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Reasoning and attributions in injury incidents in major maintenance operations

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CHAPTER 1:LITERATURE REVIEW

This section will give a broad overview of aircraft maintenance and occupational health and safety issues in aircraft maintenance. Psychological theories; the theory of reasoned action and attribution theory will be utilised to aid the researcher in explaining psychological behaviour towards causes of injury incidents. The different types of errors and violations that can contribute to the causes of injuries and incidents in any maintenance environment in the workplace will also be discussed. Empirical research done on these issues will be discussed.

1.1 Aircraft maintenance

1.1.1 Human factors and aircraft maintenance

Human factors is the science of analysing the limitations of humans as we interact with the environment and preventing or mitigating the inevitability of human error (Wurmstein, 2004). According to human factors, human limitations fall under five broad categories: physical, physiological, psychological, psychosocial and pathological. But what is the relevance of human factors to aircraft maintenance? There are many issues associated with human factors in aviation maintenance and these can fall under training for inspectors and maintenance personnel, safety of maintenance workers, reduction of human error that compromises safety and also reducing the overall cost of maintenance. All these aspects will be discussed in relation to the current study.

Human factors states that we must not look at individuals only but we must also look at the failures in the systems that humans create. Human factors help us analyse these failures and come up with strategies to prevent them. It is argued that in order to have a safe environment we need to look closely at the factors that may impact on safety; these are organisational influences, management/supervision, violations, and preconditions such as environmental and individual behavioural factors.

1.1.2 Workplace safety

Maurino (2000; p953) states "safety is a state of mind…safety partly rests in formal structures and protocols, but fundamentally in attitudes…safety intertwines with risks and human life". Workplace safety is related to worker's ability to perform their jobs without making errors (Burnette, 1998). The current study aims to identify the causes and contributory factors relating to injury and incidents in the maintenance environment. This will help us identify prevention strategies to contribute to the safety of the maintenance environment. It is argued that workplace safety depends upon a combination of complete, systematic preparation and responsible individual behaviour (Burnette, 1998). Burnette (1998) categorises workplace safety issues as the individual, task related, tools and equipment, facilities and environment, materials, administration and the organisation. These factors reflect the complexity of modern workplaces and ignoring one or more could impair an otherwise safe programme and reduce the organisation's ability to maintain the aircraft reliably. The next section will focus on some of the safety issues relating to aircraft maintenance.

There are problems and issues in the workplace, but general trends in society also affect the aviation industry (Shepherd & Parker, 1991). The safety problems present in the maintenance environment are not unique although there may be different priorities from other industries. A report by Shepherd and Parker (1991; p234) cites the following three environmental problems affecting maintenance technicians “inadequate lighting; noise, especially short term noise such as riveting; and ambient temperature resulting from the open floor plan associated with hangers”. The report also mentions work support systems, work platforms, the use of composite materials and non-day-work schedules as the concerns of aircraft maintenance.

It could be argued that while most people equate aviation danger with problems in flight, Benoff (2003) says that hazards on the ground, in the hangar, in the shops and out of the ramp, can be equally damaging to equipment and to people. According to the US Department of Labour, serious aviation maintenance errors are on the rise.
In 1998, some 4% of the maintenance workforce suffered serious injury, in 2001 that figure had climbed to 6.3%. All totalled, on-the-job injuries resulted in more than 9700 lost workdays (Benoff, 2003). It is argued that heavy workload is one issue that affects aviation maintenance coupled with a limited number of employees, making it difficult for all efficiency and safety goals to be achieved. Maintenance personnel often have to make a choice as to which goal is perceived by management to be most important and most often choose efficiency over safety concerns.

The maintenance environment can pose a risk to the wellbeing of employees through potential hazards that may exist in the environment. There are physical, chemical and environmental hazards that may exist in aircraft maintenance. Potential physical hazards are the hangar's physical construction including walkways, overhangs, common and power hand tools, work platforms, fall arrest systems, ventilation, etc (Benoff, 2003). Everyday, maintenance personnel use a variety of chemicals to keep their aircraft airworthy. Chemicals are a major hazard in the aircraft maintenance environment and it is important for a technician to have basic understanding of chemistry and chemical reaction, since, in combination, some do pose a danger (Benoff, 2003).

Environmental hazards may include spillages on the floor, a dirty work environment with no order, and tools and equipment not stored properly. It is argued by Burnette (1998; p32) "A clean and well ordered workplace demonstrates a professional attitude towards the work being performed; it also reduces a number of workplace hazards present". Aircraft maintenance safety is about two important issues. First ensuring that only airworthy aircraft are provided for flight operations and second, emphasising the requirements of occupational safety and health necessary to protect the welfare of maintenance technicians.

1.2 Accidents

Accidents in the workplace include those that could have been prevented by the employer or even accidents that have been caused by the negligence of a colleague. The term "accident" has been used with various shades of meaning for certain purposes. It is argued that an accident is "any unexpected event that interrupts or interferes with the

orderly progress of the production activity and progress" (McCormick & Ilgen, 1997; 422). In this frame of reference, an accident may cause damage to equipment or materials or it may delay production, without resulting in an injury or fatality.

