action; also, an action will also influence thinking, feeling, and action in the same way. This broad categorization cannot explain the difference in degrees of effect amongst these three components nor can it classify events as primarily cognitive, affective or conative. Hence, differentiating the magnitude of impact of each individual component is difficult. Although the coexistence of emotion and cognition cannot be refuted, the question is to what extent they affect each other (Isen, 1984).

There are two notions of thought which advocate two extreme interpretations. The first one is represented by Lazarus (1984) who concluded that cognition is primary, and always precedes affect. In other words, emotion and cognition are always fused in nature, and that cognition always mediates emotion. The second one is represented by Zajonc (1980) who concluded that affection is primary, and frequently occurs before and independently of cognition, and that in most cases feeling and thought interact with each other. High involvement cognitive activities usually accompany affect, whereas cognition enters feeling at various stages of the affective processes, and vice versa. Affect accompanies all cognitions, but the reverse cannot be applied.

2.3 Theory of Reasoned Action

Fishbein (1967) introduced a theory advocating the uni-dimensional nature of attitude, and referred to the conceptual model as the theory of reasoned action (see Figure 1). According to this theory, an individual's intention to behave in a certain way is a function of attitude and subjective norms (Ajzen, 1985; Ajzen and Fishbein, 1972; Fishbein, 1980). Not all attitudes can predict behaviour because attitude is "a hypothetical variable that is abstracted from the totality of an individual's belief, behavioural intention, or behaviour" and, therefore, attitude may sometimes be "uncorrelated or even negatively correlated with behaviour" (Fishbein, 1966). This theory of reasoned action proposes not to take specific beliefs or behavioural intentions as part of attitude. Instead, these factors should be treated as variables that exist on their own. One should be prepared to accept that these variables, like attitude, may or may not predict a specific behaviour (Fishbein, 1966).

Attitude is generally perceived as consisting of three interrelated components: cognitive, affective and conative (Rosenberg and Hovland, 1960). Under this concept, cognitive refers to perceptual responses or verbal statements of belief, affective represents feelings and emotion toward the object, while conative is the overt behaviour associated with the attitude. By contrast, the attitude concept of Ajzen and Fishbein (1972, 1977) is limited to the evaluative component. They viewed attitude as whether the individual is in favor of or against performing the behaviour. Ajzen and Fishbein (1980) viewed attitude as a uni-dimensional measured attitude and as a favorable versus unfavorable attitude. This suggested that attitude is a viewpoint indicating favorable or unfavorable consideration of certain situations, such that attitude are implicated motivational factors that affect views, hopes, fears, as well as expectations.

The uni-dimensional concept of attitude proposed by Ajzen and Fishbein (1980) is different to that of earlier scholars who advocated that uni-dimensional attitude scale could accurately predict behaviour. Instead, Ajzen and Fishbein (1972, 1977) argued that attitude cannot always predict behaviour. They contended that beliefs are the building blocks of attitude, and that behavioural intention is the link between attitude and behaviour. Therefore, attitude when shaped by beliefs will influence intention which ultimately serves to predict overt behaviour. Hence, attitude cannot directly predict behaviour; it has to work through intention.

Attitude toward any object are determined by beliefs which may be formed by direct observation, or can be obtained indirectly from outside sources, or self generated through inference processes. In other words, it is the object that is used in the generic sense to refer to any aspect of the individual's world. Beliefs about an object (a thing, a person, an event or behaviour) are formed by associating them with various characteristics, qualities, and attributes, and an attitude toward that object is being shaped at the same time. Hence, people have a favorable attitude toward objects which they believe have positive characteristics, and an unfavorable attitude towards objects which they believe have negative characteristics. An attitude is an index of the degree to which a person likes or dislikes an object (Ajzen and Fishbein, 1980).

Within the theory of reasoned action, attitude is limited to attitude toward behaviour but not any other objects such as persons, things, or institutions. According to Ajzen and Fishbein (1980), attitude toward behaviour is the only attitude that is directly relevant for predicting and understanding human behaviour.

The first step to determine behaviour is to predict and understand behavioural intentions. The two major factors that determine behavioural intentions are the personal or attitudinal factor and the social or normative factor (Ajzen and Fishbein, 1972). The personal factor, attitude, refers to the individual's judgment that the behaviour is good or bad, while the social factor, the subjective norm, refers to the individual's perception of the social pressures exerted on him or her to perform or not to perform the behaviour. The individual attitude when interacting with the subjective norms will form the behavioural intention which, in turn, will predict overt behaviour (Ajzen and Fishbein, 1973; Fishbein, 1966, 1967, 1973, 1980; Fishbein and Ajzen, 1972, 1974, 1975). In general, individuals will tend to behave in a certain way when they evaluate that behaviour positively, when they believe that others think they should do it, and when they are motivated to comply with it. When there is an agreement between the attitude and the subjective norm, it is clear what the behavioural intention will be. On the other hand, a person may evaluate a behaviour as positive but not intend to do it because others do not value it. Therefore, when attempting to predict behaviour, all four concepts of belief, attitude, behavioural intention, and behaviour, should be carefully considered

According to Fishbein and Ajzen (1975), the validity of predictions is subject to three conditions. First, that the intention and behaviour measurement correspond to specific action, target, context, and time frame. Second, that intention does not change in the period during assessment of intention and assessment of behaviour. Third, the behaviour under consideration is within the individual's volitional control.

Volitional control is an action that a person is able and intends to perform. According to the theory of reasoned action, attitude follow reasonably from the beliefs people hold about the object of the attitude, just as intentions and actions follow reasonably from the attitude. Additional variables have been proposed to improve the predictive accuracy of the reasoned model. Some of them are the inclusion of personal norms (Fishbein, 1967), moral obligations (Gorsuch and Ortberg, 1983; Zucherman and Reis, 1978), and competing attitude (Davidson and Morrison, 1983) but the most significant one was proposed by Ajzen (1985) who proposed the notion of perceived behavioural control. This is based on the belief that the possession of requisite resources and opportunities for performing the behaviour in question, is a determinant of behavioural intentions and overt behaviour.

2.4 Theory of Planned Behaviour

Ajzen (1985) extended the theory of reasoned action by adding the variable of perceived behavioural control as an antecedent to behavioural intentions and overt behaviour, in which cognitive self recognition is a crucial element. This modified concept is called the theory of planned behaviour (see Figure 2), in which perceived behavioural control serves as an exogenous variable which has a direct effect on behaviour and an indirect effect on behaviour via behavioural intentions.

This new theory extended the boundary of the theory of reasoned action from being monitored by the volitional control of the individual, to going beyond the limitation of the theory of reasoned action in which individuals could have incomplete volitional control when dealing with behaviours (Madden, Ellen and Ajzen, 1992). Perceived behaviour control refers to beliefs of possessing required resources and opportunities for carrying out the specific task. The more resources and opportunities that individuals believe they possess, the greater is their perceived behavioural control over the behaviour. The theory assumes that perceived behavioural control has a motivational effect on behavioural intentions. It refers to people's perceived ease or difficulty of performing the behaviour as well as past experience with anticipated obstacles. When people believe they have little control over performing the behaviour because of a lack of resources or opportunities, then their intentions to perform the behaviour may be low even if their attitude and/or subjective norms are favourable toward the act. The inclusion of perceived behaviour control enhances the prediction of behavioural intention and behaviour (Madden, Ellen & Ajzen, 1992), and it is important to note that a behavioural intention can predict a specific behaviour only when the behaviour is under volitional control. In other words, if the individual can decide at will to perform or not to perform the behaviour in question (Ajzen, 1991). Moreover, Armitage and Conner (2001) conducted a meta-analytic review on the efficacy of the theory of planned behaviour and found a relatively good correlation between intention and behaviour. Bandura, Adams, Hardy and Howells (1980) contended that people's behaviour is strongly influenced by the confidence that they have in their ability to perform the behaviour required.

2.5 Summary of the Theory of Reasoned Action and the Theory of Planned Behaviour

In summary, the theory of reasoned action provides an approach for explaining, predicting, and influencing human social behaviour in many given behavioural domains. The theory is concerned with relations among beliefs, attitude and intentions, and behaviours. In fact, the concept of attitude has long been an area of research and has played a major role in the history of social psychology (Fishbein and Ajzen, 1974). Nevertheless, there is little consistent evidence to support the phenomenon that knowledge of a subject's attitude would allow one to predict the way a person would behave. Fishbein and Ajzen (1974) proposed that the explanation for the inconsistent findings is that the relationship of attitude to behaviour is contingent upon their relationship to other components. They contended that beliefs are the building blocks of attitude and behavioural intention is the link between attitude and behaviour. Fishbein (1967) presented what is now referred to as the theory of reasoned action as an attempt to bridge the gap between traditional measures of attitude toward a stimulus object and behaviour. In this theory, beliefs are viewed as determinants of attitude, and behavioural intention is considered as a consequence of attitude (Fishbein, 1967). Subsequent research indicated that behavioural intentions could be predicted from attitude, and that intentions were significantly related to overt behaviours (Ajzen and Fishbein, 1974). Therefore, when attempting to predict behaviour, all four concepts – belief, attitude, behavioural intentions and behaviour – should be considered.

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The theory of planned behaviour can help us predict and understand performance of specific action tendencies. Perceived behavioural control can have motivational implications, influencing the formation of behavioural intentions. When resources or opportunities are seen as inadequate, motivation to performing the task is likely to decline. In addition to being affected by perceived behavioural control, intentions are also influenced by attitude toward the behaviour and by subjective norms. Ajzen (1991) pointed out that as a general rule, the more favorable the attitude and subjective norm and the greater the perceived control the stronger should be the person's intention to perform the behaviour in question.

Both the theory of reasoned action (Figure 1) and the theory of planned behaviour (Figure 2) were used to construct the theoretical framework for this study.

