Spring 2014

The Relationship Among HFACS Levels and Analysis of Human Factors in Unmanned and Manned Air Vehicles

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Recommended Citation

Yesilbas, Veysel. "The Relationship Among HFACS Levels and Analysis of Human Factors in Unmanned and Manned Air Vehicles" (2014). Doctor of Philosophy (PhD), Dissertation, Engineering Management & Systems Engineering, Old Dominion University, DOI: 10.25777/n4je-8513
https://digitalcommons.odu.edu/emse_etds/137

THE RELATIONSHIP AMONG HFACS LEVELS AND ANALYSIS OF HUMAN FACTORS IN UNMANNED AND MANNED AIR VEHICLES

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

ENGINEERING MANAGEMENT

OLD DOMINION UNIVERSITY
May 2014

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ABSTRACT

THE RELATIONSHIP AMONG HFACS LEVELS AND ANALYSIS OF HUMAN FACTORS IN UNMANNED AND MANNED AIR VEHICLES

Veysel Yesilbas
Old Dominion University, 2014
Director: Dr. T. Steven Cotter

This dissertation analyzes the structural relationships among the Human Factors Accident Classification System levels for unmanned air vehicle and manned air vehicle accidents and the common relationships between unmanned air vehicle and manned air vehicle accident causes. The study acquired DOD HFACS accident classification data from 347 United States Air Force Class A accident reports for the years between 2000 and 2013.

The dissertation utilized a set of analysis that is considered to contribute substantially to the respective domain of the study. The correlations found among categorical levels were applied to HFACS taxonomy based on the Reason Model via path analysis – structural equation modeling. The study concluded the presence of statistically significant paths at both UAV and MAV accidents and common partial paths of those aircraft types within the framework of DOD HFACS taxonomy. The study also suggests that accident data can be utilized to test and improve the failure model of an organization through identification of significant effects such as technology and structural changes in the organization.

ACKNOWLEDGMENTS

There are many people that I need to acknowledge whose help, encouragement and belief in me made this dissertation possible. First of all, I want to thank my advisor, Dr. Steve Cotter, commitment and his knowledge that he shared with me during this journey. I am sincerely grateful for the opportunity to learn from and work with him.

I would like to extend my sincere gratitude and appreciation to each member of my dissertation committee for their valuable contributions: Dr. Resit Unal, Dr. Holly Handley, and Dr. Gokay Sursal. They provided numerous valuable comments and suggestions during my doctoral study under significant time constraints. Without their constructive criticism and advice, this thesis would have not progressed as smoothly as it did throughout its completion.

I would like to thank to Dr. Souza-Poza for his advice and direction during this study. I should not forget the faculty's academicians, Dr. Adrian Gheorghe and Dr. Maria Pilar Pazos-Lago, who helped me in this study. I would also like to thank to experts of the inter-rater reliability study for their willingness to give up hours of their valuable time. Their experience contributed to improve the reliability of the analysis.

I would especially like to thank my lovely wife, who has passionately supported me without ever complaining. Throughout this Ph.D. endeavor, she gave me a wonderful gift: my daughter. My son, accept my apologies for not having played with you as much as I wanted. I hope I can make it up to you some day, and I hope this determination in the study encourages you in future school life. I would also like to thank my parents for their love and unconditional support over my life. I have always felt my mother's prayers blessing me.

NOMENCLATURE

UAV	Unmanned Air Vehicle
MAV	Manned Air Vehicle
HFACS	Human Factors Analysis and Classification System

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CHAPTER 1

INTRODUCTION

Accident investigation and evaluation has been an important part of military and commercial aviation since its beginning. Investigators and researchers seek to understand the root causes leading to accidents, exploit the reasons behind root causes, and improve flight safety by presenting safety recommendations that can be used by other researchers, educators, managers of airline or military organizations, and aircraft manufacturers.

Among aviation accident investigation tools, the Human Factors Analysis and Classification System (HFACS) has been used by the United States Department of Defense (DOD) since 2005 as well as by commercial aviation sectors and countries worldwide. The taxonomy of HFACS has been used not only in aviation domain but also studied for its application to accident investigation in different sectors such as maritime shipping, mining, and commercial traffic. While the need for humans in operating environment is decreasing, the expectation for human performance quality in aviation and industrial sectors is increasing.

This research applies a quantitative *ex post facto* approach to test the relationship among the HFACS taxonomy levels using data from 347 United States Air Force Accident Investigation Board (AIB) summaries and reports between the fiscal years of 2000 and 2013. This research analyzes the structure of causal paths among HFACS levels by applying the structural equation modeling (SEM) methodology and then compares the common significant paths between unmanned and manned air vehicle accident causes by applying path analysis for unmanned and manned accidents.

The views expressed in this dissertation are those of the author and do not reflect the official policy or position of the United States Armed Forces, Department of Defense, or Government or those of any other NATO nations and their Armed Forces.

1.1 Background of the Study

Based on James Reason's (1990) "Swiss Cheese" model of accident causation, the HFACS was designed to define the "holes in the Swiss Cheese" and to facilitate the application of Reason's model to accident investigation and analysis (Wiegmann & Shappell, 2003). The taxonomy of the HFACS has been used by the United States (US) Department of Defense (DOD) throughout its services with slight changes made through the levels and sublevels. The structure of HFACS levels and the causes of unmanned aerial vehicle (UAV) accidents have not been studied in the way of comparison with manned air vehicles (MAV) accidents. In other words, the structure of HFACS levels and the relationship of human factors between UAV and MAV accidents has not been thoroughly evaluated using empirical multiple regression causal models.

1.2 Statement of the Problem

The rapid rise in UAV employment (Department of Defense, 2011) has been accompanied by increased attention to their high accident rates which are greater than MAV (Menda et al., 2011). Such high rates had negative implications for UAV affordability and mission effectiveness. According to a study conducted by the US Air Force, human causal factors are 68 % of all UAV accidents in the US Armed Forces. As aircrafts and systems become more reliable and steadfast with the help of technological developments, human factors in aviation accidents comes to the forefront as a vital point in terms of human life and enormous cost. Being used in the military aviation and studied widely in the literature, the utility, validity, and reliability of HFACS has also been assessed to gain a better usage and understanding of human factors in accidents. As these assessments and studies help to improve the validity of accident causation systems, further evaluation studies from different perspectives are needed to contribute to HFACS. Although being sufficient as a reporting and investigation tool, HFACS needs to be tested and evaluated for significant common causal paths among its levels and for correlation of common causal paths between unmanned and manned air vehicle accident causes.

1.3 Purpose of the Study

The purpose of this study is to analyze the structural relationships of accident causes among HFACS levels in comparable UAV and MAV and to analyze the common paths between UAV and MAV accident causes.

1.4 Significance of the Study

Given the inherent risks, economic impacts, and potential negative consequences associated with deficiencies in support personnel and pilot skills, decisions, judgments, and perception errors, decreasing accident rates is crucial to military and commercial aviation and industrial organizations, which all suffer from budget constraints. In order to mitigate the potential for aviation accidents, it is important to ensure that accidents are investigated and evaluated in an appropriate methodology and taxonomy so as to understand the causes for individual and all cases as well. This understanding requires testing of HFACS taxonomy that is used widely in both aviation and other sectors. As O'Connor, Walliser, and Philips (2010) recommend, organizations must evaluate the reliability and validity of mishap coding systems, as applied by the proposed end-users, prior to the widespread adoption of a system. Therefore it is imperative to have a tested and evaluated taxonomy or analyses system by a variety of perspectives so as to augment the external and internal validity. In that context, evaluation of the HFACS itself, used by all DOD services, is vital since it constitutes a basis from which to understand, intervene, and take necessary precautions throughout the organizations. This study's analysis of causal paths within the structure of HFACS can be regarded as contributing to the evaluation of external validity of the system.

1.5 Research Contributions

The taxonomy of HFACS is tested for significant paths among HFACS levels through structural equation modeling within the context of two different aircraft type, UAV and MAV. The contribution to Reason's (1990) model and Wiegmann and Shappell (2003), HFACS is that the study analyzed the structure of realized HFACS levels. This methodology also tested for significant covariance of accident causes between UAVs and MAVs in terms of human factors. Similar analyses can be used in other areas that have critical effect of human factors such as mining, shipping, or other type of industries.

The methodology that set forth the path(s) among HFACS levels and sublevels can be applied to other domains and organizations that use HFACS taxonomy by the mean of analyzing the secondhand accident investigation reports.

1.6 Delimitations

The most important reason that formed the delimitations of the study was the available data. The accident reports of UAVs and MAVs analyzed in this study were limited to ones used in the United States Air Force. The intended testing of accident causation system was the DOD HFACS since most of the reports are evaluated with this model. The accidents examined were only the Class-A accidents of US Air Force UAVs and MAVs, and the time frame covered the fiscal years from 2000 to 2013. The accident reports that did not find any human factors as the accident cause and accident reports for which root causes were not determined were excluded. The study also classified the accident reports and the aircrafts according to their use of concept rather than a variety of aircraft; UAV and MAV. No latent variable such as mission type, accident phase, was included in the study. The base version of DOD HFACS published in 2005 was used to assess and classify the accident causes of the summarized reports. Even though there were different types of unmanned and manned aircrafts, the reports were classified within the context of unmanned and manned aircrafts.

1.7 Definitions of Key Terms

UAV - Unmanned Air Vehicle.

MAV - Manned Air Vehicle

UAV/MAV Mission is a period including taxi to runway, take-off, flight, landing, and taxi back for a specific purpose.

Class A Accidents are the accidents that result in fatality or total permanent disability, loss of an aircraft, or property damage of $2 million or more (USAF Accident Investigation Boards, 2012).

CHAPTER 2

LITERATURE REVIEW

Reviewing the literature helps to understand the theoretical basis for and the background of the study and also assists in establishing the scope of the study. The literature review for this study is organized in two major sections and four sub-sections that helps to analyze the structure of HFACS levels and the relationship between UAV and MAV accident causes. The first part constitutes the ground for HFACS that is human factors in aviation, accident causation taxonomies and the Reason (1990) model. The second part consists of review of previous studies, which are HFACS adaptation to various areas, exploratory studies of HFACS, and testing/evaluation studies of HFACS.

2.1 Human Factors and Accident Causation in Aviation

The new era of technology and operation environment has led to aviation development of various types of air vehicles for a variety of purposes. The mounting interest for aviation is a direct result of their tested and proven capabilities in many fields. These developments, caused by many effects, have brought out substantial issues that are related to human factors. In aviation, human factors play an important role, because human factor effects are vital to protecting human life and minimizing organizations' expenditures. As aircrafts become more reliable with the help of technological developments, human factors in aviation accidents come to the forefront as a vital point.

Human factors are steadily seen as a major cause of manned aircraft accidents. According to Wiegmann and Shappell (2003), the percentage of accidents that implicate human error ranges from 70% to 80%. In addition, the percentage of accidents related to human error has increased relative to those attributable to equipment failures over the past 40 years (Shappell & Wiegmann, 2000). Rash, LeDuc, and Manning (2006) advocate that knowledge of human-related factors is necessary for the successful formulation of countermeasures to prevent these types of accidents, and such understanding can be achieved by the application of accident analysis techniques to existing accident databases.

There have been many studies toward the development of accident causation models and frameworks due to the desire for decreasing human errors in aviation accidents that result in fatalities and cost a great amount of resources in terms of investigation time, loss of aircraft assets, and litigation. According to Senders and Moray (1991), the aviation sector had witnessed a proliferation of human error frameworks twenty years ago. This proliferation during 1990s resulted from the overall accident rate declining over the last half century, but reductions in human error-related accidents have not kept pace with reductions in accidents related to mechanical and environmental factors (Wiegmann & Shappell, 2003). A study by Wiegmann, Rich, and Shappell (2000) summarizes more than 100 research and technical articles that either directly presents a specific human error or accident analysis system or use error frameworks in analyzing human performance data within a specific context or task.

2.2 Reason's Accident Causation Model and the HFACS

Reason's (1990) Accident Causation Model is a theoretical model that aims to explain how accidents occur in organizations and among its levels. The main assumption of the theory is that accidents occur in such a way that the causes have relationships with other levels of the organization. A second assumption of the model is that the components of organizations need or are obliged to function together at least to prevent accidents. From these assumptions, Reason theorizes that most accidents can be traced to active and latent human failures that result from prior latent human failures at higher organizational levels. Combinations of latent errors pose the greatest threat to safety of a complex system.

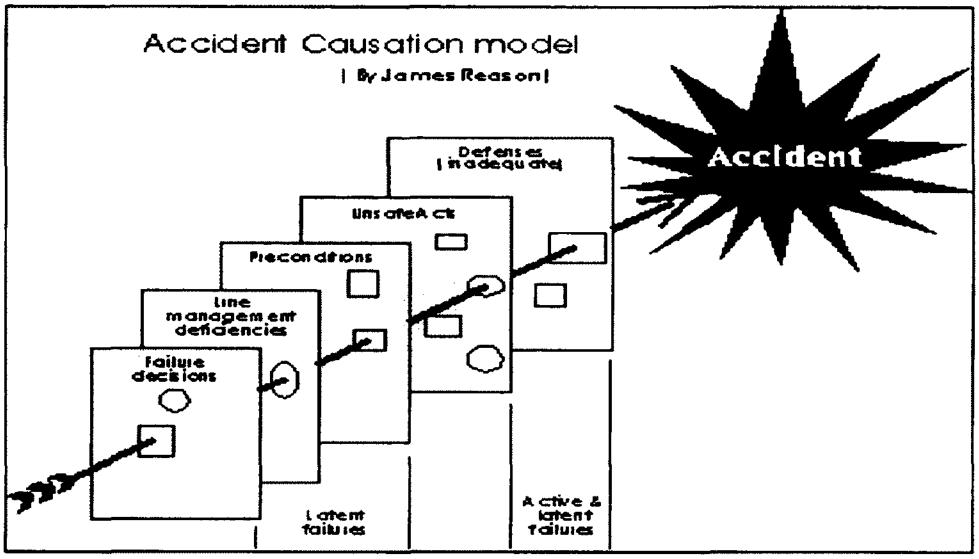


Figure 1. **Reason's (1990) Model**

The Human Factors Analysis and Classification System (HFACS), originally adapted from Reason's (1990) model to military aviation by Wiegmann and Shappell (2003), identifies four levels within an organization at which latent and active human errors can occur: Organizational Influences, Unsafe Supervision, Preconditions for Unsafe Acts, and Unsafe Acts. Among other aviation accident investigation tools, HFACS has been used by the U.S. Department of Defense since 2005 with some changes especially at the levels of Preconditions for Unsafe Acts and Unsafe Acts. The taxonomy of HFACS has been studied not only in the aviation domain but also in a variety of sectors such as maritime shipping, mining, and traffic accidents. Furthermore, HFACS has been studied in many countries such as India (Gaur, 2005), China (Li & Harris, 2006), and Australia (Olsen & Shorrock, 2010). Figures 2 and 3 illustrate the four layers of the HFACS taxonomy.

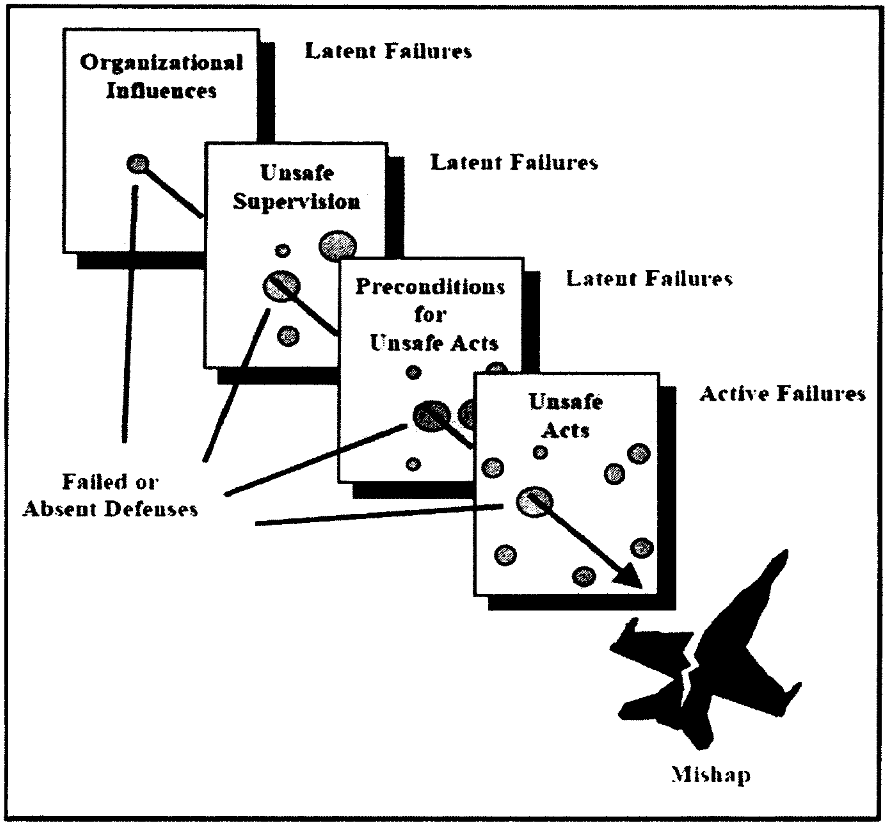


Figure 2. The "Swiss Cheese" Model of Human Error Causation (Reason, 1990) Adapted for the HFACS Taxonomy by Wiegmann and Shappell (2003).

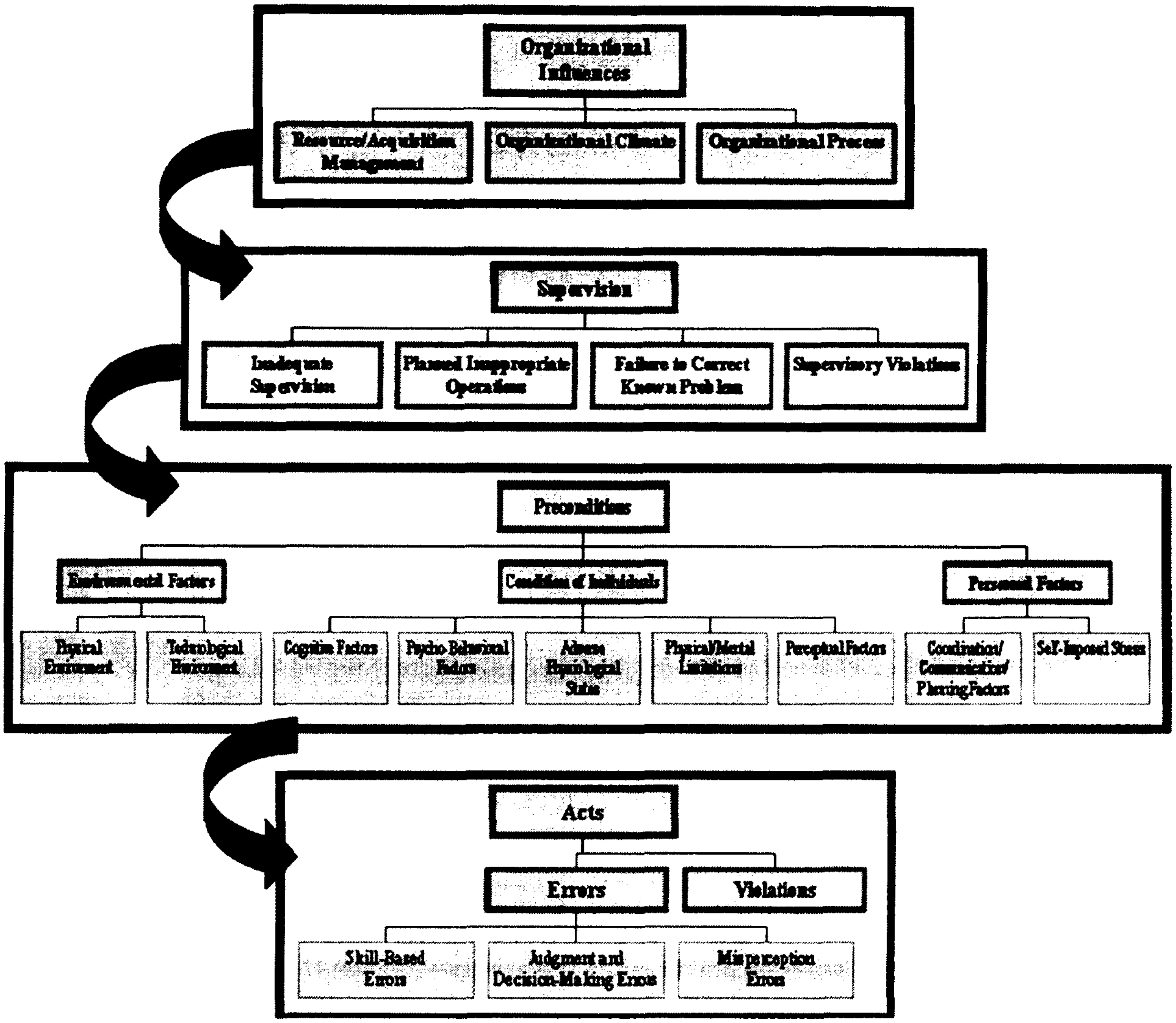
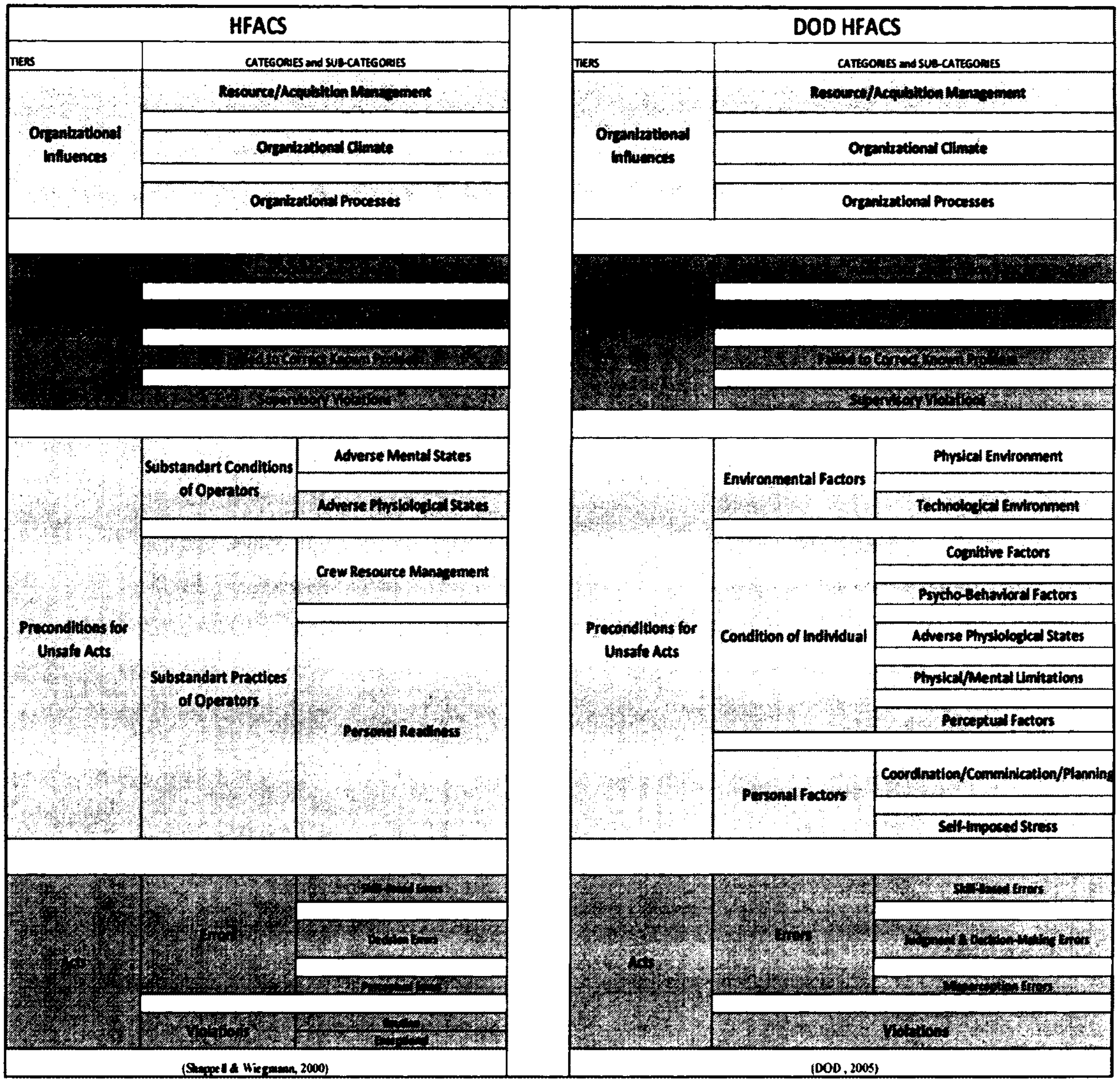


Figure 3. DOD HFACS Model (2005) Adapted from HFACS. (Each of the boxes breakdown to respected nanocodes of human error)

The taxonomy used in the reports of this study was the United States Department of Defense DOD HFACS (DOD, 2005). The DOD HFACS is an adapted version of the HFACS with changes at the levels of Preconditions and Unsafe Acts. The U.S. Department of Defense started using the DOD HFACS by a memorandum in 2005 among its services. Figure 4 illustrates a comparison of the original HFACS and the DOD HFACS levels.



(Shappell & Wiegmann, 2000)

(DOD, 2005)

Figure 4. **Schematic comparison of HFACS (Shappell & Wiegmann, 2000) and DOD HFACS (DOD, 2005)**

2.3 Previous Studies

Numerous studies of the HFACS can be found in the literature. It is possible to cluster these studies in order to see the big picture and locate this study into the appropriate cluster: (1) HFACS application and adaptation to various areas, (2) exploratory studies of HFACS, and (3) evaluation and testing of the HFACS. This study is aimed to contribute to the last two clusters. Most of the literature regarding HFACS consists of exploratory analysis aiming to exploit human factors in aviation. Testing or evaluation studies of HFACS are the least found in the literature.

2.3.1 HFACS Application and Adaptation to Various Areas

Although HFACS is being used mainly by aviation organizations and especially by military domain, it has been also used for a variety of areas such as human error in maintenance (Krulak, 2004), shipping (Celik & Cebi, 2009), motor vehicle accidents (Iden, 2012), and mining (Lenné, Salmon, Liu, & Trotter, 2012). This wide usage and adaptation of the HFACS concludes that humans persist as the critical element or factor to safety, although the technology has been improving in an accelerated manner.

An investigation of human error in shipping accidents by Celik and Cebi (2009) is an example of HFACS adaptation to different sectors other than aviation. Celik and Cebi generated an analytical HFACS based on Fuzzy Analytical Hierarchy Process (FAHP) in order to identify the role of human factors in shipping accidents. This study furthers HFACS by using a decision making process, FAHP, to quantify human contributions to shipping accidents.

Among the adaptations of HFACS to mining, Lenné, et al. (2012) aimed to provide an analysis of the systematic factors involved in mining accidents and to examine organizational and supervisory failures that are predictive of sub-standard performance at the operator level. The main finding in this study was to direct few critical categories at the higher levels.

Another HFACS application to a different area is the analysis of motor vehicle crashes in the U.S. Military. Iden (2012) aimed to provide a greater understanding of the causal factors associated with serious and fatal off-duty personnel motor vehicle crashes for military service members with the goal of preventing future losses. This study used archival narratives from Class A and Class B off duty motor vehicle crashes in the United States Air Force, Navy, and Marine Corps.

2.3.2 Exploratory Studies of HFACS in Aviation

Many studies seek to gain knowledge of accident causation in organizations by analyzing historical or second hand data. Even though many studies analyze the accidents of services within the U.S. Department of Defense, there are also many studies that analyze accident causes within general aviation from different countries.

In a study of HFACS applied to "Civil Aircraft Accidents in India," (Gaur, 2005) evaluated 48 accident reports that occurred between 1990 and 1999. While the aim was to identify the causal factors, the classification was based from the reports by the author and independent assessor. The study found that one or more human factors contributed to 37 of the 48 accidents.

In another example of a HFACS study, Li and Harris (2006) analyzed 523 accident reports in the Republic of China (ROC) Air Force between 1978 and 2002. They sought to quantify the relationship between the levels and components in the HFACS taxonomy. The study described the common paths between categories at four levels in the HFACS and suggested that active failures were promoted by latent conditions in the organization. The main focus of the study was to determine any pathway throughout the accidents in terms of HFACS rather than testing the structure.

The study "Human Factors in Remotely Piloted Aircraft Operations" by Tvaryanas, Thompson, and Constable (2006) analyzed 221 remotely piloted aircraft mishaps within the U.S military services over 10 years. In reviewing the reports and coding human factors using the DOD HFACS, they sought to analyze the distribution and determinants of operator errors. Suggesting that latent failures at the organizational level were most common and were associated with operator error and mechanical failures, the results revealed that 60.2% of mishaps involved operation-related human casual factors.

Another study by Tvaryanas and Thompson (2008) identified recurrent pathways within an accident database using the HFACS. They used exploratory principal component analysis to assess the structure within the set of crew member-related mishaps for the MQ-1 Predator remotely piloted aircraft. A total of 95 mishap reports for the period October 1996 to September 2005 were reviewed and 433 causal human factors were identified for further analysis. Using exploratory factor analysis, the mishap dataset was reduced to eight factors while still accounting for 72% of the variance in the original dataset. The authors found that "...perception and skill-based error pathways shared common latent failures and collectively were responsible for the majority of crewmember related mishaps. Common latent failures were observed in HFACS categories of resource/acquisitions management, organizational processes, and technological environment" (pp. 528-529). This study, by presenting the linkages between active and latent failures and associated probabilities, demonstrated an example of structural approach for a greater understanding of a mishap database. The study suggested that mathematically linking human performance failures to systemic factors furthers the descriptive approach to a more structural approach. The majority of accidents were caused by latent failures involving organizational factors and technological environment.

O'Connor, Cowan, and Alton (2010), examined the results of two different methods, identifying human factors safety concerns in U.S. Naval Aviation. The first method was the analysis of 47 F/A-18 and 16 H-60 mishaps using DOD HFACS taxonomy. The second method was an analysis of the responses of 68 squadrons to a survey regarding the human factor issues that were considered as the most important concern. The study revealed that the concerns of the squadrons and the results of the DOD HFACS analysis were different. The DOD HFACS nanocodes were not seen as major concerns among squadrons. The study recommended that HFACS needed to be improved in terms of findings and interpretation.

2.3.3 Evaluation/Testing of HFACS

As the HFACS is used in a variety of areas, there have been some studies to evaluate or test the HFACS taxonomy from different aspects.

O'Connor (2008) evaluated the internal validity, external validity, and utilitarian criteria of DOD HFACS by identifying the human factors causes of two aviation mishap scenarios with the help of 123 naval aviators. The main concern of the study was to evaluate the reliability of the nanocodes that were considered to be causal of mishaps. The study concluded that mutual exclusivity, training, and parsimony were required to use DOD HFACS effectively.

The studies of HFACS Evaluation by Trained Raters (O'Connor, et al., 2010) and by Simulated Mishap Boards (O'Connor & Walker, 2011) focused on the level of agreement on the factors that caused accidents. The studies included a limited number of mishaps, one and two respectively, that scrutinized the reliability of nanocodes. The studies found that there were high levels of agreement regarding the factors that did not contribute to the accidents while the level of agreement on the factors that did cause the accident as classified using DOD HFACS were low. The former and the latter studies found that the level of agreement on the factors that did cause the incident as classified using DOD HFACS were lower than desirable. Agreement of 50% or greater between raters that a particular nanocode was causal was found only a mean of 22.5% and 14.6% of selected nanocodes respectively. The latter study also found that the acceptable levels of reliability were only achieved for 56.9% of nanocodes.