Arbus and Kerrick (1951) in Fisher et al (2003) define an accident as an unplanned event in a chain of planned events. Others state that "unexpectedness is not enough and that accidents are an error with sad consequences and secondly a notion of error" (Fisher et al, 2003; p151). It is also argued that an "accident can be defined by the outcomes rather than their antecedent behaviours; this means that a sequence of events can occur repeatedly without notice or without being labelled an accident" (Fisher et al, 2003; p151). One could argue from what is mentioned above, that accidents may involve sad consequences and some events may go unnoticed and that we need to look at the sequence of events that lead to the accident.

It is argued that occupational accidents can be attributed to two fundamental causes, the characteristic of the work and organisational environments and the psychological and behavioural characteristics of the individual (Amparo, Alistair, Tomas & Sue, 2002). Amparo, Alistair, Jose, and Sue (2002) point out that where work systems and associated technology has improved, attention needs to focus more on the individual and how they may contribute to safety performance in general, and occupational accidents in particular. It is also argued that interest has turned to the less technical aspects of the workplace such as the social environment and the role it may play in occupational injury, and, related to

that, the role of organisational culture in managing health and safety at work (Cox & Cheyne, 1998).

The main aim of this research is to explore further what are the reasons and attributions and the sequence of events that lead to these injury incidents in major maintenance. The focus of this research is to have data that can be used as the basis for taking action, which will reduce the possibilities of subsequent accidents. Thus, determining the causes of accidents is important. The causes of accidents are sometimes attributed to some device, equipment or materials that are involved, or to some events such as falling. Such information however, contributes little to explaining the circumstances and behaviour that contribute to accident occurrences. Unfortunately the basic causes of accidents are very illusive, so we usually have to deal largely with empirical relationships between possible variables and accidents (McCormick & Ilgen, 1997).

In this regard one can hypothesise that accidents may be a consequence of two variables, the situation and the individual. Accidents in different work situations can be influenced by a number of factors such as, the nature of job activities, the presence or the use of potentially accident producing agents (such as machinery, tools, moving objects, chemicals etc.), work methods, environmental circumstances (such as slippery floors, high temperature), the presence and use of protective clothing and gear and work schedules. One could argue that we also need to pay attention to the individual.
In doing so, it is argued that the extent to which individuals contribute to the occurrence or avoidance of an accident is influenced by the extent to which their work activities tend

to be “safe” behaviours or “unsafe” behaviours (McCormick & Ilgen, 1997). But we need to look at the underlying reasons that cause these accidents. In doing so, the research will employ two psychological theories, attribution theory and reasoned action theory to aid us. Attribution theory is utilised to help us to explore the perceived causes, through examining information, beliefs and motivation. Reasoned action theory is used to help us in predicting the kind of behaviour that would lead to these injury incidents and furthermore explore attitudes towards safety and the social influences. Previous research has focused on surveys to identify the “causes” of accidents not the human reasoning behind these “causes”. One could argue that understanding the role of human error in an accident or injury is important in order to identify a set of human actions that exceed some limits of acceptability in a system.

1.3 Theories of human error

Aircraft maintenance is an essential component of the aviation system that supports the global aviation industry. As air traffic grows and the stringent requirements of commercial schedules impose increased demands upon aircraft utilisation, the pressures on maintenance operations to be done on time will continue to escalate. One could say it is true for any maintenance environment in the transport industry to meet the required demands. However this can open further windows of opportunity for human error and subsequent breakdowns in the systems safety. According to the Civil Aviation Authority (2002) there is no question that human error in aircraft maintenance has been the causal factor in several air carrier accidents. It is also beyond question that unless the aviation industry learns from these occurrences, maintenance-related safety breakdowns will continue to occur.

Numerous investigations have been done regarding the causal factors that lead to aircraft accidents, but few have focused on incidents and injuries that happen in the aircraft maintenance environment (Hobbs & Reason, 2003, Williamson & Feyer, 1990).

The findings from the study of NTSB air carrier accidents and incidents from 1984 to 2002 make these conclusions: That 76.5% of maintenance-related events had a failure to follow established procedures, 19.8% of maintenance-related events had inadequate or missing inspections, and 15.2% of these events were marked by errors or omissions by the maintenance organisations and individuals (Collier, 2004). These were found to be contributing factors to air carrier accidents. The next section will look at different types of errors and their contribution to accidents in the maintenance environment focusing on previous research.

1.3.1 Errors

One essential fact of human nature is that people commit errors. This tendency to commit errors is so pronounced and widespread that we simply assume that errors will occur. It is argued that from a human factors perspective, there is no such thing as error free operation by humans (Norman, 1981). Researchers have been fascinated by the nature of human errors and there are many different types of errors being researched especially in the maintenance work environment. One could argue that an error is a failure to carry out the intended action and this can be caused by inattention, bad judgement or ignorance. It is also stated by Reason, Manstead, Stradling, Baxter and Campbell, (1990; p1315) "errors are defined as the failure of planned actions to achieve their intended consequences – it can involve two psychologically distinct kinds of straying…the

unwitting deviation of action from intention (slips and lapses), the departure of planned actions from some satisfactory path towards a desired goal (mistakes), and violations are deviations from safe operating procedures, rules and standards". It is argued that 84-94% of accidents in certain contexts were due mainly to some form of human error (Salminen & Tallberg, 1996).

There are various types and categories of errors. They include errors of commission and errors of omission, skill-based errors, mistakes and violations. There are different categories under the different types mentioned above. The skill-based errors are errors that happen when the actions taken do not follow as planned. These include slips, lapses, trips and fumbles (Hobbs & Reason, 2003). A slip is when the action is not what was intended and a lapse is related to memory, when you forget to carry out an action. Trips are forcible interruptions to an ongoing motor program; a fumble is a poorly executed motor program.