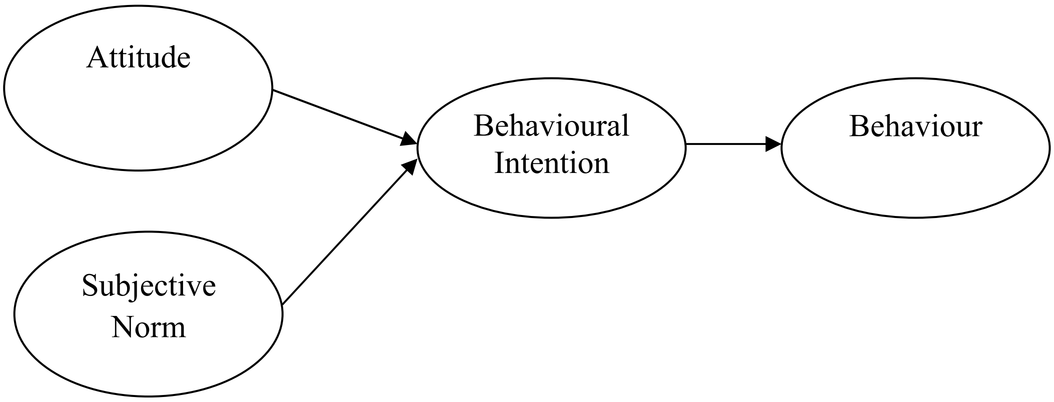

Figure 1. Theory of Reasoned Action

(Source: adapted from Madden, Ellen & Ajzen, 1992)

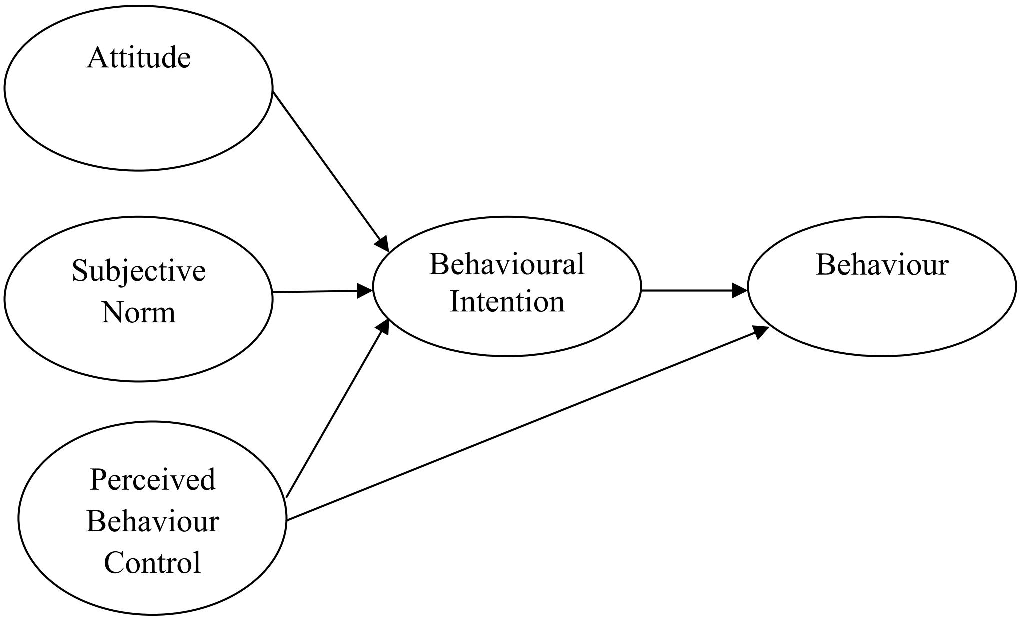

Figure 2. Theory of Planned Behaviour

(Source: adapted from Madden, Ellen & Ajzen, 1992)

2.6 Research Questions and Hypotheses

Followings are the research questions in this research along with their attendant hypotheses.

The first research question is "Will the instrument developed by Rundmo and Hale (2003) be reliable and valid in a non-Western sample?" From this question, the following hypotheses were developed.

Hypothesis 1: The instrument developed by Rundmo and Hale (2003) will exhibit reliability in a non-Western sample.

Hypothesis 2: The instrument developed by Rundmo and Hale (2003) will have the same factor structure in a non-Western sample.

The second research question is "Will selected demographic variables such as age, level of education, and working experience be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance?" From this question, the following hypotheses were developed.

Hypothesis 3: Age will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

Hypothesis 4: Level of education will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

Hypothesis 5: Work experience will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

The third research question is "Will there be a relationship between mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance?" From this question, the following hypotheses were developed.

Hypothesis 6: Mechanics' attitude will predict their behavioural intentions to communicate and regulate safety-related information.

Hypothesis 7: Mechanics' intention to communicate safety-related information will predict their behaviour towards aircraft safety maintenance.

Hypothesis 8: Mechanics' intention to regulate safety-related information will predict their behaviour towards aircraft safety maintenance.

The fourth question is " Will the relationship between mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance vary across the two companies?" From this question, the following hypotheses were developed.

Hypothesis 9: The relationship between mechanics' attitude, behavioural intentions, and behaviour safety toward aircraft maintenance will vary across the two companies.

2.7 Research Model

In the research model shown in Figure 3, attitude is treated as the causal factor influencing both behavioural intentions and behaviour (Ajzen, 1985, 1988, 1991). It was hypothesized that attitude affects behavioural intentions and the behavioural intentions have affects on behaviour. The model was used to determine the inter-relationship between the attitude dimensions and the behavioural intentions as well as the behaviour towards aircraft safety maintenance and accident prevention.

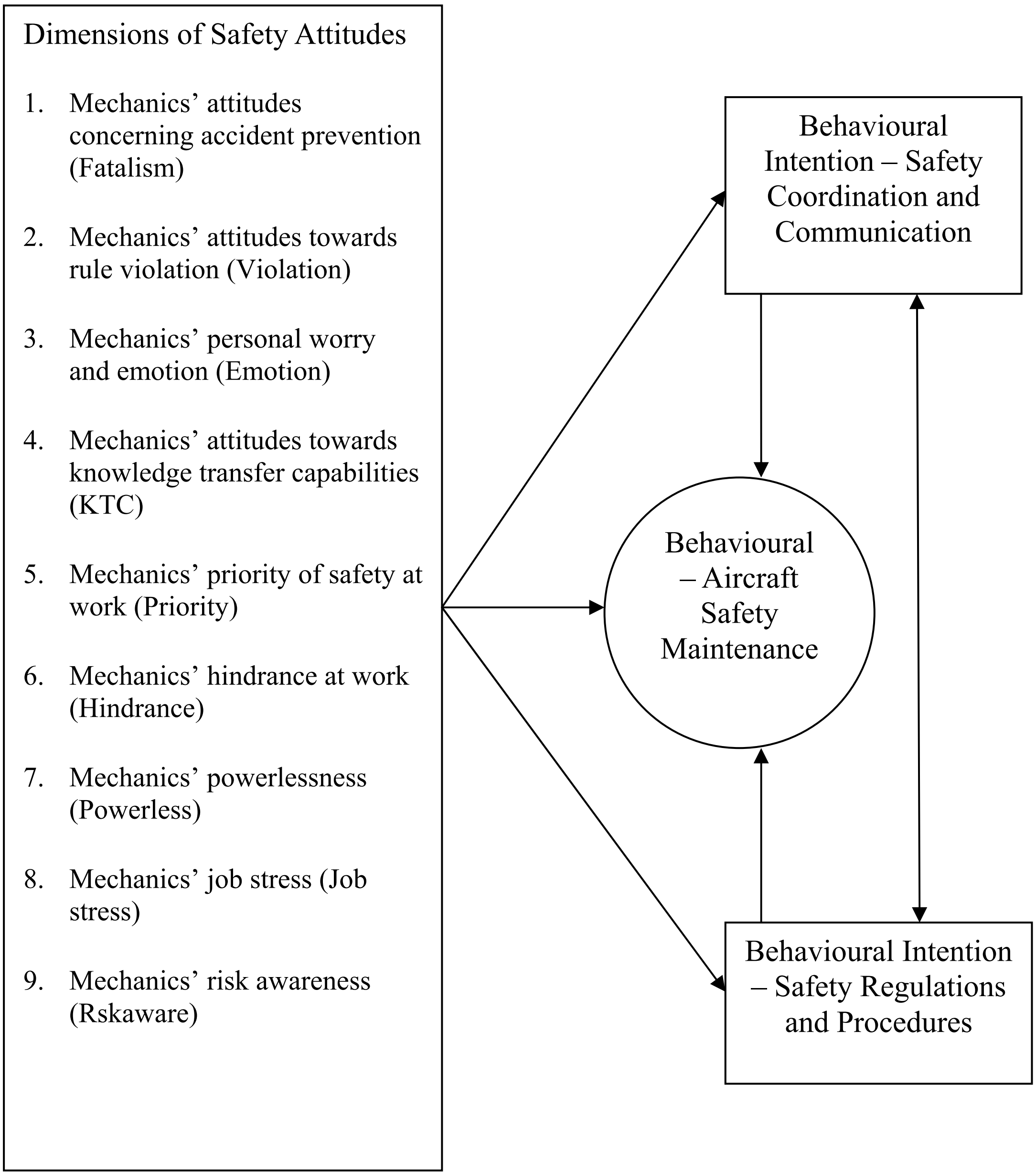

Figure 3. Research Model

(Source: adapted from Rundmo and Hale, 2003)

Through studying line maintenance mechanics' attitude towards safety in aircraft maintenance, nine dimensions of attitude were identified. The dimensions of attitude are based on the peculiar working environment in aircraft line maintenance. Time pressure, adverse weather condition, rotating shifts, inconvenient access of maintenance documents and a busy ramp working environment are the most potent error-provoking factors for line maintenance mechanics. Nine key variables are defined in the research model, they are attitude towards accident prevention; rule violations; personal worry and emotion; knowledge transfer capabilities; priority of safety; powerlessness; hindrance at work; job stress; and risk awareness. Two dimensions of behavioural intentions are considered. The first dimension of behavioural intention is concerned with coordination and communication, and the second dimension consists of procedures and safety regulations. The attitude dimensions act as independent variables, behavioural intentions are the mediating variables, and behaviour acts as the dependent variable.