Another study by Olsen and Shorrock (2010) evaluated adaptation of HFACS in the Australian Defense Force (ADF) to classify factors that contribute to incidents in the context of a particular air traffic control (ATC) unit. According to study the ADF adaptation of HFACS is unreliable for incident analysis at the ATC unit level and may therefore be invalid in this context. Thus, the evaluation of HFACS in this study was about assessing inter-coder consensus between many coders for incident reports.

Walker, O'Connor, Phillips, Hahn, and Dalitsch (2011) applied lifted rule probabilities at the nanocode level within HFACS to identify common linkages within the

DOD version of HFACS. The study focused on utilizing HFACS as both an accident investigation and reporting tool. They established the relationship between identified Unsafe Acts and the latent conditions preceding that action by applying Lifted Association Rules to *a priori* probabilities. The authors reported that the most significant lift was in Skill-Based Errors Breakdown in Visual Scan to Preconditions Channelized Attention. Other significant relationships were between Skill-Based Errors Procedural Error to Organizational Process Procedural Guidance/Publications and between Skill-Based Errors Over-control/Under-control to Preconditions Restricted Vision. Overall, there were seven significant lifts between Unsafe Acts and Preconditions, two significant lifts between Unsafe Acts and Supervision, and one significant lift between Unsafe Acts and Operational Influences. There were no significant lifts involving all four layers of the HFACS.

2.4 The Gap Analysis

HFACS has been used to analyze accidents especially in aviation. Based on Reason's model of human error, HFACS (Shappell & Wiegmann, 2000) is a commonly used analytical framework to evaluate the effect of human factors in aviation accidents. There are many studies exploiting human affects in aviation accidents using the HFACS taxonomy. Nevertheless, the structural relationships of accident causes among HFACS levels in comparable UAV and MAV accident causes have not been studied. This study tested for and modeled significant paths among HFACS levels and sublevels in UAV and MAV accidents and evaluated the significant common paths between UAV and MAV accident causes.

A potential contribution of this study was to test the application of accident coding within the structure of the HFACS versus the four levels within an organization in which latent and active human errors are hypothesized to occur by Reason's Accident Causation Model (Figures 1 and 2). Evaluation studies of HFACS have been generally based on the level of agreement on the factors that caused or contributed to accidents. In other words, the coding or classification of causes is the focus area that has been discussed for in prior testing or evaluation. The structure or the HFACS model as used in practice has not been studied. This type of testing may contribute to revision of the accident coding practices and procedures or to revision of the HFACS model itself.

CHAPTER 3

RESEARCH METHODOLOGY

Research methodology can be regarded as the style of establishing connection among the literature review and data type. This chapter explains the data source and analysis framework for the research. A quantitative *ex post facto* approach, analyzing U.S. Air Force Accident Investigation Board (AIB) reports between the years of 2010 and 2013, are used to test for significant paths within the Human Factors Analysis and Classification System (HFACS) taxonomy and for common significant paths between UAV and MAV accident causes.

The data for this study came from United States Air Force Legal Operations Agency web site. This database (USAF Accident Investigation Boards, 2012) contained a list of Class A aerospace and ground mishaps (or accidents) and their corresponding summaries and full narratives from the Accident Investigation Board (AIB) of USAF reports between the years of 2000 and 2013. These accidents involved aircraft, remotely piloted aircraft, space systems, and missiles. An accident report is listed on this site after approval of Accident Investigation Board of the USAF. Class A accident reports are used as they have the most comprehensive information and are prepared with a high level of expertise.

The US Air Force conducts aerospace accident investigations of all Class A accidents involving Air Force aircraft, UAVs, missiles, and space systems or equipment, unless they result in damage solely to government property, in which case the accident investigation is discretionary (USAF Accident Investigation Boards. 2012). Aerospace Accident Investigation Boards (AIBs), which collect, evaluate and release the accident data are convened under the authority of "Air Force Instruction (AFI) 51-503, Aerospace Accident Investigations" (2010) document.

This U.S Air Force legal document includes the data collection arrangements and the regulations of report contents as well. The report, arranged by Aerospace Accident Investigation Boards and prepared in accordance with Air Force Instruction (AFI) 51-503, Aerospace Accident Investigations (2010), includes three main sections: The Executive Summary, the Summary of Facts, and the Statement of Opinion. Appendix A includes a AIBs report's cover, executive summary and outline.

Human Factors Analysis, conducted in the "Summary of Facts" section of the AIBs report, discusses human factors that directly relate to the mishap using the DOD Human Factors Analysis and Classification System (DOD HFACS) definitions in AFI 91-204 Attachment 5 and may include the following: perceived crew or maintainer complacency, overconfidence, under-motivation or over-motivation to succeed, distraction, disruption, pressure, channelized attention, uncharacteristic mistake, or other degradation that may have led to the accident (Air Force Instruction (AFI) 51-503, Aerospace Accident Investigations, 2010).

The United States Air Force Legal Operations Agency web site database presents summary and detailed accident reports based on the investigation findings including human factors. The timeframe included 14 fiscal years, 2000-2013, of the accident reports. The majority of the reports in the database include only the executive summaries of the accidents, which may be due to the information being classified and not intended to be shared with the public. This study acquired HFACS accident classification data from

347 reports of which 75 detailed accident reports were available for the years between 2010 and 2013.

3.1 Establishment and Verification of Rater Reliability for this Research

Given that 272 of the accident reports are summaries and require classification by the researcher, the issue of classification reliability had to be addressed. This section sets forth the methodology used to establish and verify researcher rater reliability.

The fundamental sampling question to address is the accuracy and repeatability with which the rater classifies each of the remaining 272 accident summaries within the HFACS system relative to the known classification by the panels of "experts" in the 75 detailed accident reports. The first issue addressed was the sampling plan and design. As with all attribute classification sampling problems, the researcher had control of only the misclassification difference to detect between any two raters and the sample size necessary to achieve a stated $1 - \alpha$ confidence in the difference to detect. The first decision criterion for sampling plan selection was whether or not the required $1 - \alpha$ confidence can be met, or, if not met, how close the resultant confidence approaches the required confidence. The second decision criterion is the resultant sampling resolution. In general, the selected sample size resulted in a tradeoff between confidence in the difference to detect and the sampling resolution. For a given sample size, the smaller the difference to detect the lower the resultant confidence but the greater the sampling resolution as rater reliability approaches 100%.

For this study, rater reliability was established by comparing the researcher's classifications to those of two other expert pilots of a sample subset of the 75 detailed accident reports with known HFACS accident classifications by panels of "experts." Since the 75 HFACS detailed reports had known classifications, there were no defective classifications in the population, and, therefore, the Hyper-geometric sampling distribution did not apply. Thus, the binomial sampling distribution, B(*n*, *p*) applied under the assumption that a countable large number of combinations, C_N^n , exist for the selected sample size *n*. from the population of N = 75 detailed accident reports. The following methodology was applied to select a sample size sufficient to achieve a stated 1 – α, confidence in the difference to detect between any two raters.

1. Given that the O'Connor, et. al. (2010) study indicated only a 55% agreement among raters, it was reasonable to assume in this study that with no prior training the researcher and two expert pilots would randomly agree only 50% of the time. Thus, $p = 0.50$ joint agreement represents the base random assignment case. Joint agreement of the researcher and two expert pilots with the classifications made by the panels of "experts" is a matter of bias assessment in attribute agreement analysis and training and retraining was included in the design in order to approach or exceed the 55% agreement observed by O'Connor, et. al.
2. Next, a Microsoft Excel spreadsheet was set up to assess the tradeoff between confidence in the difference to detect and the sampling resolution over a range of sample sizes. (The output of the spreadsheet analysis and description of formulas used in set forth in Appendix B.) A summary of the analysis is presented in the following table.

Table 1. Summary Analysis Results of Sample Size Selection Criteria

Sample Size, n =	20	25	30	35	40
LCL(0.5-0.4,0.92)	0.0000	0.0087	0.0254	0.0384	0.0488
LCL(0.5-0.3,0.93)	0.0000	0.0000	0.0167	0.0303	0.0413
LCL(0.5-0.2,0.99)	0.0000	0.0016	0.0276	0.0478	0.0641
LCL(0.5-0.1,0.999)	0.0000	0.0396	0.0710	0.0954	0.1151
Resolution (bins)					
p(Misclass) = 0.5	11	14	15	16	17
p(Misclass) = 0.4	11	13	14	15	16
p(Misclass) = 0.3	11	12	13	14	15
p(Misclass) = 0.2	10	10	12	12	14
p(Misclass) = 0.1	7	8	9	9	10
p(Misclass) = 0.05	5	5	6	7	7

Sample sizes in increments of 1 were considered in the range of n = 20 to n = 40.

- The LCL (0.5 – p_i, confidence level) is the lower confidence limit for the stated difference in misclassification proportions at the stated confidence level = (1 - α).

$$LCL = (0.5 - \hat{p}_i) - Z_\alpha \sqrt{\frac{0.5(1-0.5)}{n} + \frac{\hat{p}_i(1-\hat{p}_i)}{n}} \qquad (1)$$

  Selection criterion: LCL > 0 indicating the ability to detect the stated difference (p_i = 0.4, 0.3, 0.2, 0.1, and 0.05) at the indicated confidence level.

- Resolution (bins) is the number of misclassification bins with P(misclassification = x) ≥ 0.005. For example, for p = 0.5 and n = 20, there were 11 misclassification bins as shown in Table 2.

Table 2. Number of Misclassifications $p = 0.5$, $n = 20$

Number(Misclassified)	p(Misclassified = x)
5	0.0148
6	0.0370
7	0.0739
8	0.1201
9	0.1602
10	0.1762
11	0.1602
12	0.1201
13	0.0739
14	0.0370
15	0.0148

Based on this analysis, a sample size n = 30 was selected as jointly providing ≥ 90% confidence in detecting differences between any two raters from the $p = 0.50$ base random assignment case to reduced misclassification rates of $p = 0.40$, 0.30, 0.20, 0.10, and 0.05 respectively and providing intermediate sampling resolution comparable to that of larger sample sizes. Allowing for all possible sample combinations of n = 30 out of the population of N = 75 HFACS detailed reports, $C_{40}^{30} = 1.1496 \times 10^{11}$ assuring that the binomial sampling distribution applies.

The sampling design to establish and verify rater reliability was as follows:

1. The sample of $n = 30$ detailed accident reports were randomly selected from the population of N = 75 detailed reports. The remaining 45 detailed reports were randomly assigned to two categories: 10 to training and 20 to testing.
2. The researcher and two expert pilots jointly established classification criteria from the 10 training detailed accident reports.

3. The researcher and two expert pilots independently classified accident causes from the summaries of the 10 testing accident reports in accordance with the established HFACS classification criteria in two randomly ordered replicates.
4. Attribute agreement analysis was conducted on the classifications. If the measurement metrics Each Appraiser versus Expert Standard > 50%, All Appraisers versus Expert Standard > 50%, and Between Appraiser agreement > 50%, the researcher would proceed to Step 5. If any one of the measurement metrics < 50%, the remaining 45 detailed reports would be randomly re-assigned to two categories: 10 to training and 20 to testing. Step 2 would be repeated updating the joint classification criteria to include new information. Step 3 would be repeated on the new set of 10 testing reports. Attribute agreement analysis in this step would be conducted evaluating for all measurement metrics > 50%.
5. The researcher and two expert pilots independently classified accident causes of the summaries of the n = 30 detailed accident reports in accordance with the established HFACS classification criteria in two randomly ordered replicates. Attribute agreement analysis was conducted evaluating for Each Appraiser versus Expert Standard > 50%, All Appraisers versus Expert Standard > 50%, and Between Appraiser agreement > 50%. If this set of criteria was not met, the process would return to Step 1 and the remaining 45 detailed reports would be randomly re-assigned to two categories: 10 to training and 20 to testing. Steps 1 to 5 were iterated until the set of criteria

was met. As this set of criteria was met, the researcher proceeded to classification in Step 6.

6. The researcher classified accident causes of the remaining 272 summary reports in accordance with established HFACS criteria.
7. Upon completion of the classification, a random sample of $n = 30$ was selected from the 272 summary reports classified by the researcher. Using the established classification criteria, the $n = 30$ summary reports were submitted in random order to the researcher for re-classification. The $n = 30$ summary reports were submitted in random order to the two expert pilots who independently classified accident causes in accordance with the established HFACS classification criteria in two randomly ordered replicates. Attribute agreement analysis was conducted and meeting the set of criteria in Step 5 indicated acceptable classification by the researcher.

3.2 Methodological Design and Rationale for the Design

Apprehending human errors causation path in UAV and MAV accidents can reveal important findings to understand the required interventions for UAVs and MAVs. However, it is impossible to manipulate human errors in order to investigate their potential influence on UAVs for some certain reasons. This study is based on the analysis of human errors contribution to accidents in unmanned and manned types of aircrafts. The *ex-post facto* method was used for the design of the research. In this design, the events were the Accidents, Class A Mishap, that had already occurred. These data were analyzed for significant paths among HFACS Categorical levels in manned or unmanned types of aircraft by the means of factor analysis and for commonality of identified significant paths between UAV and MAV accident causes by means of structural equation modeling (SEM).

Factor analysis, attempting to find latent variables which cannot be observed (Cox, 2005), is a technique for exploring any number of linearly interrelated variables to a reduced number of unobservable variables. In this study, exploratory factor analysis was conducted to identify any potential statistically significant paths of relationships between HFACS categorical levels using the correlation matrix.

Structural equation modeling is a technique that combines factor analysis (the measurement model), which relates sets of directly observable variables to underlying conceptual (latent) variables, with path analysis of the relationships among those conceptual variables (Harris, 2001). To this end, factor analysis was conducted first to exploit the possible paths among the category level of DOD HFACS. Having the factors or components, paths were tested for their statistically significant causation.

Path analysis, results from the estimation of a causal model from correlations, was developed by Wright (1934) as a flexible means of relating the correlation coefficients between variables in a model to the functional relations among them for the purpose of examining genetic studies. This subject was followed by the studies of Turner and Stevens, Tukey in the 1950s (Wright, 1960) and many researchers recently. Path analysis, one of the applications of structural equation modeling and known also as causal analysis, is an extension of the regression model, used to test the fit of the correlation of causal models. The analysis was grounded on the estimation of the relationships in the hypothesized model by the researcher.

The three rules of path analysis, known as Wright's Rules (Loehlin, 2004), are based on the idea that if a situation can be presented as a proper path diagram, then the correlation between any two variables in the diagram can be expressed as the sum of the compound paths connecting these two points. As in having some rules to be followed, path analysis also has some assumptions that should be taken into account cautiously and prudently to prevent any misinterpretation of the model and analysis. Given that direct effects in a path model were found to be statistically significant, as Kline (1991) states, the researcher must be aware of the fact that global goodness-of-fit indices provide limited information about the adequacy of path models: they reflect only the "average" fit of a model. He also expresses that a fit index can imply satisfaction even when the proportions of the model clearly do not match sample data. Any proposed model can be revised to fit the data by reducing the degrees of freedom. The conditions necessary to establish causal relations include time precedence and robust relationship in the presence of other variables (Lei & Wu, 2007).

As Everitt and Dunn (1991, p. 304) articulate the myths and realities of causal models and latent variables, they state that even though any convincing, respectable, and reasonable a path diagram may appear, any causal inferences extracted are rarely more than a form of statistical fantasy as path analysis deals with correlation, not causation of variables.

Consequently, a researcher dealing with path analysis must be aware of fact that the numbers neither tell every aspect of model nor confirms the model hypothesized. An investigator needs additional evidences to imply causality in a path analysis. As Kline (2011) articulates, among plausible models with equal or near-equal fit, the researcher must explain why any one of them may actually be correct. He must directly acknowledge the existence of equivalent or near-equivalent models and describe what might be done in future research to differentiate between any serious competing models.

As all the causal effects in this study were unidirectional, the models analyzed are recursive. According to Kline (2011), the use of an estimation model other than Maximum Likelihood requires explicit justification. As an assumption, the exogenous variables, established at first main level of DOD HFACS, were considered to be measured without error. There are two options for the analysis of recursive path models, which are multiple regression or estimation with an SEM computer program (Kline, 2011). Maximum likelihood estimation as the default model in AMOS (Analysis of Moment Structures) software program was used for SEM analysis of the hypothesized path models to obtain the standardized total effects and goodness of fit statistics.

According to Miller and Salkind (2002) the prospective outcomes of "natural" experiments such as *ex-post facto* research design discovers and exposes causal relationships under controlled conditions; thus, statements of greater rigor are made possible and increased validity of social treatments or program is demonstrated.

Tvaryanas and Thompson's (2008) and Walker, O'Connor, Phillips, Hahn, and Dalitsch's (2011) observations of no complete paths through the HFACS taxonomy corresponding to Reason's (1990) "Swiss Cheese" model implies that this research should test for all possible combinations of incomplete and complete paths through the DOD HFACS taxonomy as shown in Figure 5.

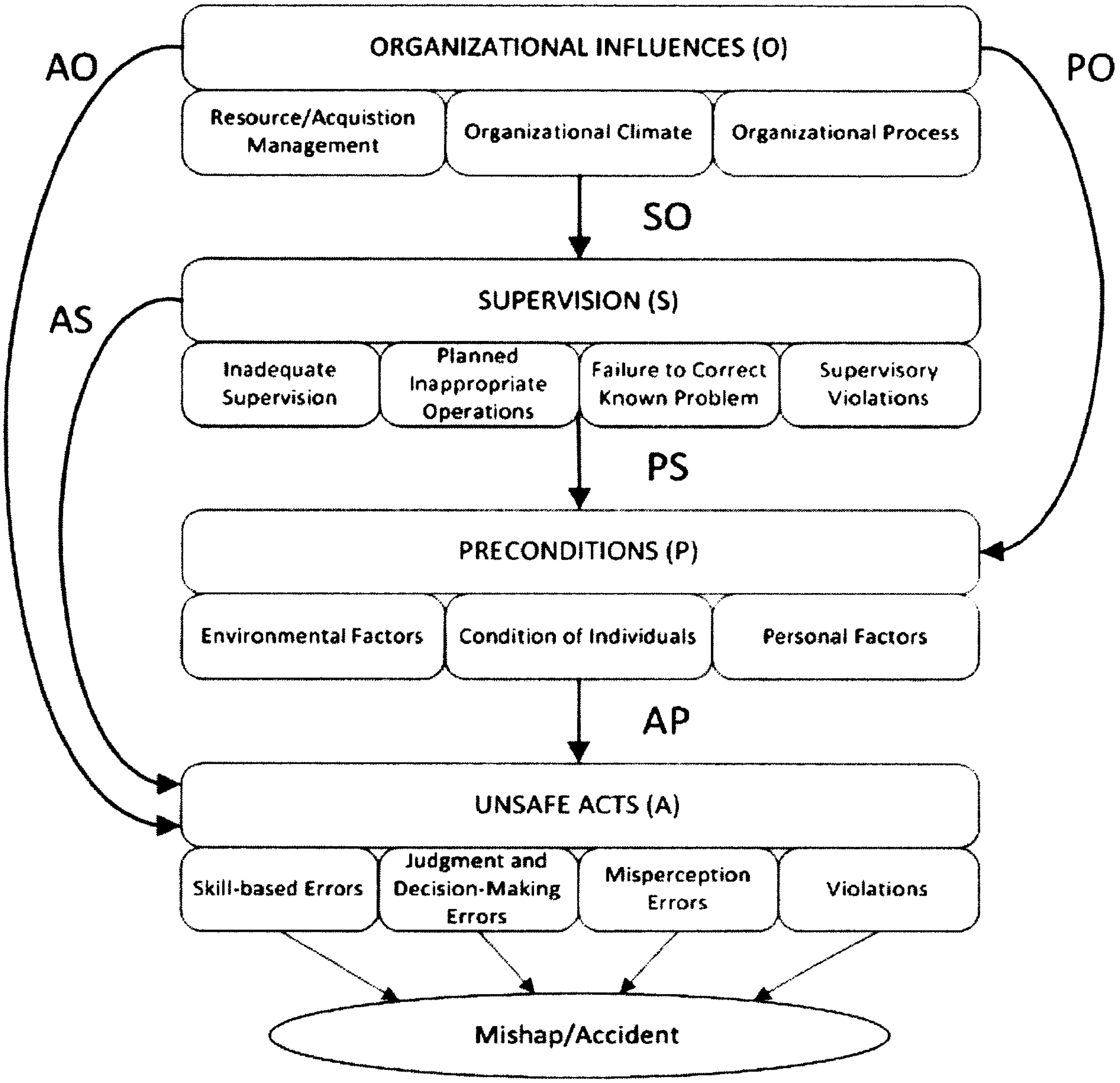


Figure 5. **All Possible Covariance Paths of the HFACS Taxonomy**

The general mathematical structural equation model for the all possible paths model would be:

$$P(Act_i) = \Sigma j=1\text{-}3\ \Sigma k=1\text{-}4\ \Sigma l=1\text{-}3\ (\beta_{AP} X_{P.j} + \beta_{AS} X_{S.k} +$$

$$\beta_{AO} X_{O.l} + \beta_{AS.P} X_{P.j} X_{S.k} + \beta_{AO.P} X_{P.j} X_{O.l} + \beta_{AO.S} X_{S.k} X_{O.l} + \beta_{AO.PS} X_{P.j} X_{S.k} X_{O.l})$$

$$X_{M.n} = 0,1$$

$$\Sigma_i P(Act_i) = 1.0,\ i = 1 - 4 \qquad (2)$$

This research, however, elected to use dummy variables as "pass through" paths when a given HFACS level was not specified in an accident report. This simplified the model to that shown in Figure 6.

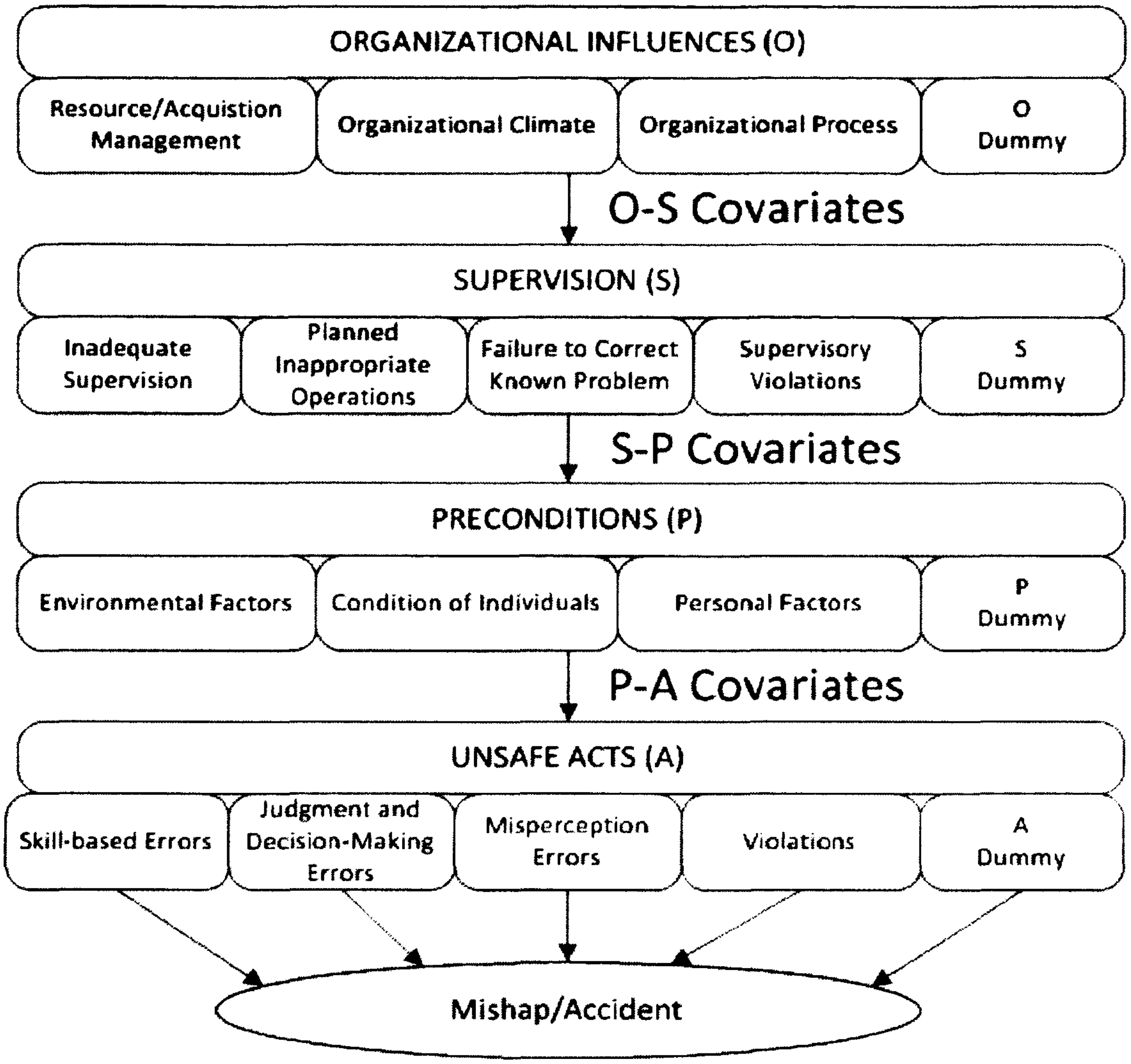


Figure 6. Hypothesized Covariance Paths of the HFACS Taxonomy using Dummy Variables

This yielded a simplified structural equation model conforming to Reason's original (1990) "Swiss Cheese" model.

$$P(Act_i) = \Sigma j{=}1\text{-}4\ \Sigma k{=}1\text{-}5\ \Sigma l{=}1\text{-}4\ \beta_{AO.PS}\, X_{P.j}\, X_{S.k}\, X_{O.l}$$

$$X_{M.n} = 0,1$$

$$\Sigma_i\, P(Act_i) = 1.0,\ i = 1 - 4 \qquad (3)$$

The simplified model provided additional information on the significance of inclusion or lack of inclusion of latent human failures at higher organizational levels.

3.3 Research Questions

The main purpose of first and second question was to test for significant paths among HFACS levels within the context of UAV and MAV accidents. The main purpose of the third question was to identify common paths between the UAV and MAV accidents within the context of HFACS levels.

1. What is, or are, the causation path(s) model for MAV accidents among the categorical levels of HFACS?
2. What is, or are, the causation path(s) model for UAV accidents among the categorical levels of HFACS?
3. Are there any common paths between UAV and MAV accident path(s) in terms of HFACS categorical levels?

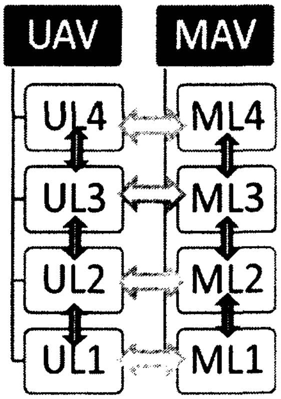


Figure 7. Methodological Design of Research Questions

While vertical dark grey arrows stand for the Research Questions 1 and 2, horizontal light grey arrows stand for the Research Question 3.

UL4: UAV Accidents HFACS Level-4 which is Organizational Influences.
UL3 UAV Accidents HFACS Level-3 which is Supervision
UL2: UAV Accidents HFACS Level-2 which is Preconditions
UL1: UAV Accidents HFACS Level-1 which is Unsafe Acts
ML4: MAV Accidents HFACS Level-4 which is Organizational Influences
ML3: MAV Accidents HFACS Level-3 which is Supervision
ML2: MAV Accidents HFACS Level-2 which is Preconditions
ML1: MAV Accidents HFACS Level-1 which is Unsafe Acts

The HFACS, developed by Shappell and Wiegmann (2000) and based on organizational model of human error of Reason (1990), provides a hierarchical structure that differentiates between various levels within an organization in which an error might occur: 1) Unsafe Acts, 2) Preconditions for Unsafe Acts, 3) Unsafe Supervision, and 4) Organizational Influences. (Walker, et al., 2011)

3.4 Proposed Hypotheses for the Factor Analysis and SEM Models

$H1_O$: There is no statistically significant causation path among the levels of HFACS in MAV accidents.

FOR MAV ACCIDENTS: $\beta_{AP} = \beta_{AS} = \beta_{AO} = \beta_{PS} = \beta_{PO} = \beta_{SO} = 0$

$H1_a$: There is at least one statistically significant causation path among the levels of HFACS in MAV accidents.

FOR MAV ACCIDENTS: β_{AP} OR β_{AS} OR β_{AO} OR β_{PS} OR β_{PO} OR $\beta_{SO} \neq 0$

$H2_O$: There is no statistically significant causation path among the levels of HFACS in UAV accidents.

FOR UAV ACCIDENTS: $\beta_{AP} = \beta_{AS} = \beta_{AO} = \beta_{PS} = \beta_{PO} = \beta_{SO} = 0$

H2$_a$: There is at least one statistically significant causation path among the levels of HFACS in UAV accidents.

FOR UAV ACCIDENTS: β_{AP} OR β_{AS} OR β_{AO} OR β_{PS} OR β_{PO} OR $\beta_{SO} \neq 0$

H3$_O$: There is no common statistically significant path between UAV and MAV accident paths in terms of HFACS Categorical levels.

H3$_a$: There is at least one common statistically significant path between UAV and MAV accidents paths in terms of HFACS levels.

3.5 Data Analysis

For the first two research questions, having identified number of accident error nanocodes in each respective category of HFACS levels in UAV and MAV accidents from the reports of "USAF Accident Investigation Boards" (2012), a factor analysis was conducted. This factor analysis provided correlation information on the potentially statistically significant paths among HFACS category levels. Given the statistically significant correlations identified by factor analysis, four SEM path models were hypothesized for each aircraft type at $\alpha = 0.05$ and 0.10 significance levels. Each model was created and tested in the SPSS/AMOS software in order to determine model fit and confirm the significant paths within DOD HFACS taxonomy. This concluded the testing for significance of the β coefficients in hypotheses **H1$_O$**, **H1$_a$** and **H2$_O$** and **H2$_a$**.

For the third research question; three different comparisons were made to establish the base for common paths between UAV and MAV accidents. The first comparison was made between the factor analysis, using the Tables 13, 14, 15 and 16 at the two significance levels of the two aircraft type, UAV and MAV. The second comparison was made via contrasting the results of the path analysis for each aircraft type, MAV and UAV. The third comparison was conducted via applying MAV data to UAV model and at the two significance levels to identify similar paths within the context of DOD HFACS. UAV data could not be fit to the MAV model due to insufficient degrees of freedom from the sample size. In this comparison, the total effects of the respective analysis are compared to contrast the common paths. This comparison concluded the testing for significance of the β coefficients in hypotheses **$H3_0$** and **$H3_a$** for common significant paths between UAV and MAV accidents in terms of HFACS categorical levels. All of statistical tests are performed at the 0.05 and 0.10 significance levels. Table 3 shows the methodological design of the analysis.