In some studies, human errors have been classified according to Rasmussen's (1986) hierarchical levels; skilled-based behaviour, rule-based behaviour and knowledge-based behaviour. Skilled-based behaviour "represents sensorimotor performance without conscious control" (Salminen & Tallberg, 1996; p980). Rule-based behaviour happens in familiar work situations and it is governed by the application of rules. Knowledge-based behaviour happens in new or unfamiliar situations and behaviour is guided by interpreted knowledge, reasoning and planning. According to Salminen and Tallberg (1996) out of 200 operational problems in nuclear plants, 16.5% were due to skill-based error, 51% to

rule-based error and 22.5% to knowledge-based error. In Australia 54.8% of human errors leading to fatal occupational accidents were due to skilled-based behaviour, 13.6% were due to rule-based behaviour and 13.7% due to knowledge-based behaviour (Williamson & Feyer, 1990). These studies used Rasmussen's SRK model in their analysis and largely used a survey methodology.

Salminen and Tallberg (1996) conducted a study to examine the effect of human error in industrial accidents. Data was collected from 178 fatal occupational accidents in Finland between 1985 and 1990 and data was also collected from 99 occupational accidents in Southern Finland in 1988 and 1989. The sample comprised of women and men who were injured in accidents and the age group ranged from 25 years to 44 years. The workers were interviewed regarding the injuries they had experienced. Work task and work phases were categorised (Salminen & Tallberg, 1996).

Rasmussen's (1986) SRK model; skill, rule and knowledge-based errors and technical fault were used to analyse the results. The results indicate that error types contribute differently to injuries and accidents. Fatal accidents had more skill-based errors (66%) and rule-based errors (18%) were more prominent in serious injuries, and knowledge-based errors and technical fault were found to be very low. According to the authors (Salminen & Tallberg, 1996), the particular type of error occurrence depends on the nature of the task. However the study fails to identify why these particular errors are contributing factors. It can be argued that major accidents may generally be caused by human failures or errors, technical faults or external forces.

They almost, always result from a number of causes, including maintenance personnel, supervisors, management, and equipment. Technical failures usually arise from human errors such as poor maintenance, overloading or improper use. Therefore attention should be directed more to finding out why and preventing human errors and failures at all levels. On that note, the focus will be on mistakes and violations.

1.3.2 Mistakes

There are other types of errors called mistakes. Mistakes are related to planning. It is argued that the "actions may go entirely as planned, but the plan itself is not adequate to achieve the intended outcome" (Hobbs & Reason, 2003, p40). These are higher level failures, associated with the formulation of the plan. Mistakes can be further sub-divided into two classes, according to the level of performance at which they occur. These include rule-based mistakes and knowledge-based mistakes (Hobbs & Reason, 2003).

"Rule based mistakes involve failures in the selection or application of these problem solving rules" (Reason & Maddox, 1998, p40). The errors can involve the application of a bad rule or the misapplication of a normally good rule that local circumstances have rendered inappropriate. "Knowledge based mistakes are characterised by the need to solve novel problems for which the individual possesses no pre-packaged "rules" and is thus required to work out a solution from first principles" (Reason & Maddox, 1998, p5).

1.3.3 Violations

Errors represent the mental and physical activities of individuals that fail to achieve the intended outcome. Not surprising, given the fact that human beings by their very nature

make errors, these accidents dominate most accident databases. Violations on the other hand, are much less common and refer to the wilful disregard for the rules and regulations. Violations are defined as deliberate, though not necessarily reprehensible, deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system (Reason et al, 1990). As with errors, there are many ways to distinguish between types of violations; routine violations and situational violations (Hobbs & Reason, 2003). Routine violations are part of the normal every day work and these are committed to finish the job quickly, the person does not follow all the procedures put in place to complete a task. Situational violations are exceptional violations that occur in a particular set of circumstances or a particular situation (Lawton, 1998).

According to Hobbs & Reason (2003; p55) this violation may "become established at the skilled-based level of performance, the principle of least effort is the major force in human behaviour". Situational violations are caused by the mismatch between work situations and procedures. For example, the procedures that you need to use might not apply to the work situation you are in, so you just get the job done without following those rules (Hobbs & Reason 2003). The important distinction that we need to make is that errors are defined in relation to the cognitive processes of the individual; violations can only be described with regard to the social context in which the behaviour is governed by operating procedures, codes of practice and norms (Reason et al, 1990). Bouquet, Detwiler Roberts, Jack and Shappell (2000) found that violations committed by aviation maintenance technicians represent an inordinately high percentage of unsafe

acts. The two most common violations they committed were installation and failure to follow procedure and directives. The fix for this may involve finding a different way to perform certain tasks, which differ from protocols laid out in service manuals. The “I know best” mentality may work very well in some instances, but has a potential for catastrophe. It could be a problem in the procedure, not just the violation (i.e. the inability to follow a rule or procedure).

There is a lot of research done on the concepts mentioned above and this is evident in the research done by Hobbs and Williamson (2002). They examined whether the involvement in maintenance safety occurrences can be predicted on the basis of self-reported unsafe acts. A maintenance behaviour questionnaire was developed to explore the patterns of unsafe acts committed by aircraft maintenance mechanics. They identified violations and mistakes as significantly related to occurrences of accidents that jeopardised the quality of aircraft maintenance but were not related to workplace injuries. Skilled-based errors were not related to work quality incidents but were related to workplace injuries. One could argue that the limitation of their study (Hobbs and Williamson, 2002) is that it does not explain in detail how the skill-based errors are related to workplace injuries; they just give a description but do not go into a causal understanding. So the aim of this research is to look at operators explanations, attributions and reasons towards the causes of these injuries and what contribution if any do human errors have.