3. Methodology

3.1 Sample

By using different approaches in calculating the sample size, the sample size in this research is acceptable. First approach applied the formula n = square of (Z x standard deviation / precision unit). For 95% confidence level and standard score Z = +/-1.96 for 5-point Likert scale, the standard deviation is 0.67, confidence interval = +/-0.1 or precision unit = 0.1. Hence, the sample size is equal to square of the value of 1.96 x 0.67 / 0.1, that is 171. Another approach considered that the questionnaire has 56 opinion items, by applying the ratio of 4 to 1, the sample size required is 224. (Cavana, 2001). The third approach applied the general N/s table (Cavana, 2001), for a population size of 380 mechanics in company A and company B, the required sample size is 237. Last approach considered that a 30% response rate is generally acceptable for anonymous questionnaire survey (Cavana, 2001). Since the total population from which to take the sample was 380 mechanics (200 from company A and 180 from company B) and the attitude questionnaire had 56 test items, a minimum of 224 subjects were required. The sample size in this research is 262 with 129 mechanics from company A and 133 mechanics from company B, which is considered acceptable by comparing the results found in the above four approaches.

3.2 Data Collection and Questionnaire Design

In this descriptive-exploratory study, 380 line maintenance mechanics (129 from company A and 133 from company B) were selected to anonymously and voluntarily participate in the research. The method of data collection was by means of self-administered questionnaire. The questionnaire comprised four sections. The first section was designed to collect demographic details. The second section consisted of nine attitude constructs each related to mechanics' attitude towards aircraft safety maintenance and accident prevention. Each construct consisted of two to nine test items relating to mechanics' attitude to safety. Section three consisted of two behavioural intention constructs that were related to mechanics' behavioural intentions towards communication and safety regulations. Each construct consisted of six to seven test items related to mechanics' safety behavioural intentions. Section four consisted of two test items related to mechanics' behaviour towards an accident in the last twelve months in which they had been involved or which they had observed.

After finalizing the attitude test items, survey forms were distributed to the respondents. Respondents were asked to provide a range of demographic details, including their age, gender and years of experience in the aircraft maintenance industry. The questionnaire was distributed to the participants through each team's shift-in-charge and was collected by the same person. Participants could also return the completed survey form anonymously in a reply-paid envelope. To encourage a high return rate, the questionnaire was bilingual (English and Chinese) and it was kept simple and easy to read.

All the mechanics who were working in aircraft line maintenance from the two companies received the questionnaire. The mechanics were those who would responsible for meeting the arrival and departure of the daily transit aircrafts. They were also responsible for defect rectification, removal, inspection, adjustment, and repair of the aircraft components in line maintenance. There were no special selection criteria for the mechanics, as long as they were working in line maintenance they could participate.

3.3 Data Analysis

Descriptive and one-way ANOVA was used to find out the significant variances between the two groups. One-way ANOVA and Post-hoc Tukey's tests were also used to determine the relationship between demographic variables, attitudes, intentions and safety behaviour. Factor analysis was used to condense and summarize dimensions of the mechanics' safety attitude. The analysis was useful for the study of multivariate data and for identifying the structure of variations (Jolliffe, 2002). The analysis scanned all responses and identified correlating factors and latent dimensions. PLS path modeling was used to test the relationship between attitude, intentions, and behaviour as well as for analyzing latent variables. The results of PLS modeling among three different datasets were compared between company A and company B. The full model was run first with the attitude-intention-behaviour relationship and then with the attitude-behaviour relationship in order to find their significant differences. The full model with attitude-intention-behaviour relationship was further tested by structural equation modeling (SEM) using AMOS 16 with maximum-likelihood estimation for comparison and model fitness.

4. Findings

Of the 380 delivered, 129 questionnaires were returned from company A and 133 from company B. All the mechanics were male. The total response rate was 68.9% (262/380) which is according to Cavana (2001) is acceptable for data analysis. The response rate for company A was 64.5% (129/200) and for company B it was higher at 73.8% (133/180).

4.1 Characteristics of the Sample

Table 1. summarizes the key demographic variables of the research.

Demographic Variables	Measures	Frequency	Percentage
Age	under 20	6	2.3%
	20 to 29	68	26.0%
	30 to 39	112	42.7%
	40 or above	76	29.0%
Level of education	F5 or below	52	19.8%
	HKCEE	120	45.8%
	Matriculation	16	6.1%
	Diploma	54	20.6%
	Bachelors or above	18	6.9%
Work experience	below 10 years	90	34.4%
	10 to 19 years	111	42.4%
	20 to 29 years	41	15.6%
	30 years or above	20	7.6%

Table 1 Characteristics of the Sample

The age and years of experience distributed across company A and company B are shown in Table 2. The table indicates that the majority of respondents from company A were between the age 30-39 (37.2%) and 40 or above (37.9%) whereas the majority of respondents from company B were between the age 30-39 (48.1%). Company A mechanics were more experienced than company B regarding the years of experience in the age groups 20-29 and 30 or above age groups. In these groups, company A (31.8%) has twice the amount of experienced mechanics as company B (only 15%). Overall, the age of the majority of mechanics was 30 or above (71.7%) and their experience ranged from less than ten years to over 30 years with a majority having less than 20 years of experience (76.7%). For company B, 85% of the mechanics had less than 20 years of experience while for company A 68.4% had less than 20 years of experience. This indicates that company A mechanics were older and of more experienced than those in company B.

Table 2. Age and years of experience between company A and company B mechanics

	Company A (N=129)		Company B (N=133)	
	Frequency	Percentage	Frequency	Percentage
Age				
Under 20	4	3.1%	2	1.5%
20 to 29	28	21.7%	40	30.0%
30 to 39	48	37.2%	64	48.1%
40 or above	49	38.0%	27	20.3%
Work experience				
Below 10 years	34	26.3%	56	42.1%
10 to 19 years	54	41.9%	57	42.9%
20 to 29 years	27	20.9%	14	10.5%
30 years or above	14	10.9%	6	4.5%
Total	129		133	

4.2 Significant Variance between Companies

4.2.1 Age and Work Experience

There was a significant difference in age and years of experience between the mechanics of company A and company B (see Table 2). The mechanics of company A were older and more experienced than the mechanics of company B. There was a significant variance of 0.021 with a mean of 3.100 and standard deviation of 0.846 for company A and for company B a mean of 2.872 and standard deviation of 0.742. The mechanics of company A were older. For years of experience, the significant difference between both companies was 0.000 with a mean of 2.167 and standard deviation of 0.942 for the mechanics of company A and for company B a mean of 1.774 and standard deviation of 0.813. The mechanics of company A were more experienced. There was no significant difference in the education level between the two companies but the mechanics of company B were generally younger and more highly educated.

4.2.2 Dimensions of Attitude

For attitudinal dimensions, there was significant variance between company A and company B. The first dimension of attitude that showed a significant difference between the two companies was mechanics personal worry and emotion on EMOT16 and EMOT19 with a significance variance of 0.020 and 0.054. For EMOT16 (When I think about accidents I feel nauseous), the mean for company A was 3.240 and standard deviation was 1.116 while for company B the mean was 2.917 and standard deviation was 1.108. For EMOT19 (The problems I would experience as a result of an accident would last), the mean for company A was 3.13 and standard deviation was 1.182 while for company B, the mean was 3.401 and standard deviation was 1.069. Company A has more positive attitude on EMOT16 than company B perhaps because the mechanics of company A had encountered more accidents than company B, such that they were more worried when thinking about accidents. For EMOT19, on the other hand, the mechanics of company B may have been faced with fewer accidents but the effects of the accidents were stuck in their memory. This is probably true since the mechanics of company B were younger and less experienced.

The second dimension of attitude that showed a significant difference was mechanics attitude towards knowledge transfer capabilities on KNOW20 and KNOW25 with a significance difference at 0.015 and 0.006. For KNOW20 (When something about problem-solving best practices, everyone knows it in a short period), the mean for company A was 2.969 and standard deviation was 0.918 while for company B, the mean was 3.256 and standard deviation was 0.982. For KNOW25 (I am able to successfully leverage the knowledge of others as I perform the daily work), the mean for company A was 3.690 and standard deviation was 0.694 while for company B, the mean was 3.546 and standard deviation was 0.938. The mechanics of company B have a more positive attitude towards problem solving than company A but, on the other hand, company A's mechanic are more active in absorbing other colleagues experience in solving daily problems.

The third dimension of attitude that showed a significant difference concerned with mechanics' priority of safety in item SAFE27 with significant difference at 0.035. For company A, the mean was 4.256 and standard deviation was 0.912 while for company B, the mean was 4.008 and standard deviation was 0.981 (SAFE27: If you don't take good care of yourself you have nothing). Company A's mechanics were evidently more positive in selecting this item than company B's mechanics. This might be correlated to their longer years of experience compared to their counterparts in company B as company A was established in 1950 while company B was not founded until 1995. The organizational culture plus redundancy that occurred in company A in 1998 may have also affected their selection.