Table 3. Methodological Design

Research Question	Data Collection	Data Collection Reference	Data Analysis Methods	Data Analysis Tool	Expected Outputs	Relationship to Research Questions
Pre-Analyze	Rater reliability to be established by comparing the researcher's classifications to those of two other expert pilots.	USAF Accident Investigation Boards	Attribute Agreement Analysis	Minitab	To ensure the rater reliability to extend what previous studies presented.	Establishment and Verification of Rater Reliability for this Research
1 and 2	Coding and normalization of the accident causes according to HFACS		Factor Analysis Structural Equation Modelling (SEM) (Path Analysis)	SPSS SPSS /AMOS	1. The paths among of HFACS Category levels. 2. See the UAV and MAV models whether they fit to HFACS.	Test the paths in UAVs and MAVs accidents in terms of human factors.
3			Structural Equation Model (Path Analysis)	SPSS /AMOS	3. Compare UAV and MAV accidents in terms of HFACS taxonomy.	Contrast the common paths between UAV and MAV accidents

3.6 Internal and External Validity of the Research

Experimental design and the research methods are considered to be the tools of establishing the internal validity. In this study, structural equation modeling was used to test the structure and identify the statistically significant paths among the levels of DOD HFACS taxonomy in two aircraft types, UAV and MAV at 0.05 and 0.10 significance levels.

The question of "… can the results obtained reasonably be used to make generalization about the world beyond that specific research context?" (Leedy & Ormrod, 2013, p. 17) addresses the issue of external validity. The methodology of this study can be used to test other structures of HFACS adaptations and accident causation taxonomies as well. The external validity of a research study is the extent to which the conclusions drawn can be generalized to other contexts (Leedy & Ormrod, 2013). The conclusions of the study address the issues regarding the critiques of HFACS. According to Leedy and Ormrod (2013), there are three commonly used strategies that enhance external validity: A real-life setting, a representative sample, and replication in a different context. Considering these three commonly used strategies:

- The setting is real life since the samples are taken from actual aircraft accidents and tested in an *ex post facto* approach.
- Representative Sample – the U.S. Air Force is considered to be one of the biggest air forces in the world from very different perspectives, and the usage of the UAV as well as MAV is the most frequent within the U.S. Air Force.

- The timeframe includes 14 fiscal years of the accident reports. Earlier accident reports related with old aircrafts might not depict the current technological developments.

The results of this study, which aim to exploit the covariance among the variables within the levels of HFACS and type of aircrafts, can be replicated in a different (generalization and applicability) air force, commercial aviation or sector.

Analyzing the research questions, a methodology can be found to tailor the HFACS being used in military aviation or adapted it to other domains other than aviation. Since most of the evaluation studies of HFACS are concerned about the inter-rater reliability and level of agreement on the factors that caused or contributed to accident, which can be regarded as internal validity of HFACS, it is vital to analyze the structure of the HFACS itself, which is external validity. The validity of the study and validity of HFACS are used in two different settings.

3.7 Research Protocol

A protocol is an essential part of any study as it outlines in detail the study rationale and methodology and provides a plan of action for the investigators to follow (Noyes, 2008). Consequently, the author ensures a distinctive understanding into the designated methods of the study. Holloway and Mooney (2004) articulated that both a systematic review and a piece of original research require a carefully considered methodology called a protocol before you can begin; how to construct a protocol is one of the most difficult tasks asked of anyone beginning this type of work.

The data for this study originated from MAV and UAV accidents in the United States Air Force. The time frame is from fiscal years of 2000 to 2013. It was collected by Unites States Legal Operations Agency that can be considered as a reliable source since it is an official governmental institution. The US Air Force conducts aerospace accident investigations of all Class A accidents involving Air Force aircraft, unmanned aerial vehicles (UAVs), missiles, and space systems or equipment, unless they result in damage solely to government property (in which case the accident investigation is discretionary). Aerospace Accident Investigation Boards (AIBs) are convened under the authority of Air Force Instruction (AFI) 51-503, Aerospace Accident Investigations (USAF Accident Investigation Boards, 2012).

Structural equation models were constructed in the SPSS/AMOS software package to test the structure of HFACS levels in both accident types. MAV data were fit to the UAV model to determine if any significant accident causal paths were common between UAV and MAV accidents.

CHAPTER 4

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

The main objective of this study was to analyze the structural relationships of accident causes among DOD HFACS levels in comparable UAV and MAV and to analyze the relationship between UAV and MAV accident causes paths. For the first two research questions, structural equation models were constructed in the SPSS/AMOS software package to test the structure of DOD HFACS levels in both MAV and UAV aircraft types. For the third research question, three different comparisons were made to establish a base for common paths between UAV and MAV accidents. The first comparison was made between the results of factor analysis. The second comparison was made via contrasting the results of the path analysis for each aircraft type, MAV and UAV. The third comparison was made via applying MAV data to UAV model at two significance levels to identify similar paths within the context of DOD HFACS. UAV data could not be fit to MAV model due to insufficient degrees of freedom from the sample size. In this comparison the standardized total effects of the respective analysis were compared to contrast the common paths. All analyses were conducted at two different *p* values, 0.05 and 0.10.

The DOD HFACS describes four main tiers, named as main levels in this study, of failures/conditions explained in the previous sections. The next layers following the "level" are named as category and nanocodes in DOD HFACS. This study used four tiers as main levels, categories and sub categories as "categories", and nanocodes. As the main purpose of the study was concerned about the structure rather than internal content, this arrangement was established to conduct the analysis in a simple and a functional technique. The levels and the respective categories and abbreviations used in the analysis are shown in Table 4.

Table 4. Levels, Categories, Respective Number of Nanocodes and Abbreviations used in the Analysis

LEVELS	CATEGORIES	ABBREVIATION	Number of HFACS Nanocodes
Organizational Influences (O)	Resource/Acquisition Management	ORG	9
	Organizational Climate	OC	5
	Organizational Processes	OP	6
	Dummy Variable	ODMY	1
Total Number of Nanocodes in Organizational Influences			**20+1**
Unsafe Supervision (S)	Inadequate Supervision	SI	6
	Planned Inappropriate Operations	SP	7
	Failed to Correct Known Problem	SF	2
	Supervisory Violations	SV	4
	Dummy Variable	SDMY	1
Total Number of Nanocodes in Unsafe Supervision			**19+1**
Preconditions for Unsafe Acts (P)	Environmental Factors	PE	19
	Condition of Individuals	PC	55
	Personal Factors	PP	18
	Dummy Variable	PDMY	1
Total Number of Nanocodes in Preconditions for Unsafe Acts			**92+1**
Acts (A)	Skill-Based Errors	AE1	6
	Judgment & Decision-Making Errors	AE2	6
	Misperception Errors	AE3	1
	Violations	AV	3
	Dummy Variable	ADMY	1
Total Number of Nanocodes in Acts			**16+1**
Total number of DOD HFACS Nanocodes and Dummy Variables			**147+4**

4.2 Inter-rater Reliability

The attribute agreement analysis is used to measure and evaluate the accuracy of subjective ratings by people. In general, it is more likely that subjective ratings are accurate and useful if there is a substantial agreement in measurements among appraisers. For this study, rater reliability was established by comparing the researcher's classifications to those of two other expert pilots of sample subset executive summaries of the 48 detailed accident reports with known DOD HFACS accident classifications by panels of United States Air Force "experts".

As no human subject information was part of the crash data and the experts provided information only about the crash data that does not include any human subject data about themselves, the study was judged to be exempt from review by the Old Dominion University Institutional Review Board (IRB).

At the beginning of the inter-rater reliability study, the researcher and two expert pilots, having a diverse experience in aviation, jointly studied the DOD HFACS taxonomy together with detailed reports. The training and subsequent phase of the inter-rater reliability analysis provided raters with a common understanding of DOD HFACS and its contents. Each phase of this study improved the understanding of the system and the raters' accident coding causes or factors. The design to establish and verify rater reliability was divided into mainly three sections: Training, Testing and Evaluation.

4.2.1 Training

The initial training included the joint review of the study's purpose and DOD HFACS taxonomy including some sample detailed accident reports. The other part of this training consisted of reviewing ten detailed accident reports jointly. While some reports included "causal", "contributory", "non-contributory" classification, most of the detailed reports provided all relative causes with respective nanocode(s). As the executive summaries of the reports did not include the "non-contributory" factors, it would not be possible to infer any cause. To this end, the raters decided to classify the all human errors found as causal factors without making any further sorting as "causal" or "contributory." The presence of any cause was assigned a nanocode within a respective category. For the reports in which a nanocode was not assigned a letter D was entered to the respective level as dummy variable.

4.2.2 Inter-rater Reliability Testing

The second section of the rater-reliability analysis, named as testing, consisted of three rounds by the three raters. The researcher and two expert pilots independently classified accident causes of the summaries of $n = 48$ detailed reports in accordance with the established DOD HFACS classification criteria in two randomly ordered replicates for each round. Round 1, Round 2 and Round 3 included 10, 10, and 28 executive summaries respectively of detailed accident reports. Minitab® Statistical Analysis (16.2.1) software was used for inter-rater reliability of Each Appraiser versus Standard, All Appraisers versus Standard, and Between Appraisers. Although the analysis was executed at nanocode and category level, the latter one is used in this study, since the structural equation models were constructed and statistical analyses were conducted at the categorical level.

4.2.2.1 Round One Attribute Agreement Analysis

At the DOD HFACS category level path, the preliminary percentage of agreement results of round one showed acceptable Within Appraisers repeatability of 96.15%, 82.69%, and 69.23% respectively and acceptable between appraisers agreement of 50.0%. However, for Each Appraiser versus Standard, raters one and two exhibited acceptable agreement at 73.08% and 63.46% respectively. Rater three agreed with the standard only 44.23%, which was less than the specified 50% average. After these results, the raters reviewed the same accident reports to identify the differences in code assignments, agree on the correct assignment per report, and the criteria for each assignment. The results of Round One analysis are presented in Table 5.

Table 5. Attribute Agreement Analysis of Round 1

ROUND 1 ATTRIBUTE AGREEMENT ANALYSIS OF HFACS CATEGORY LEVEL				
Assessment Agreement	Appraiser	# Inspected	# Matched	Percent 95 % CI
Within Appraisers	Rater1	52	50	96.15 (86.79, 99.53)
	Rater2	52	43	82.69 (69.67, 91.77)
	Rater3	52	36	69.23 (54.90, 81.28)
Each Appraiser vs. Standard	Rater1	52	38	73.08 (58.98, 84.43)
	Rater2	52	33	63.46 (48.96, 76.38)
	Rater3	53	23	44.23 (30.47, 58.67)
Between Appraisers		52	26	50.00 (35.81, 64.19)
All Appraisers vs. Standard		52	22	42.31 (28.73, 56.80)

Two factors were identified as the causes for this low level of agreement. First, it was the initial part of independent study, and the raters did not think that they had sufficient understanding of the HFACS classification code definitions. Second, they thought that including as many nanocodes as possible would contribute in finding the causes of the accidents. However, including more nanocodes than required decreased the level of agreement.

4.2.2.2 Round Two Attribute Agreement Analysis

The raters performed round two attribute agreement analysis on an additional 10 randomly selected accident summaries classifying two replicates with approximately a one week interval between replicates. The Assessment Agreement results of round two are shown in Table 6. The Within Appraisers, Each Appraiser versus Standard, Between Appraisers, and All Appraisers versus Standard agreement percentages were all above the specified 50% average.

Table 6. Round 2 Attribute Agreement Analyses

ROUND 2 ATTRIBUTE AGREEMENT ANALYSES OF HFACS CATEGORY LEVEL				
Assessment Agreement	Appraiser	# Inspected	# Matched	Percent 95 % CI
Within Appraisers	Rater1	57	54	94.74 (85.38, 98.90)
	Rater2	57	53	92.98 (83.00, 98.05)
	Rater3	57	48	84.21 (72.13, 92.52)
Each Appraiser vs. Standard	Rater1	57	50	87.72 (76.32, 94.92)
	Rater2	57	51	89.47 (78.48, 96.04)
	Rater3	57	47	82.46 (70.09, 91.25)
Between Appraisers		57	44	77.19 (64.16, 87.26)
All Appraisers vs. Standard		57	43	75.44 (62.24, 85.87)

4.2.2.3 Round Three Attribute Agreement Analysis

Twenty eight executive summaries of detailed accident reports were randomly selected and rated in two replicates by the raters with approximately a one week interval between replicates. The Assessment Agreement results of round three are shown in Table 7. The raters' Within Appraisers, Each Appraiser versus Standard, Between Appraisers, and All Appraisers versus Standard agreement percentages were all above specified 50% average.

Table 7. Round 3 Attribute Agreement Analyses

ROUND 3 ATTRIBUTE AGREEMENT ANALYSIS OF HFACS CATEGORY LEVEL				
Assessment Agreement	Appraiser	# Inspected	# Matched	Percent 95 % CI
Within Appraisers	Rater1	163	144	88.34 (82.40, 92.83)
	Rater2	163	152	93.25 (88.25, 96.58)
	Rater3	163	137	84.05 (77.51, 89.31)
Each Appraiser vs. Standard	Rater1	163	133	81.60 (74.78, 87.22)
	Rater2	163	135	82.82 (76.14, 88.27)
	Rater3	163	126	77.30 (70.10, 83.49)
Between Appraisers		163	117	71.78 (64.21, 78.54)
All Appraisers vs. Standard		163	109	66.87 (59.08, 74.04)

The results from Round Three were assessed to be sufficient to continue evaluating the remaining reports which do not have detailed reports.

4.2.3 Evaluation of the Remaining Reports

All the remaining reports having no detailed accident information were rated by the researcher in accordance with round three. After all reports were rated, thirty executive summaries of reports having no detailed information were randomly selected and rated in two replicates by the raters with approximately a one week interval between replicates. The round four inter-rater attribute agreement analysis results are shown in

Table 8. The raters' Within Appraisers and Between Appraisers agreement percentages were all above specified 50% minimum.

Table 8. Round 4 Attribute Agreement Analyses

ROUND 4 ATTRIBUTE AGREEMENT ANALYSIS OF HFACS CATEGORY LEVEL				
Assessment Agreement	Appraiser	# Inspected	# Matched	Percent 95 % CI
Within Appraisers	Rater1	180	142	78.89 (72.19, 84.61)
	Rater2	180	167	92.78 (87.97, 96.10)
	Rater3	180	142	78.89 (72.19, 84.61)
Between Appraisers		180	95	52.78 (45.21, 60.25)

The results of Round Four were assessed to be sufficient to utilize the classifications for exploratory factor analysis, structural equation modeling, and statistical analyses of path effects.

4.3 Data Arrangement

The data of this study, 347 Class A accident reports, were acquired from United States Air Force Legal Operations Agency web site. This website contains a list of Class A aerospace and ground mishaps or accidents and their corresponding summaries and full narratives from the Accident Investigation Board (AIB) of USAF reports.

The study acquired accident classification data from 347 reports of which 75 are detailed and classified in accordance with DOD HFACS taxonomy for the years between 2010 and 2013. Arrangement of the available accident reports with respect to years, aircraft type, and report form is presented in Table 9.

Table 9. Classification of Accident Reports

YEAR	REPORT NUMBERS		TOTAL REPORTS IN YEARS	FORM OF THE REPORT
	MAV	UAV		
2000	21	2	23	272 EXECUTIVE SUMMARIES IN 10 YEARS
2001	27	3	30	
2002	30	9	39	
2003	32	5	37	
2004	18	5	23	
2005	17	5	22	
2006	18	5	23	
2007	15	5	20	
2008	21	8	29	
2009	17	9	26	
2010	6	6	12	75 DETAILED REPORTS IN 4 YEARS
2011	12	16	28	
2012	12	10	22	
2013	8	5	13	
SUM	**254**	**93**		
TOTAL	**347**			

An accident database was prepared in a Microsoft Excel workbook and each report's accident cause was entered to its respective nanocode as 1 for occurrence versus 0 for nonoccurrence. Since the majority of reports did not classify mishap or accident impacts as major, minor, or contributory in terms of human injury cost or aircraft cost, no weighting system was employed. All causes or factors found in the accident reports were entered as having an equal weight of 1, regardless of the impact of the respective mishap or accident. The 0-1 non-occurrence versus occurrence entry created a Poisson process by HFACS nanocode, category, and category level. As the study is concerned with the structural evaluation of DOD HFACS taxonomy, fourteen (14) DOD HFACS categories and four (4) dummy variables as set forth in Table 4 were used in this study. To reduce the total number of cells, nanocode(s) found at each report were aggregated to into their respective HFACS category level. Eighty four accident reports were assigned no DOD HFACS nanocode by the USAF AIB and were excluded from the analysis. The numbers of excluded reports for UAV and MAV were 33 and 51 respectively. The detailed numbers of the reports assigned DOD HFACS nanocodes are depicted in Table 10.

Table 10. Accident Reports Containing HFACS Nanocode

	MAV Accident Reports	UAV Accident Reports	TOTAL
All Reports	254	93	347
Reports Including DOD HFACS Nanocode	203	60	263

4.4. Sample Size

The sample size for factor analysis and structural equation modeling was assessed within the same context for the two different set of data, UAV and MAV. According to Kline (2011), a sample size of less than 100 is considered to be small, between 100-200 medium, and bigger than 200 cases are considered large. In that context the sample size for UAV of $n = 60$ can be concluded as small and MAV of $n = 203$ can be considered as a large sample size for the analysis. Another consideration for sample size is the complexity of the structure or model (Kline, 2011). As the proposed model includes no latent variable and linearity or single-direction between the categories, it can be concluded that the model hypothesized doesn't have a complexity in terms of paths or correlations.

4.5 Data Normalization

Normalization can be considered as a method for producing a set of appropriate relations that support the data requirements of an analysis. To normalize the mishap and accident occurrence data, each report's nanocode counts were aggregated within categories and divided by the total number of nanocodes, plus one for the dummy variable within each category level to yield Poisson occurrence rates. For example, if an accident report was assigned three nanocodes in Personal Factors (PE) category under Preconditions for Unsafe Acts (P) main level of DOD HFACS, it was divided by its respective sum of total nanocode, 93 (Table 4), yielding a Poisson occurrence rate of 0.0322581 per report. The normalization to Poisson occurrence rates standardized the data for subsequent exploratory factor analysis (EFA) and structural equation modeling.

4.6 Descriptive Analysis of the Data

The exploratory findings regarding UAV and MAV accidents in terms of DOD HFACS Category and main levels are presented in Figure 8 and Figure 9 respectively. The total DOD HFACS nanocodes found in 60 UAV accident reports was 234, and the number for 203 MAV accident reports was 676. The nanocode rate per accident was 3.9 and 3.3 for UAV and MAV respectively.

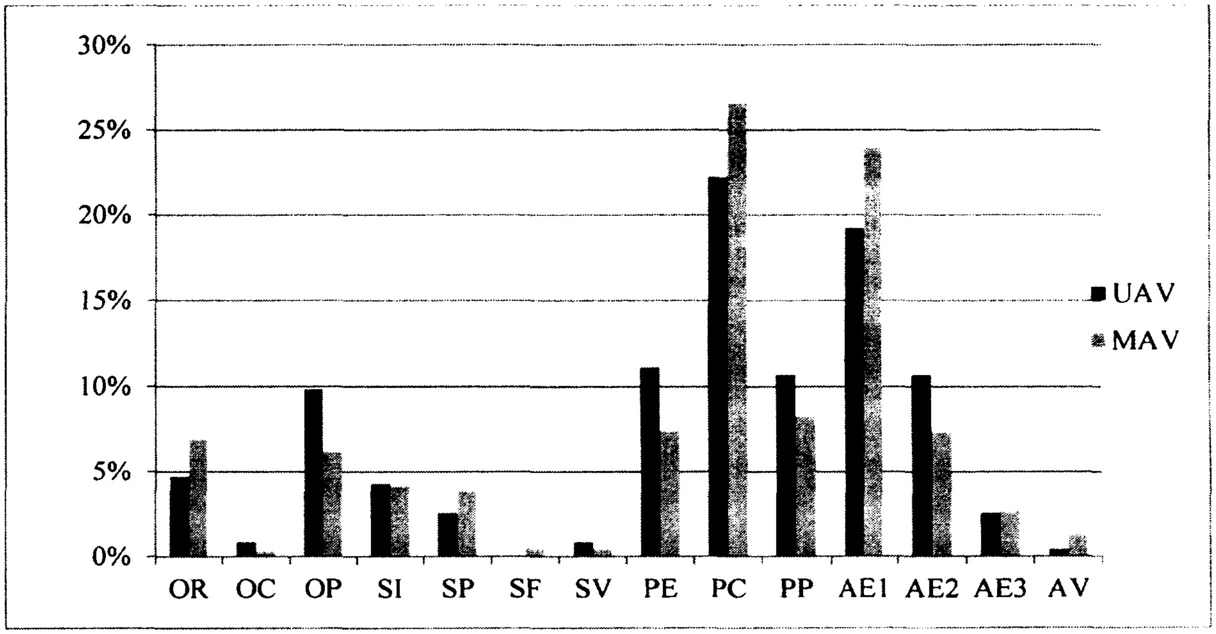


Figure 8. **UAV and MAV Accident Rates in Terms of DOD HFACS Category Levels**

The accident rates in terms of the DOD HFACS main levels are depicted in Figure 9. The rates of UAV and MAV accidents can be considered to be close and consisent in terms of the DOD HFACS main levels. The rates of O and P levels in UAV are higher than MAV respective levels, whereas the rates of S and A levels in MAV are higher than UAV respective levels by slight percenteges.

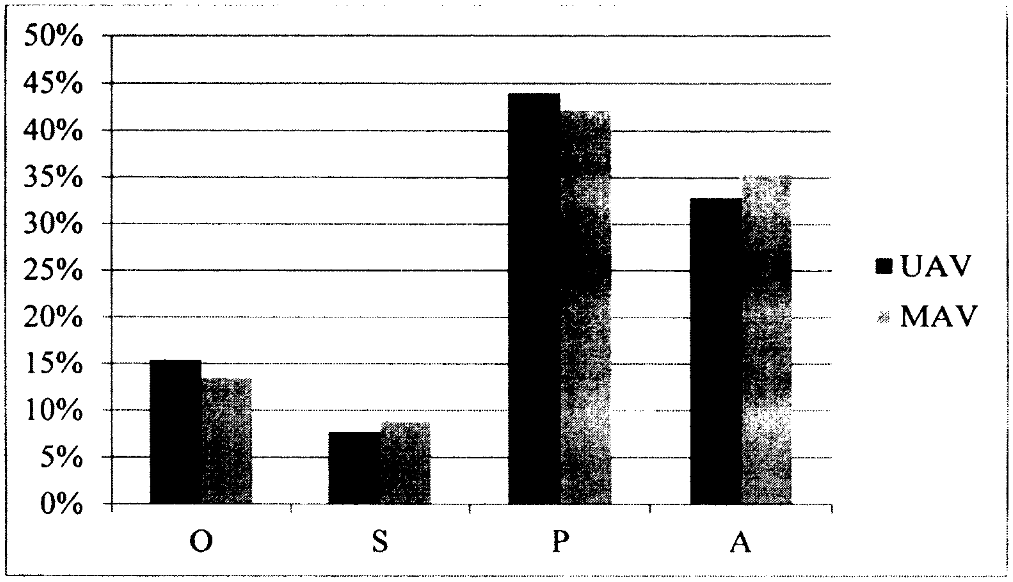


Figure 9. **UAV and MAV Accident Rates in Terms of DOD HFACS Main Levels**

The descriptive statistics were obtained using IBM Statistical Package for the Social Sciences (SPSS version 21) program. The descriptive statistics are presented in Table 11 and Table 12.

Table 11. Descriptive Statistics for MAV Accident Reports

Variable Name	Mean	S.D	Variance	Skewness	Kurtosis
ORG	0.011	0.024	0.001	2.333	6.141
OC	0.000	0.005	0.000	9.999	98.960
OP	0.010	0.022	0.000	2.182	4.127
ODMY	0.032	0.022	0.001	-0.728	-1.484
SI	0.007	0.020	0.000	3.007	8.882
SP	0.006	0.019	0.000	3.194	10.132
SF	0.001	0.006	0.000	8.102	64.284
SV	0.001	0.006	0.000	8.102	64.284
SDMY	0.039	0.021	0.000	-1.385	-0.082
PE	0.003	0.006	0.000	3.032	12.127
PC	0.010	0.014	0.000	2.653	11.740
PP	0.003	0.006	0.000	2.746	9.979
PDMY	0.004	0.005	0.000	0.501	-1.766
AE1	0.050	0.050	0.002	0.734	-0.063
AE2	0.015	0.033	0.001	2.066	3.401
AE3	0.006	0.018	0.000	2.916	6.565
AV	0.003	0.013	0.000	4.460	18.073

Table 12. Descriptive Statistics for UAV Accident Reports

Variable Name	Mean	S.D	Variance	Skewness	Kurtosis
ORG	0.009	0.019	0.000	1.679	0.846
OC	0.002	0.009	0.000	5.334	27.360
OP	0.018	0.029	0.001	1.377	0.873
ODMY	0.025	0.024	0.001	-0.068	-2.065
SI	0.008	0.019	0.000	1.835	1.413
SP	0.005	0.020	0.000	4.169	17.083
SV	0.002	0.009	0.000	5.334	27.360
SDMY	0.038	0.021	0.000	-1.294	-0.339
PE	0.005	0.006	0.000	0.859	-0.258
PC	0.009	0.016	0.000	1.810	2.643
PP	0.004	0.010	0.000	2.720	7.616
PDMY	0.003	0.005	0.000	0.895	-1.241
AE1	0.047	0.055	0.003	0.989	0.212
AE2	0.026	0.044	0.002	2.024	4.719
AE3	0.006	0.019	0.000	2.736	5.671
AV	0.001	0.008	0.000	7.746	60.000

Since the category Supervisory Failure (SF) category of UAV accidents had a zero assignment rate, it was eliminated from factor analysis and structural equation modeling. Descriptive statistics were calculated for the remaining variables.

Fundamental research findings are presented within the context of analysis executed during study, including factor analysis and path analysis and structural equation modeling (SEM) respectively. The study was based on 347 Class A accident reports of USAF Accident Investigation Board (AIB) between the years of 2000 and 2013. The following findings are summarized from the descriptive analysis of the reports:

- Eighty four (84) accident reports out of 347 contained no DOD HFACS nanocodes. Thirty three (51) MAV reports and fifty one (33) UAV reports contained no DOD HFACS nanocodes. The remaining 263 reports had at least one nanocode assigned.
- A total of 234 DOD HFACS nanocodes were assigned to 60 UAV accident reports, and 676 nanocodes were assigned to 203 MAV accident reports. The nanocode rate per accident was 3.9 and 3.3 for UAV and MAV respectively.
- The rate of nanocode assignment to each main category level was as follows:
    - "Organizational Influences" was 15.4% for UAV and 13.5% for MAV,
    - Unsafe Supervision (S) was 7.7% for UAV and 8.9% for MAV,
    - Preconditions for Unsafe Acts (P) was 44% for UAV and 42.3% for MAV,
    - Unsafe Acts (A) was 32.9% for UAV and 35.3% for MAV.

- "Condition of Individuals" (PC) had the highest accident rate among the category level of DOD HFACS in both types of aircraft, 22.2% and 26.6% for UAV and MAV respectively. Skill-Based Errors (AE1) had the second highest accident rate as 19.2% and 24%% for UAV and MAV respectively.
- Out of 147 HFACS nanocodes, ninety seven (97) nanocodes were assigned to MAV accident reports and sixty seven (67) were assigned to UAV accident reports. In other words 66% of the available nanocodes were used to classify MAV accident causes and 46 % for UAV accident causes.

From the above summary, the number of the nanocodes assigned per accident report displayed close values among the HFACS category and main levels in terms of UAV and MAV aircraft types.

4.7 Factor Analysis

An exploratory factor analysis was performed using SPSS to explore the potential for dimension reduction. The Pearson correlation matrix, that provides the pattern of relationships, and its associated significance matrix for MAV and UAV are presented in Appendix C and Appendix D respectively. The correlations found statistically significant at $p <= 0.05$ and $p <= 0.1$ levels among MAV DOD HFACS category levels are presented in Tables 13 and 14 and among UAV DOD HFACS category levels in Tables 15 and 16 with their correlations values. When determining the statistically significant correlations, those found at the same category level are collinear, and were excluded from subsequent path analysis, since this study was focused on the relationships among the levels. In other words, any statistically significant collinear relationship within the same DOD HFACS category level was eliminated as out of scope of the study and research questions. The numbers in Tables 13, 14, 15 and, 16 are the correlation values of the respective categories.

Table 13. Correlations Found Statistically Significant at $p <= 0.05$ among DOD HFACS Categories of MAV Accidents

FROM	LOWER LEVEL							
ORG	SI 0.162	SF 0.272	PC -0.201	PDMY 0.249	AE1 -0.268	AE2 -0.181	ADMY 0.422	
OC	SI 0.216	SP 0.224	SV 0.401	SDMY -0.190	PC 0.388	AE1 0.151	AE2 0.239	AE3 0.144
OP	SI 0.140	SV 0.122	SDMY -0.153	AE1 -0.154	ADMY 0.230			
ODMY	SI -0.125	PDMY -0.229	AE1 0.243	AV 0.151	ADMY -0.451			
SI	PP 0.132							
SP	PC 0.241	PP 0.233	PDMY -0.127	PE 0.125				
SF	**No statistically significant correlation found**							
SV	AE1 0.134	AE2 0.176						
SDMY	PP -0.241							
PE	**No statistically significant correlation found**							
PC	AE1 0.204	AE2 0.284	AE3 0.317	ADMY -0.217				
PP	**No statistically significant correlation found**							
PDMY	AE2 -0.135	ADMY 0.126						

Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant relationships at p value <= 0.05 in Table 12 suggested the following potentially statistically significant MAV accident causal paths to be tested in subsequent structural equation modeling.

OC ⇒ SP ⇒ PC ⇒ AE1 ⇒ Mishap/Accident

OC ⇒ SP ⇒ PC ⇒ AE2 ⇒ Mishap/Accident

OC ⇒ SP ⇒ PC ⇒ AE3 ⇒ Mishap/Accident

OC ⇒ SP ⇒ PDMY ⇒ AE2 ⇒ Mishap/Accident

Other statistically significant relationships at p value <= 0.05 in Table 12 suggested the following additional MAV accident causal paths containing non-statistically significant relationships to be tested in subsequent structural equation modeling.