A study by Feyer, Williamson and Cairns (1997) focused on human factors, errors and their contribution to accident causation. The sample included 1020 cases that were derived from all work-related deaths occurring in Australia throughout the years 1982-1984. Cases were included as a sample if they were actively involved in work at the time of fatality, were of working age and they contained enough information to be coded. The study looked at the nature of work practices involved in fatalities and their subsequent behavioural events in the accident sequence.

They identified the precursor events and contributing factors as pre-existing factors that could have had a direct contribution to the occurrence of an accident or fatality. Precursor events were classified into one of the four categories; environmental, equipment, medical and behavioural. Behavioural was further classified as errors, which were skilled-based behaviour, rule based behaviour and knowledge based behaviour. Contributing factors were further classified into eight categories; environmental, equipment, work practice, supervision, and training, task error, medical and other (Feyer, Williamson and Cairns, 1997).

The results of the study provide evidence that poor work practices, including supervision and training practices, were involved in 45% of total cases and were ranked as the root cause of 80% of the cases. Unsafe procedures were most common, occurring in 54% of the cases. It was stated that "the examination of the relationship between different types of work practices and types of human error occurring later in the accident sequence revealed that different error types were more likely to be associated with particular work

practices" (Feyer, Williamson and Cairns, 1997;p62). Common human errors were related to slips, rule based errors and skilled based errors.

1.3.4 Human factors analysis and classification system

Human factors classification systems (HFACS) was developed in response to the trend that showed some form of human error, at various levels, as a primary causal factor in 80% of aviation accidents (Mussulman & White, 2004). HFACS facilitates the recognition for human causes of an accident and provides a tool to assist in the investigation process but also to target training and prevention efforts. HFACS looks at four levels of human failure, these levels include unsafe acts (operator error), preconditions for unsafe acts (such as fatigue and inadequate communication) unsafe supervision (such as pairing inexperienced aviators for a difficult mission), and organisational factors (such as lack of flight time because of budget constraints) (Mussulman & White, 2004). Dekker (2001;p3) states that we must also look at "factors that disappear behind the label "human error", long standing organisational deficiencies, design problems and procedural shortcomings". It is argued that we must be able to explain and find out the error producing conditions in the work environment (Dekker, 2001).

It is argued by Kanki and Watson (2002) that the HFACS tries to address valid concern that human error has been "under served" by traditional maintenance error analysis systems, most systems adequately identify what happened, but not why it occurred. One could argue that this system would identify different factors that may cause or have

caused the accident; it does not only focus on the individual. The next section will discuss psychological theories, attribution and reasoned action.

1.4 Why psychological theories?

One could argue that research cannot only rely on human error theories. There needs to be some psychological theory to explain the actions or behaviour behind the injury incidents. The psychological theories of reasoned action and attribution theory will be utilised in this research to help us find out the reasons and attributions behind behaviour that lead to these injury incidents in major maintenance operations. The literature reviewed above with regard to studies in aviation maintenance safety have focused less on input from psychological theories, as they are mainly survey type studies (Feyer et al, 1997; Hobbs & Williamson, 2002; Reason et al, 1990; Hobbs & Reason, 2003).

The next section will discuss attribution theory that is concerned with determining whether the behaviour was internally caused by the person or externally caused by the context or the situation. The theory relates to reasoned action theory in that they both look at the person and the environmental influences. The relationship between reasoned action theory and attribution theory is that they both focus on influences behind the actions that take place. Reasoned action theory focuses on intentions and attitude towards behaviour and the influences that significant people might have on those intentions. Both the theories are used because they complement each other in that attribution theory is looking at external and internal attributions and reasoned action theory looks at the attitudes and the social influences that other people have on the person's behaviour.

We use the Fishbein and Ajzen (1980) theory of reasoned action to attempt to explain how and whether a particular behavioural intent translates into the behaviour itself. What specific beliefs, attitudes, and norms influence the transition? Which play a key role, and which are sideline variables? How do they shift over time, and how can they be influenced? This will be looked at in terms of factors that may contribute towards injury incidents in major maintenance.

1.5 Reasoned action theory

1.5.1 History of attitude/behaviour research

The "attitude" construct is said to have received its first serious attention from Darwin in 1872 (Bem, 1965). Darwin defined an attitude as a motor concept, or the physical expression of an emotion. For early psychologists "attitude" was an emotion or thought with a motoric (behavioural) component (Bem, 1965). Beginning in the1930's, psychologists began to argue actively about what components should comprise the attitude concept. Although there was an agreement that all attitudes should contain an evaluative component, theorists disagreed about whether beliefs (cognitions) and behaviours should be included as part of the attitude concept. The prevailing view among cognitive social psychologists was that "attitude" has both affective and belief components and that attitudes and behaviour should be consistent, i.e., people with positive attitudes should behave positively towards the attitude object (Bentler & Speckart, 1979).