The fourth dimension that showed a significant difference between the two companies was concerned with mechanics' job stress. STRESS37 and STRESS38 had a significant difference of 0.031 and 0.008. For STRESS37, the mean for company A was 3.054 and standard deviation was 0.979 while for company B, the mean was 1.000. For STRESS38, the mean for company A was 2.900 and standard deviation was 0.983 while for company B, the mean was 2.571 and standard deviation was 0.987 (STRESS37: I can do my work independently and according to my own views, STRESS38: I can decide when and how each individual work-task shall be implemented). Company A's mechanics have a more positive attitude towards both job stress items. This can probably be attributed to company A having a higher volume of work than company B. This was reflected by their monthly staff meetings in which the works consultative committee complained that there was insufficient manpower to cope with the daily workload and unplanned callouts.

4.2.3 Behavioural Dimensions

There is also significant variance between two companies on dimensions of behavioural intention. The first dimension of behavioural intention that showed significance difference between the two companies was concerned with Mechanics behavioural intention towards communication with respect to INT-COM46 and INT-COM47, which indicated a significance difference at 0.045 and 0.030. For item INT-COM46, the mean for company A was 3.713 and standard deviation was 0.945 while for company B, the mean was 3.451 and standard deviation was 0.945. For INT-COM47, the mean for company A was 3.605 and standard deviation was 0.972 while for company B, the mean was 3.605 and standard deviation was 1.157 (INT-COM46: Safety communication, INT-COM47: Safety improvement objectives).

The second dimension of behavioural intention that showed a significance difference between the two companies was concerned with mechanics' behavioural intention towards maintenance procedures and regulations with respect to item INT-REG53, INT-REG55, INT-REg56, and INT-REG57, which indicated a significance difference at 0.048, 0.005, 0.015, and 0.024 respectively. The mean for company A had a range of 3.69 to 3.853 and standard deviation was 0.953 to 1.044 while for company B, the range for the mean was 3.308 to 3.587 and standard deviation was 1.122 to 1.198 (INT-REG53: Safety precautions, INT-REG55: Materials handling procedures, INT-REG56: Labeling and sign posting, INT-REG57: Protection and safety devices). It had the same result with mechanics' ideal behavioural intention towards procedures and safety regulations such that company A has a higher significance than company B in all six behavioural intention items. The mechanics of company A generally required more time to achieve safety objectives, which correlated with their safety culture and years of experience.

4.3 Relationship of Demographic Variables on Attitude, Behavioural Intentions and Behaviour

One-way ANOVA and Post-hoc Tukey Tests were used to identify the possible effects of demographic variables such as age, level of education, and work experience on attitude, behavioural intentions, and behaviour. Among all these demographic variables, only age and work experience were found to be related to attitude, behavioural intentions and behaviour.

4.3.1 Age

In relation to age, respondents were divided into four groups of similar age range for comparison. Group one included ages under 20, group two included ages 20 to 29, group three included ages 30 to 39, and group four included mechanics age 40 and above. Using ANOVAs, with age as the independent variable and the attitude, intention and behaviour dimensions as the dependent variables, the results showed that some attitude, intention to regulate, and safety behaviour scores did not vary across age groups. Knowledge transfer scores varied significantly across age groups ($F(3,258) = 3.160$, $p = 0.025$). Post-hoc Tukey procedures indicate that mechanics between the ages of 20 to 29 had significantly lower knowledge scores ($M = 3.30$) than mechanics aged 40 and above ($M = 3.43$; $p = 0.02$). Priority of safety scores varied significantly across age groups ($F(3,258) = 2.998$, $p = 0.031$).

Post-hoc Tukey procedures, however, did not yield any significant differences between groups. Intention to communicate scores varied significantly across age groups (F (3,258) = 3.448, p = 0.017). Post-hoc Tukey procedures indicate that mechanics between the ages of 20 to 29 had significantly lower intent scores (M = 3.25) than mechanics aged 40 and above (M = 3.68; p = 0.024).

4.3.2 Level of Education

Respondents were divided into five groups according to their level of education. group one included level at Form 5 or below, group two included level HKCEE, group three included level at matriculation, and group four included level at diploma, and group five included level at bachelor or above. Using ANOVAs, with level of education as the independent variable and dimensions of attitude, intentions and behaviour as the dependent variable, results indicating that attitude, intentions, and safety behaviour scores did not vary across level of education.

4.3.3 Work Experience

In relation to work experience, respondents were divided into four groups. Group one included work experience less than 10 years, group two included work experience between 10 to 19 years, group three included work experience between 20 to 29 years, and group four included mechanics work experience 30 years or above. Using ANOVAs, with work experience as the independent variable and the dimensions of attitude, intention, and behaviour as the dependent variables, the results showed that some attitude and intention scores did not vary across levels of work experience. Worry and emotion scores varied significantly across levels of work experience (F (3,258) = 3.307, p = 0.021). Post-hoc Tukey procedures indicate that mechanics who had 30 or more years of work experience had significantly higher worry and emotion scores (M = 3.73) than mechanics with 10 or less than 10 years of experience (M = 3.10; p = 0.012) and mechanics with between 10 to 19 years of experience (M = 3.14; p = 0.020). Knowledge of transfer scores varied significantly across levels of work experience (F (3,258) = 4.316, p = 0.005). Post-hoc Tukey procedures indicate that mechanics who had 30 or more years of work experience had significantly higher knowledge scores (M = 3.68) than mechanics with 10 or less than 10 years of experience (M = 3.17; p = 0.003).

Job stress scores also varied significantly across levels of work experience (F (3,258) = 3.756, p = 0.005). Note that higher stress scores indicate lower stress levels. Post-hoc Tukey procedures indicate that mechanics who had 30 or more years of work experience had significantly higher stress scores (M = 3.18) than mechanics with 10 or less than 10 years of experience (M = 2.76; p = 0.015), mechanics with between 10 to 19 years of experience (M = 2.74; p = 0.009), and mechanics with between 20 to 29 years of experience (M = 2.70; p = 0.012). Thus, mechanics who had 30 or more years of work experience reported having less stress than mechanics with less than 30 years of work experience. Safety behaviour scores varied significantly across levels of work experience (F (3,258) = 3.538, p = 0.015). Note that higher safety scores indicate a greater percentage of practicing unsafe behaviours. Post-hoc Tukey procedures indicate that mechanics who had 30 or more years of work experience had significantly higher safety scores (M = 3.05) than mechanics with 10 or less than 10 years of experience (M = 2.54; p = 0.017). Thus, mechanics who had 30 or more years of work experience reported having a greater percentage of unsafe behaviour in comparison to mechanics with 10 or less than 10 years of work experience.

4.4 Exploratory Factor Analysis

To simplify participants' various responses toward behavioural intentions and behaviour, exploratory factor analysis (EFA) was conducted to extract the common factors underlying the dimensions of attitude, behavioural intentions and behaviour. The extraction method used was the principle component analysis and the rotation method was varimax with Kaiser normalization. Validity of the items was also tested. Factor analysis was run with the initial 262 respondents to examine the underlying factor structure of the dependent variable, mediating variable and the independent variables, using the principle components method to test the dimensions of mechanics' safety attitude (Jolliffe, 2002). The analysis is useful to the study of multivariate data or to identify the structure of the evaluations. The analysis scanned all responses and identified correlating factors and latent dimensions.

4.4.1 Factor Loading for Attitude

The original 41 attitude items were included in the first-round EFA analysis, and eleven factors were extracted with Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy at 0.776 (should be greater than 0.70 indicating sufficient items for each factor, and is inadequate when less than 0.5) and with total variance explained equivalent to 62.5. As there was only one item in factor 10 and 11 with a loading above 0.4, the number of factors were reduced to nine and the EFA was run again using the same method mentioned above. After loading with nine factors, it was found that the KMO figure was the same as previous but the total variance explained reduced to 57.24. Six variables were found (KNOW20, KNOW21, SAFE28, HIND29, STRESS32, and STRESS33) that had factor loadings at 0.4 or below 0.4 and they were deleted. STRESS34 and STRESS36 were low compared to other stress subscale items and they were removed.

After the third loading, nine factors were found to be underlying the dimensions of mechanics' attitude. The KMO figure was 0.767 and the total variance explained increased to 63.69. The attitude figures had increased slightly after the third loading.

With variable 30 deleted, Cronbach's alpha for priority safety increased from 0.470 to 0.81. For mechanics' job stress, Cronbach's alpha increased from 0.416 to 0.757 and for mechanics' powerless, Cronbach's alpha increased from 0.426 to 0.583. For knowledge transfer Cronbach's alpha increased from 0.718 to 0.771.

The dimension of attitude Cronbach's alpha ranged from the lowest 0.526 (Hindrance) to the highest 0.830 (Violation). Factor loading for the dimension of safety attitude with SAFE27 (If you don't take good care of yourself you have nothing) got the highest indicator of 0.851 and FAT10 (Accidents seems inevitable despite the efforts of the company to prevent them) got the lowest indicator of 0.526. The rest of the indicators ranged between 0.551 and 0.832. The final results of exploratory factor analysis are shown in Table 3 below.