ORG ⇒ SI ⇒ PP → ADMY ⇒ Mishap/Accident

ORG ⇒ SF → PDMY → ADMY ⇒ Mishap/Accident

ORG → SDMY → PC ⇒ AE1 ⇒ Mishap/Accident

ORG → SDMY → PC ⇒ AE2 ⇒ Mishap/Accident

ORG → SDMY → PC ⇒ AE3 ⇒ Mishap/Accident

ORG → SDMY → PDMY ⇒ AE2 ⇒ Mishap/Accident

OC ⇒ SI ⇒ PP → ADMY ⇒ Mishap/Accident

OC ⇒ SP ⇒ PP → ADMY ⇒ Mishap/Accident

OC ⇒ SV → PDMY → AE1 ⇒ Mishap/Accident

OC ⇒ SV → PDMY → AE2 ⇒ Mishap/Accident

OC ⇒ SDMY ⇒ PP → ADMY ⇒ Mishap/Accident

OC ⇒ SDMY → PC ⇒ AE1 ⇒ Mishap/Accident

OC ⇒ SDMY → PC ⇒ AE2 ⇒ Mishap/Accident

OC ⇒ SDMY → PC ⇒ AE3 ⇒ Mishap/Accident

OC ⇒ SP ⇒ PE ⇒ ADMY ⇒ Mishap/Accident

OP ⇒ SI ⇒ PP → ADMY ⇒ Mishap/Accident

OP ⇒ SV → PDMY → AE1 ⇒ Mishap/Accident

OP ⇒ SV → PDMY → AE2 ⇒ Mishap/Accident

OP ⇒ SDMY ⇒ PP → ADMY ⇒ Mishap/Accident

ODMY ⇒ SI ⇒ PP → ADMY ⇒ Mishap/Accident

ODMY → SDMY → PDMY ⇒ AE1 ⇒ Mishap/Accident

ODMY → SDMY → PDMY → AV ⇒ Mishap/Accident

Table 14. Correlations Found Statistically Significant at $p <= 0.1$ among DOD HFACS Categories of MAV Accidents

FROM	LOWER LEVEL								
ORG	SI 0.162	SP* -0.103	SF 0.272	PC -0.201	PDMY 0.249	AE1 -0.268	AE2 -0.181	ADMY 0.422	AV* -0.10
OC	SI 0.216	SP 0.224	SV 0.401	SDMY -0.190	PC 0.388	AE1 0.151	AE2 0.239	AE3 0.144	
OP	SI 0.140	SV 0.122	SDMY - 0.153	PDMY* 0.111	AE1 -0.154	AE2* 0.095	AV* -0.096	ADMY 0.230	
ODMY	SI -0.125	PP* 0.097	PDMY -0.229	AE1 0.243	AV 0.151	ADMY - 0.451			
SI	PP 0.132	AE1* 0.103							
SP	PC 0.241	PP 0.233	PDMY -0.127	PE 0.125	AE1* 0.115	ADMY* -0.099			
SF	**No statistically significant correlation found**								
SV	AE1 0.134	AE2 0.176	AE3* 0.105						
SDMY	PP -0.241	AE1* -0.103							
PE	ADMY* 104								
PC	AE1 0.204	AE2 0.284	AE3 0.317	AV* 0.091	ADMY -0.217				
PP	AV* 0.102								
PDMY	AE2 -0.135	AE3* -0.101	ADMY 0.126						

* Statistically significant correlations at p value = 0.10.

Additional statistically significant correlations at *p* value <= 0.10 in Table 13 suggested the following additional MAV accident causal paths containing statistically significant relationships to be tested in subsequent structural equation modeling.

ORG ⇒ SP ⇒ PC ⇒ AE1 ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PC ⇒ AE2 ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PC ⇒ AE3 ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PC ⇒ AV ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PP ⇒ AV ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PDMY ⇒ AE2 ⇒ Mishap/Accident

ORG ⇒ SP ⇒ PDMY ⇒ AE3 ⇒ Mishap/Accident

ORG ⇒ SI ⇒ PP ⇒ AV ⇒ Mishap/Accident

OC ⇒ SI ⇒ PP ⇒ AV ⇒ Mishap/Accident

OC ⇒ SP ⇒ PC ⇒ AV ⇒ Mishap/Accident

OP ⇒ SI ⇒ PP ⇒ AV ⇒ Mishap/Accident

ODMY ⇒ SI ⇒ PP ⇒ AV ⇒ Mishap/Accident

Likewise, additional statistically significant correlations at *p* value <= 0.10 in Table 13 suggested the following additional MAV accident causal paths containing non-statistically significant relationships to be tested in subsequent structural equation modeling.

ORG ⇒ SP ⇒ PDMY → AE1 ⇒ Mishap/Accident

OP ⇒ SDMY → PDMY ⇒ AE2 ⇒ Mishap/Accident

OP ⇒ SDMY → PDMY ⇒ AE3 ⇒ Mishap/Accident

OP ⇒ SDMY → PDMY → AV ⇒ Mishap/Accident

ORG ⇒ SI → PDMY → AE1 ⇒ Mishap/Accident

OC ⇒ SI → PDMY → AE1 ⇒ Mishap/Accident

OP ⇒ SI → PDMY → AE1 ⇒ Mishap/Accident

ODMY ⇒ SI → PDMY → AE1 ⇒ Mishap/Accident

OC ⇒ SP ⇒ PDMY → AE1 ⇒ Mishap/Accident

OP ⇒ SV → PDMY → AE3 ⇒ Mishap/Accident

OC ⇒ SDMY → PDMY → AE1 ⇒ Mishap/Accident

OP ⇒ SDMY → PDMY → AE1 ⇒ Mishap/Accident

Table 15. Correlations Found Statistically Significant at $p <= 0.05$ among DOD HFACS Categories of UAV Accidents

FROM	**LOWER LEVEL**						
ORG	PC -0.255	PDMY 0.254	AE1 -0.260	ADMY 0.265			
OC	**No statistically significant correlation found**						
OP	SI 0.233						
ODMY	SI -0.283	SDMY 0.255	PC -0.234	PDMY -0.240	AE1 0.336	AE2 0.246	
SI	PP 0.290	AE3 0.298	AV 0.291	ADMY -0.247			
SP	**No statistically significant correlation found**						
SF	**No statistically significant correlation and nanocode found**						
SV	AE3 0.557	AV 0.701					
SDMY	PP -0.226	AV -0.236	ADMY 0.256				
PE	**No statistically significant correlation found**						
PC	AE1 0.479	AE2 0.00.524	ADMY -0.241				
PP	AE3 0.278						
PDMY	**No statistically significant correlation found**						

Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at *p* value <= 0.05 in Table 15 suggested the following potentially statistically significant UAV accident causal paths to be tested in subsequent structural equation modeling.

OP ⇒ SI ⇒ PP ⇒ AE3 ⇒ Mishap/Accident
ODMY ⇒ SI ⇒ PP ⇒ AE3 ⇒ Mishap/Accident
ODMY ⇒ SDMY ⇒ PP ⇒ AE3 ⇒ Mishap/Accident

Other statistically significant relationships at *p* value <= 0.05 in Table 14 suggested the following additional UAV accident causal paths containing non-statistically significant relationships to be tested in subsequent structural equation modeling:

ORG → SDMY → PC ⇒ AE1 ⇒ Mishap/Accident
ORG → SDMY → PC ⇒ AE2 ⇒ Mishap/Accident
OP ⇒ SI → PDMY → AV ⇒ Mishap/Accident
ODMY ⇒ SI → PDMY → AV ⇒ Mishap/Accident
ODMY ⇒ SDMY → PC ⇒ AE1 ⇒ Mishap/Accident
ODMY ⇒ SDMY → PC ⇒ AE2 ⇒ Mishap/Accident
ODMY → SV → PDMY → AE3 ⇒ Mishap/Accident
ODMY → SV → PDMY → AV ⇒ Mishap/Accident
ORG → SDMY → PC ⇒ ADMY ⇒ Mishap/Accident
ODMY ⇒ SI → PDMY → ADMY ⇒ Mishap/Accident
ODMY ⇒ SDMY → PC ⇒ ADMY ⇒ Mishap/Accident

Table 16. Correlations Found Statistically Significant at *p* <= 0.1 among DOD HFACS Categories of UAV Accidents

FROM	**LOWER LEVEL**						
ORG	PC -0.255	PDMY 0.245	AE1 -0.260	ADMY 0.265			
OC	**No statistically significant correlation found**						
OP	SI 0.233	SV* 0.188	SDMY* -0.171	AE1* -0.197			
ODMY	SI -0.283	SV* -0.192	SDMY 0.255	PC -0.234	PDMY -0.240	AE1 0.336	AE2 0.246
SI	PP 0.290	AE3 0.298	AV 0.291	ADMY -0.247			
SP	**No statistically significant correlation found**						
SF	**No statistically significant correlation and nanocode found**						
SV	AE3 0.557	AV 0.701					
SDMY	PC* 0.167	PP -0.226	AE3* -0.210	AV -0.236	ADMY .256		
PE	**No statistically significant correlation found**						
PC	AE1 0.479	AE2 0.524	ADMY -0.241				
PP	AE3 0.278	ADMY* -0.199					
PDMY	AE1* -0.188	AE2* - 0.184	ADMY* 0.181				

* Statistically significant correlations at *p* value = 0.10.

Additional statistically significant relationships at *p* value <= 0.10 in Table 16 suggested the following additional UAV accident causal paths containing statistically significant relationships to be tested in subsequent structural equation modeling.

OP ⇒ SDMY ⇒ PC ⇒ AE1 ⇒ Mishap/Accident

ODMY ⇒ SI ⇒ PP ⇒ ADMY ⇒ Mishap/Accident

Likewise, additional statistically significant relationships at *p* value <= 0.10 in Table 16 suggested the following additional UAV accident causal paths containing non-statistically significant relationships to be tested in subsequent structural equation modeling.

OP ⇒ SV → PDMY ⇒ AE3 ⇒ Mishap/Accident
OP ⇒ SV → PDMY ⇒ AV ⇒ Mishap/Accident
ODMY ⇒ SDMY → PDMY → AE3 ⇒ Mishap/Accident
ODMY ⇒ SDMY → PDMY ⇒ AE1 ⇒ Mishap/Accident
ODMY ⇒ SDMY → PDMY ⇒ AE2 ⇒ Mishap/Accident

4.8 Structural Equation Model (SEM) and Path Analysis

Given the statistically significant correlations identified by factor analysis, four SEM path models were hypothesized for each aircraft type at both significance levels. Each model was created and tested in the SPSS/AMOS software in order to determine model fit and confirm the significant paths within the DOD HFACS taxonomy.

This study applied the following four goodness of fit measures and their recommended criteria for testing model fit: the chi-square (CMIN), the chi-square divided by the degree of freedom (CMIN/DF), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The AMOS goodness of fit measures (Arbuckle, 2010) are set forth in Table 17.

Table 17. AMOS Fit Measures

AMOS Fit Measures	Acceptable Criteria
The chi-square dividing by the degree of freedom($\chi 2 / df$)	$1.0 < \chi 2 / df < 3.0$
Comparative Fit Index (CFI)	$0.95 \leq$ CFI
Goodness of Fit Index (GFI)	$0.9 \leq$ GFI
Root Mean Square Error of Approximation (RMSEA)	RMSEA around 0.05

As the standardized total effect of one variable on another approximates the part of their observed correlation due to presumed causal relations (Kline, 2011), total effects are also discussed with the perspective of fit indices, maximum likelihood estimates, model, and factor analysis.

The path models presented in the figures in this chapter were fit to covariance matrices from the normalized raw data of MAV and UAV accident reports by the mean of SPSS/AMOS 21 software (Arbuckle, 2012). All the fitted models converged to an admissible solution. The factor "Accident" loading on ADMY variable was constrained to 1 and its error variable was pruned to establish the scale for estimates of path coefficients and their corresponding statistics needed for path analysis. The findings from this analytical approach are also discussed together with the model fit indices in a holistic approach to provide a comprehensive analysis.

4.8.1 MAV Model, (N = 203, $p <= 0.05$)

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.05$ in Table 13, three models were analyzed for MAV accidents for potentially statistically significant MAV accident causal paths. The first MAV model (A) yielded unsatisfactory goodness of fit values suggesting model revision. The second MAV model (B) at $p < 0.05$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the exogenous variables of ORG-ODMY and OP-ODMY and the error variables of SI-SDMY and PC-PDMY. The covariance selected according to modification indices were all related to dummy variables of the first three levels. This circumstance was consistent with the value of indices as well as the feature of the dummy variables, since they were assigned an indicator value of 1 at the absence of any error within the respective categorical level. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first MAV model (A) at $p <= 0.05$ level are presented in Appendix E.

The second model (B) of MAV at $p <= 0.05$ level yielded better goodness of fit indices. The path diagram of the second MAV model (B) at $p <= 0.05$ level is presented in Figure 10. The detailed AMOS output of the second model (B) is presented in Appendix F.

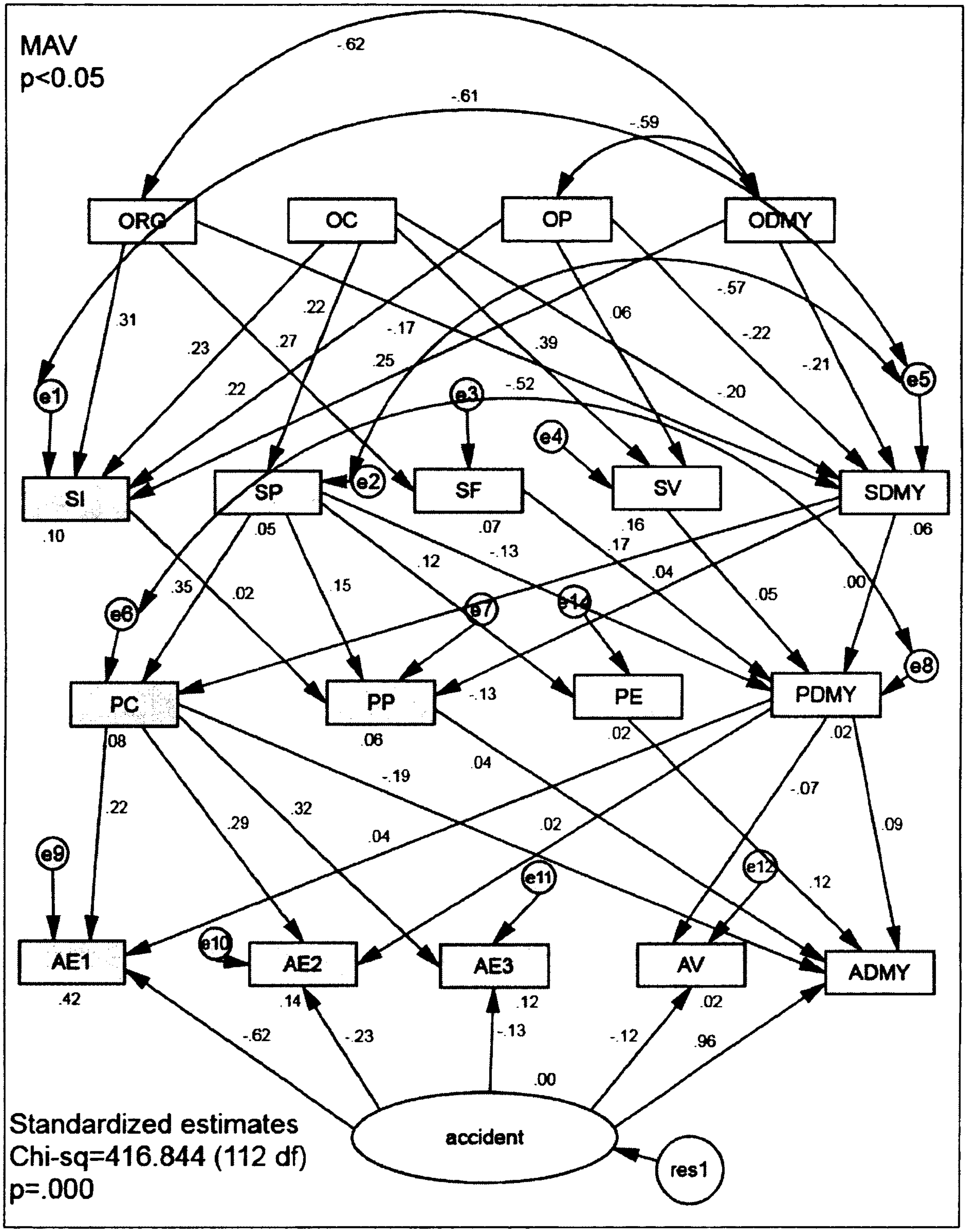


Figure 10. Path Diagram of Revised MAV Model (B) at $p <= 0.05$ Level

The third model (C) was constructed according to the $p <= 0.05$ level of regression weights of the second model (B) and statistically non-significant relationships. OP-SV, ODMY-SI, ODMY-SDMY were pruned to improve the second model in terms of goodness of fit results. This third model (C) presented similar fit statistics with the second model (B) implying small amount difference between the pruned (C) and non-pruned model (B). Since the overall model Chi-sq/df, CFI, GFI, and RMSEA statistics did not change significantly, the second model (B) was retained as the actual one to be utilized in the model assessments and path analysis. The detailed AMOS output of the third (C) model is presented in Appendix G. The goodness of fit indices of MAV model at $p <= 0.05$ level for three models are presented in Table 18.

Table 18. The Goodness of Fit Indices of MAV Models at $p <= 0.05$ Level

MAV $p < 0.05$	Model	
Chi-sq/df ($1.0 < \chi 2 / \mathrm{df} < 3.0$)	A	8.637
	B	3.722
	C	3.667
CFI ($0.95 \leq$ CFI)	A	0.242
	B	0.741
	C	0.740
GFI ($0.9 \leq$ GFI)	A	0.707
	B	0.831
	C	0.829
RMSEA (around 0.05)	A	0.194
	B	0.116
	C	0.115

In model B, the loadings of Accident on AV and AE3 were not statistically significant at $p <= 0.05$. Accident loaded on AV with a coefficient of -0.055 and standard error of 0.033 yielding a critical ratio (CR) of -1.669 for a 9.5% significance level. Accident loaded on AE3 with a coefficient of -0.081 and standard error of 0.043 yielding a CR of -1.890 for a 5.9% significance level. Since both Reason's Swiss Cheese model and the design of the HFACS coding system assume that if an unsafe act occurs an accident results and since the significances levels of AV and AE3 fell within the 90.0% to 94.9% confidence interval, both AV and AE3 were retained in model B for subsequent comparability with the MAV ($p <= 0.10$) and UAV structural equation models. Accident loading onto AE1 was statistically significant with a coefficient of -1.123 and standard error of 0.097 yielding a CR of -11.575 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.281 and standard error of 0.078 yielding a CR of -3.590 for a significance of less than 0.1%.

The estimated path coefficient and its corresponding standard error for each path were needed to assess the statistical significance of the respective path on Accident outcomes. Current structural equation modeling software is not programmed to provide path coefficients and their standard errors in terms of the HFACS accident cause assignments. As can be seen in structural path models in Figures 11 through 15, in order the model HFACS paths within the SEM framework, each path had to be decomposed into $O \rightarrow S \rightarrow P \rightarrow A$ estimates and the $A \leftarrow$ Accident loading. Current SEM software, SPSS/AMOS included, provide estimates of unstandardized regression weights, standard errors, and critical ratios for direct effects, standardized regression weights for direct effects, and unstandardized and standardized total, direct, and indirect effects. To overcome this limitation, this work applied the principle of the variance of the product of independent random variables from mathematical statistics. This principle is applicable, because the covariance matrix provides independent estimates of SEM direct effect coefficients between HFACS categorical levels. Thus, each HFACS path is composed of independent random variables of SEM direct effect coefficients and their standard errors. Correspondingly, each path effect on Accident outcome is the $\beta = \beta_O \times \beta_S \times \beta_P \times \beta_A \rightarrow$ Accident product. From mathematical statistics, it is known that if random variables X_1, $X_2, \ldots, X_n$ (β_O, β_S, β_P, and β_A for this analysis) are independent, the variance of the product is

$$\mathrm{Var}(X_1 \ldots X_n) = \textstyle\prod_n (\mathrm{var}(X_i) + (E[X_i])^2) - \prod_n (E[X_i])^2 \qquad (4)$$

If the means of the random variables are zero, $\mathrm{Var}(X_1 \ldots X_n) = \prod_n \mathrm{var}(X_i)$. Application of the principle of the variance of the product of independent random variables provided the two estimates of path standard errors, path β coefficient not equal 0 and equal 0, by which to test statistical significance of the path effect. Both cases were applied in this work to test for significant path effect from mean model effect. Since the potentially statistically significant MAV accident causal paths were hypothesized from factor analytic correlation analysis of individual inter-categorical pair wise relationships at $\alpha = 0.05$ or $p <= 0.05$ and $\alpha = 0.10$ or $p <= 0.10$ and each path is comprised of the joint product of four β direct relationships, the joint α for judging path significance must be adjusted to

$$\alpha_{\text{path}} = 1 - (1 - \alpha)^4 \qquad (5)$$

For the paths hypothesized at correlation $\alpha = 0.05$, this yields $\alpha_{\text{path}} = 1 - (1 - 0.05)^4 = 0.1855$ or $Z = \pm 1.324$. For paths hypothesized at correlation $\alpha = 0.10$, this yields $\alpha_{\text{path}} = 1 - (1 - 0.10)^4 = 0.3439$ or $Z = \pm 0.947$.

Statistical tests and Pareto rankings of the paths were performed for unstandardized path effects to identify the main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations from Table 13 at *p* value <= 0.05 suggested the twenty six potentially statistically significant MAV accident causal paths to be tested in path analysis. Table 19 presents the path Pareto analysis of unstandardized effects, standardized effects and statistically significant paths at *p* value <= 0.1855 level for both the path β coefficient equal 0 and not equal to 0.

From Table 19, three paths for the $\beta \neq 0$ case were found statistically significant at *p* value <= 0.1855. These paths are OC>SP>PC>AE3 with CR = -1.3499, OC>SP>PC>AE2 with CR = -1.7194, and OC>SP>PC>AE1 with CR = -1.7738. With development of an optimal path pruning process (similar to empirical modeling best subsets regression), the potentially retained unstandardized paths that exhibit the most positive effect relative to the mean effect on accidents are OC>SDMY>PC>AE1 with effect 0.0823 and CR = 1.3034, OC>SP>PE>ADMY with effect 0.0194 and CR = 1.2025, OC>SDMY>PC>AE2 with effect 0.0177 and CR = 1.2025, and ORG>SDMY>PC>AE1 with effect 0.0141 and CR = 1.1328. The paths with the most negative effect relative to the mean are OC>SP>PC>AE1 with effect -0.1947 and CR = -1.7738, OC>SP>PC>AE2 with effect -0.0419 and CR = -1.7194, OC>SV>PDMY>AE1 with effect -0.0099 and CR = -0.318, and OC>SP>PC>AE3 with effect -0.0071 and CR = -1.3499. The standardized paths that exhibit the most positive effect on accidents are OC>SDMY>PC>AE1, ORG>SDMY>PC>AE1, OC>SP>PE>ADMY and OC>SDMY>PC>AE2. The standardized paths with the most negative effect on accidents are OC>SP>PC>AE1, OC>SV>PDMY>AE1, OP>SP>PC>AE2 and OC>SP>PC>AE3. For the $\beta = 0$ case, four paths were found statistically significant at p value $<= 0.1855$. These were OC>SDMY>PC>AE1 with CR = 3.921, ORG>SDMY>PC>AE1 with CR=1.3446, OC>SP>PC>AE2 with CR = -2.747, and OC>SP>PC>AE1 with CR = -9.209. The observation that OC>SDMY>PC>AE1 with CR = 3.921 and ORG>SDMY>PC>AE1 with CR=1.345 were statistically significant for the $\beta = 0$ case but with CR = 1.3034 and CR=1.328 respectively, were not statistically significant for the $\beta \neq 0$ case supports the supposition that development of an optimal path pruning process will reveal more statistically significant paths in a reduced model.

Table 19. Total Effects and Significance of MAV Paths at $p <= 0.1855$ Level

PATHS									Unstd. Effects	SE	CR	SE β=0	CR	Std. Effects
										β≠0				
OC	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0823	0.0631	1.3034	0.021	**3.921**	0.0045
OC	>>	SDMY	>	PC	>>	AE2	<<	Accident	0.0177	0.0139	1.2769	0.0151	1.17	0.0023
OC	>>	SP	>>	PE	>>	ADMY	<<	Accident	0.0194	0.0161	1.2025	0.0373	0.52	0.0033
ORG	>	SDMY	>	PC	>>	AE1	<<	Accident	0.0141	0.0124	1.1328	0.0105	**1.345**	0.0039
ORG	>	SDMY	>	PC	>>	AE2	<<	Accident	0.003	0.0027	1.1133	0.0076	0.401	0.0019
OC	>>	SDMY	>	PC	>>	AE3	<	Accident	0.003	0.0028	1.0739	0.0076	0.396	0.0013
ORG	>	SDMY	>	PC	>>	AE3	<	Accident	0.0005	0.0005	0.9574	0.0038	0.136	0.0011
OC	>>	SP	>>	PP	>	ADMY	<<	Accident	0.0066	0.0129	0.5108	0.0442	0.15	0.0011
OP	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.0012	0.003	0.4177	0.0255	0.049	0.001
ORG	>>	SF	>	PDMY	>	ADMY	<<	Accident	0.001	0.0024	0.4058	0.0187	0.052	0.0008
OC	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.0052	0.0159	0.3266	0.0606	0.086	0.0009
OC	>>	SP	>>	PDMY	>>	AE2	<<	Accident	0.0009	0.0056	0.1582	0.0154	0.057	0.0001
OC	>>	SI	>>	PP	>	ADMY	<<	Accident	0.001	0.0087	0.1189	0.0441	0.023	0.0002
ORG	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0003	0.0024	0.1177	0.0244	0.012	0.0002
OP	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	0.0019	0.113	0.0249	0.009	0.0002
ODMY	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	0.0022	0.11	0.0286	0.009	0.0002
ODMY	>>	SDMY	>>	PDMY	>	AE1	<<	Accident	0.0001	0.0046	0.0179	0.0126	0.007	0
ORG	>	SDMY	>	PDMY	>>	AE2	<<	Accident	0	0.0005	0.0076	0.0078	0.001	0
ODMY	>>	SDMY	>>	PDMY	>	AV	<	Accident	0	0.0001	-0.0235	0.0035	-0.001	0.0001
OP	>>	SV	>	PDMY	>>	AE2	<<	Accident	0	0.0002	-0.0832	0.0058	-0.003	0
OC	>>	SV	>	PDMY	>	AE2	<<	Accident	-0.0006	0.0049	-0.1289	0.0449	-0.014	-0.0001
OP	>>	SV	>	PDMY	>>	AE1	<<	Accident	-0.0003	0.0015	-0.2005	0.0081	-0.036	-0.0001
OC	>>	SV	>	PDMY	>	AE1	<<	Accident	-0.0099	0.0311	-0.318	0.0559	-0.177	-0.0054
OC	>>	SP	>>	PC	>>	AE3	<<	Accident	-0.0071	0.0053	**-1.3499**	0.0077	-0.93	-0.0031
OC	>>	SP	>>	PC	>>	AE2	<<	Accident	-0.0419	0.0244	**-1.7194**	0.0153	**-2.747**	-0.0053
OC	>>	SP	>>	PC	>>	AE1	<<	Accident	-0.1947	0.1098	**-1.7738**	0.0211	**-9.209**	-0.0107

Table 20. Standardized Total Effects of MAV Model at p <.05 level

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	Accident	PE	PP	PC	PDMY
SF	0	0	0.272	0	0	0	0	0	0	0	0	0	0	0
SV	0	0.393	0	0.055	0	0	0	0	0	0	0	0	0	0
SP	0	0.224	0	0	0	0	0	0	0	0	0	0	0	0
SDMY	-0.206	-0.197	-0.17	-0.22	0	0	0	0	0	0	0	0	0	0
SI	0.246	0.229	0.314	0.222	0	0	0	0	0	0	0	0	0	0
PE	0	0.028	0	0	0	0	0.125	0	0	0	0	0	0	0
PP	0.032	0.063	0.029	0.034	0	0	0.146	-0.13	0.023	0	0	0	0	0
PC	-0.034	0.045	-0.028	-0.037	0	0	0.348	0.167	0	0	0	0	0	0
PDMY	-0.001	-0.01	0.009	0.002	0.036	0.053	-0.132	0.004	0	0	0	0	0	0
ADMY	0.008	-0.004	0.007	0.008	0.003	0.005	-0.058	-0.036	0.001	0.961	0.123	0.036	-0.192	0.088
AV	0	0.001	-0.001	0	-0.003	-0.004	0.009	0	0	-0.116	0	0	0	-0.071
AE2	-0.01	0.013	-0.008	-0.011	0.001	0.001	0.1	0.049	0	-0.235	0	0	0.292	0.016
AE3	-0.011	0.014	-0.009	-0.012	0	0	0.11	0.053	0	-0.125	0	0	0.317	0
AE1	-0.008	0.01	-0.006	-0.008	0.002	0.002	0.072	0.037	0	-0.618	0	0	0.223	0.042

ORG

As presented in Table 13, HFACS DOD category ORG has significant correlations with SI (0.162), SF (0.272), PC (-0.201), PDMY (0.249), AE1 (-0.268), AE2 (-0.181), and ADMY (0.422). As standardized total effects presented in Table 20, ORG had total effects on SI (0.272), SF (0.314), SDMY (-0.17), PC (-0.028), PDMY (0.009), PP (0.029), AE1 (-0.006), AE2 (-0.008), AE3 (-0.009), ADMY (0.007). Table 21, extracted from Table 19 presents the test statistics of paths emanated from ORG category level DOD HFACS. Six paths were tested and one path, ORG>SDMY>PC>AE1, was found statistically significant at *p* <= 0.1855 value. The path ORG>SDMY>PC>AE2 was noted above as having the potential for being retained as statistically significant under an optimal path pruning process.

Table 21. ORG Category Level of MAV Paths

PATHS									Unstd. Effects	*p* <= 0.1855	Std. Effects
ORG	>	SDMY	>	PC	>>	AE1	<<	Accident	0.0141	Sig	0.0039
ORG	>	SDMY	>	PC	>>	AE2	<<	Accident	0.0030	No	0.0019
ORG	>>	SF	>	PDMY	>	ADMY	<<	Accident	0.0010	No	0.0008
ORG	>	SDMY	>	PC	>>	AE3	<<	Accident	0.0005	No	0.0011
ORG	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0003	No	0.0002
ORG	>	SDMY	>	PDMY	>>	AE2	<<	Accident	0.0000	No	0.0000

OC

As presented in Table 13, HFACS DOD category OC had significant correlations with SI (0.216), SP (0.224), SV (0.401), SDMY (-0.190), PC (0.288), AE1 (0.151), AE2 (0.239) and AE3 (0.144). As standardized total effects presented in Table 20, OC had total effects on SI (0.229), SP (0.224), SV (0.393), SDMY (-0.197) PC (0.045), AE1 (0.010), AE2 (0.013) and AE3 (0.014). Table 22, extracted from Table 19 presents the test statistics of paths emanated from OC. Thirteen paths were tested and four paths were found statistically significant at $p <= 0.1855$ value. Path OC>SDMY>PC>AE1 was found statistically significant for the path $\beta = 0$ case. Three paths OC>SDMY>PC>AE2, OC>SP>PE>ADMY, and OC>SDMY>PC>AE3 were noted above as having the potential for being retained as statistically significant under an optimal path pruning process.

Table 22. OC Category Level of MAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
OC	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0823	Sig	0.0045
OC	>>	SP	>>	PE	>>	ADMY	<<	Accident	0.0194	No	0.0033
OC	>>	SDMY	>	PC	>>	AE2	<<	Accident	0.0177	No	0.0023
OC	>>	SP	>>	PP	>	ADMY	<<	Accident	0.0066	No	0.0011
OC	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.0052	No	0.0009
OC	>>	SDMY	>	PC	>>	AE3	<<	Accident	0.0030	No	0.0013
OC	>>	SP	>>	PDMY	>>	AE2	<<	Accident	0.0009	No	0.0001
OC	>>	SV	>	PDMY	>	AE2	<<	Accident	-0.0006	No	-0.0001
OC	>>	SP	>>	PC	>>	AE3	<<	Accident	-0.0071	Sig	-0.0031
OC	>>	SV	>	PDMY	>	AE1	<<	Accident	-0.0099	No	-0.0054
OC	>>	SP	>>	PC	>>	AE2	<<	Accident	-0.0419	Sig	-0.0053
OC	>>	SP	>>	PC	>>	AE1	<<	Accident	-0.1947	Sig	-0.0107
OC	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0010	No	0.0002

OP

As presented in Table 13, OP had significant correlations with SI (0.140), SV (0.122), SDMY (-0.153), AE1 (-0.154) and ADMY (0.230). As standardized total effects presented in Table 20, OP had total effects on SI (0.222), SV (0.055), SDMY (-0.220), AE1 (-0.008), and ADMY (-0.008). Table 23, extracted from Table 19 presents the test statistics of paths emanated from OP. None of the four OP originated paths were found statistically significant at $p <= 0.1855$ value.