In 1975, Fishbein and Ajzen laid out a theory, which they claimed would improve our ability to predict behaviour. In published reports the variables specified by the theory generally did account for more of the variance in behaviour than had the previous attitude/behaviour measures. However, it soon became clear that some important limitations on the theory's domain were required; that additional variables would be included, and that the theory was better understood as a taxonomy, as opposed to an explanatory system. Ajzen (1988) has published an updated version of the theory of reasoned action called the theory of planned behaviour. The theory of reasoned action will be used in this current research to investigate whether attitudes have a contribution in behaviours that lead to injury incidents in major maintenance operations. The theory will be discussed along with research undertaken to test the theory and the major problems that the theory may seem to have.

1.5.2 Components of the theory of reasoned action

Reasoned action theory is designed to try to identify the determinants of behaviour, intentions to help us understand human behaviour. It is argued that the theory is concerned with the causal antecedents of volitional behaviour.

> "The theory of reasoned action is based on the assumption that human beings usually behave in a sensible manner, that they take into account available information and implicitly or explicitly consider the implications of their actions" (Ajzen, 1988;p117).

The theory postulates that a person's intention to perform or not to perform behaviour is the immediate determinant of that action. Barring unforeseen events, people are expected to act in accordance with their attributions. Ajzen & Fishbein (1980) states that people

will consider the implications of their actions before they decide to engage or not to engage in a given behaviour. Ajzen and Fishbein's theory of reasoned action is divided up into three main areas, intention, attitude and subjective norms.

1.5.2.1 Intention

The theory of reasoned action "suggests that a person's behaviour is determined by his intention to perform the behaviour and that this intention is in turn, a function of his attitude towards the behaviour and his subjective norms" (Ajzen & Fishbein, 1980; p345). It is argued that the person forms an intention to engage in certain behaviour. Intentions are assumed to capture the motivational factors that have an impact on a behaviour, they are indicators of how hard people are willing to try, and how much of an effort they are planning to exert, in order to perform the behaviour (Ajzen, 1988). These intentions remain behavioural dispositions until, at the appropriate time and opportunity, an attempt is made to translate the intention to behaviour.

According to the theory the immediate antecedent of any behaviour is the intention to perform that behaviour and there is strong likelihood that the person might perform the behaviour when the person's intention is stronger. It is stated by Ajzen (1988) that intentions are highly correlated with volitional behaviour. Intentions have been found to predict a variety of corresponding action tendencies, ranging from simple strategy choices in laboratory games, to actions of personal or social significance, such as having an abortion, smoking marijuana, and choosing among a selection of candidates (Ajzen & Fishbein, 1975). Ajzen (1988) argues that we need to some extent account for the

intentions people form by examining their attitude towards behaviour, their subjective e norm, and the relative importance of these two factors. More importantly to understand intentions we need to explore why people hold certain attitudes and subjective norms (Ajzen & Fishbein, 1975).

1.5.2.2 Attitude towards behaviour

According to the "Theory of reasoned action, attitude towards behaviour is determined by salient beliefs about the behaviour, termed behavioural beliefs. Each behavioural belief links the behaviour to a certain outcome or to some other attribute such as the cost incurred by performing that behaviour" (Ajzen, 1988; p120). The attitude towards behaviour is determined by the person's evaluation of the outcomes associated with the behaviour and the strength of these associations. A person who believes that performing a given behaviour will lead to mostly positive outcomes will hold favourable attitudes towards performing that behaviour (Bentler & Speckart, 1979). Whereas a person who believes that performing the behaviour will lead to mostly negative outcomes will hold unfavourable attitudes (Ajzen & Fishbein, 1975).

1.5.2.3 Subjective norm

It is argued that attitudes towards behaviour are made up of beliefs about engaging in the behaviour and the associated evaluation of that belief (Ajzen & Fishbein, 1975). The subjective norm is also a determinant of intention in the theory of reasoned action. Subjective norms are people's beliefs that specific individuals or groups approve or disapprove of performing behaviour. This determinant is the person's perception of social

pressure from “referents” to perform or not to perform the behaviour under consideration. These “referents” include parents, spouse, close friends, co-workers, managers and others (Ajzen & Fishbein, 1975). These beliefs that underlie subjective norms are called normative beliefs. Ajzen and Fishbein (1980) argue, in order to gain an understanding of the factors influencing behaviour it is required to look for the determinants of the attitudinal and normative components. These determinants are beliefs individuals hold about themselves and their environment. Therefore beliefs are viewed as underlying a person’s attitude and subjective norms and they ultimately determine intentions and behaviour. It is stated that a person’s attitude towards behaviour is determined by the set of salient beliefs they hold about performing the behaviour (Ajzen & Fishbein, 1975).

Salient beliefs are a small number of beliefs that a person can attend to at any given point. Also, in forming a subjective norm, an individual takes into account normative expectations of other sources that are important to them. In determining subjective norms, salient references need to be identified (Ajzen and Fishbein, 1980). Using the theory of reasoned action we want to find the attitudinal and normative behaviour behind the way the employees are behaving with regard to safety in their work environment.