Table 3. Factor Loadings and Cronbach's Alpha for Attitude Dimensions

Variables	Attitude Dimensions	Factor Loading	Cronbach's Alpha
A. Mechanics' attitude concerning accident prevention			0.814
FAT5	Accidents just happen, there is little one can do to avoid them	0.779	
FAT7	Accidents are unavoidable, because of the busy ramp working environment	0.767	
FAT6	What happens at work is a matter of chance	0.686	
FAT9	The use of machines and technical equipment make accidents unavoidable	0.670	
FAT8	If the odds are against you, it's impossible to avoid an accident	0.646	
FAT10	Accident seems inevitable despite the efforts of the company to prevent them	0.526	
B. Mechanics' attitude towards rule violation			0.830
VIOL12	Sometimes production has to be given priority before safety	0.815	
VIOL13	Sometimes it is necessary to ignore safety regulations to get a job done	0.809	
VIOL14	I have to be more interested in production than safety	0.720	
VIOL11	Sometimes it is necessary to turn a blind eye to rule violations	0.706	
VIOL15	I cannot always follow safety rules myself	0.588	
C. Mechanics' personal worry and emotion			0.725
EMOT18	I am a bit afraid when I think about safety	0.770	
EMOT16	When I think about accidents I feel nauseous	0.722	

EMOT19	The problems I would experience as a result of a serious accident would last	0.696	
EMOT17	If several accidents happen my career may be endangered	0.673	
D. Mechanics' attitude towards knowledge transfer capabilities			0.771
KNOW23	Guidelines for dealing with recurring problems are written and easy to access	0.832	
KNOW24	I can find important information I need from the firm's database	0.803	
KNOW22	New joint customer approved maintenance manual can be readily available on LAN (Local area network, company computer)	0.783	
KNOW25	I am able to successfully leverage the knowledge of others as I perform the daily work	0.586	
E. Mechanics' priority of safety			0.810
SAFE27	If you don't take good care of yourself you have nothing	0.851	
SAFE26	There is nothing more important than safety	0.778	
F. Mechanics' hindrance at work			0.517
HIND30	Some people are accident prone	0.756	
HIND31	Rules and instructions relating to safety makes it difficult to attain production goals	0.756	
G. Mechanics' job stress			0.757
STRESS38	I can decide when and how each individual work-task shall be implemented	0.799	
STRESS39	I have a fair opportunity of influencing the decisions to be made by my superiors	0.747	
STRESS35	I can take short breaks whenever I wish without taking account of others	0.681	

STRESS40	My immediate superiors ask for my advice before making their decisions	0.636	
STRESS37	I can do my work independently and according to my own views	0.626	
H. Mechanics' risk awareness			0.531
RISK41	If an employee had an accident, it would be more serious than most other problems I face in my job	0.744	
RISK42	Lots of small incidences are a sign that more serious accidents could also occur	0.551	
I. Mechanics' powerlessness			0.583
POW45	Sometimes I feel that I'm being pushed around	0.769	
POW43	The company is run by so few people. There is not much I can do	0.721	

4.4.2 Factor Loading for Behavioural Intentions

For the behavioural intention and behaviour items (see Table 4), the loadings were high with KMO reaching 0.923 and total variance explained was 66.420. The factor loading for behavioural intention varied from 0.736 to 0.780 and Cronbach's alpha for intention-communication was 0.930 while for intention-regulation it was 0.905. According to Cronbach (1951), an alpha close to one indicates that the answers among respondents vary because of different opinions rather than different interpretations of questions. In other words, reliability is measuring the consistency among indicators for a given construct. An alpha coefficient at 0.60 or above is considered acceptable for social science research (Nunnally, 1978; Robinson and Shaver, 1973; Robinson, Shaver and Wrightsman, 1991). The two behaviour questions had factor loadings of between 0.909 and 0.928 with Cronbach's alpha 0.850.

Table 4. Factor loadings and Cronbach's alpha for Behavioural Intentions and Behavioural Dimensions

Variables	Behavioural Intentions and Behavioural Dimenions	Factor Loading	Cronbach's Alpha

J. Safety coordination and communication			0.930
INT-COM46	Safety communication	0.799	
INT-COM47	Safety improvement objectives	0.788	
INT-COM48	Safety observations and audits	0.830	
INT-COM49	Safety implementation of decisions	0.822	
INT-COM50	Control and inspection routines	0.821	
INT-COM51	Safety rules and regulations	0.808	
INT-COM52	Emergency procedures	0.780	
K. Maintenance procedures and safety regulations			0.905
INT-REG53	Safety precautions	0.780	
INT-REG54	Safety material transport	0.773	
INT-REG55	Materials handling procedures	0.823	
INT-REG56	Labeling and sign posting	0.736	
INT-REG57	Protection and safety devices	0.807	
INT-REG58	Abnormal procedures	0.736	
L. Mechanics' own unsafe behaviour or observed			0.850
BEHA59	How often have you observed an unsafe behaviour, rule violations or other related unsafe incidents in the last twelve months	0.928	
BEHA60	How often you had been involved in an unsafe behaviour, rule violations and any other related unsafe incidents in the last 12 months	0.909	

4.5 Aircraft Model

4.5.1 Reliability and Validity

The items were checked to ensure the reliability and validity of constructs. In the knowledge transfer item 1 and 2 (KNOW20 and KNOW21) were developed by survey designers, not adapted from original measurements. This item had a low factor loading, so KNOW20 and KNOW21 were removed and Cronbach's alpha increased to 0.771. In the priority safety variable, item 3 (SAFE28) was developed by survey designers, not adapted from original measurements. This item had a low factor loading (-0.009), and leads to low Cronbach's alpha value, so item 3 of priority safety was omitted. Alpha improved from 0.48 to 0.81. In the hindrance variable, item 3 (HIND29) had a low factor loading (0.400) and a cross factor loading of 0.359 with rule violation so this item was deleted and Cronbach's alpha increased from 0.470 to 0.517. In the job stress variable, items 1 and 2 (STRESS32, STRESS33) were developed by survey designers. These items had a low factor loading (0.298 and -0.171) and led to low AVE (0.16). Jobstress1 and jobstress 2 were omitted and AVE (average variance extracted) improved to 0.30. Jobstress3 (STRESS34) and jobstress5 (STRESS35) had a low factor loading (0.416 and 0.414) and were also omitted. AVE improved to 0.46, which was acceptable. In the powerless variable, item 2 (POW44) was developed by survey designers. This item gave a low factor loading of 0.331 and a cross loading of 0.441 with job stress variable, so this item was removed and Cronbach's alpha increased from 0.426 to 0.583.

To conclude, the reliabilities and validities of the attitudinal constructs varied between 0.526 and 0.851, though not high they were acceptable. The reliabilities and validities for the behavioural intentions and behaviour items were moderately high. For the first intention-dimension the alpha value was 0.930 and for the second intention-dimension alpha was 0.915. For the behaviour reliability, the alpha was 0.850. The results of the PLS model among three different datasets from both company A and company B were compared. The model was first run with indicator-intention-behaviour relationship and then with indicator-behaviour relationship in order to determine their differences.

4.5.2 Model of Attitude-Intention-Behaviour Relationship

Table 5 represents the full model of company A and company B. Table 6 represents the attitude-intention-behaviour model for company A whilst Table 7 is the attitude-intention-behaviour model for company B.

In the full model shown in Table 5, fatalism, KTC, hindrance, risk awareness and powerless have no relationship with unsafe behaviour, intention-communication and intention-regulation. Both violation and job stress have a significant relationship with intention-communication. The correlation for violation (γ=-0.17***, $p<0.01$) was strongly negatively related to intention-communication, and job stress (γ=0.36***, $p<0.01$) was strongly positively correlated to intention-communication. They are strong indicators of intention-communication. Violation also had significant relationship with unsafe behaviour (γ=0.20**, $p<0.05$) which means that violation is a strong indicator of unsafe behaviour. Emotion and priority safety had a significant correlation with unsafe behaviour. Emotion to unsafe behaviour (γ=0.15**, $p<0.05$) is positively correlated but priority safety to unsafe behavior (γ=-0.21***, $p<0.01$) is strongly negatively correlated. Behavioural intention was not the mediator between attitude and behaviour but intention-communication was strongly correlated with intention-regulation (β=0.79***, <0.01). The R^2 for intention-communication was 24.1%, for intention-regulation was 67.7%, and for unsafe behaviour was 20%. The high variance in intention-regulation providing 67.7% of the regulation variance can be predicted by communication and coordination.

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Table 5. Full Model of Attitude-Intention-Behaviour Relationships

	Intention-Communication $R^2 = 0.241$	Unsafe Behaviour $R^2 = 0.200$	Intention-Regulation $R^2 = 0.677$
Fatalism	/	/	/
Violation	–0.17***	0.20**	/
Emotion	/	0.15**	/
KTC	/	/	/
Priority	/	–0.21**	/
Hindrance	/	/	/
Job Stress	0.36***	/	/
Riskaware	/	/	/
Powerless	/	/	/
Intention-Regulation	*0.79****		

For a comparison of the two models in Table 6 and Table 7, company A has an indicator named KTC that is positively correlated with communication and regulation but not found in company B. Violation was strongly negatively correlated with regulation (γ=–0.23***, p<0.01) and communication (γ=–0.15***, p<0.01). KTC was strongly positively correlated with both communication (γ=–0.15***, p<0.01) and regulation (γ=0.12***, p<0.01). In addition, intention–regulation was strongly and negatively correlated with unsafe behaviour (γ=–0.22***, p<0.01) in company A, but not found in company B.

For company B, the two indicators that were different from company A were hindrance and powerless. Hindrance was negatively correlated with intention–communication (γ=–0.14*, p<0.1) and powerless was strongly positively correlated with unsafe behaviour (γ=0.18***, p<0.01). Furthermore, for company A, attitude indicators for fatalism, hindrance, and riskaware have no relationship with behavioural intentions and behaviour. For company B, the attitude indicators for fatalism, riskaware and KTC indicated no correlation with behavioural intentions and behaviour. In both companies, fatalism and riskaware had no relationship with the intention-behaviour model.