Table 23. OP Category Level of MAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
OP	>>	SV	>	PDMY	>>	AE1	<<	Accident	-0.0003	No	-0.0001
OP	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.0012	No	0.0010
OP	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	No	0.0002
OP	>>	SV	>	PDMY	>>	AE2	<<	Accident	0.0000	No	0.0000

ODMY

As presented in Table 13, HFACS DOD category ODMY had significant correlations with SI (-0.125), PDMY (-0.229), AE1 (0.243), AV (0.151), and ADMY (-0.451). As standardized total effects presented in Table 20, ODMY had total effects on SDMY (-0.206), SI (0.246), PP (0.032), PC (-0.034), PDMY (-0.001), ADMY (0.008), AE1 (-0.008), AE2 (-0.010), and, AE3 (-0.011). Table 24, extracted from Table 19 presents the test statistics of paths emanated from ODMY. Three ODMY originated paths were tested and none of them were found statistically significant at $p < 0.05$ value.

Table 24. ODMY Category Level of MAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
ODMY	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	No	0.0002
ODMY	>>	SDMY	>>	PDMY	>	AE1	<<	Accident	0.0001	No	0.0002
ODMY	>>	SDMY	>>	PDMY	>	AV	<<	Accident	0.0000	No	0.0001

4.8.2 Additional Paths for MAV model at $p <= 0.10$

Observing Table 14, ORG-SP, ORG-AV, OP-AE2, OP-AV, OP-ADMY, ODMY-PP, SI-AE1, SP-AE1, SP-ADMY, SV-AE3, SDMY-AE1, PE-ADMY, PC-AV, PP-AV and PDMY-AE3 were found to have additional statistically significant correlations in MAV model at $p <= 0.10$ level. Applying these correlations to path diagram, twenty four more paths were suggested as potentially statistically significant paths in addition to twenty six MAV paths at $p <= 0.05$ level.

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.10$ in Table 14, three models were analyzed for MAV accidents for potentially statistically significant MAV accident causal paths. The first MAV model (A) at $p <= 0.10$ level yielded unsatisfactory goodness of fit values suggesting model revision. The second MAV model (B) at $p <= 0.10$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the same as in MAV model (B) at $p <= 0.05$ level; the exogenous variables of ORG-ODMY and OP-ODMY and the error variables of SI-SDMY and PC-PDMY. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first MAV model (A) at $p <= 0.10$ level are presented in Appendix H.

The second model (B) of MAV at $p <= 0.10$ level yielded better goodness of fit indices. The path diagram of the second MAV model (B) at $p <= 0.10$ level is presented in Figure 11. The detailed AMOS output of the second model (B) is presented in Appendix I.

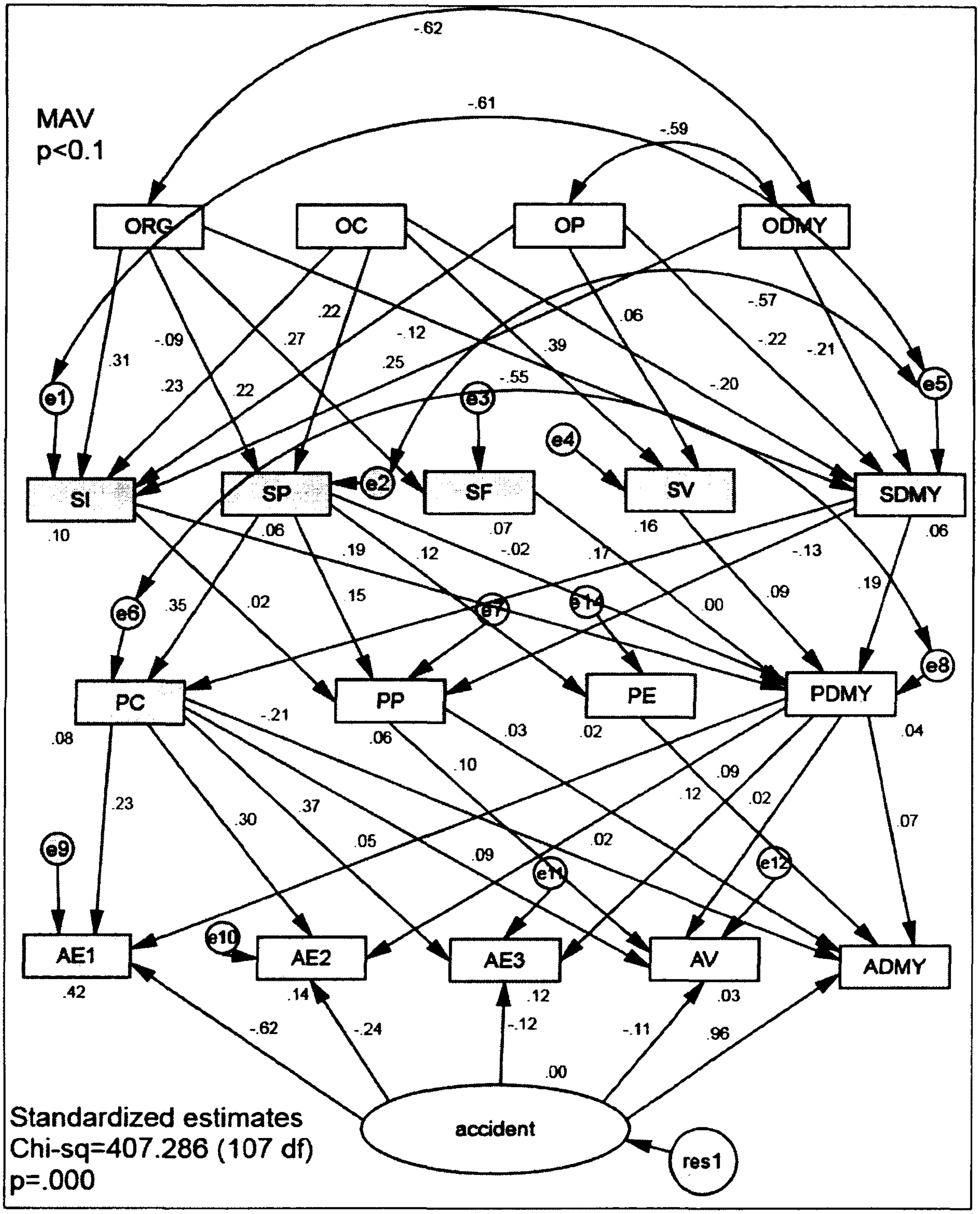


Figure 11. **Path Diagram of Revised MAV Model (B) at *p* <= 0.10 Level**

The third model (C) was constructed according to the $p <= 0.10$ level of regression weights of the second model (B) and statistically non-significant relationships that were utilized in the path analysis. Based on these assessments a path, OP-SV, was pruned to improve the second model in terms of goodness of fit statistics. This third model (C) presented similar fit statistics with the second model (B) implying small amount difference between the pruned (C) and non-pruned model (B). Since the overall model Chi-sq/df, CFI, GFI, and RMSEA statistics did not change significantly, the second model (B) was selected as the actual one to be utilized in the model assessments. The detailed AMOS output of the third (C) model is presented in Appendix J. The goodness of fit indices of MAV model at $p <= 0.10$ level for three models are presented in Table 25.

Table 25. The Goodness of Fit Indices of MAV Models at $p <= 0.10$ Level

MAV $p < 0.1$	Model	
Chi-sq/df ($1.0 < \chi2 / df < 3.0$)	A	8.972
	B	3.806
	C	3.760
CFI ($0.95 \leq$ CFI)	A	0.242
	B	0.745
	C	0.745
GFI ($0.9 \leq$ GFI)	A	0.708
	B	0.834
	C	0.834
RMSEA (around 0.05)	A	0.199
	B	0.118
	C	0.117

In model B, the loadings of Accident on AV was not statistically significant at $p <= 0.1$. Accident loaded on AV with a coefficient of -0.053 and standard error of 0.033 yielding a CR of -1.613 for a 10.7% significance level. Since both Reason's Swiss Cheese model and the design of the HFACS coding system assume that if an unsafe act occurs an accident results AV was retained in model B for comparability with the MAV ($p <= 0.05$) and UAV structural equation models. Accident loading onto AE1 was statistically significant with a coefficient of -1.122 and standard error of 0.097 yielding a CR of -11.563 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.281 and standard error of 0.078 yielding a CR of -3.596 for a significance of less than 0.1%. Accident loading onto AE3 was statistically significant with a coefficient of -0.081 and standard error of 0.043 yielding a CR of -1.884 for a significance of 6.0%.

Statistical tests and Pareto rankings of the additional 24 paths were performed for unstandardized path effects to identify the statistically significant and main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at p value $<= 0.10$ suggested the fifty potentially statistically significant MAV accident causal paths to be tested in path analysis. Table 26 presents the path Pareto analysis of unstandardized effects and statistically significant paths at $p <= 0.10$ level.

From Table 26, eight out of fifty paths for the $\beta \neq 0$ case were found statistically significant at p value $<= 0.3439$. The unstandardized paths that exhibit the most positive effect relative to the mean model effect on accidents are OC>SDMY>PC>AE1 with effect 0.0847 and CR = 1.3111, OC>SDMY>PDMY>AE1 with effect 0.0224 and CR =

0.4953, OC>SP>PE>ADMY with effect 0.0190 and CR = 0.9313, OC>SDMY>PC>AE2 with effect 0.0177 and CR = 1.2741, ORG>SP>PC>AE1 with effect 0.0167 and CR = 1.0882, and ORG>SDMY>PC>AE1 with effect 0.0102 and CR = 0.8741. The paths with the most negative effect relative to the mean model effect are OC>SP>PC>AE1 with effect -0.1990 and CR = -1.7931, OC>SP>PC>AE2 with effect -0.0416 and CR = -1.7164, OC>SI>PDMY>AE1 with effect -0.0264 and CR = -0.5492, OC>SV>PDMY>AE1 with effect -0.0220 and CR = -0.5156, and OC>SP>PC>AE3 with effect -0.0081 and CR = -1.3452. Paths OC>SP>PC>AE1, OC>SP>PC>AE2, and OC>SP>PC>AE3 were statistically significant in the MAV ($p <= 0.05$) model. The paths OC>SP>PC>AE1 and OC>SP>PC>AE2 are statistically significant exhibiting the most negative effect. The standardized paths that exhibit the most positive effect on accidents are OC>SDMY>PC>AE1, ORG>SP>PC>AE1, OC>SP>PE>ADMY, and ORG>SDMY>PC>AE1. The standardized paths with the most negative effect relative to the mean are OC>SP>PC>AE1, OC>SP>PC>AE2, OC>SP>PC>AE3 and ORG>SI>PDMY>AE1.

For the case of $\beta = 0$, eight paths were found statistically significant at p value <= 0.3439. The observation that OC>SI>PDMY>AE1 with CR=-1.2422 and OC>SV>PDMY>AE1 with CR=-1.270 were statistically significant for the $\beta = 0$ case but with CR = -0.5492 and CR=-0.5156 were not statistically significant for the $\beta \neq 0$ case supports the supposition that development of an optimal path pruning process will reveal more statistically significant paths in a reduced model.

Table 26. Total Effects and Significance of MAV Paths at $p <= 0.3439$ Level

PATHS (from MAV $p <= 0.05$ model)									Unstd. Effects	SE	CR	SE β=0	CR	Std. Effects
										β≠0				
OC	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0847	0.0646	**1.3111**	0.021	**4.015**	0.0047
OC	>>	SP	>>	PE	>>	ADMY	<<	Accident	0.019	0.0204	0.9313	0.045	0.423	0.0033
ORG	>	SDMY	>	PC	>>	AE1	<<	Accident	0.0102	0.0116	0.8741	0.011	0.92	0.0028
OC	>>	SDMY	>	PC	>>	AE2	<<	Accident	0.0177	0.0139	**1.2741**	0.015	**1.165**	0.0023
OC	>>	SDMY	>	PC	>>	AE3	<<	Accident	0.0034	0.0032	**1.0701**	0.008	0.418	0.0015
ORG	>	SDMY	>	PC	>>	AE2	<<	Accident	0.0021	0.0025	0.8578	0.008	0.267	0.0014
ODMY	>>	SDMY	>>	PDMY	>	AE1	<<	Accident	0.0052	0.0113	0.4591	0.015	0.356	0.0013
OC	>>	SP	>>	PP	>	ADMY	<<	Accident	0.0053	0.0124	0.4287	0.044	0.12	0.0009
ORG	>	SDMY	>	PC	>>	AE3	<<	Accident	0.0004	0.0005	0.7593	0.004	0.096	0.0009
OP	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.001	0.0029	0.3547	0.026	0.04	0.0008
OC	>>	SDMY	>>	PP	>	ADMY	<<	Accident	0.0042	0.0118	0.3584	0.05	0.085	0.0007
OC	>>	SP	>>	PDMY	>>	AE2	<<	Accident	0.0002	0.0035	0.0523	0.016	0.011	0.0002
ORG	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	0.0023	0.1019	0.024	0.009	0.0002
ODMY	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	0.0021	0.0952	0.029	0.007	0.0002
OC	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0008	0.0082	0.103	0.044	0.019	0.0001
OP	>>	SI	>>	PP	>	ADMY	<<	Accident	0.0002	0.0018	0.0978	0.025	0.007	0.0001
ORG	>	SDMY	>	PDMY	>>	AE2	<<	Accident	0.0002	0.001	0.1646	0.009	0.018	0.0001
ODMY	>>	SDMY	>>	PDMY	>	AV	<<	Accident	0	0.0002	0.1253	0.004	0.004	0.0001
OP	>>	SV	>	PDMY	>>	AE2	<<	Accident	0	0.0003	-0.1326	0.006	-0.007	0
ORG	>>	SF	>	PDMY	>	ADMY	<<	Accident	-0.0001	0.0019	-0.0374	0.019	-0.004	-0.0001
OP	>>	SV	>	PDMY	>	AE1	<<	Accident	-0.0007	0.0021	-0.3114	0.008	-0.081	-0.0002
OC	>	SV	>	PDMY	>>	AE2	<<	Accident	-0.0014	0.0068	-0.2069	0.012	-0.112	-0.0002
OC	>	SV	>	PDMY	>>	AE1	<<	Accident	-0.022	0.0427	-0.5156	0.017	**-1.27**	-0.0012
OC	>>	SP	>>	PC	>>	AE3	<<	Accident	-0.0081	0.006	**-1.3452**	0.008	**-0.982**	-0.0035
OC	>>	SP	>>	PC	>>	AE2	<<	Accident	-0.0416	0.0243	**-1.7164**	0.015	**-2.739**	-0.0053
OC	>>	SP	>>	PC	>>	AE1	<<	Accident	-0.199	0.111	**-1.7931**	0.021	**-9.437**	-0.011

Table 26 (continued)

PATHS (additional paths from MAV p <= 0.10 model)									Unstd. Effects	SE β≠0	CR	SE β=0	CR	Std. Effects
ORG	>>	SP	>	PC	>>	AE1	<<	Accident	0.0167	0.0153	**1.0882**	0.0094	**1.7746**	0.0046
ORG	>>	SP	>	PC	>>	AE2	<<	Accident	0.0035	0.0033	**1.0633**	0.0068	0.515	0.0022
ORG	>>	SP	>>	PC	>>	AE3	<<	Accident	0.0007	0.0007	0.9188	0.0037	0.1847	0.0015
ORG	>	SP	>	PC	>>	AV	<<	Accident	0.0001	0.0001	0.5776	0.0028	0.0295	0.0003
ORG	>	SP	>	PP	>>	AV	<<	Accident	0	0.0001	0.5209	0.0028	0.0128	0.0001
ORG	>>	SP	>	PDMY	>>	AE2	<	Accident	0	0.0004	-0.0441	0.0073	-0.0021	-0.0001
ORG	>	SP	>	PDMY	>>	AE3	<	Accident	0	0.0001	-0.1231	0.0039	-0.0028	-0.0002
ORG	>>	SI	>>	PP	>	AV	<<	Accident	0	0.0001	-0.1425	0.0035	-0.0053	-0.0001
OC	>>	SI	>>	PP	>	AV	<<	Accident	-0.0001	0.0005	-0.1439	0.0063	-0.0108	-0.0001
OC	>>	SP	>	PC	>	AV	<<	Accident	-0.001	0.0013	-0.737	0.0063	-0.1571	-0.0008
OC	>>	SI	>>	PP	>	AV	<<	Accident	-0.0001	0.0005	-0.1439	0.0063	-0.0108	-0.0001
ODMY	>>	SI	>>	PP	>>	AV	<<	Accident	0	0.0001	-0.133	0.0041	-0.0039	-0.0001
ORG	>>	SP	>>	PDMY	>	AE1	<<	Accident	-0.0002	0.0024	-0.1001	0.0101	-0.0242	-0.0007
OP	>>	SDMY	>>	PDMY	>	AE2	<<	Accident	0.0003	0.0017	0.1982	0.0092	0.0376	0.0002
OP	>>	SDMY	>>	PDMY	>	AE3	<<	Accident	0.0002	0.0004	0.6413	0.005	0.0485	0.0005
OP	>>	SDMY	>>	PDMY	>	AV	<<	Accident	0	0.0002	0.1322	0.0038	0.0052	0.0001
ORG	>>	SI	>>	PDMY	>	AE1	<<	Accident	-0.0072	0.0133	-0.5423	0.0117	-0.6122	-0.002
OC	>	SI	>	PDMY	>>	AE1	<<	Accident	-0.0264	0.0481	-0.5492	0.0213	**-1.2422**	-0.0015
OP	>>	SI	>>	PDMY	>	AE1	<	Accident	-0.0055	0.0106	-0.5146	0.012	-0.4556	-0.0014
ODMY	>>	SI	>	PDMY	>>	AE1	<<	Accident	-0.0062	0.0125	-0.4978	0.0138	-0.4534	-0.0016
OC	>>	SP	>	PDMY	>	AE1	<<	Accident	0.0029	0.0244	0.1189	0.0226	0.1285	0.0017
OP	>>	SV	>	PDMY	>>	AE3	<<	Accident	0	0.0001	-0.3921	0.0032	-0.0093	-0.0001
OC	>>	SDMY	>	PDMY	>	AE1	<<	Accident	0.0224	0.0453	0.4953	0.0249	0.901	0.0012
OP	>>	SDMY	>>	PDMY	>>	AE1	<<	Accident	0.0054	0.0111	0.4897	0.0127	0.4257	0.0014

4.8.3 UAV MODEL, (N = 60, $p <= 0.05$)

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.05$ in Table 15, three models were analyzed for UAV accidents for potentially statistically significant UAV accident causal paths. The first UAV model (A) at $p <= 0.05$ level yielded unsatisfactory goodness of fit values suggesting model revision. The second UAV model (B) at $p <= 0.05$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the exogenous variables of ORG-ODMY and OP-ODMY and the error variables of SI-SDMY and PC-PDMY. The covariance selected according to modification indices were all related to dummy variables of the first three levels. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first UAV model (A) at $p <= 0.05$ level are presented in Appendix K. Since no path was founded to be pruned, the second model (B) was selected as the actual one to be utilized in model assessments. The path diagram of the second UAV model (B) at $p <= 0.05$ level is presented in Figure 12.

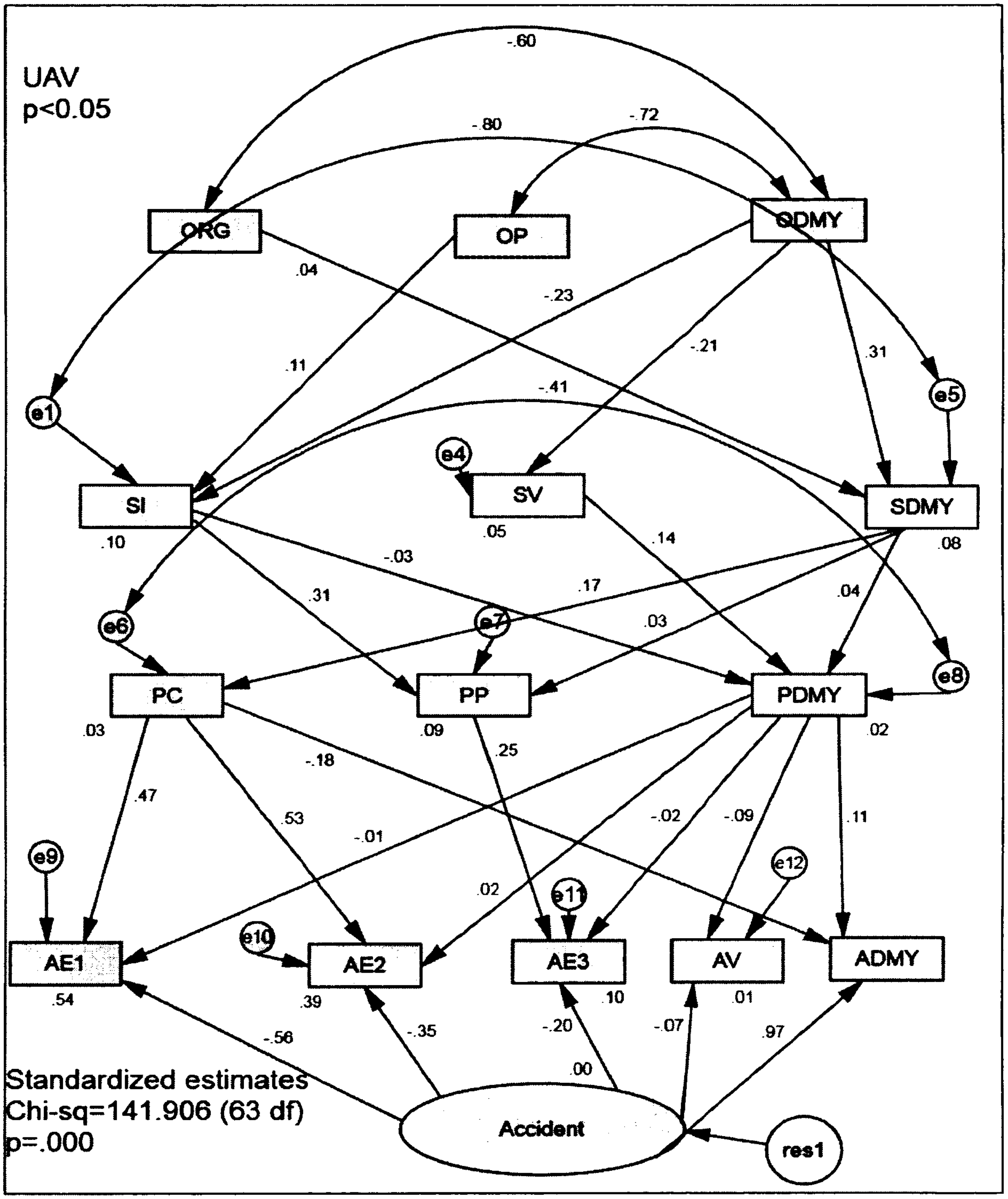


Figure 12. **Path Diagram of Revised UAV Model (B) at *p* <= 0.05 Level**

The second model (B) of UAV at $p <= 0.05$ level yielded better goodness of fit indices. The detailed AMOS output of the second (B) are presented in Appendix L. The goodness of fit indices of UAV model at $p <= 0.05$ level for two models are presented in Table 27.

Table 27. The Goodness of Fit Indices of UAV Models at $p <= 0.05$ Level

UAV $p < 0.05$	Models	
Chi-sq/df ($1.0 < \chi2 / df < 3.0$)	A	4.865
	B	2.252
CFI ($0.95 \leq$ CFI)	A	0.243
	B	0.769
GFI ($0.9 \leq$ GFI)	A	0.625
	B	0.748
RMSEA (around 0.05)	A	0.256
	B	0.104

In model B, the loadings of Accident on AV and AE3 were not statistically significant at $p <= 0.05$. Accident loaded on AV with a coefficient of -0.022 and standard error of 0.038 yielding a critical ratio (CR) of -0.571 for a 56.8% significance level. Accident loaded on AE3 with a coefficient of -0.132 and standard error of 0.084 yielding a CR of -1.584 for an 11.3% significance level. Since both Reason's Swiss Cheese model and the design of the HFACS coding system assume that if an unsafe act occurs an accident results both AV and AE3 were retained in model B for subsequent comparability with the UAV ($p <= 0.10$) and MAV structural equation models. Accident loading onto AE1 was statistically significant with a coefficient of -1.108 and standard error of 0.174 yielding a CR of -6.377 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.545 and standard error of 0.159 yielding a CR of -3.428 for a significance of less than 0.1%.

Statistical tests and Pareto rankings of the paths were performed for unstandardized path effects to identify the statistically significant and main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at *p* value <= 0.05 that suggested fourteen potentially statistically significant UAV accident causal paths were tested in path analysis. Table 28 presents the path Pareto analysis of unstandardized effects and statistically significant paths in UAV accidents at *p* <= 0.1855 level.

From Table 28, none of the fourteen paths were found statistically significant at *p* value <= 0.1855 for both the $\beta \neq 0$ case and the $\beta = 0$ case. That is none of the path effects statistically differed from the model mean effect on accidents. Within the range of model effects, the unstandardized and standardized paths that exhibit the most positive effect on accidents are ODMY>SDMY>PC>AE1 with effect 0.0366 and CR = 0.7917 and ODMY>SI>PP>AE3 with effect 0.0017 and CR = 0.6033. The unstandardized and standardized paths with the most negative effect within the range of model effects are ODMY>SDMY>PC>AE2 with effect -0.0241 and CR = -0.9089, ORG>SDMY>PC>AE1 with effect -0.0113 and CR = -0.2689, and ODMY>SDMY>PC>ADMY with effect -0.0099 and CR = -0.7019.

Table 28. **Total Effects and Significance of UAV Paths at $p <= 0.1855$ Level**

PATHS								Unstd. Effects	SE	CR	SE β=0	CR	Std. Effects
									β≠0				
ODMY	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0366	0.0462	0.7917	0.0286	1.2802	0.0103
ODMY	>>	SI	>>	PP	>>	AE3	<	Accident	0.0017	0.0028	0.6033	0.0157	0.1073	0.0036
ODMY	>>	SI	>	PDMY	>	ADMY	<<	Accident	0.0007	0.0107	0.0689	0.0681	0.0109	0.0007
ODMY	>>	SI	>	PDMY	>	AV	<	Accident	0	0.0001	0.0299	0.0069	0.0005	0.0004
OP	>>	SI	>	PDMY	>	AV	<	Accident	0	0.0001	-0.0224	0.0062	-0.0002	-0.0002
ODMY	>>	SDMY	>>	PP	>>	AE3	<	Accident	-0.0002	0.0022	-0.0834	0.015	-0.0124	-0.0004
ODMY	>	SV	>	PDMY	>	AE3	<	Accident	-0.0001	0.0006	-0.0961	0.0105	-0.0057	-0.0001
ODMY	>	SV	>	PDMY	>	AV	<	Accident	0	0.0001	-0.1821	0.0047	-0.0035	-0.0019
ORG	>	SDMY	>	PC	>	ADMY	<<	Accident	-0.002	0.0092	-0.2227	0.0568	-0.036	-0.0013
ORG	>	SDMY	>	PC	>>	AE2	<<	Accident	-0.005	0.019	-0.2632	0.0264	-0.1892	-0.0014
ORG	>	SDMY	>	PC	>>	AE1	<<	Accident	-0.0113	0.0421	-0.2689	0.0314	-0.3602	-0.002
OP	>>	SI	>>	PP	>>	AE3	<	Accident	-0.0007	0.0017	-0.4193	0.014	-0.0515	-0.0017
ODMY	>>	SDMY	>	PC	>	ADMY	<<	Accident	-0.0099	0.0141	-0.7019	0.0517	-0.1908	-0.0089
ODMY	>>	SDMY	>	PC	>>	AE2	<<	Accident	-0.0241	0.0265	-0.9089	0.0241	-1.0026	-0.0095

Table 29. Standardized Total Effects of UAV Model at $p <= 0.05$ Level

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.213	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.307	.000	.044	.000	.000	.000	.000	.000	.000	.000
SI	-.233	.110	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.065	.034	.001	.000	.026	.314	.000	.000	.000	.000
PC	.052	.000	.007	.000	.168	.000	.000	.000	.000	.000
PDMY	-.010	-.003	.002	.137	.041	-.027	.000	.000	.000	.000
ADMY	-.010	.000	-.001	.015	-.025	-.003	.969	.000	-.179	.112
AE3	-.016	.009	.000	-.003	.005	.079	-.196	.249	.000	-.022
AV	.001	.000	.000	-.012	-.004	.002	-.074	.000	.000	-.086
AE2	.027	.000	.004	.003	.090	-.001	-.348	.000	.528	.023
AE1	.024	.000	.003	-.001	.079	.000	-.564	.000	.468	-.006

ORG

HFACS DOD category ORG had significant correlations with PC (-0.255), PDMY (0.245), AE1 (-0.260), and ADMY (0.265), presented in Table 15. As standardized total effects presented in Table 29, ORG, had effects on SDMY (0.044), PP (0.001), PC (0.007), PDMY (0.002), ADMY (-0.001), AE2 (0.004), and AE1 (0.003). Table 30, extracted from Table 28, presents the test statistics of paths emanated from ORG category level. Three paths were tested and no paths were found statistically significant at $p <=0.1855$ value.

Table 30. ORG Category Level of UAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
ORG	>	SDMY	>	PC	>>	AE2	<<	Accident	-0.0050	No	-0.0014
ORG	>	SDMY	>	PC	>>	AE1	<<	Accident	-0.0113	No	-0.0020
ORG	>	SDMY	>	PC	>	ADMY	<<	Accident	-0.0020	No	-0.0013

OP

HFACS DOD category OP has significant correlations with only SI (0.233) presented in Table 15. As standardized total effects presented in Table 29, OP had effects on SI (0.110), PP (0.034), PDMY (-0.003), AE3 (0.009). Table 31, extracted from Table 28, presents the test statistics of paths emanated from OP category level. Two paths were tested and no path was found statistically significant at $p <= 0.1855$ value.

Table 31. OP Category Level of UAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
OP	>>	SI	>>	PP	>>	AE3	<<	Accident	-0.0007	No	-0.0017
OP	>>	SI	>>	PDMY	>>	AV	<<	Accident	-0.0000	No	-0.0002

ODMY

As presented in Table 15, the HFACS DOD category ODMY in UAV accidents has statistically significant correlations with SI (-0.283), SDMY (0.255), PC (-0.234), PDMY (-0.240), AE1 (0.336), and AE2 (0.246). SV, located at the second main level of DOD HFACS, did not have any statistically significant correlation with the exogenous variables present at the first level, ORG, OP, ODMY. To this end a path from ODMY to

SV was drawn to exemplify the Reason model. As standardized total effects presented in Table 29, ODMY had effect on SV (-0.213), SI (-0.233), SDMY (0.307), PP (-0.065), PC (0.052), PDMY (-0.010), ADMY (-0.010), AE3 (-0.016), AV (0.001), AE2 (0.027), and, AE1 (0.024). Table 32, extracted from Table 28, presents the test statistics of paths emanated from ODMY category level. Nine paths were tested and no paths were found statistically significant at $p <= 0.1855$ value.