The theory of reasoned action traces the causes of behaviour to the person’s salient beliefs. Each successive step in this sequence from behaviour to beliefs provides a more comprehensive account of factors that determine behaviour. At the initial level, behaviour is assumed to be determined by intention. At the next level these intentions themselves are explained in terms of attitude towards behaviour and subjective norms. The third level

accounts for the attitudes and subjective norms in terms of the beliefs about the consequences of performing the behaviour and about the normative expectations of relevant referents. In the final analysis then, a person's beliefs represent the information (be it correct or incorrect) they have about themselves and about the world around them, it follows that their behaviour is ultimately determined by this information (Ajzen, 1988). The theory of reasoned action will be applied to injury incidents, and this will be illustrated with the use of an example. Time pressure is one of the concepts that concern maintenance workers because they have to get aircraft back into service as early as possible. According to Reason and Hobbs (2003;p 65) "a particular risk that the maintenance personnel are faced with is real or self imposed time pressures and will result in one attempting to take shortcuts to get the aircraft back into service more quickly". Using reasoned action theory one might argue that the maintenance personnel would have specific beliefs about whether to take shortcuts or not.

Maintenance personnel might evaluate their beliefs about taking shortcuts and also taking into account the consequences and the outcomes of performing that behaviour.
The theory also argues that the intention to perform that behaviour is also influenced by subjective norms, which are influences from the social environment. Maintenance personnel might be influenced by the way they think their co-workers, supervisors or management would think of them if they perform the behaviour or not. It could be argued that in using this theory, it will help us to understand the motivation behind maintenance personnel behaviour when they make choices in their work environment that might endanger their safety.

A lot of research on attitude-behaviour has been done within the framework of the theory of reasoned action. Evidence in support of the theory has been accumulated in a variety of experimental and natural settings (Ajzen & Madden, 1986). The behaviours involved a range from strategy choice, to actions of appreciable personal or social significance such as having an abortion, smoking, etc. (Ajzen & Madden, 1986). However from the literature reviewed there is little evidence to show research done on the application of reasoned action theory to the aircraft maintenance environment, although research has been made to personal safety in terms of condom use (Wulfert, 1995) and seatbelt use (Field, Boehm, Vincent & Serafin, 2003).

The research describing seat belt use establishes that the failure to wear seat belts is risky and that varied programs attempting to persuade people to wear seat belts have failed (Field et al, 2003). It is argued that when faced with a risk, for which an inexpensive solution is available; individuals often choose the risk rather than the solution. Protection from certain kinds of risks, for example, using seat belts, condoms or protective gear, is largely under personal control, but individuals often choose not to comply with behaviours which could reduce the risk and save their lives (Field et al, 2003). The reasoning behind not using safety solution was that they are uncomfortable and that if you have not been affected by the risk that you are taking, then there is no reason to use the safety options available. The second reasoning is that if there is no strong subjective norm or pressure from social referents to use safety options, people tend not to use them

The study explored the relationship between the participant and intention to wear seat belts. Questionnaires were administered to participants in four conditions or groups (Field

et al, 2003). The results provide support for the theory of reasoned action, in terms of intention as being a major determinant of behaviour. Also smaller factors of normative social pressure from friends and family provide some support for the argument that the subjective norm is one component related to intention.

But there was no evidence to support the contribution of subjective norms to the formation of intention. One could say even though there is some protection provided some people might opt to take the easier way and not take the protection that might save their lives. One could argue that this relates to the current research, it would be interesting to see from the results if this would be the same, that maintenance personnel might opt for the easier option in the way they do things in their work environment even though it might have safety implications. The next section with focus on another psychological theory, attribution theory.

1.6 Attribution theory

We all have a need to explain the world, both to ourselves and to other people, attributing cause to the events. This gives us a sense of control. When explaining behaviour, it can affect the standing of people within a group especially ourselves. But what do we use to explain behaviour, how do we arrive at the cause of behaviour? In this research, attribution theory will be utilised to help us explain the causes of behaviour.
Attribution theory was developed over time by Fritz Heider, Edward Jones, Keith Davis and Harold Kelly. However Heider (1958) was the first to propose a psychological theory

of attribution. But Weiner and colleagues developed a theoretical framework that has been the major paradigm of social psychology.

Attribution theories are the theories that describe how people decide on the causes of human action. They discuss what occurs as a result of assigning certain kinds of causes (Kelly, 1972). “Attribution theory deals with the rules the average individual uses in attempting to infer the causes of observed behaviour” (Jones, 1972; p1). The theory applies to the process whereby people attribute characteristics, intentions, feelings and traits to objects in their social world (Kanouse & Hanson, 1972). It is argued that attribution theory is a motivational theory looking at how the average person constructs the meaning of an event based on his or her motives to find a cause of his or her knowledge of the environment (Heider, 1958). One could say that attribution theory basically looks at how people make sense of the world, what cause and effect inferences they make about behaviours of others and themselves.

Attribution theory is concerned with how individuals interpret events and how it relates to their thinking and behaviour (Heider, 1958). Attribution theory assumes that people try to determine why people do what they do. The following section will focus on different theorists of attribution theory and different aspects that may influence the attributions we make. Previous research done on attribution theory will be discussed and will also try to rationalise the theory in the context of the current research and point out its limitations.

1.6.1 Heider's 'naïve psychology' of attribution.

Attribution theory is a social psychology theory initiated by Fritz Heider in 1958, which aims to explain why things happen and why we chose certain explanations (Jones, 1972). The theory explains how individuals attribute the causes to events and how this cognitive perception affects their motivation. Heider (1958) discussed what he called "naïve" or "common sense" psychology. In his view, people were like amateur scientists, trying to understand other people's behaviour by piecing together information until they arrive at a reasonable explanation or cause (Jones, 1972). Heider (1958) first introduced attribution theory as "naïve psychology" to help explain the behaviours of others by describing ways in which people make causal explanation for their actions.