Table 6. Model of Attitude-Intention-Behaviour Relationships of Company A

	Intention-Communication $R^2 = 0.272$	Unsafe Behaviour $R^2 = 0.243$	Intention-Regulation $R^2 = 0.596$
Fatalism	/	/	/
Violation	–0.15***	0.15***	–0.23***
Emotion	/	0.09**	/
KTC	0.15***	/	0.12***
Priority	/	–0.16***	/
Hindrance	/	/	/
Job Stress	0.28***	/	/
Riskaware	/	/	/
Powerless	/	/	/
Intention-Regulation	*0.65****	*–0.22****	*/*

Table 7. Model of Attitude-Intention-Behaviour Relationships of Company B

	Intention-Communication $R^2 = 0.291$	Unsafe Behaviour $R^2 = 0.289$	Intention-Regulation $R^2 = 0.746$
Fatalism	/	/	/
Violation	–0.25**	0.09*	/
Emotion	/	0.23***	/
KTC	/	/	/
Priority	/	–0.2***	/
Hindrance	–0.14*	/	/
Job Stress	0.40***	/	/
Riskaware	/	/	/
Powerless	/	0.18***	/
Intention-Regulation	*0.86****	*/*	*/*

4.5.3 Model of Attitude-Behaviour-Relationship

Table 8 represents the full model of company A and company B. Table 9 represents the attitude-behaviour model for company A whilst Table 10 is the attitude-behaviour model for company B.

Table 8. Full model of Attitude-Behaviour Relationship

	Unsafe Behaviour R^2 = 0.204
Fatalism	/
Violation	0.21**
Emotion	0.15***
KTC	/
Priority	–0.15***
Hindrance	0.12*
Job Stress	/
Riskaware	/
Powerless	/

For a comparison of the two models in Table 9 and Table 10. The indicators that can predict the total variance of unsafe behaviour were 21.2% for company A and 30.5% for company B. The correlation was moderately weak (γ=0.10*, p<0.1) perhaps because the mechanics of company A had a heavier workload than company B. Besides working for daily transit aircraft, the mechanics of company A were also required to work on aircraft that have longer transit times in Hong Kong.

Fatalism, violation, emotion, and priority safety are significant predictors of unsafe behaviour for company A in which violation and priority safety are strongly correlated. For company B, violation, emotion, KTC, priority safety, and powerless are the predictors of unsafe behaviour in which emotion, priority safety, and powerless are strongly correlated. Fatalism was the indicator for unsafe behaviour found in company A but not in company B, while KTC and powerless was the indicator for unsafe behaviour in company B only. The attitude-behaviour model omitted the behavioural intention dimension. In this model, attitude was a direct influence on behaviour without the mediating variables.

Table 9. Model of Attitude-Behaviour Relationship of Company A

	Unsafe Behaviour $R^2 = 0.212$
Fatalism	0.10*
Violation	0.25***
Emotion	0.08*
KTC	/
Priority	–0.16***
Hindrance	/
Job Stress	/
Riskaware	/
Powerless	/

Table 10. Model of Attitude-Behaviour Relationship of Company B

	Unsafe Behaviour $R^2 = 0.305$
Fatalism	/
Violation	0.08*
Emotion	0.21***
KTC	–0.12*
Priority	–0.20***
Hindrance	/
Job Stress	/
Riskaware	/
Powerless	0.16***

4.6 Relationship between Attitude, Intentions, and Safety Behaviour using Structural Equation Modeling (SEM)

The research models were further tested by structural equation modeling (SEM) using AMOS 16 with maximum likelihood estimation. Each attitude's effects on intentions and unsafe behaviour was examined. However, in SEM the intention is to examine the effect of latent constructs and not variables (constructs are symbolized by an ellipse while variables are symbolized by rectangles). In this case, safety attitudes were chosen as the latent construct and the attitude were used as the indicator variables of the latent construct. The unobserved exogenous latent constructs were fatalism, violation, emotion, knowledge, etc. The indicator variables for fatalism were the fatalism items, etc. The unobserved endogenous latent constructs were: intentions and unsafe behaviour whilst intentions were the mediating variable.

4.6.1 Confirmatory Factor Analysis

SEM affords a level of precision not possible with traditional factor analysis. It allows multiple measures of a theoretical construct by specifying how many dimensions or subscales a construct has and which items are specific to which dimension. SEM provides support for these theoretical models by allowing conduction of a specific confirmatory factor analysis (Norris, 1997). The results of second-order CFA are $\chi 2$ (552) = 1072.27, p = 0.000, NFI = .68; CFI = .81; RMSEA = 0.06. The second-order CFA model did not fit the data very well. The chi-square value was statistically significant. The NFI and CFI values were below 0.90. However, that the RMSEA was at the acceptable 0.06 criterion. Although almost all the indicator variables loaded highly onto their respective constructs, not all the attitude dimensions were significantly related to the safety attitude construct. In particular, knowledge transfer and powerlessness were not significantly related to the safety attitude construct.

4.6.2 Test of the Proposed Model

The proposed structural model is depicted in Appendix 1. Note that the link between safety attitudes and safety behaviour was not included in the model. This link was initially specified but its error term was negative and was distorting the results of the model. Because the link was also not statistically significant and because Ajzen and Fishbein (1980) proposed that intentions fully mediate attitude' effect on behaviour, it was not included in the model. Safety and risk items were loaded on the same factor. The results show that $\chi 2$ (767) = 1534.19, p = 0.000, NFI = 0.68; CFI = 0.81; RMSEA = 0.06. The proposed model did not fit the data very well. The chi-square value was statistically significant. The NFI and CFI values were below 0.90. However, that the RMSEA was at the acceptable .06 criterion.

4.6.3 Revised Structural Models

Because the proposed model did not fit the data very well, several models were tested. In the first revised model the attitude dimensions that loaded highly onto the safety attitudes construct were included. Accordingly, fatalism and emotion and worry were not included in the revised structural model. The results showed that the value $\chi 2$ (425) is 972.65 p = 0.000, NFI = 0.73; CFI = 0.82; RMSEA = 0.07. The proposed model did not fit the data very well. The chi-square value was statistically significant. The NFI and CFI values were below 0.90. The RMSEA fell below the moderately acceptable 0.08 criterion. For testing of hypotheses:

Because the first revised model did not fit the data very well, a second revised model was tested. In the second revised model only one behaviour item (59) was used. Because the other behaviour item, 60, yielded a negative error value, it was deleted from the model. The results showed that $\chi 2$ (396) = 888.35, p = 0.000, NFI = 0.73; CFI = 0.83; RMSEA = 0.07. The proposed model also did not fit the data very well. The chi-square value was statistically significant. The NFI and CFI values were below 0.90. The RMSEA fell below the moderately acceptable 0.08 criterion.

Since the second revised model also did not fit the data very well, a third revised model was tested. In the third revised model, only the attitude dimensions that loaded significantly onto the safety attitudes construct were included in the model. As such, the hindrance and powerlessness dimensions were deleted from the model. Further, only items that loaded highly onto their respective constructs were included. Only two safety items were retained; the risk items were not included. Job stress item 36 was also deleted. The results showed that $\chi 2$ (202) = 403.04, p = 0.000, NFI = .85; CFI = .91; RMSEA = 0.06. This model fit the data well. Although the chi-square value was statistically significant and the NFI value was below 0.90, the CFI value was above 0.90. Further, the RMSEA was at the acceptable 0.06 criterion. The third model with best-fitting structural equation model for attitude, intentions and safety maintenance behaviour is shown in Figure 4 below.

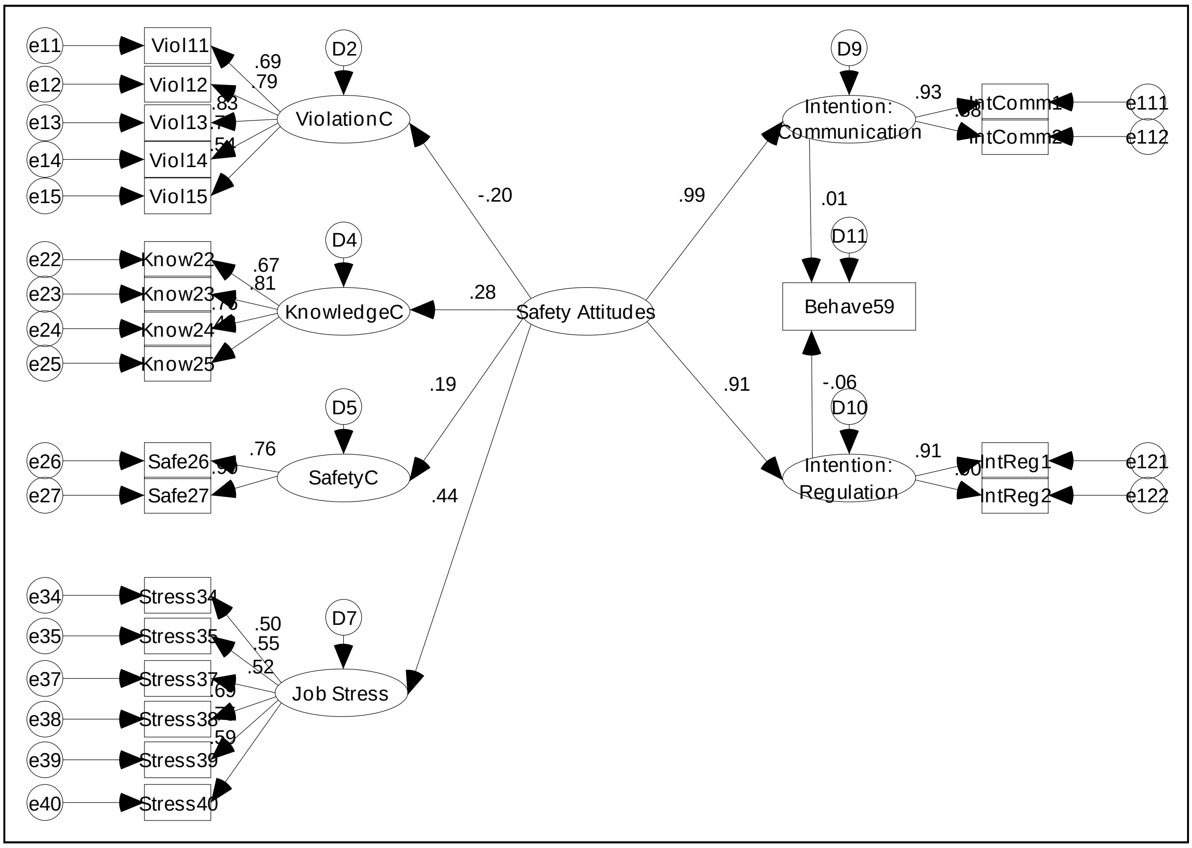

Figure 4. Best-fitting Structural Equation Model for Attitude, Intentions and Safety Maintenance Behaviour

4.7 Hypotheses Testing

The nine hypotheses of this research were tested and the results are elaborated below.