Table 32. ODMY Category Level of UAV Paths

PATHS									Unstd. Effects	$p <=$ 0.1855	Std. Effects
ODMY	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0366	No	0.0103
ODMY	>>	SI	>>	PP	>>	AE3	<<	Accident	0.0017	No	0.0036
ODMY	>>	SDMY	>	PC	>	ADMY	<<	Accident	-0.0099	No	-0.0089
ODMY	>>	SDMY	>	PC	>>	AE2	<<	Accident	-0.0241	No	-0.0095
ODMY	>>	SI	>	PDMY	>	ADMY	<<	Accident	0.0007	No	0.0007
ODMY	>>	SI	>	PDMY	>	AV	<<	Accident	0.0000	No	0.0004
ODMY	>	SV	>	PDMY	>	AV	<<	Accident	0.0000	No	-0.0019
ODMY	>	SV	>	PDMY	>	AE3	<<	Accident	-0.0001	No	-0.0001
ODMY	>>	SDMY	>>	PP	>>	AE3	<<	Accident	-0.0002	No	-0.0004

4.8.4 Additional Paths for UAV model at $p <= 0.10$

Observing Table 16; OP-SV, OP-SDMY, OP-AE1, ODMY-SV, SDMY-PC, SDMY-AE3, PP-ADMY, PDMY-AE1, PDMY-AE2, and, PDMY-ADMY were found as additional statistically significant correlations in UAV model at $p <= 0.10$ level. Applying these correlations to path diagram seven more paths were suggested as potentially statistically significant paths in addition to fourteen UAV paths at $p <= 0.05$ level.

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.10$ in Table 16, three models were analyzed for UAV accidents for potentially statistically significant UAV accident causal paths. The first UAV model (A) at $p <= 0.10$ level yielded unsatisfactory goodness of fit values suggesting model revision. The second UAV model (B) at $p <= 0.10$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the same as in UAV model (B) at $p <= 0.05$ level; the exogenous variables of ORG-ODMY, OP-ODMY and error variables of SI-SDMY and PC-PDMY. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first UAV model (A) at $p <= 0.10$ level are presented in Appendix M.

The second model (B) of UAV at $p <= 0.10$ level yielded better goodness of fit indices. The path diagram of the second UAV model (B) at $p <= 0.10$ level is presented in Figure 13. The detailed AMOS output of the second (B) is presented in Appendix N.

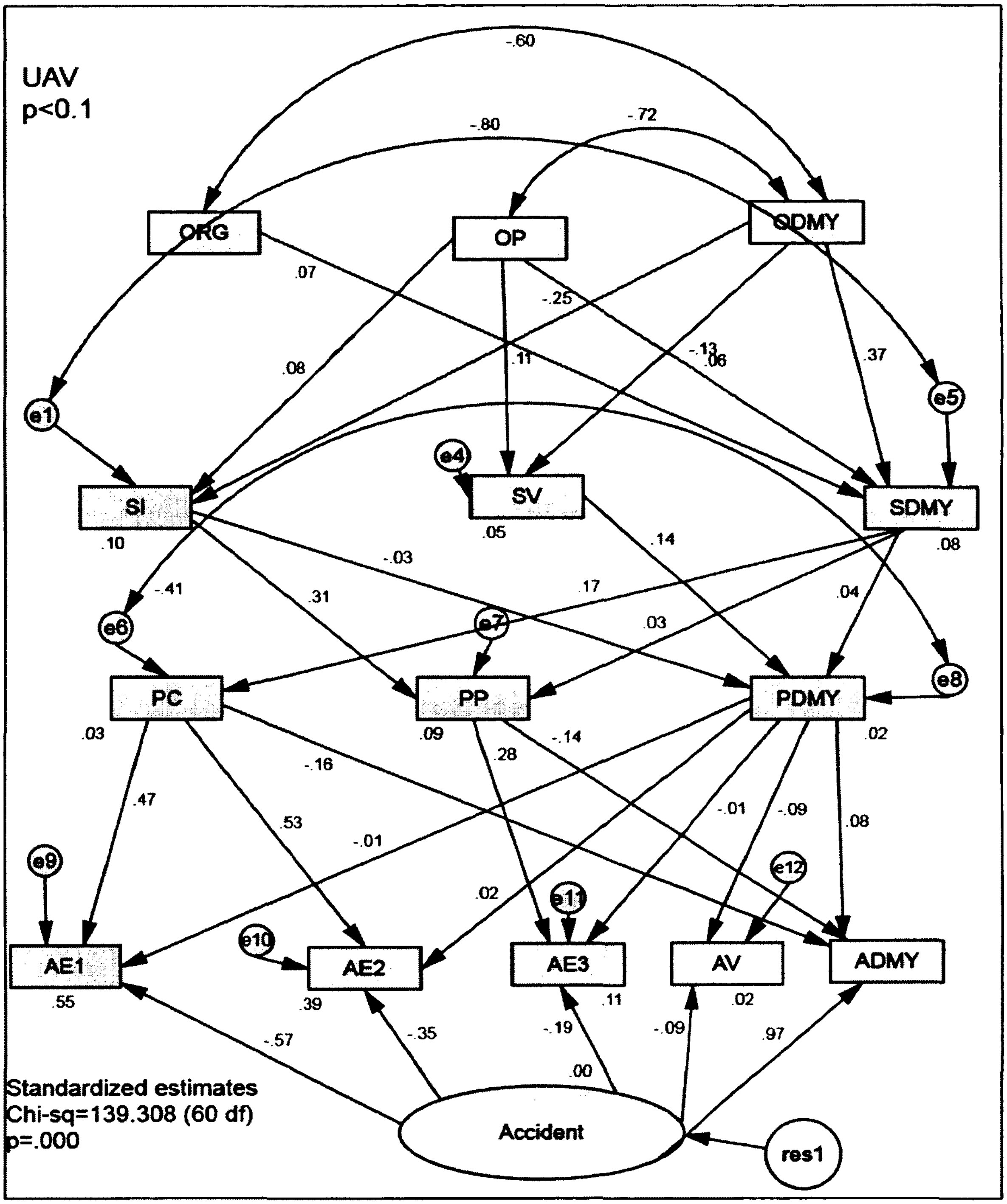


Figure 13. Path Diagram of Revised UAV Model (B) at $p <= 0.10$ Level

The third model (C) was constructed according to the p <= 0.10 level of regression weights of the second model (B) and statistically non-significant relationships that were utilized in the path analysis. Based on these assessments a path, OP-SV was pruned to improve the second model in terms of goodness of fit results. This third model (C) presented similar fit statistics with the second model (B) implying small amount difference between the pruned (C) and non-pruned model (B). Since the overall model Chi-sq/df, CFI, GFI, and RMSEA statistics did not change significantly, the second model (B) was selected as the actual one to be utilized in the model assessments. The detailed AMOS output of the third (C) model is presented in Appendix O. The goodness of fit indices of UAV model at p <= 0.10 level for three model are presented in Table 33.

Table 33. Goodness of Fit Indices of UAV Models at p <= 0.10 Level

UAV p <= 0.10	Model	
Chi-sq/df ($1.0 < \chi 2 / df < 3.0$)	A	5.038
	B	2.322
	C	2.291
CFI ($0.95 \leq$ CFI)	A	0.245
	B	0.768
	C	0.770
GFI ($0.9 \leq$ GFI)	A	0.631
	B	0.750
	C	0.749
RMSEA (around 0.05)	A	0.262
	B	0.150
	C	0.148

In model B, the loadings of Accident on AV and AE3 were not statistically significant at p <= 0.10. Accident loaded on AV with a coefficient of -0.026 and standard error of

0.038 yielding a critical ratio (CR) of -0.687 for a 49.2% significance level. Accident loaded on AE3 with a coefficient of -0.134 and standard error of 0.084 yielding a CR of -1.585 for an 11.3% significance level. Since both Reason's Swiss Cheese model and the design of the HFACS coding system assume that if an unsafe act occurs an accident results both AV and AE3 were retained in model B for comparability with the UAV ($p <= 0.05$) and MAV structural equation models. Accident loading onto AE1 was statistically significant with a coefficient of -1.130 and standard error of 0.174 yielding a CR of -6.502 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.550 and standard error of 0.160 yielding a CR of -3.430 for a significance of less than 0.1%.

Statistical tests and Pareto rankings of the paths were performed for unstandardized path effects to identify the statistically significant and main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at p value <= 0.10 that suggested the twenty one potentially statistically significant UAV accident causal paths were tested in path analysis. Table 34 present the path Pareto analysis of unstandardized effects and statistically significant paths in UAV accidents at $p <= 0.10$ level.

From Table 34, none of twenty one paths were found statistically significant at p value <= 0.3439 for the $\beta \neq 0$ case. One path was found statistically significant at p value <= 0.3439 for the $\beta = 0$ case. The unstandardized paths that exhibit the most positive effect within the range of the mean model effect on accidents are ODMY>SI>PP>ADMY with effect 0.0118 and CR = 0.6903, and ODMY>SI>PP>AE3 with effect 0.0023 and CR = 0.6251. For the $\beta = 0$ case, the path ODMY>SDMY>PC>AE1 is statistically significant. The paths with the most negative effect within the range of the mean model effect are ORG>SDMY>PC>AE1 with effect -0.0689 and CR = -0.7863, ODMY>SDMY>PC>AE2 with effect -0.0286 and CR = -0.7574, and ORG>SDMY>PC>AE1 with effect -0.0197 and CR = -0.3451.

Table 34. Total Effects and Significance of UAV Paths at $p < 0.3439$ Level

PATHS (first 14 UAV $p <= 0.05$ model; last 7 UAV $p <= 0.10$ model)									Unstd. Effects	SE β≠0	CR	SE β=0	CR	Std. Effects
ODMY	>>	SI	>>	PP	>>	AE3	<<	Accident	0.0023	0.0037	0.6251	0.0167	0.1365	0.0046
ODMY	>>	SI	>	PDMY	>>	ADMY	<<	Accident	0.0008	0.0117	0.0684	0.0719	0.0112	0.0007
ODMY	>>	SI	>	PDMY	>	AV	<<	Accident	0	0.0001	0.0333	0.0073	0.0006	0.0001
OP	>>	SI	>	PDMY	>	AV	<<	Accident	0	0.0001	-0.0172	0.007	-0.0002	0
ODMY	>>	SV	>	PDMY	>	AE3	<<	Accident	0	0.0006	-0.0135	0.0126	-0.0006	0
ODMY	>>	SV	>	PDMY	>	AV	<<	Accident	0	0.0001	-0.1395	0.0057	-0.0021	-0.0001
ODMY	>>	SDMY	>>	PP	>>	AE3	<<	Accident	-0.0003	0.0036	-0.0785	0.0203	-0.0138	-0.0006
OP	>>	SI	>>	PP	>>	AE3	<<	Accident	-0.0007	0.0024	-0.2844	0.016	-0.0429	-0.0015
ORG	>	SDMY	>	PC	>	ADMY	<<	Accident	-0.0034	0.0119	-0.2839	0.0636	-0.053	-0.0021
ORG	>	SDMY	>>	PC	>>	AE2	<<	Accident	-0.0082	0.0243	-0.3361	0.0298	-0.2742	-0.0022
ODMY	>>	SDMY	>	PC	>>	ADMY	<<	Accident	-0.0118	0.0195	-0.6049	0.0694	-0.1698	-0.0108
ORG	>	SDMY	>>	PC	>>	AE1	<<	Accident	-0.0197	0.057	-0.3451	0.0353	-0.5569	-0.0034
ODMY	>>	SDMY	>>	PC	>>	AE2	<<	Accident	-0.0286	0.0378	-0.7574	0.0326	-0.8791	-0.0113
ODMY	>>	SDMY	>>	PC	>>	AE1	<<	Accident	-0.0689	0.0876	-0.7863	0.0386	**-1.7853**	-0.017
ODMY	>>	SI	>>	PP	>>	ADMY	<<	Accident	0.0118	0.0172	0.6903	0.0605	0.1958	0.0109
OP	>	SV	>	PDMY	>	AV	<<	Accident	0	0.0001	0.1213	0.0054	0.0017	0.0001
ODMY	>>	SDMY	>	PDMY	>	AE3	<<	Accident	0	0.0014	0.005	0.0202	0.0003	0
OP	>	SV	>	PDMY	>	AE3	<<	Accident	0	0.0005	0.0118	0.0121	0.0005	0
ODMY	>>	SDMY	>	PDMY	>	AE1	<<	Accident	0	0.0281	-0.0012	0.0494	-0.0007	0
ODMY	>>	SDMY	>	PDMY	>>	AE2	<<	Accident	-0.0003	0.011	-0.0246	0.0416	-0.0065	-0.0001
OP	>	SDMY	>>	PC	>	AE1	<<	Accident	-0.0105	0.0522	-0.2019	0.0343	-0.3072	-0.0029

4.9 Comparative Model Analysis

This part of the analysis is conducted for the purpose of answering the third research question of whether there is a common statistically significant path between UAV and MAV accidents in terms of HFACS categorical levels. These two aircraft types are compared in three different ways to examine the findings. The first comparison is made with factor analysis, using the Tables 13, 14, 15 and 16 at two levels of the two aircraft type, UAV and MAV. The second comparison is made via contrasting the results of the path analysis for each aircraft type, MAV and UAV. The third comparison is conducted via fitting MAV data to the UAV model at two significance levels to identify similar paths within the context of DOD HFACS. UAV data could not be fit to the MAV model due to insufficient degrees of freedom from the sample size.

4.9.1 First Comparison: Common Correlations Extracted from Factor Analysis

The first comparison is made based on the results of the factor analysis using the Tables 13, 14, 15 and 16 at two levels for the two aircraft types, UAV and MAV. Table 35 presents the common correlations among DOD HFACS levels within the context of UAV and MAV accidents extracted by the means of factor analysis at two significance levels.

Table 35. Common Correlations between UAV and MAV Accidents

FROM	**LOWER LEVEL**			
ORG	PC (-)	PDMY	AE1 (-)	ADMY
OP	SI	SV*	SDMY* (-)	AE1* (-)
ODMY	SI (-)	PDMY (-)	AE1	
SI	PP			
SDMY	PP (-)			
SV	AE3*			
PC	AE1	AE2	ADMY (-)	
PDMY	AE2* (-)	ADMY*		

* Common statistically significant correlation at $p <= 0.10$ level

(-) Negatively correlated

4.9.2 Second Comparison: Common Paths Extracted by Path Analysis

The second comparison of this part is conducted via contrasting the results of the path analysis for each aircraft type, MAV and UAV. The results extracted in accordance with the path analysis are compared in two significance levels. No statistically significant path was found as common between UAV and MAV accidents at $p <= 0.05$ and $p <= 0.1$ levels.

4.9.3 Third Comparison: Model with Reciprocal Data

The third comparison is conducted via applying MAV data to UAV model at two significance levels to contrast similar statistically significant paths within the context of DOD HFACS. UAV data could not be fit to MAV model due to insufficient degrees of freedom from the sample size. In this comparison the standardized total effects of the respective analysis are compared to contrast the similar paths. As discerning criteria for similar paths between the two different models, the statistically significance paths in UAV model are compared with "UAV Model with MAV Data".

4.9.3.1 UAV Model with MAV Data at $p <= 0.05$ level (N = 203)

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.05$ in Table 15, two models were analyzed for "UAV model with MAV data" for potentially statistically significant UAV accident correlations using MAV data. The first "UAV model with MAV data" (A) at $p <= 0.05$ level yielded unsatisfactory goodness of fit values suggesting model revision. The second model (B) at $p <= 0.05$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the exogenous variables of ORG-ODMY, OP-ODMY, and error variables of SI-SDMY and PC-PDMY. The covariance selected according to modification indices were all related to dummy variables of the first three levels. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first "UAV model with MAV data" (A) at $p <= 0.05$ level are presented in Appendix P. Since the UAV models at both levels used the second model (B), this analysis utilized the second model for the purpose of comparison. The path diagram of the second "UAV model with MAV data" model (B) at $p <= 0.05$ level is presented in Figure 14.

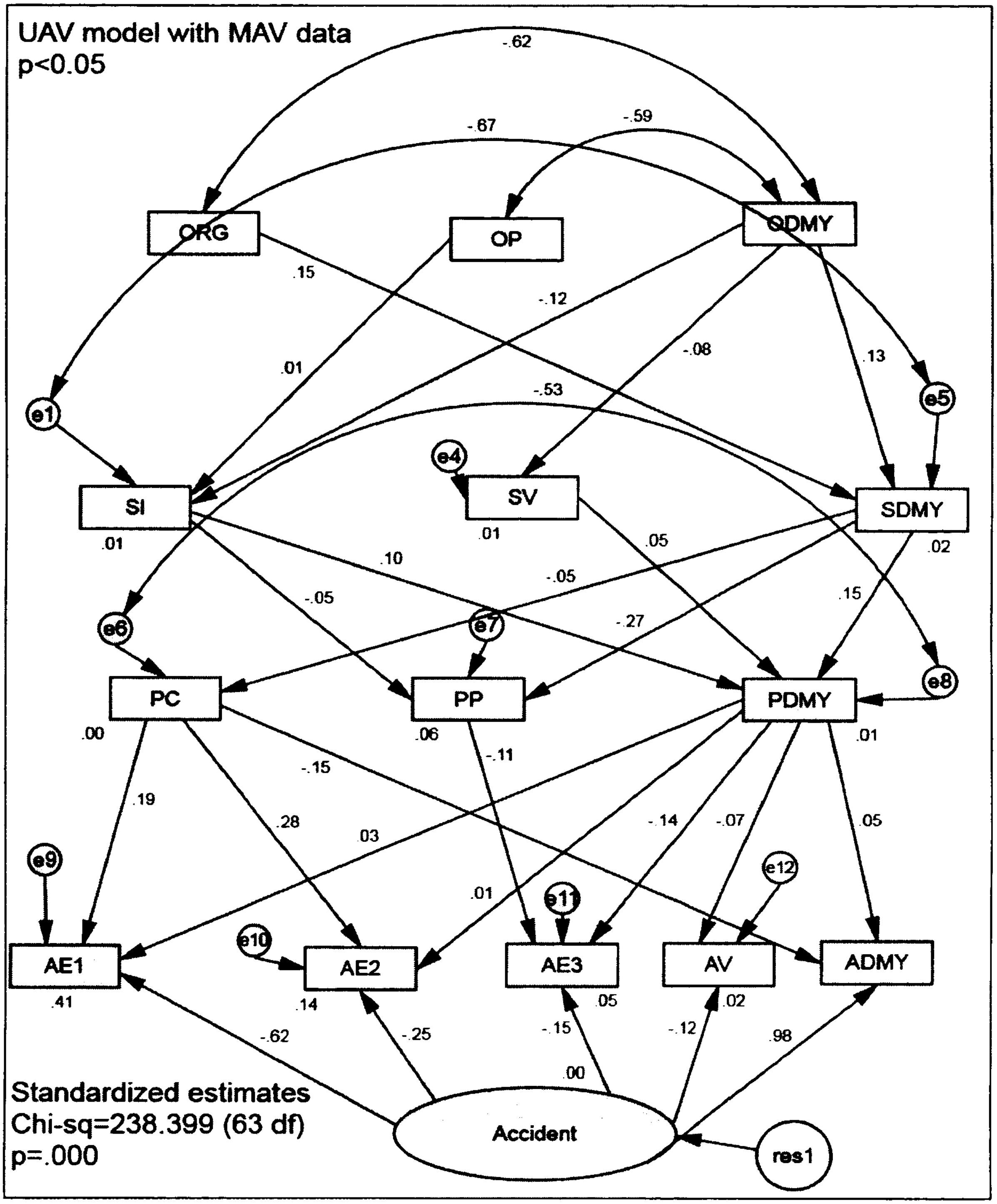


Figure 14. Path Diagram of Revised "UAV Model with MAV Data" (B) at $p <=$ 0.05 Level

The second model (B) of "UAV model with MAV data" at $p <= 0.05$ level yielded better goodness of fit indices. The detailed AMOS output of the second (B) is presented in Appendix Q. The goodness of fit indices of "UAV model with MAV data" at $p <= 0.05$ level for two models are presented in Table 36.

Table 36. Goodness of Fit Indices of UAV Models With MAV Data at $p <= 0.05$ Level

UAV model with MAV data $p < 0.05$	Model	Value
Chi-sq/df ($1.0 < \chi 2 / \mathrm{df} < 3.0$)	A	10.466
	B	3.784
CFI ($0.95 \leq$ CFI)	A	0.201
	B	0.779
GFI ($0.9 \leq$ GFI)	A	0.713
	B	0.867
RMSEA (around 0.05)	A	0.216
	B	0.117

In model B, the loading of Accident on AV was not statistically significant at $p <= 0.05$. Accident loaded on AV with a coefficient of -0.057 and standard error of 0.032 yielding a CR of -1.778 for a 7.5% significance level. Since both Reason's Swiss Cheese model and the design of the HFACS coding system assume that if an unsafe act occurs an accident results, AV was retained in model B for subsequent comparability with the "UAV model with MAV data" ($p <= 0.10$). Accident loading onto AE1 was statistically significant with a coefficient of -1.100 and standard error of 0.096 yielding a CR of -11.432 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.290 and standard error of 0.077 yielding a CR of

-3.769 for a significance of less than 0.1%. Accident loaded on AE3 with a coefficient of -0.098 and standard error of 0.044 yielding a CR of -2.225 for a 2.6% significance level.

Statistical tests and Pareto rankings of the paths were performed for unstandardized path effects to identify the statistically significant and main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at p value <= 0.05 that suggested the fourteen potentially statistically significant "UAV model with MAV data" accident causal paths were tested in path analysis. Table 37 presents the path Pareto analysis of unstandardized effects and statistically significant paths in "UAV model with MAV data" accidents at $p <= 0.1855$ level. From Table 37, none of the fourteen paths were found statistically significant at p value <= 0.1855.

Table 37. Total Effects and Significance of "UAV Model with MAV Data" Paths at $p <= 0.1855$ Level

PATHS									Unstd. Effects	SE β≠0	CR	SE β=0	CR	Std. Effects
ORG	>	SDMY	>>	PC	>>	AE1	<<	Accident	0.0037	0.0071	0.5253	0.0087	0.4245	0.0011
ORG	>	SDMY	>>	PC	>>	AE2	<<	Accident	0.0006	0.0012	0.5026	0.0063	0.096	0.0004
ODMY	>>	SDMY	>	PC	>>	AE1	<<	Accident	0.0036	0.0074	0.4822	0.0099	0.3595	0.0009
ORG	>>	SDMY	>>	PC	>>	ADMY	<<	Accident	0.0011	0.0024	0.4798	0.0211	0.054	0.001
ODMY	>	SDMY	>	PC	>>	AE2	<<	Accident	0.0006	0.0013	0.4621	0.0072	0.0812	0.0004
ODMY	>>	SDMY	>>	PC	>>	ADMY	<<	Accident	0.0011	0.0025	0.4417	0.024	0.0457	0.0009
ODMY	>	SI	>>	PP	>>	AE3	<<	Accident	0	0.0001	0.2965	0.0042	0.0101	0.0001
OP	>>	SI	>	PDMY	>	AV	<<	Accident	0	0	0.0392	0.0026	0.0005	0
OP	>>	SI	>>	PP	>>	AE3	<<	Accident	0	0.0001	-0.0278	0.0038	-0.0005	0
ODMY	>>	SV	>	PDMY	>	AV	<<	Accident	0	0	-0.3158	0.0023	-0.004	0
ODMY	>	SI	>	PDMY	>	ADMY	<<	Accident	-0.0007	0.002	-0.3488	0.0255	-0.0278	-0.0006
ODMY	>	SV	>	PDMY	>	AE3	<<	Accident	0	0.0001	-0.4335	0.0151	-0.0029	-0.0001
ODMY	>>	SI	>	PDMY	>	AV	<<	Accident	0	0.0001	-0.4361	0.0029	-0.0094	-0.0001
ODMY	>>	SDMY	>>	PP	>>	AE3	<<	Accident	-0.0003	0.0004	-0.7565	0.0201	-0.0137	-0.0005

4.9.3.2 UAV Model with MAV Data at $p <= 0.10$ level (N = 203)

Based on the relationships (Pearson correlations) found statistically significant at $p <= 0.10$ in Table 16, two models were analyzed for "UAV model with MAV data" potentially statistically significant UAV accident correlations using MAV data. The first "UAV model with MAV data" (A) at $p <= 0.10$ level yielded unsatisfactory goodness of fit values suggesting model revision. The second model (B) at $p <= 0.10$ level was constructed according the modification indices of the first model. These indices suggested applying four covariance among exogenous and error variables. The covariance applied were the exogenous variables of ORG-ODMY, OP-ODMY, and error variables of SI-SDMY and PC-PDMY. Analysis and parameter summaries, models, unstandardized and standardized total, direct, indirect effects, modification indices, model fit summary, and path diagrams of the first "UAV model with MAV data" (A) at $p <= 0.10$ level are presented in Appendix R. Since the UAV models at both levels used the second model (B), this analysis utilized the second model for the purpose of comparisons. The path diagram of the second "UAV model with MAV data" model (B) at $p <= 0.10$ level is presented in Figure 15.

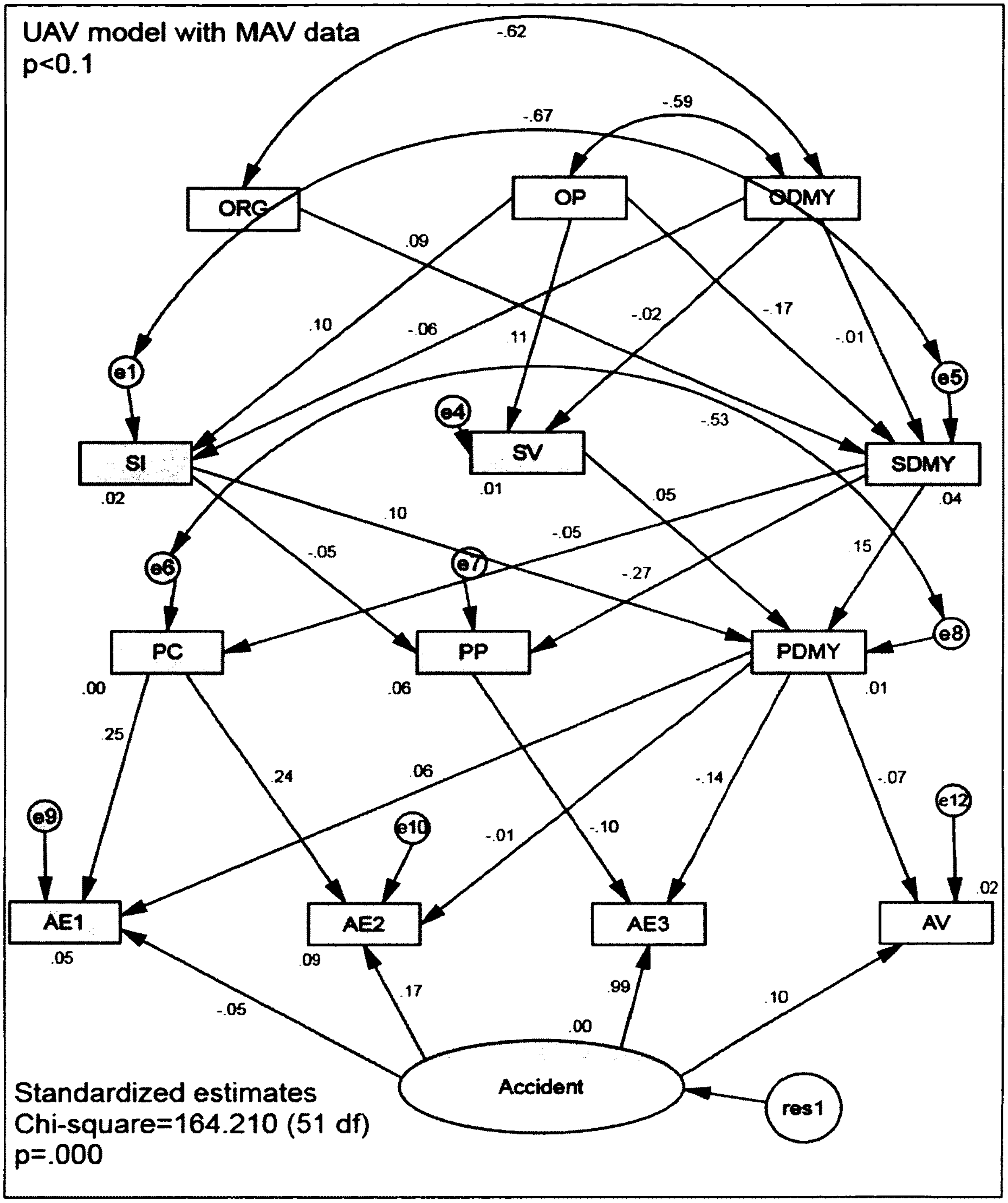


Figure 15. **Path Diagram of Revised "UAV Model with MAV Data" (B) at *p* <= 0.10 Level**

The second model (B) of "UAV model with MAV data" at $p <= 0.10$ level yielded better goodness of fit indices. The detailed AMOS output of the second (B) is presented in Appendix S. The goodness of fit indices for two models are presented in Table 38.

Table 38. Goodness of Fit Indices of UAV Model with MAV Data at $p <= 0.1$ Level

UAV model with MAV data $p < 0.1$	Model	
Chi-sq/df ($1.0 < \chi2 / \mathrm{df} < 3.0$)	A	10.837
	B	3.837
CFI ($0.95 \leq$ CFI)	A	0.207
	B	0.781
GFI ($0.9 \leq$ GFI)	A	0.715
	B	0.870
RMSEA (around 0.05)	A	0.221
	B	0.120

In model B, the loadings of Accident on AE1, AE2, AE3 and AV were statistically significant at $p <= 0.10$. Accident loading onto AE1 was statistically significant with a coefficient of -1.102 and standard error of 0.096 yielding a CR of -11.471 for a significance of less than 0.1%. Accident loading onto AE2 was statistically significant with a coefficient of -0.288 and standard error of 0.077 yielding a CR of -3.743 for a significance of less than 0.1%. Accident loaded on AE3 with a coefficient of -.099 and standard error of 0.044 yielding a CR of -2.245 for a 2.5% significance level. Accident loaded on AV with a coefficient of -0.058 and standard error of 0.032 yielding a critical ratio (CR) of -1.808 for a 7.1% significance level.

Statistical tests and Pareto rankings of the paths were performed for unstandardized path effects to identify the statistically significant and main contributing paths. Given the constraint of the HFACS implementation of Reason's Swiss Cheese model of accident causation, the statistically significant correlations at p value <= 0.10 suggested the twenty one potentially statistically significant "UAV model with MAV data" accident causal paths to be tested in path analysis. Table 39 presents the path Pareto analysis of unstandardized effects and statistically significant paths in "UAV model with MAV data" accidents at $p <= 0.3439$ level.

From Table 39 none of twenty one paths was found statistically significant at p value <= 0.3439.