Heider's naïve analysis of action deals with how observable behaviour is linked to unobservable causes. It is a fundamental activity that enables individuals to create organisation from chaos and relate the continuously changing stimuli to stable properties of the environment (Heider, 1958). This activity leads, in turn, to the crucial distinction between internal and external causes. It is argued that the result is felt to depend on two sets of conditions, factors within a person and factors within the environment.
The internal and external environment leads to internal and external attributions. Internal attributions come from within the person and external attributions come from outside the person. Internal attributions are behaviours, which reflect the person's traits, attitude, skills, effort, ability and intention. External attributions reflect the situation a person is in. People are likely to make internal attributions when the event is positive and external ones for negative events (Jones, 1972).

Heider (1958) believed that people have two behavioural motives, the need to understand the world around them and the need to be in control of the environment. He proposed that people act on the basis of their beliefs whether these beliefs are valid or not. Hence they make internal or external attributions. It is also argued that our attributions are significantly driven by our emotional and motivational drives. Blaming other people and avoiding personal recrimination are self-serving attributions (Jones, 1972). One could argue that attribution theory suggests, when we observe an individual's behaviour we attempt to determine whether the behaviour was internally caused (i.e. by the person) or externally caused (i.e. by the context or situation).

One could say from reading the literature this internal-external distinction is central to most attribution models. There is no single or dominant theory of attribution, but rather a variety of perspectives that address how individuals assess behaviours and other actions (Martinko, 1995). Despite these differences in perspectives, the common theme in attribution theory is that the discrepancy leads to attribution of cause.

The basic idea of attribution theory can be applied to the maintenance environment. For instance, maintenance technicians might attribute cause of injuries and incidents in major maintenance to the environmental conditions, context and instruments thereby making external attributions. Some might make internal attributions to say they contributed or caused the injury incident. However, this is less likely to happen because according to the theory people are likely to make internal attributions when the event is positive rather

than when it is negative. People are subject to a self-serving bias. Heider (1958) argues that both personal forces and environmental factors operate on the "actor" and the balance determines the attribution of responsibility (Lewis & Daltray, 1990).

1.6.2 Kelly's covariation theory

Kelly (1972) advanced Heider's theory by adding hypotheses about the factors that affect the formation of attributions. Kelly's contribution to attribution theory builds on Heider's proposal that understanding of the distal environment is gained by means of causal analysis (Jones, 1972). He begins with a question of what information is used to arrive at a causal attribution and in what way is it used. How do individuals establish the validity of their own or of another person's impressions of an object? He argues that to explain an event, we need to look for features present when the event occurs and absent when it does not occur. Kelly suggested that perceivers examine three different kinds of information in their efforts to establish validity (Ross & Fletcher, 1972). It is argued that individuals attribute behaviour to internal or external causes depending on basic informational cues. The events are analysed along three dimensions, distinctiveness, consistency and consensus.

Distinctiveness refers to whether the behaviour is expressed towards a specific target only or is used generally across all targets. If the present behaviour in the current situational context is not likely to occur in other contexts, then the behaviour is said to be distinctive. It could be argued consistency refers to the generality of the behaviour across different time periods. If the present behaviour is characteristic of previous behaviours in the past, then it would be considered consistent.

Consensus refers to the generality of the behaviour across a number of different individuals (Jones, 1972). If the present behaviour is evident in other individuals in the same settings, then the behaviour is said to have a high level of consensus.

It is stated that generally a person will attribute behaviour to internal (person) causes if that behaviour has low distinctiveness, high consistency and low consensus (Schaffer, 2002). Kelly and Michela (1980) see consistency and distinctiveness as the important parameters of individual experience. The basic point is that a person trusts his reactions to a stimulus (i.e. attributes them to objective properties of the stimulus) when they are consistent (over time and modality) and distinctive from those to other stimuli.

1.6.3 Jones and Davis's theory of correspondence inference

When we are making attributions about other people, we compare actions with alternative actions, evaluating the choices they have made. It is easier for us to make internal attributions when there are fewer non-common effects between the choices. That is, when both choices have a lot in common and there are thus fewer things to differentiate them. When the behaviour is not what we forecast, we assume that it is due to their internal preferences or character traits. Jones and Davis proposed a few distinctive reasons an actor has for an action and the less these reasons are widely shared in the culture, the more informative is that action about identifying the disposition of the actor (Kelly & Michella, 1980). Kelly and Michela (1980) argue that correspondent inference concerns a naïve perceiver's explanation for a target person's action. They argue that the statement made above incorporates three main classes of antecedents. That is, information, beliefs and motivation.

The theory is an attempt to formalise how individuals make inferences about a person's intention and, in turn, their dispositions (Hewstone, 1983). The theory states that there is a strong tendency to infer that other's intentions and dispositions correspond with their actions. The problem of the perceiver is to decide which effects of the observed action, if any, was intended by the actor. To infer that any effects were intended, the perceiver must believe that the actor "knew" the consequences of his action. In addition, the actor must be seen to be "capable" of intentionally producing the observed effects (Jones, 1972). These are then the preconditions for the assignment of intentions, which themselves, are the prerequisite for inferences concerning the underlying personal dispositions of an actor.