Hypothesis 1: Will the instrument developed by Rundmo and Hale (2003) be reliable and valid in a non-Western sample?

Only partial support was found for hypothesis 1 that the instrument developed by Rundmo and Hale (2003) will exhibit reliability in a non-Western sample. Some of the subscales had low reliabilities but others had high reliabilities.

Hypothesis 2: The instrument developed by Rundmo and Hale (2003) will have the same factor structure in a non-Western sample.

There is only partial support for the hypothesis that the instrument developed by Rundmo and Hale (2003) will have the same factor structure in a non-Western sample. First, the EFA and PLS did not yield all nine factors. Second, SEM modeling and the attitude-intention-behaviour model results yielded a four-factor attitude structure. Third, there was no relationship between intentions and safety behaviour. So, the AMOS result did complement the PLS modeling. However, that Rundmo and Hale's sample consisted of managers whereas the sample for this research consisted of mechanics. It is possible that even if the mechanics had the intent to communicate or regulate safety, they could not translate it into action if the management was not supportive of safety.

Hypothesis 3: Age will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

Only partial support was found for the hypothesis that age will be related to mechanics' attitude, behavioural intention, and behaviour towards aircraft safety maintenance.

Hypothesis 4: Level of education will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

No support was found for the hypothesis that level of education will be related to mechanics' attitude, behavioural intention, and behaviour towards aircraft safety maintenance.

Hypothesis 5: Work experience will be related to mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance.

Only partial support was found for the hypothesis that working experience will be related to mechanics' attitude, behavioural intention, and behaviour towards aircraft safety maintenance.

Hypothesis 6: Mechanics' attitude will predict their behavioural intentions to communicate and regulate safety-related information.

There is strong support for the hypothesis that mechanics' attitude will predict their behavioural intentions to communicate and regulate safety-related information. Both PLS modeling and SEM modeling showed strong support with PLS results indicating that attitude will not only predict intentions not to regulate safety-related information but will also affect safety behaviour directly.

Hypothesis 7: Mechanics' intention to communicate safety-related information will predict their behaviour towards aircraft safety maintenance.

There is no support for the hypothesis that mechanics' intention to communicate safety-related information will predict their behaviour towards aircraft safety maintenance. Neither PLS modeling nor SEM modeling showed any support.

Hypothesis 8: Mechanics' intention to regulate safety will predict their behaviour towards aircraft safety maintenance.

There is no support for the hypothesis that mechanics' intention to regulate safety will predict their behaviour towards aircraft safety maintenance. Neither SEM modeling nor PLS modeling showed any support..

Hypothesis 9: The relationship between mechanics' attitude, behavioural intentions, and behaviour safety toward aircraft maintenance will vary across the two companies.

There is no support for the hypothesis that the relationship between mechanics' attitude, behavioural intentions, and behaviour toward aircraft safety maintenance will vary across the two companies. The multi-group analysis indicates that the relationships were similar across both companies.

5. Discussion

Results indicate that knowledge transfer, priority safety, and intention to communicate vary significantly across age groups. Mechanics between the ages of 20-29 had significantly lower knowledge scores and lower intent to communicate scores than mechanics aged 40 or above. However, level of education, attitude, intentions, and safety behaviour did not yield any significant differences between the age groups.

For work experience, some attitude and intention scores did not vary across levels of experience, but worry and emotion, knowledge transfer, job stress, and safety behaviour scores did vary significantly. Results indicate that mechanics with 30 or more years of work experience had a higher worry and emotion score than mechanics with 10 or more years of experience. Mechanics with 30 or more years experience had significantly higher knowledge scores than mechanics with 10 or less years of experience. Furthermore, mechanics who had 30 or more years of work experience reported having less stress than mechanics with less than 30 years of work experience, while mechanics who had 30 or more years of work experience reported have a greater percentage of unsafe behaviour in comparison to mechanics with 10 years or less of work experience. Mechanics with more experience tend to have more findings in all measured components of the model. This could be because increased experience in aircraft maintenance results in more attributes.

The findings from this research suggest that the ideal attitude for mechanics to show is low fatalism, low violation, high emotion and worry, high knowledge transfer capabilities, high priority safety, low hindrance, low job stress, and low powerless. The low violation, high knowledge transfer capabilities, and low job stress seem to be particularly important to mechanics safety intentions and behaviour. Rundmo (1996) concluded that the safety objectives seemed to be reached more effectively when the shop floor workers are committed to safety and are actively involved in safety work.

The research also showed that high worry and emotion was important to mechanics' unsafe behaviour. Worry and emotion seem related to protection of unsafe behaviour although it did not affect behavioural intentions. It is interesting to note that worry and emotion is good for mechanics. Priority safety also exerted a negative influence on unsafe behaviour. But the most important influences for improving mechanics' attitude to safety would appear to be violation, knowledge transfer capabilities, and job stress. The self- reported behaviour with regard to how much time mechanics spent on the achievement of aircraft safety maintenance was influenced by behavioural intentions related to safety regulations and procedures.

Although the research shows that intention is related to self-report behaviour, some might question the validity of this link. However, there are several studies showing a significant relationship between self-reported behaviour and observed behaviour (West, French, Kemp and Erlander, 1993). Reason et al. (1998) developed the self administered driver behaviour questionnaire (DBQ) which was used to predict skill-based behaviour, mistaken intentions, and violations. Parker, Reason, Manstead and Stradling (1995) showed that DBQ can use to predict future involvement in accidents caused by driver behaviour. Also, Rundmo (1992, 1996) showed that self-report risk behaviour is a significant predictor of accidents and near-misses.

The research models were tested by SEM modeling using AMOS with maximum likelihood estimation. Results indicate that the model fit the data well. Although the chi-square value was statistically significant, the NFI was 0.05 below 0.90 but the CFI was 0.01 above 0.90. Further, the RMSEA was at the acceptable 0.06 criterion. The results from the SEM modeling complement the PLS modeling as both models indicate that intention is not the mediator between attitude and behaviour. SEM results indicated that attitude has a strong influence on intentions but PLS results indicated that attitude has a relationship with intention-communication as well as behaviour. In the comparison model, SEM with multi-group analysis indicated a similar attitude, intentions and behaviour relationship across the two companies although the PLS results exhibit some differences in the attitudinal-behaviour relationship between them.

This research showed the dimensions of aircraft maintenance mechanics' attitude that are predictors of behavioural intentions and behaviour and that attitude has a relationship with behavioural intentions, and behavioural intentions affects behaviour, which in turn affects aircraft safety. It adds to the body of knowledge in the field of attitude, behaviour and safety in accordance with the theory of reasoned action and the theory of planned behaviour.

6. Implications

This research provides empirical evidence that the dimensions of mechanics' attitude have an association with safety intention. In company A, it also demonstrates that behavioural intentions moderate the interaction with unsafe behaviour within the framework of the theory of planned behaviour advocated by Ajzen (1985). Although this theoretical framework has been extensively studied within the context of behavioural intention, this is the first known research incorporating the attitude and behaviour of aircraft mechanics.

The attitude of aircraft maintenance mechanics is important since non-compliance with safety regulations and procedures could lead to fatal accidents (Hale and Glendon, 1987; Reason, 1990). Dejoy (1996) reported that non-compliance with safety standards reflected a combination of organizational and individual attitude. Hence interventions to reduce non-compliance require the co-operation of the organization as well as the individual. For safe work behaviour, the individual's attitude must take account of the hazards presented by the situation, and it is at this stage that personal beliefs about risk can influence safety compliance. While some unsafe behaviour may arise from an intention to take known risks, other forms of unsafe behaviour occur when a person lacks the experience to make sound risk judgments. If the higher rate of accidents among younger workers reflects poor judgment of risk or noncompliance, it would suggest that a reduction of accidents could be achieved by focusing on the hazard appraisal stage of safety compliance. Successful maintenance requires every mechanic to improve their attitude towards the work they are required to undertake and perform duplicate inspection to ensure that the work they perform meets the required standard (Darin, 2004).

Mechanics do not have direct communication with upper levels. Therefore, in order to include their input in the policy making processes, management should provide them with more opportunities such as periodic safety committee meetings. In such meetings mechanics would have the opportunity of discussing and resolving safety problems with staff of different rank and specialism. This may lead to some cognitive, behavioural and attitude changes that help them improve their safety standards.

In-service training is the means for becoming proficient with infrequently used equipment. In addition to using special tooling, mechanics also need to manipulate special equipment such as mobile platforms to access to work places such as the aircraft wings, stabilizers, rudder or the nose of the aircraft. A bad attitude or inadequate training in the use of the equipment may be a primary cause of stress and accidents. Moreover, preventing accidents or errors depends not only on the education and training of practitioners, but also on understanding the nature and extent of errors, determining behaviours that prevent or mitigate errors, and changing the conditions that prevent errors (Helmreich, Klinect and Wilhelm, 1999).

However, educational and other strategies may be ineffective, and aircraft safety maintenance will not improve unless mechanics believe that their role is critical in preventing aircraft accidents. If mechanics have the attitude that aircraft maintenance is a wasted resource that will ultimately make no difference to aircraft safety, then it is necessary to change this attitude before intentions and behaviour can be altered. In order to change mechanics' attitude towards aircraft safety maintenance, the attitude must be identified and the relationships between attitude, behavioural intentions and behaviour must be explored.