Table 39. Total Effects and Significance of "UAV Model with MAV Data" Paths at $p <= 0.3439$ Level

PATHS											Unstd. Effects	SE β≠0	CR	SE β=0	CR	Std. Effects
ORG	>	SDMY	>>	PC	>>	AE1	<<	Accident			0.0018	0.0044	0.4078	0.0093	0.1914	0.0005
ORG	>	SDMY	>	PC	>	ADMY	<<	Accident			0.0007	0.0018	0.3848	0.0224	0.0303	0.0006
ORG	>	SDMY	>	PC	>	AE2	<<	Accident			0.0004	0.0011	0.4127	0.0067	0.0658	0.0003
ODMY	>>	SDMY	>>	PP	>>	AE3	<<	Accident			0	0.0004	0.0675	0.005	0.0051	0
ODMY	>>	SI	>>	PP	>>	AE3	<<	Accident			0	0.0001	0.2058	0.0043	0.0057	0
OP	>>	SI	>	PDMY	>	AV	<<	Accident			0	0.0001	0.3996	0.0029	0.0079	0.0001
ODMY	>>	SV	>	PDMY	>	AV	<<	Accident			0	0	-0.0648	0.0025	-0.0006	0
ODMY	>>	SV	>	PDMY	>	AE3	<<	Accident			0	0.0001	-0.0863	0.0035	-0.0022	0
ODMY	>>	SI	>	PDMY	>	AV	<<	Accident			0	0	-0.2843	0.003	-0.0046	-0.0001
OP	>>	SI	>>	PP	>>	AE3	<<	Accident			0	0.0001	-0.2844	0.0043	-0.0097	-0.0001
ODMY	>>	SDMY	>	PC	>>	AE2	<<	Accident			-0.0001	0.0012	-0.0457	0.0084	-0.0065	0
ODMY	>>	SDMY	>	PC	>	ADMY	<<	Accident			-0.0001	0.002	-0.043	0.0281	-0.003	-0.0001
ODMY	>>	SDMY	>	PC	>>	AE1	<<	Accident			-0.0002	0.0048	-0.0452	0.0116	-0.0189	-0.0001
ODMY	>>	SI	>	PDMY	>	ADMY	<<	Accident			-0.0004	0.0016	-0.2705	0.0263	-0.0167	-0.0003
ODMY	>>	SDMY	>	PDMY	>	AE1	<<	Accident			0.0001	0.0041	0.0291	0.013	0.0092	0
ODMY	>>	SI	>	PP	>>	ADMY	<<	Accident			0.0001	0.0008	0.1096	0.0226	0.0037	0.0001
OP	>>	SV	>	PDMY	>	AE3	<<	Accident			0.0001	0.0001	0.4539	0.0035	0.0171	0.0001
OP	>>	SV	>	PDMY	>	AV	<<	Accident			0	0	0.3275	0.0025	0.0049	0
ODMY	>>	SDMY	>	PDMY	>	AE2	<<	Accident			0	0.0007	0.0116	0.0093	0.0008	0
ODMY	>>	SDMY	>	PDMY	>	AE3	<<	Accident			0	0.0003	-0.0641	0.0049	-0.0035	0
OP	>>	SDMY	>	PC	>	AE1	<<	Accident			-0.0035	0.0073	-0.4839	0.0105	-0.3356	-0.0009

4.10 Comparative Goodness of Fit Statistics

All the first models (A) of the respective aircraft type and significance level had low levels of fit within the context of ($\chi2$ / df), RMSEA, GFI, CFI statistics. Applying covariance to the second models (B), the results improved in fit indices. The third models were constructed to improve models according to respective regression weights of the second models (B) and statistically non-significant relationships that were utilized in the path analysis. However; the results of the third models (C) presented similar fit statistics with the second models (B) implying small amount difference between the pruned (C) and non-pruned models (B). Since the overall model Chi-sq/df, CFI, GFI, and RMSEA statistics did not change significantly, the second models (B) were selected as the actual models to be utilized in the analysis. The third models (C) were not applicable to UAV model at $p <= 0.05$ level and "UAV model with MAV data" at both significance level. All the second (B) models of that utilized in analysis did not exactly fit but presented close satisfactory results in terms of goodness of fit indices. The second UAV (B) models at both levels depicted fit measures in terms of $\chi2$ / df measures. The comparative measures of goodness of fit of all models are presented in Table 40.

Table 40. Comparative Goodness of Fit Statistics

AMOS Fit Measures	Acceptable Criteria	Model	MAV at $p < 0.05$ Level	MAV at $p < 0.1$ Level	UAV at $p < 0.05$ Level	UAV at $p < 0.1$ Level	UAV with MAV Data at $p < 0.05$ Level	UAV with MAV Data at $p < 0.1$ Level
Chi-square dividing by the degree of freedom ($\chi2$ / df)	$1.0 < \chi^2/\text{df} < 3.0$	A	8.637	8.972	4.865	5.038	10.466	10.837
		B	3.722	3.806	2.252	2.322	3.784	3.896
		C	3.667	3.76	-	2.291	-	-
Comparative Fit Index (CFI)	0.95 ≤ CFI	A	0.242	0.242	0.243	0.245	0.201	0.207
		B	0.741	0.745	0.769	0.768	0.779	0.781
		C	0.74	0.745	-	0.770	-	-
Goodness of Fit Index (GFI)	0.9 ≤ GFI	A	0.707	0.708	0.625	0.631	0.713	0.715
		B	0.831	0.834	0.748	0.750	0.867	0.870
		C	0.829	0.834	-	0.749	-	-
Root Mean Square Error of Approximation (RMSEA)	RMSEA around 0.05	A	0.194	0.199	0.256	0.262	0.216	0.221
		B	0.116	0.118	0.213	0.150	0.117	0.120
		C	0.115	0.117	-	0.148	-	-

4.11 Results of the Hypothesis

Three main analyses, MAV models, UAV models and comparisons, were conducted to answer the three research questions. According first two main analyses, there were statistically significant causal paths at two levels, $p <= 0.1855$ and $p <= 0.3439$ among MAV DOD HFACS Category levels shown in Tables 19 and 26. There were no statistically significant causal paths at $p <= 0.1855$ among UAV DOD HFACS Category levels as shown in Table 28. There was one statistically significant causal path at $p <= 0.3439$ among UAV DOD HFACS Category levels for the case $\beta = 0$ as shown in Table 34. For the third question, there were no common statistically significant causal paths at two levels, $p <= 0.1855$ and $p <= 0.3439$, as shown in Tables 37 and 39. In that context:

H1$_O$: There is no statistically significant causation path among the levels of HFACS in MAV accidents.

H1$_a$: There is at least one statistically significant causation path among the levels of HFACS in MAV accidents.

Conclusion: Based on critical ratios in Tables 19 and 26, statistically significant path effect coefficients were observed at joint $\alpha = 0.1855$ ($\alpha = 0.05$ individual direct effect coefficients) and joint $\alpha = 0.3439$ ($\alpha = 0.10$ individual direct effect coefficients) under both cases path $\beta \neq 0$ and $\beta = 0$ for MAV accidents. Reject **H1$_O$** of no statistically significant causation path leading to MAV accidents and conclude that one or more statistically significant accident causation path(s) are identified by SEM analysis.

H2$_O$: There is no statistically significant causation path among the levels of HFACS in UAV accidents.

H2$_a$: There is at least one statistically significant causation path among the levels of HFACS in UAV accidents.

Conclusions: Based on critical ratios in Table 28, statistically significant path effect coefficients were not observed at joint $\alpha = 0.1855$ ($\alpha = 0.05$ individual direct effect coefficients) under both cases path $\beta \neq 0$ and $\beta = 0$ for UAV accidents. Fail to reject **H2$_O$** of no statistically significant causation path at joint

$\alpha = 0.1855$ leading to UAV accidents and conclude that no statistically significant accident causation path(s) are identified by SEM analysis. Based on critical ratios in Table 34, statistically significant path effect coefficients were not observed at joint $\alpha = 0.3439$ ($\alpha = 0.10$ individual direct effect coefficients) under the case of path $\beta \neq 0$ for UAV accidents. Fail to reject **$H2_O$** of no statistically significant causation path at joint $\alpha = 0.3439$ for the case of path $\beta \neq 0$ leading to UAV accidents and conclude that no statistically significant accident causation path(s) are identified by SEM analysis. Conversely, based on critical ratios in Table 34, one statistically significant path effect coefficient was observed at joint $\alpha = 0.3439$ ($\alpha = 0.10$ individual direct effect coefficients) under the case of path $\beta = 0$ for UAV accidents. Reject **$H2_O$** of no statistically significant causation path at joint $\alpha = 0.3439$ for the case of path $\beta = 0$ leading to UAV accidents and conclude that statistically significant accident causation path(s) are identified by SEM analysis.

H3o: There is no common statistically significant path between UAV and MAV accident paths in terms of HFACS categorical levels.

H3a: There is at least one common statistically significant path between UAV and MAV accidents paths in terms of HFACS levels.

Conclusion: Based on critical ratios in Tables 37 and 39, statistically significant common path effect coefficients were not observed at joint $\alpha = 0.1855$ ($\alpha = 0.05$ individual direct effect coefficients) and joint $\alpha = 0.3439$ ($\alpha = 0.10$ individual direct effect coefficients) under both cases path $\beta \neq 0$ and $\beta = 0$ for MAV accident data fit to UAV accident models. Fail to reject **H1**$_{O}$ of no statistically significant common causation paths between UAV and MAV accident paths and conclude that no statistically significant common accident causation path(s) are identified by SEM analysis.

CHAPTER 5

RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter discusses results, conclusions, and recommendations for future research from this investigation of USAF MAV and UAV accident causes.

5.1 Introduction

The main objective of this study was to analyze the structural relationships of accident causes among DOD HFACS levels in comparable UAVs and MAVs and to analyze any potential common relationships between UAV and MAV accident cause paths. In the pursuit of these objectives, this work developed two types of analyses that are considered to contribute to the study MAV and UAV accident causes. The first analytical contribution was the structuring DOD HFACS accident codes such that they can be analyzed by attribute agreement analysis for inter-rater reliability estimates. The second analytical contribution was the normalization of DOD HFACS accident code data such that it can be analyzed for path effect and statistical significance within the structural equation modeling (SEM) methodology. These two analytical methods are discussed separately in order to establish their contributions to the analysis of accident causes within the aviation domain and suggest their application to the analysis of accident causes in other industrial, service, and governmental domains.

5.2 Inter-rater Reliability Results

The main contribution of this study to inter-rater reliability analysis of the assignment of HFACS codes in MAV and UAV accident reports was the development of the inter-rater reliability attribute agreement analysis study methodology in Section 4.2.

Typically, attribute agreement analysis is applicable to units that require subjective assignment to one of a few categories. For example, the assignment of a unit of finished product to one of categories grade A, grade B, rework to the next higher grade, sell to third world, or scrap. Another example would be classification of loan applications to very low, low, medium, or high risk or to reject categories. The entire unit is assigned to the category based on its cumulative characteristics. Given that there are three "Organizational Influences" categories, four "Unsafe Supervision" categories, three "Preconditions for Unsafe Acts" categories, and four "Unsafe Acts" categories plus one dummy variable for each category level, there are $4 \times 5 \times 4 \times 5 = 400$ path classifications for each MAV or UAV accident under the HFACS. This number of path classifications can be multiplied further, since USAF experts assign category codes that create partial paths and multiple paths within the same accident report. Thus, assignment of an accident report to a discrete path classification is not always possible.

The attribute agreement analysis inter-rater reliability method developed as part of this work overcame this need for discrete path classification by:

- Treating each HFACS categorical level as an independent assignment. This decomposed each path by Reason's Swiss Cheese model to four independent classification problems.
- Adding a dummy variable to each HFACS categorical level as a pass through category for accidents in which USAF investigators did not make code assignment for the given level.
- Normalizing the data into a Poisson process by dividing the number of nanocode assignments within a respective category by the total number of

nanocodes within the categorical level plus one for the introduced dummy variable.

These modifications allowed each path to be treated as arising from a multiplicative process of independent variables for subsequent SEM analysis.

The inter-rater reliability procedure developed in Section 3.1 was designed to verify the individual rater's reliability before and after rating the 272 accident summaries. The first step was to establish the measurement standard for acceptable inter-rater agreement. To this end, this work relied on a prior study by O'Connor, et. al. (2010) indicating only a 55% agreement among raters of aircraft accident reports. This study set the standard for between rater agreement and all raters' agreement to experts' classification at greater than or equal to 50% average or 50/50 odds of random assignment classification.

The second step was the tradeoff analysis between confidence in the difference to detect and the sampling resolution over a range of sample sizes to select a sample size that provided $\geq$ 90% confidence in detecting differences between any two raters from the $p = 0.50$ base random assignment case.

The third step was development of the seven step rater reliability method in Section 3.1. Step One decomposed the 75 detailed accident reports into ten training, 20 pre-classification testing, and 30 inter-rater testing categories and randomly assigned each detailed accident report to each category. The three raters studied the ten training reports to develop their own classification scheme based on their observations of USAF expert investigator HFACS code assignments. The three raters were then tested on a random sample of ten reports out of the 20 pre-classification testing reports for HFACS category assignment agreement in two rounds of attribute agreement analysis. The three raters achieved the greater than 50% average agreement for between raters and all raters' agreement to experts' classification on the second round. The first inter-rater reliability testing was conducted next on the 30 detailed reports and confirmed the greater than 50% average agreement for between raters and all raters' agreement to experts' classification. This pre-classification and inter-rater testing attribute agreement analyses can continue for multiple rounds until the between raters and all raters' agreement to experts' classification achieve the average agreement rating standard. The pre-classification and inter-rater testing attribute agreement analyses established the rater's reliability *a priori* to rating the 272 accident summaries. After rating of the 272 accident summaries, the post inter-rater testing of 30 random samples from the 272 classified accident summaries by the three raters showed between rater agreement greater than the 50% average criteria establishing confidence that the summaries had been classified at a rate greater than 50/50 odds random assignment and approaching the 55% agreement in prior studies by O'Connor, et. al. (2010).

Finally the categorical level classification scheme developed for this work transformed the HFACS classification data into a format suitable for attribute agreement analysis. Each categorical level was assigned multiple rows, one for each category assigned within the level. This allowed for multiple category assignments within a category level. In addition to the category codes and the dummy variable code, a code of "N" was assigned to show disagreement between raters within a categorical level or of a rater with himself between replicates. This classification scheme is illustrated in Table 41.

Table 41. Accident Categorical Level Classification Scheme

Report	Rater 1	Rater 1	Rater 2	Rater 2	Rater 3	Rater 3
M0020_F-16C-O	D	D	D	D	D	D
M0020_F-16C-S	D	D	D	D	D	D
M0020_F-16C-P	N	N	PC	PC	N	PC
M0020_F-16C-P	D	D	N	N	D	N
M0020_F-16C-A	SB	SB	SB	SB	SB	SB
M0020_F-16C-A	N	N	N	JD	N	N
M0020_F-16C-A	MI	MI	MI	N	MI	MI
M0604_C-5-O	D	D	D	D	D	D
M0604_C-5-S	SI	SI	SI	SI	SI	SI
M0604_C-5-P	PC	PC	PC	PC	PC	PC
M0604_C-5-A	N	SB	N	N	N	N
M0604_C-5-A	JD	JD	JD	JD	JD	JD
M0710_V-16C-O	D	D	D	D	D	D
M0710_V-16C-S	D	D	D	D	D	D
M0710_V-16C-P	PC	N	N	N	N	N
M0710_V-16C-P	N	N	PP	PP	PP	PP
M0710_V-16C-P	N	D	N	N	N	N
M0710_V-16C-A	SB	SB	SB	SB	SB	SB
M0710_V-16C-A	N	JD	N	N	N	N

5.3 Factor Analysis and Path Analysis

An exploratory factor analysis was used to reduce the number of possible 400 path classifications to the few potentially significant paths represented by the statistically significant inter-categorical Pearson correlations. The combinations of significant correlations from the from the “Organizational Influences” level to the “Unsafe Acts” level of DOD HFACS variables were used to structure the hypothesized paths among the DOD HFACS category levels. As a result of this analysis, 39 and 24 statistically significant correlations of MAV and UAV accidents respectively were extracted at $p <= 0.05$ significance level. The numbers of the correlations found at $p <= 0.10$ levels were 54 and 33 for MAV and UAV accidents respectively. From these correlations, 26 MAV paths and 14 UAV paths at correlation significance of $p <= 0.05$ level and 50 MAV paths and 21 UAV paths at $p <= 0.10$ level were hypothesized for subsequent testing by the means of path analysis.

Current structural equation modeling software is not programmed to provide path coefficients and their standard errors in terms of the HFACS accident cause assignments. Current SEM software, SPSS/AMOS included, provide bootstrap estimates of unstandardized regression weights and standard errors. A contribution of this work in applying SEM analysis to DOD HFACS accident report classifications was the recognition that, because the covariance matrix provides independent estimates of SEM direct effect coefficients between HFACS categorical levels, each HFACS path is composed of independent random variables of SEM direct effect coefficients and their standard errors. Correspondingly, each path effect on Accident outcome is the $\beta_{path} = \beta_O \times \beta_S \times \beta_P \times \beta_A \rightarrow$ Accident product, and from mathematical statistics the principle of the variance of the product of independent random variables was applied to provide the two estimates of path standard errors by which the β_{path} / SE_{path} statistical significance could be tested.

Fifteen models for the two aircraft type, UAV and MAV at both significance levels, were hypothesized and six models were selected for structural equation modeling and path analysis. All the first models (A) of the respective aircraft type and significance level had low levels of fit statistics within the context of $\chi2$ / df, RMSEA, GFI, CFI values. All second SEM models (B) showed significantly improved fit indices. Third models were constructed according to respective regression weights of the second models (B), but all third models did not show substantial improvements in fit indices. Thus, second models (B) were retained for path analyses. According to Byrne (2010), fit indices yield information bearing only on the model's lack of fit and are unable to reflect the extent to which the model is plausible. The judgment of plausibility rests squarely on the researcher.

In the MAV model, three paths, including no dummy variable, emanated from category OC were found to be statistically significant at $p <= 0.1855$ and $p <= 0.3439$ levels:

OC>SP>PC>AE1

OC>SP>PC>AE2

OC>SP>PC>AE3

Seven additional paths, five emanating from category OC, were found to be statistically significant at $p <= 0.3439$ level.

OC>SDMY>PC>AE1 (for $\beta=0$ and $\beta\neq0$)

OC>SDMY>PC>AE2 (for $\beta=0$ and $\beta\neq0$)

ORG>SP>PC>AE1 (for $\beta=0$ and $\beta<\neq0$)

ORG>SP>PC>AE2 (for $\beta\neq0$)

OC>SDMY>PC>AE3 (for $\beta\neq0$)

OC>SV>PDMY>AE1 (for $B=0$)

OC>SI>PDMY>AE1 (for $B=0$)

Thus for $\beta \neq 0$, it can be observed that at the "Organizational Influences" HFACS categorical the OC, organizational climate, was the main contributor to MAV accidents.

At the "Unsafe Supervision" level, SP, planned inappropriate operations, was the main contributor. At the "Preconditions for Unsafe Acts" level, PC, condition of the individual, was the main contributor. At the "Unsafe Acts" level, AE1 skill based errors, AE2 judgment and decision making errors, and AE3 misperception errors all contributed to accidents with AE1 having the largest effect with coefficient -1.108, AE2 the next largest effect with coefficient -0.545, and AE3 the least effect with coefficient -0.132.

In the UAV model, one path was found to be statistically significant at the $p <= 0.3439$ level.

ODMY>SDMY>PC>AE1

Thus, it can be observed that the organizational causal mechanisms that lead to UAV accidents are different from those that lead to MAV accidents. MAV accident causal paths involve all organizational levels, whereas UAV accident causes are located in the "Preconditions for Unsafe Acts" and the "Unsafe Acts" organizational levels. The commonality is that PC, condition of the individual, AE1, skill based errors are the main causal contributors to both MAV and UAV accidents.

Three different comparisons were conducted for the purpose of the third research question whether there is a common statistically significant path between UAV and MAV accidents in terms of HFACS categorical levels. The first comparison was made between the results of factor analyses, the second comparison was made via contrasting the results of the path analysis for each aircraft type, and the third comparison was conducted via applying MAV data to UAV model at two significance levels to contrast common paths within the context of DOD HFACS.

The first comparison was made according to factor analysis and yielded thirteen common correlations at the $p <= 0.05$ level and nineteen common correlations at the $p <= 0.10$ level between MAV and UAV. The second comparison was based on contrasting the results of path analysis of two aircrafts. As reported above, no common statistically significant paths were identified.

The third comparison was conducted applying MAV data to the UAV models at two significance levels to contrast common statistically significant paths within the context of DOD HFACS. As reported in Chapter 4, applying MAV data to UAV models and comparing the results with UAV model showed no statistically signficant common paths under the constraint of Reason's Swiss Cheese model requiring full paths through all organizational levels. As noted above partial common paths exist at the "Preconditions for Unsafe Acts" and the "Unsafe Acts" organizational levels.

In conventional organizations, each level is generally responsible for its respective and lower levels. While it is difficult or not possible to amend or correct the higher level decisions or errors, end-users are not always able to detect these errors originated from the top level. The problem to be addressed within the context of organizational management is finding out the structure of the accident paths from the top levels to end users. Organizations concerned with accidents and human factors can utilize this methodology and find the respective failure model.

Another point is that each sector or domain may have different type of failure models. While Reason's failure model can be appropriate for traditional organizations, the model might not be suitable for organizations having low hierarchy or technology driven-complex structures. As Bar-Yam (2004) states, the complex mission is one that has a large number of possible unsuccessfull actions. Flight, the core activity of aviation, can be considered as a complex mission and an air force as a complex organziation. Considering the Reason's model as a base structure, HFACS and the structural assessments presented in this study can be utilized to identify the failure model of an organization. Accurate identification of the failure model of an organization can provide enhanced interventions and improvements in system safety in terms of human factors.

Originally developed for the nuclear power industry, Reason's model is adapted to aviation (Wiegmann & Shappell, 2003) and has been studied in different types of domains such as maintenance (Krulak, 2004), shipping (Celik & Cebi, 2009), motor vehicle accidents (Iden, 2012), and mining (Lenné, Salmon, Liu, & Trotter, 2012). These studies utilized HFACS taxonomy as a framework to adapt the Reason model to their respective organization or domain. Considering differences of these areas and the type of technology operated, the failure models can be different from the Reason's approach, suggesting more dynamic and complex structures or activities.

The levels set forth by Reason can be customized to a variety of organizations according to their decision making process, hierarchical structure, and technology being used. In that context, HFACS can be used as the mean of determining the failure structure by classifying and analyzing the accidents, mishaps, or near misses. Improving and adapting Reason's model (1990) by the means of adapted HFACS taxonomy can contribute to organizations ability to comprehend the failure structure and elaborate a variety of intervention strategies.

Given the identification of significant causation paths of an organization by the methodology set forth in this study, new failure models can be tested and improved in terms of human factors. As this type of failure model study allows identification of the significant paths and consequently the accident model it can be named as a "dynamic failure model". Obviously, there should be an optimum definition of a failure so that it can be assessed in analysis to identify the significant causation paths and failure model of an organization or a structure. In this study, Class A accidents that occurred in USAF between the Flight Years of 2000 and 2013 were used as "failures".

Knowledge of statistically significant paths and structural relations of causes is necessary for successful interventions to prevent human related accidents and improve the safety of the organization's activities. Besides this fact, since UAV and MAV have different concepts in terms of personnel training mission types, interventions at organizational level should be in accordance with these differences. Decision makers of the respective organization can utilize the differences of accident paths between MAV and UAV while deciding on wide-scale interventions.

5.4 Limitations of the Study

The majority of the reports in the USAF Accident Investigation Boards database include the executive summaries of the accidents. Given that 347 reports of which 272 of the accident reports were summaries and required classification by the researcher, the issue of classification reliability had to be address through rater reliability assessment.

The samples size of UAV accidents (N = 60) was another limitation of the study. However; as the proposed UAV model had only single-direction paths between the categories, the model hypothesized was considered not to have a complexity in terms of paths or correlations.

The narrative and detailed data available was for the years between 2000 and 2013. Since UAV usage and its accident analysis are not as common as manned aircrafts, there is a limited interval of time for the analysis. However, this time is considered to be sufficient to analyze UAV and MAV accidents.

5.5 Recommendations for Future Studies

The inter-rater reliability study methodology developed in this work can be conducted to establish and improve assessment reliability for any aviation organization applying the HFACS directly or any organization in another sector adapting the HFACS system to its sector. Other sectors will have to develop their own respective accident categorical level classification schemes and adapt the methodology for assessment and possibly certification of raters.

Future research will be required to implement SEM code to estimate path coefficients and standard errors using accepted bootstrap estimate methods. This work estimated path coefficients and standard errors as the product of independent random variables based on the observation that the covariance matrix provides independent estimates of SEM direct effect coefficients between HFACS categorical levels

Future research is needed to develop optimal path pruning methods similar to backward and forward stepwise regression and best subsets regression in empirical modeling. Such pruning methods will have to consider the tradeoff between improved model fit and magnitude of total path effect in terms of the size of its coefficient. As can be observed in Tables 19, 26, 28, and 34 of this study, there were paths that were not statistically significant and eligible for pruning but had path coefficients that were larger in magnitude than the coefficients of statistically significant paths.

USAF investigators did not always assign accident codes to each HFACS level. This was the reason that dummy variables were implemented for structural equation modeling in this study. This strongly suggests that either USAF investigators are not following the intent of Reason's Swiss Cheese model in applying the HFACS or that Reason's Swiss Cheese model does not strictly hold for MAV and UAV accident causes. In either case, the structural equation modeling methodology developed in this study will have to be modified to admit partial paths in order to relax the assumptions underlying Reason's model. It is uncertain at this time as to whether or not such partial paths or under what missing partial path conditions will yield positive definite covariance matrices. Future research will be required to develop partial path structural equation modeling.

In the future, different services of Armed Forces, having aviation departments or sectors other than aviation using HFACS, can be analyzed with the structural equation modeling methodology developed in this work. Furthermore, a more complex study may include the human errors not just in one service but also throughout armed forces and other sectors.

The methodology that set forth the path(s) among HFACS levels and sublevels can be applied to other domains and organizations that use HFACS taxonomy by the mean of analyzing the secondhand accident investigation reports. The integration of such secondhand data will require additional research to assure rater accuracy and understand the implications of the structural equation modeling process, assessment, and interpretation.

Since differing organizations and sectors have different structures and processes the relationship among HFACS levels and sublevels found in this study are unlikely to have the same path(s). The knowledge developed is not only the HFACS path(s) in USAF UAV and MAV accidents but also the analytical methodology, which can be applied to other aviation or industrial organizations as well. Additional research will be required to develop the name of the holes together with relationships among the Swiss Cheese pieces, which are HFACS levels and sublevels.

The HFACS taxonomy can be reviewed and tested regularly with the data to capture the effects of technology and structural changes of the organization. Since no latent variable such as mission type or accident phase was used in the study, further studies may include this kind of latent variables as well to observe the effect.

5.6 Conclusion

Decreasing accident rates is crucial to military and commercial aviation and to industrial organizations, especially those concerned with human factors, working under budget constraints. In order to mitigate the potential for aviation accidents, it is important to ensure that accidents are investigated and evaluated in an appropriate methodology and taxonomy so as to understand the causes for individual and all cases as well. This study conducted a set of analysis to identify statistically significant paths of UAV and MAV accidents and common paths between UAV and MAV accidents within the context of DOD HFACS taxonomy based on Reason's (1990) Accident Causation Model.

The correlations found among the variables, categories were applied to HFACS taxonomy based on the Reason Model via path analysis. In other words, the results of correlation matrix were applied to four layered- structure based on the Reason model via multiple regressions. The study concluded the presence of statistically significant paths at both UAV and MAV accidents and common partial paths of those aircraft types within the framework of DOD HFACS taxonomy. The study also suggests that accident data can be utilize to test and improve the failure model of an organization to apprehend any significant effect such as technology and structural changes in the organization.

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APPENDICES

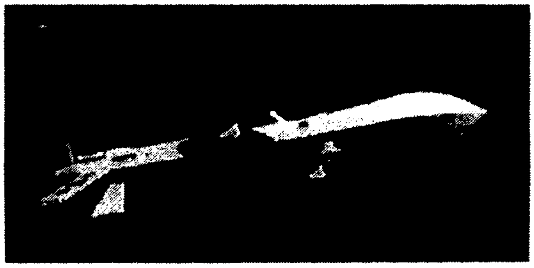
APPENDIX A. COVER, EXECUTIVE SUMMARY AND OUTLINE OF AN AIBs REPORT

This appendix includes the cover, executive summary and outline of an AIBs report.

UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

MQ-1B, T/N 06-3175

196th Reconnaissance Squadron
163d Reconnaissance Wing
March Air Reserve Base, California



LOCATION: Kandahar AB, Afghanistan

DATE OF ACCIDENT: 3 October 2009

BOARD PRESIDENT: Lieutenant Colonel Todd G. Chase

Conducted IAW Air Force Instruction 51-503, Chapter 11

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

MQ-1B, T/N 06-3175, MARCH JOINT AIR RESERVE BASE
3 October 2009

At 0353 Zulu (Z) / 0723 Local, Afghanistan on 3 October 2009 (2053 Pacific Daylight Saving Time on 2 October 2009), after normal maintenance and pre-flight checks, the Mishap Remotely Piloted Aircraft (MRPA) taxied and departed from Kandahar Air Field for a reconnaissance mission. There were two mishap crews involved in this mishap, as the mishap occurred shortly after crew swap. Mishap Crew 1 (MC1) consisted of Mishap Pilot 1 (MP1) and Mishap Sensor Operator 1 (MSO1). Mishap Crew 2 (MC2) consisted of Mishap Pilot 2 (MP2) and Mishap Sensor Operator 2.

During the flight, MC1 received a direct tasking from the Combined Forces Air Component Commander to provide close air support to United States and Afghan ground forces under attack by Anti-Afghan Forces (AAF). At the time of the tasking, AAF carried out a large, coordinated attack against U.S. and Afghan ground forces at two remote outposts. Several U.S. troops were killed during the attacks. Given the circumstances of the AAF attack and the immediate and urgent need for CAS, both Mishap Crews (MCs) were consumed with a high-degree of urgency.

While en route to the tasking, MC2 assumed control of the MRPA at approximately 0905Z. At approximately 0918Z, despite efforts by MC2 to avoid the terrain at the last minute, MC2 failed to prevent a Controlled Flight Into Terrain of the MRPA. The impact completely destroyed the MRPA.

The Accident Investigation Board President determined, by clear and convincing evidence, that the mishap was the result of pilot error caused primarily by MP2's channelized attention away from flying the MRPA and an inattention to the high terrain in the MRPA's immediate vicinity. Furthermore, inattention by both MP1 and MP2 resulted from a perceived absence of threat from the environment. Specifically, they both failed to appreciate the need for a significant increase in altitude required to safely overfly the mountainous terrain located between the MRPA and the target.