To put it simply one could say, correspondent inference theory describes how an individual might infer another's intentions and personal dispositions (personality, traits, attitude etc.) from his or her behaviour. For example, individuals may infer a disposition of kindness from a kindly act. Inferences are correspondent when the behaviour and the disposition can be assigned similar labels (e.g. kind). Jones and Davis (1965) in Jones (1972) did a considerable study of the effects of actions as opposed to the actual action. They found that there were three factors that observers used when making attributions about others; choice and effects, commonality and desirability. Choice and effect is basically the point that actors have a choice between their actions. Commonality says that the only effects that are uncommon or those unique to specific actions can be used for assigning internal attributes.

It is argued that external attributes cannot be the cause for specific actions. The more undesirable the action or the effects of the action, the more readily and more confidently causality can be inferred (Jones, 1972). Using only one of these criteria may leave the observer with many explanations for the actor's actions. But when combining all three of these criteria, it is much easier for the observer to zone in on a single attribute. This is what Jones and Davis refer to as the correspondence inference with certain combinations of undesirability and non-common effects for the actor, one can find higher correspondence.

An exploratory analysis of safety causal attributions in the aircraft dispatch and maintenance department was conducted by Yeray, Villegas, Rolo, Ernesto and Dolores (1995). It is stated that the causal attributions represents a basic construct in the organisational environment that facilitates risk management in the organisation. From this point of view it is assumed that the safety management process is influenced among other factors, by the type of explanations given when human beings try to identify and determine the associated causes of optimal safety management.

A qualitative analysis of safety causal attributions generated by aircraft dispatch and maintenance department workers from air transport companies was realised. The main objective of the research was to establish the causal attribution categories shared by workers. The sample was made up of 16 workers from three organisations of the same sector; that is, aircraft dispatch and maintenance organisations. The sample was divided into groups depending on two variables, hierarchical level and department.

Hierarchical level consisted of team and unit managers (high level), crew managers (medium level) and licensed engineers and maintenance technicians (base level). Depending on the department, the sample was from the engineering, quality assurance, line maintenance and material service department (Yeray et al, 1995).

A semi- structured interview was used to collect information about the job and the worker, and safety related cognitive processes, specifically about safety definition, risk perception, causal and responsibility attribution, identification of safety related rules and procedures, and risk management (Yeray et al, 1995). The study utilised Weiner's (1979) classification of attribution theory. The results demonstrated that workers held more uncontrollable, stable and external attributions towards safety. Moreover there was no difference among the types of causal attributions that employees from different departments and hierarchical levels presented.

In another study, attribution theory was used to explain and predict individual responses to perceived toxic exposures (Williams, Lees-Haley & Brown 1993). It is argued that following a suspected exposure to toxic substances, individuals are likely to be concerned with several questions, including what happened, how likely was the risk, what is the extent of the exposure, what action could and should be taken to avoid the exposure, who is responsible and what are the present and future threats to health (Williams et al, 1993). Using attribution theory the findings of the research are informative in understanding how individuals use available information to answer these questions and the

consequences that may arise from how they perceive the primary event (i.e. toxic exposure) and view collateral events (e.g. how injured they are) (Williams et al, 1993). It is argued that attribution theory provides theoretical constructs with which to explain and predict a person's cognitive, emotional and behavioural responses to perceived injury following a technological disaster such as a toxic spill.

As noted, attribution theory is concerned with how individuals interpret events and how this relates to their thinking and behaviour. Attribution theory assumes that people try to determine why people do what they do. A person seeking to understand why another person did something may attribute one or more causes to that behaviour.
This relates to the present research because we want to find out why the employees behave the way they do and what attributions they make towards the incidents that have happened. Attribution theory relates to injury incidents in that employees might attribute the actions or behaviours that lead to these injury incidents to themselves or to the environment for example management or work equipment they are using.
Also management and employees might have a different view of the causal attributions that lead to these injury incidents.

1.7 Research aims and rationale

The aim of this research is to find out the root causes of the perceived reasoned action and attributions of injury incidents taking place in major maintenance from the employees' perspective. The current research aims to explore underlying causes through the use of attribution theory and reason action theory. By the use of these theories, they

will aid, in exploring the internal and external attributions, attitudinal and normative behaviour of the perceived reasons and attributions of these injury incidents. From the review of the literature it would appear that most of the research on aircraft maintenance has mainly focused on the errors taking place that contribute to the accidents or any delays the aircraft might have (Hobbs and Williamson, 2002). Another aim of the current research is explore team leaders and technicians responses towards injury incidents and attributions, reasons given about the causes of those incidents. The rationale being that people might work in the same environment and have different and similar views and they might influence each other. This might be important in finding ways to create a safer work environment.

The majority of research has not focused on the safety of maintenance workers and the causes of injuries and incidents that take place in the maintenance environment. Campbell (2002) comments that during an extensive literature review, no official data was found on specific injuries in aircraft maintenance. Summers (2002;p23) suggests that "…aviation as an industry is just starting to come to grips with occupational health and safety (OHS) aspects of collecting, analysing and reviewing injury/incident data. Summers (2002) further indicates that because there is such a high level upon airworthiness safety that occupational health and safety has not been managed as well as it could be. McDonalds (2002) lends further support to the lack of data available in this area and the need for it to be addressed through research. The rationale for the research gave rise to the following research questions.

1.8 Research Questions

- What are the incidents and injuries that are happening in major maintenance operations? What are the perceived attributable causes of injury incidents in major maintenance operations?

- What are the perceived reasons behind the actions taking place that lead to these injury incidents?

- Do different types of errors and violations have any contribution towards these injury incidents in major maintenance?

- Do technicians and team leaders have different attributions and reasoned actions to injury incidents in major maintenance?