The model highlighted the importance of mechanics' attitude as direct and indirect predictors of violation, emotion, KTC, priority, and job stress behaviour. It was concluded that theory of planned behaviour is suitable for the analysis of this type of safety behaviour but that to be truly useful it should be extended to incorporate management support for safety education and safety campaign implementation.

According to the findings, the mechanics of company A have a positive attitude towards knowledge transfer capabilities. This could be attributed to the culture and climate of the company which encourages exchanges and sharing of ideas. In order to have a better effect on knowledge transfer capabilities, both companies should encourage universities to publicies their research; allow staff to take no-pay leave for technology transfer in universities; bring together the mechanics and university researchers to identify relevant safety research topics; and introduce incentive schemes to promote university-business partnership in safety research. In addition, both companies should also consider sending mechanics to overseas maintenance companies for on-the-job-training. This would broaden the mechanics' knowledge and possibly improve their attitude, intentions and behaviour towards aircraft safety maintenance.

It is recommended that both companies create better conditions for effective knowledge transfer processes. The companies should produce clear documentation for the mechanics to follow regarding duties, rules and regulations, as well as general guideline on how to ensure effective knowledge transfer processes. Both management and the mechanics should play a role in creating favorable conditions for effective knowledge transfer processes. Senior management support of the knowledge transfer processes within the company is also of paramount importance. The companies should be aware of the importance of knowledge transfer and of knowledge transfer processes. Organizational and national cultures may have a considerable effect on knowledge transfer processes.

Safety priority is positively correlated with accidents (Tharaldsen, Olsen and Rundmo, 2008), which indicates that despite high safety prioritization accidents may occur or that perceptions of unsafe acts may be high. However, organizational safety climate is negatively correlated with accidents (Tharaldsen, Olsen and Rundmo, 2008), so improving mechanic safety behaviour and individual skills can reduce accident rates. Safety attitude may also depend on organizational factors, working conditions, and the shop floor workers attitude to company safety policies (Holmes, Triggs, Gifford and Dawkins, 1997). This tells us that before attitude campaigns are implemented for aircraft maintenance mechanics, it would be wise to thoroughly examine the association between organizational factors and mechanics' individual attitude.

According to Karlene, Robert and Dean (2001), in order to stop accidents happening, mechanics should aggressively seek to know what they do not know, to recognize the cost of failure and the benefits of reliability, and to communicate the big picture to everyone. The active involvement in accident investigation by mechanics is aslo essential.

Whilst this research is but a small piece of the entire social psychological picture of attitude, personality, and behaviour, it has provided a greater understanding of aircraft maintenance mechanics' attitude, behavioural intentions, and behaviour towards aircraft safety maintenance and accident prevention. In addition, the study provides evidence that not only contributes to the body of knowledge in the field, but also provides prescriptions for successful aircraft safety maintenance in the future. Hopefully the findings of this study will provide a direction for organizational decision makers as they make choices about their organizational resources and the suitability of staff for promotion. Changing the attitude or behavioural intentions of the mechanics' towards aircraft safety maintenance is important. Eliminating unsafe acts and risk behaviour of the mechanics in addition promoting the safety climate of the organization can prevent most accidents (Hobbs and Williamson, 2003; Rundmo ,1992, 1996; Tharaldsen, Olsen and Rundmo, 2008).

7. Limitations and Future Research

One limitation of this research is that the results may not be generalisable because the sample was confined to two aircraft maintenance companies in Hong Kong. It is possible that different results may be found in a larger sample although the current model was found partially in support of the relationship between attitude, behavioural intentions and behaviour. Further research could determine if this research's findings hold for more general populations by collecting data in Hong Kong and adjacent countries like Macau, Zhuhai, Canton and Xiamen.

The research was also limited by the restrictions peculiar to survey designs. A bias may exist simply because of an individual's choice to respond or not to respond. The data in this research may not accurately reflect the true beliefs and intentions of the respondents because there is no assurance that a respondent answers a given question truthfully or not. Therefore, it is difficult to predict intention when attitude towards the behaviour, subjective norm, and perceived behaviour control may not have been truthfully self-reported. Furthermore, the fact that the mechanics knew that they were the subjects of a study may have influenced their responses. Unfortunately, this is the case with research studies where a self-report of respondents' beliefs and intentions are required.

This research provides a basis for further research in aircraft safety maintenance. The theory of reasoned action and the theory of planned behaviour have been used to predict and explain human intention and safety behaviour. More research is necessary to understand what beliefs influence the line maintenance mechanics when they are confronted with uncertainties and difficult decisions. In addition, further research is needed to identify other factors, not included in the theory of reasoned action and the theory of planned behaviour, which may influence the performance of unsafe behaviour by line maintenance mechanics. Additional research may also consider the use of theory-based behaviour interventions to determine what type of change will lead to improved behavioural intentions or external variables to the behavioural intention theory can be added.

A similar study may consider cross cultural influences by carryng out research on mechanics in China and Hong Kong concerning safety attitude to aircraft maintenance. This research could be based on Hofede's (1980, 1996 & 1997) four dimensions of national culture and may provide one means of differentiating Hong Kong as a subculture of Mainland China, if it is found that there is a difference in attitude and behaviour relating to the role of mechanics in aircraft safety maintenance.

The differences in attitude and behaviour between line maintenance mechanics and hangar mechanics could also be studied. Since statistics show that line maintenance mechanics are more prone to accidents than hangar mechanics, it would be interesting to know whether this is solely due to adverse working condition on the ramp or whether differences in attitude and behaviour play a role.

Finally, in order to improve generalizability and validity, future research should examine other sectors of the airline industry and consider a larger sample size. For example, a study could be undertaken to investigate the differences in attitude and behaviour between mechanics in an aircraft manufacturing firm and mechanics in an aircraft maintenance firm..

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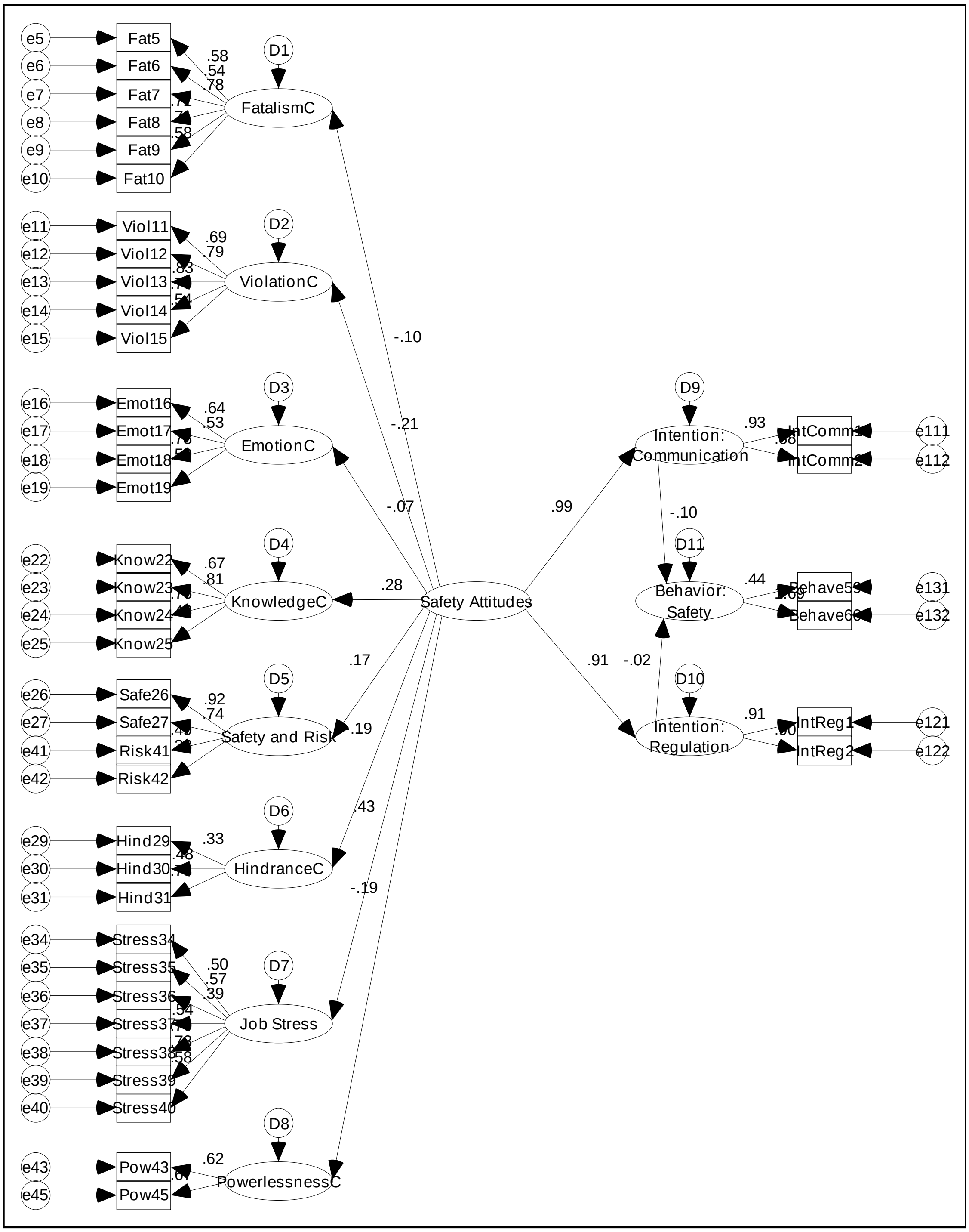
Appendix

Appendix 1. Proposed Structural Model



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