SUMMARY OF FACTS AND STATEMENT OF OPINION

MQ-1B, T/N 06-3175
3 October 2009

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APPENDIX B. HFACS SAMPLE PROBABLITIES OF MISCLASSIFICATION FOR VARIOUS SAMPLE SIZE EXPECTED MISCLASSIFICATION RATES

E[p]	P (Misclass)																				
0.5	0.18	0.17	0.17	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13
0.4	0.18	0.17	0.17	0.17	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13
0.3	0.19	0.19	0.18	0.18	0.18	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14
0.2	0.22	0.22	0.21	0.20	0.20	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16
0.1	0.29	0.28	0.28	0.28	0.27	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.22	0.22	0.22	0.21	0.21	0.21
0.05	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.35	0.34	0.34	0.33	0.33	0.32	0.31	0.31	0.30	0.29	0.28	0.28	0.28
LCL(0.5-0.4,0.92)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
LCL(0.5-0.3,0.93)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
LCL(0.5-0.2,0.99)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06
LCL(0.5-0.1,0.999)	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.12

p =	0.5																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0																					
1																					
2																					
3	0.00	0.00	0.00																		
4	0.00	0.00	0.00	0.00	0.00																
5	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00													
6	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00										
7	0.07	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00							
8	0.12	0.10	0.08	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00				
9	0.16	0.14	0.12	0.10	0.08	0.06	0.05	0.03	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00		
10	0.18	0.17	0.15	0.14	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
11	0.16	0.17	0.17	0.16	0.15	0.13	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00
12	0.12	0.14	0.15	0.16	0.16	0.15	0.14	0.13	0.11	0.10	0.08	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
13	0.07	0.10	0.12	0.14	0.15	0.15	0.15	0.15	0.14	0.13	0.11	0.10	0.08	0.07	0.05	0.04	0.03	0.03	0.02	0.01	0.01
14	0.04	0.06	0.08	0.10	0.12	0.13	0.14	0.15	0.15	0.14	0.14	0.12	0.11	0.10	0.08	0.07	0.06	0.04	0.04	0.03	0.02
15	0.01	0.03	0.04	0.06	0.08	0.10	0.12	0.13	0.14	0.14	0.14	0.14	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.04
16	0.00	0.01	0.02	0.03	0.04	0.06	0.08	0.10	0.11	0.13	0.14	0.14	0.14	0.14	0.13	0.12	0.11	0.09	0.08	0.07	0.06
17	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.10	0.11	0.12	0.13	0.14	0.14	0.13	0.13	0.12	0.10	0.09	0.08
18		0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.10	0.11	0.12	0.13	0.13	0.13	0.13	0.12	0.11	0.10
19			0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.10	0.11	0.12	0.13	0.13	0.13	0.13	0.12
20					0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.11	0.12	0.12	0.13	0.13
21							0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.11	0.12
22								0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.07	0.08	0.09	0.10
23										0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.07	0.08
24											0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06
25													0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04
26														0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
27																0.00	0.00	0.00	0.00	0.01	0.01
28																	0.00	0.00	0.00	0.00	0.01
29																			0.00	0.00	0.00
30																					0.00
31																					
32																					

p =	0.4																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0																					
1	0.00	0.00	0.00																		
2	0.00	0.00	0.00	0.00	0.00	0.00															
3	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00												
4	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00									
5	0.07	0.06	0.05	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00						
6	0.12	0.10	0.09	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00			
7	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
8	**0.18**	**0.17**	0.16	0.15	0.14	0.12	0.10	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00
9	0.16	0.17	0.17	0.17	0.16	0.15	0.14	0.12	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01
10	0.12	0.13	0.15	0.16	0.16	0.16	0.16	0.15	0.14	0.13	0.12	0.10	0.09	0.08	0.07	0.05	0.05	0.04	0.03	0.02	0.02
11	0.07	0.09	0.11	0.12	0.14	0.15	0.15	**0.15**	**0.15**	**0.15**	0.14	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04
12	0.04	0.05	0.07	0.08	0.10	0.11	0.13	0.14	0.14	**0.15**	**0.15**	0.14	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06
13	0.01	0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.13	0.14	0.14	0.14	0.14	0.14	0.13	0.12	0.11	0.10	0.09	0.08
14	0.00	0.01	0.01	0.02	0.03	0.04	0.06	0.07	0.08	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.13	0.13	0.12	0.12	0.11
15	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.13	0.13	0.13	0.12
16	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.11	0.12	0.13	0.13	0.13
17		0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.12
18			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
19					0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08
20							0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06
21										0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04
22										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02
23													0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
24																0.00	0.00	0.00	0.00	0.00	0.00
25																0.00	0.00	0.00	0.00	0.00	0.00
26																			0.00	0.00	0.00
27																			0.00	0.00	0.00

p =	0.3																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00												
1	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
2	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
5	0.18	0.16	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
6	0.19	0.19	0.18	0.17	0.16	0.15	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02
7	0.16	0.17	0.18	0.18	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03
8	0.11	0.13	0.14	0.15	0.16	0.17	0.17	0.17	0.16	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06
9	0.07	0.08	0.09	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.15	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08
10	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.12	0.13	0.13	0.14	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.13	0.12	0.11
11	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.13
12	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.14
13	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.12	0.13
14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.10
15				0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08
16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05
17							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
18							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
19										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
20													0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21																0.00	0.00	0.00	0.00	0.00	0.00
22																			0.00	0.00	0.00
p =	0.2																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
1	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
3	0.21	0.19	0.18	0.16	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02
4	0.22	0.22	0.21	0.20	0.20	0.19	0.18	0.17	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.05
5	0.17	0.18	0.19	0.19	0.20	0.20	0.19	0.19	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09
6	0.11	0.12	0.13	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.13	0.12
7	0.05	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.15
8	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.15	0.15	0.16	0.16
9	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.13	0.14
10	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.09	0.10	0.11
11	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.07
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04
13				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
14							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
15										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16													0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17																0.00	0.00	0.00	0.00	0.00	0.00

p =	0.1																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01
1	0.27	0.26	0.24	0.23	0.21	0.20	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.08	0.08	0.07	0.07
2	**0.29**	**0.28**	**0.28**	**0.28**	**0.27**	**0.27**	**0.26**	**0.25**	**0.24**	**0.24**	0.23	0.22	0.21	0.20	0.19	0.18	0.18	0.17	0.16	0.15	0.14
3	0.19	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.24	**0.24**	**0.24**	**0.24**	**0.23**	**0.23**	**0.23**	**0.22**	**0.22**	**0.22**	**0.21**	**0.21**	0.20
4	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.20	0.20	0.21	**0.21**	**0.21**
5	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.16
6	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.11
7	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
9				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
10							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																0.03	0.02	0.02	0.02	0.02	0.01
p =	0.05																				
d(Misclass)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0	0.36	0.34	0.32	0.31	0.29	0.28	0.26	0.25	0.24	0.23	0.21	0.20	0.19	0.18	0.17	0.17	0.16	0.15	0.14	0.14	0.13
1	**0.38**	**0.38**	**0.37**	**0.37**	**0.37**	**0.36**	**0.36**	**0.36**	**0.35**	**0.34**	**0.34**	**0.33**	**0.33**	**0.32**	**0.31**	**0.31**	**0.30**	**0.29**	**0.28**	**0.28**	0.27
2	0.19	0.20	0.21	0.22	0.22	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.27	0.27	0.27	0.27	0.28	0.28	**0.28**	**0.28**	**0.28**
3	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.18	0.18	0.19
4	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09
5	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
7							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX C. MAV ACCIDENT REPORTS PEARSON CORRELATION MATRIX

CORRELATION																		
	ORG	OC	OP	ODMY	SI	SP	SF	SV	SDMY	PE	PC	PP	PDMY	AE1	AE2	AE3	AV	ADMY
ORG	1	-0.046	0.135	-0.664	0.162	-0.103	0.272	-0.057	0.005	-0.05	-0.201	-0.067	0.249	-0.268	-0.181	-0.006	-0.1	0.422
OC		1	0.171	-0.142	0.216	0.224	-0.012	0.401	-0.19	-0.04	0.388	0.038	-0.078	0.151	0.239	0.144	-0.021	-0.064
OP			1	-0.638	0.14	0.072	0.034	0.122	-0.153	-0.04	0.047	-0.065	0.111	-0.154	0.095	0.01	-0.096	0.23
ODMY				1	-0.125	0.016	-0.088	-0.088	0.038	0.046	0.075	0.097	-0.229	0.243	0.05	-0.002	0.151	-0.451
SI					1	0.141	0.265	0.06	-0.659	-0.04	0.03	0.132	0.01	0.103	0.073	-0.021	-0.075	0.024
SP						1	0.275	-0.04	-0.626	0.125	0.241	0.233	-0.127	0.115	-0.01	-0.014	-0.071	-0.099
SF							1	-0.015	-0.233	0.019	-0.083	-0.057	0.073	-0.02	-0.058	-0.038	-0.026	0.012
SV								1	-0.233	-0.05	0.073	-0.057	-0.012	0.134	0.176	0.105	-0.026	-0.078
SDMY									1	-0.02	-0.045	-0.241	0.066	-0.103	-0.027	0.08	0.113	0.047
PE										1	0.202	-0.026	-0.338	-0.01	-0.038	-0.044	-0.051	0.104
PC											1	0.059	-0.528	0.204	0.284	0.317	0.091	-0.217
PP												1	-0.366	0.066	-0.045	-0.058	0.102	-0.042
PDMY													1	-0.069	-0.135	-0.101	-0.07	0.126
AE1														1	0.025	0.014	-0.005	-0.641
AE2															1	0.25	-0.01	-0.301
AE3																1	0.101	-0.2
AV																	1	-0.138
ADMY																		1
Sig. (1-tailed)																		
ORG		0.255	0.028	0	0.01	0.073	0	0.209	0.475	0.262	0.002	0.172	0	0	0.005	0.467	0.077	0
OC			0.007	0.022	0.001	0.001	0.431	0	0.003	0.27	0	0.296	0.134	0.016	0	0.02	0.38	0.183
OP				0	0.024	0.154	0.317	0.042	0.015	0.267	0.254	0.179	0.057	0.014	0.089	0.442	0.085	0
ODMY					0.037	0.412	0.107	0.107	0.297	0.257	0.144	0.083	0.001	0	0.239	0.488	0.016	0
SI						0.023	0	0.197	0	0.279	0.336	0.03	0.445	0.071	0.149	0.383	0.145	0.37
SP							0	0.284	0	0.038	0	0	0.035	0.051	0.445	0.424	0.157	0.079
SF								0.416	0	0.395	0.121	0.208	0.152	0.387	0.207	0.294	0.354	0.435
SV									0	0.226	0.151	0.208	0.435	0.029	0.006	0.067	0.354	0.133
SDMY										0.365	0.26	0	0.174	0.071	0.354	0.128	0.054	0.252
PE											0.002	0.355	0	0.445	0.294	0.268	0.234	0.069
PC												0.2	0	0.002	0	0	0.097	0.001
PP													0	0.174	0.264	0.206	0.073	0.276
PDMY														0.162	0.027	0.076	0.161	0.037
AE1															0.363	0.422	0.469	0
AE2																0	0.444	0
AE3																	0.075	0.002
AV																		0.025
ADMY																		

APPENDIX D. UAV ACCIDENT REPORTS PEARSON CORRELATION MATRIX

CORRELATIONS																
	ORG	OC	OP	ODMY	SI	SP	SV	SDMY	PE	PC	PP	PDMY	AE1	AE2	AE3	AV
ORG	1	-0.088	-0.228	-0.49	0.019	-0.011	-0.088	-0.044	0.018	-0.255	-0.028	0.254	-0.26	-0.161	-0.014	-0.062
OC		1	0.188	-0.192	-0.083	-0.047	-0.034	0.102	-0.144	0.082	-0.086	0.081	-0.053	0.022	-0.062	-0.024
OP			1	-0.652	0.233	-0.021	0.188	-0.171	-0.146	-0.094	-0.018	0.126	-0.197	-0.142	-0.027	0.132
ODMY				1	-0.283	-0.008	-0.192	0.255	0.094	0.234	0.003	-0.24	0.336	0.246	-0.011	-0.135
SI					1	-0.113	0.415	-0.811	0.053	-0.145	0.29	0	-0.026	-0.011	0.298	0.291
SP						1	-0.047	-0.458	0.03	-0.035	-0.023	-0.074	0.024	-0.092	-0.084	-0.033
SV							1	-0.337	-0.144	0.017	-0.086	0.081	-0.053	0.022	0.557	0.701
SDMY								1	-0.066	0.167	-0.226	0.017	0.023	0.048	-0.21	-0.236
PE									1	-0.073	0.072	-0.508	0.017	0.05	-0.06	-0.101
PC										1	0.261	-0.393	0.479	0.524	0.146	0.102
PP											1	-0.303	0.112	0.15	0.278	-0.06
PDMY												1	-0.188	-0.184	-0.097	-0.085
AE1													1	0.396	0.032	-0.112
AE2														1	0.282	0.11
AE3															1	0.391
AV																1
Sig. (1-tailed)																
ORG		0.252	0.04	0	0.442	0.467	0.252	0.369	0.446	0.025	0.416	0.025	0.022	0.109	0.457	0.32
OC				0.071	0.264	0.361	0.397	0.218	0.136	0.268	0.257	0.269	0.342	0.432	0.319	0.427
OP				0	0.037	0.437	0.075	0.096	0.134	0.238	0.446	0.169	0.065	0.139	0.418	0.157
ODMY					0.014	0.475	0.071	0.025	0.239	0.036	0.491	0.032	0.004	0.029	0.466	0.153
SI						0.195	0	0	0.343	0.135	0.012	0.5	0.423	0.467	0.01	0.012
SP							0.361	0	0.41	0.395	0.43	0.288	0.427	0.243	0.261	0.401
SV								0.004	0.136	0.448	0.257	0.269	0.342	0.432	0	0
SDMY									0.309	0.1	0.041	0.448	0.432	0.359	0.054	0.035
PE										0.29	0.293	0	0.448	0.351	0.325	0.221
PC											0.022	0.001	0	0	0.132	0.218
PP												0.009	0.197	0.127	0.016	0.324
PDMY													0.075	0.079	0.231	0.259
AE1														0.001	0.404	0.196
AE2															0.015	0.201
AE3																0.001
AV																

APPENDIX E. PATH ANALYSIS OUTPUT OF MAV MODEL A ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	36	0	18	0	0	54
Total	51	0	18	0	0	69

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	171
Number of distinct parameters to be estimated:	54
Degrees of freedom (171 - 54):	117

Result (Default model)

Minimum was achieved

Chi-square = 1010.570

Degrees of freedom = 117

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.237	.064	-3.711	***par_1
SI	<---	ORG	.264	.056	4.709	***par_2
SI	<---	OC	.970	.282	3.434	***par_3
SP	<---	OC	.925	.283	3.263	.001par_4
SDMY	<---	OC	-.811	.298	-2.721	.007par_5
SI	<---	OP	.201	.060	3.335	***par_6

SI	<---	ODMY	.229	.059	3.866	***par_7
SDMY	<---	ORG	-.108	.059	-1.829	.067par_14
SV	<---	OC	.503	.083	6.089	***par_17
SV	<---	OP	.015	.018	.852	.394par_18
SDMY	<---	ODMY	-.214	.063	-3.417	***par_19
SF	<---	ORG	.069	.017	4.011	***par_22
PDMY	<---	SP	-.046	.019	-2.464	.014par_8
PC	<---	SP	.254	.049	5.160	***par_13
PDMY	<---	SDMY	-.005	.017	-.293	.769par_15
PDMY	<---	SV	-.018	.061	-.304	.761par_20
PP	<---	SI	.007	.020	.354	.723par_23
PP	<---	SP	.047	.022	2.136	.033par_24
PP	<---	SDMY	-.041	.020	-2.051	.040par_25
PC	<---	SDMY	.119	.044	2.691	.007par_26
PE	<---	SP	.039	.022	1.786	.074par_28
PDMY	<---	SF	.099	.060	1.655	.098par_35
AE1	<---	PC	.738	.220	3.355	***par_9
AE2	<---	PC	.635	.142	4.467	***par_10
AE3	<---	PC	.374	.076	4.913	***par_11
AE2	<---	PDMY	.097	.396	.245	.806par_12
AE1	<---	PDMY	.380	.612	.620	.535par_16
AV	<---	PDMY	-.164	.162	-1.016	.310par_21
ADMY	<---	PDMY	.452	.343	1.319	.187par_27
ADMY	<---	PC	-.362	.123	-2.940	.003par_29
ADMY	<---	accident	1.000			
AV	<---	accident	-.055	.033	-1.669	.095par_30
AE3	<---	accident	-.081	.043	-1.890	.059par_31

AE2	<---	accident	-.281	.078	-3.590	***par_32
AE1	<---	accident	-1.123	.097	-11.575	***par_33
ADMY	<---	PP	.152	.218	.695	.487par_34
ADMY	<---	PE	.538	.224	2.403	.016par_36

Probability level = .000

Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.214	-.811	-.108	-.237	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.011	.084	.006	.011	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.025	.138	-.013	-.028	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.001	-.048	.007	.001	.099	-.018	-.046	-.005	.000	.000	.000	.000	.000	.000
ADMY	.011	-.039	.009	.012	.045	-.008	-.085	-.052	.001	1.000	.538	.152	-.362	.452
AV	.000	.008	-.001	.000	-.016	.003	.008	.001	.000	-.055	.000	.000	.000	-.164
AE2	-.016	.083	-.007	-.018	.010	-.002	.157	.075	.000	-.281	.000	.000	.635	.097
AE3	-.010	.052	-.005	-.011	.000	.000	.095	.045	.000	-.081	.000	.000	.374	.000
AE1	-.018	.084	-.007	-.020	.038	-.007	.170	.086	.000	-1.123	.000	.000	.738	.380

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.221	-.176	-.118	-.240	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.239	.212	.291	.206	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000

PP	.038	.063	.024	.040	.000	.000	.147	-.143	.025	.000	.000	.000	.000	.000
PC	-.039	.044	-.021	-.042	.000	.000	.337	.176	.000	.000	.000	.000	.000	.000
PDMY	.004	-.043	.033	.004	.114	-.021	-.170	-.020	.000	.000	.000	.000	.000	.000
ADMY	.009	-.007	.008	.010	.010	-.002	-.062	-.042	.001	.968	.124	.036	-.199	.089
AV	.000	.003	-.002	.000	-.008	.002	.012	.001	.000	-.116	.000	.000	.000	-.071
AE2	-.012	.013	-.006	-.013	.002	.000	.098	.052	.000	-.234	.000	.000	.300	.016
AE3	-.013	.015	-.007	-.014	.000	.000	.110	.057	.000	-.125	.000	.000	.327	.000
AE1	-.009	.008	-.003	-.010	.005	-.001	.070	.039	.000	-.614	.000	.000	.229	.042

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.214	-.811	-.108	-.237	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.099	-.018	-.046	-.005	.000	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.152	-.362	.452
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.055	.000	.000	.000	-.164
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.635	.097
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.374	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.123	.000	.000	.738	.380

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.221	-.176	-.118	-.240	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.239	.212	.291	.206	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.147	-.143	.025	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.337	.176	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.114	-.021	-.170	-.020	.000	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.968	.124	.036	-.199	.089
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.116	.000	.000	.000	-.071
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.234	.000	.000	.300	.016
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.125	.000	.000	.327	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.614	.000	.000	.229	.042

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.011	.084	.006	.011	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.025	.138	-.013	-.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.001	-.048	.007	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.011	-.039	.009	.012	.045	-.008	-.085	-.052	.001	.000	.000	.000	.000	.000
AV	.000	.008	-.001	.000	-.016	.003	.008	.001	.000	.000	.000	.000	.000	.000
AE2	-.016	.083	-.007	-.018	.010	-.002	.157	.075	.000	.000	.000	.000	.000	.000
AE3	-.010	.052	-.005	-.011	.000	.000	.095	.045	.000	.000	.000	.000	.000	.000

AE1	-.018	.084	-.007	-.020	.038	-.007	.170	.086	.000	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMYSI		accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.038	.063	.024	.040	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.039	.044	-.021	-.042	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.004	-.043	.033	.004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.009	-.007	.008	.010	.010	-.002	-.062	-.042	.001	.000	.000	.000	.000	.000
AV	.000	.003	-.002	.000	-.008	.002	.012	.001	.000	.000	.000	.000	.000	.000
AE2	-.012	.013	-.006	-.013	.002	.000	.098	.052	.000	.000	.000	.000	.000	.000
AE3	-.013	.015	-.007	-.014	.000	.000	.110	.057	.000	.000	.000	.000	.000	.000
AE1	-.009	.008	-.003	-.010	.005	-.001	.070	.039	.000	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.080	.000
ORG	<-->	ODMY	89.027	.000
OP	<-->	ODMY	82.267	.000
OP	<-->	OC	5.926	.000
e2	<-->	e3	21.006	.000
e2	<-->	e4	4.428	.000
e5	<-->	e3	10.595	.000
e5	<-->	e4	6.222	.000
e5	<-->	e2	75.379	.000
e1	<-->	e3	9.486	.000
e1	<-->	e5	84.190	.000
res1	<-->	ODMY	39.245	.000
res1	<-->	ORG	29.671	.000
res1	<-->	OP	12.185	.000
e6	<-->	OC	25.719	.000
e6	<-->	ORG	6.045	.000
e6	<-->	e14	5.888	.000
e8	<-->	ODMY	9.792	.000
e8	<-->	ORG	8.223	.000
e8	<-->	e14	21.757	.000
e8	<-->	e7	23.608	.000
e8	<-->	e6	51.059	.000
e10	<-->	OC	4.088	.000
e10	<-->	OP	4.389	.000

e11	<-->	e10	4.462	.000
e9	<-->	e1	4.590	.000
e9	<-->	e10	13.014	.000
e9	<-->	e11	6.811	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SF	<---	SP	19.967	.094
SF	<---	SDMY	10.828	-.062
SF	<---	SI	9.138	.057
SV	<---	SP	4.206	-.041
SV	<---	SDMY	4.938	-.040
SP	<---	SF	16.371	.894
SP	<---	SDMY	65.726	-.499
SDMY	<---	SF	9.814	-.728
SDMY	<---	SV	5.241	-.534
SDMY	<---	SP	71.605	-.610
SDMY	<---	SI	64.903	-.525
SI	<---	SF	8.787	.653
SI	<---	SDMY	71.398	-.519
accident	<---	ODMY	39.245	-.507
accident	<---	ORG	29.671	.417
accident	<---	OP	12.185	.288
PE	<---	PC	5.661	.069
PE	<---	PDMY	21.049	-.373
PP	<---	PDMY	24.524	-.405

PC	<---	OC	25.719	1.030
PC	<---	ORG	6.045	-.099
PC	<---	SF	4.179	-.324
PC	<---	PE	5.797	.376
PC	<---	PDMY	52.737	-1.320
PDMY	<---	ODMY	9.792	-.051
PDMY	<---	ORG	8.223	.044
PDMY	<---	PE	21.419	-.274
PDMY	<---	PP	22.548	-.274
PDMY	<---	PC	43.921	-.164
ADMY	<---	ODMY	28.798	-.328
ADMY	<---	ORG	17.214	.240
ADMY	<---	OP	7.791	.173
AE2	<---	OC	4.088	.866
AE2	<---	OP	4.389	.192
AE2	<---	SV	4.744	.730
AE2	<---	AE1	7.407	-.116
AE1	<---	AE2	11.134	-.269
AE1	<---	AE3	5.978	-.364

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	54	1010.570	117	.000	8.637
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI

Default model	.000	.707	.571	.484
Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.241	.007	.264	.008	.242
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.765	.184	.185
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	893.570	795.750	998.839
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	5.003	4.424	3.939	4.945
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.194	.183	.206	.000

Independence model	.195	.186	.205	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	1118.570	1129.783	1297.483	1351.483
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

ECVI

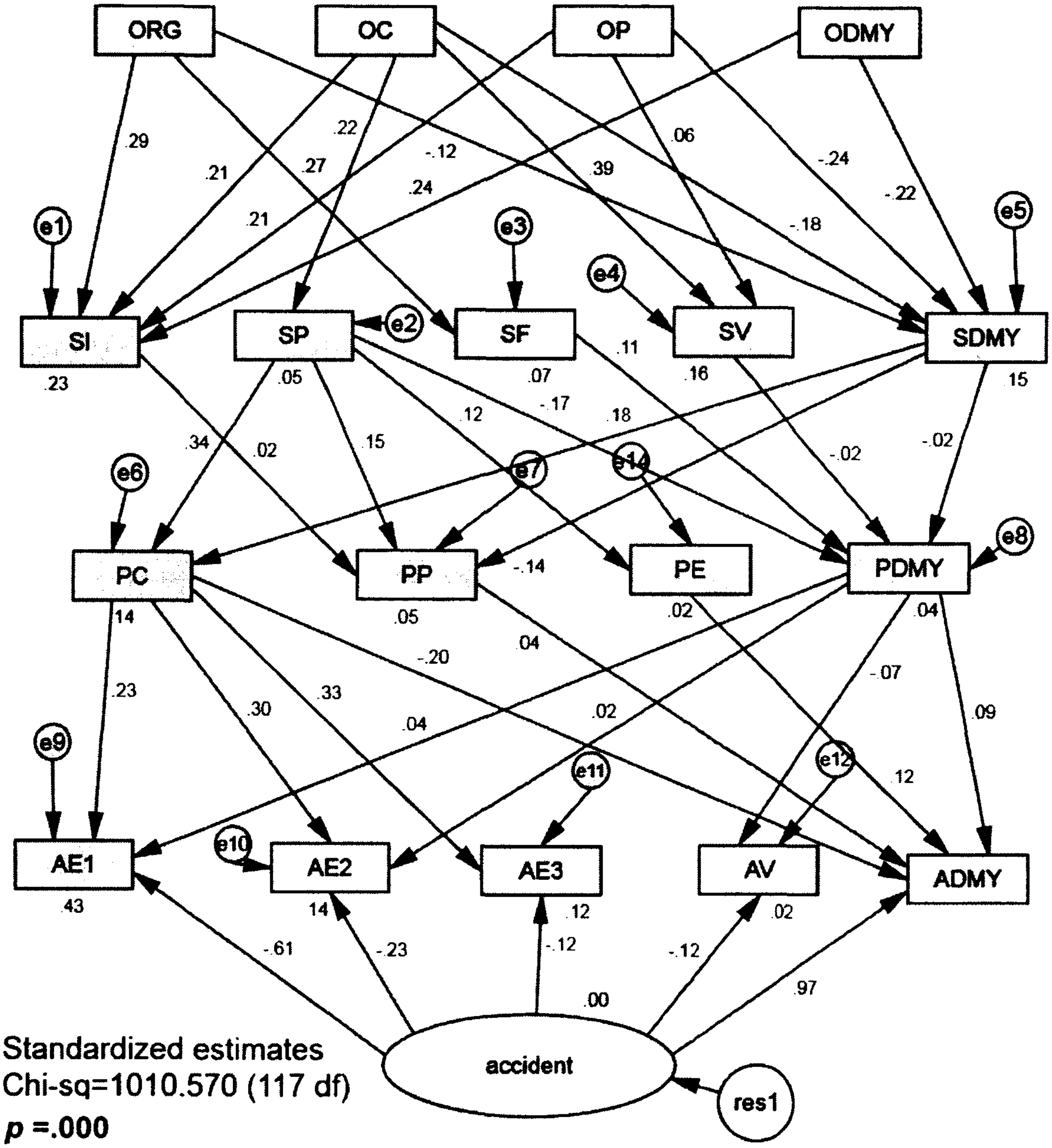
Model	ECVI	LO 90	HI 90	MECVI
Default model	5.537	5.053	6.059	5.593
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	29	32
Independence model	28	30

MAV

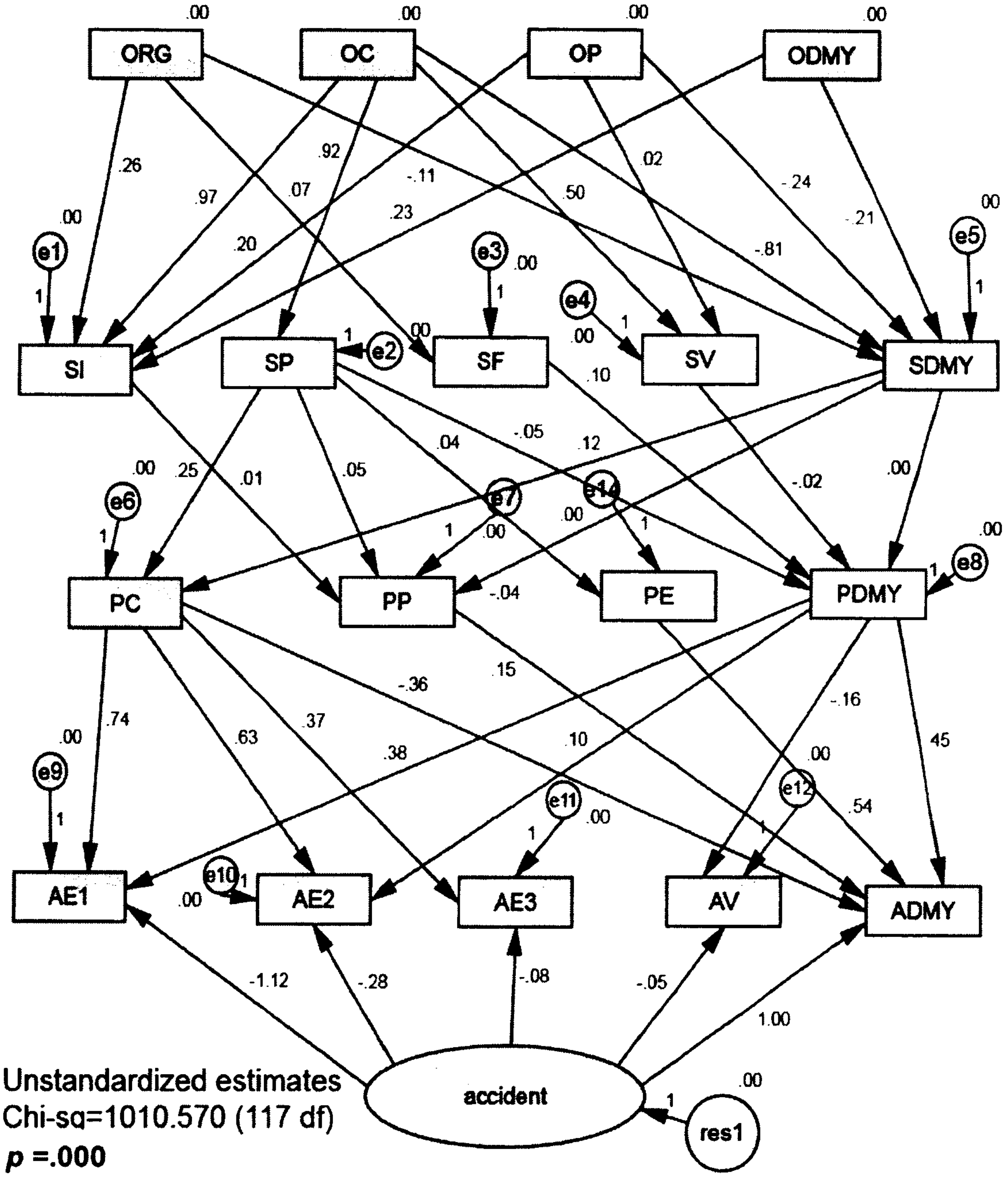
p **<0.05**



Standardized estimates
Chi-sq=1010.570 (117 df)
p **=.000**

MAV

***p* <0.05**



Unstandardized estimates

Chi-sq=1010.570 (117 df)

***p* =.000**

APPENDIX F. PATH ANALYSIS OUTPUT OF MAV MODEL B ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	36	5	18	0	0	59
Total	51	5	18	0	0	74

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 171

Number of distinct parameters to be estimated: 59

Degrees of freedom (171 - 59): 112

Result (Default model)

Minimum was achieved

Chi-square = 416.844

Degrees of freedom = 112

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.199	.075	-2.633	.008par_1
SI	<---	ORG	.264	.086	3.058	.002par_2
SI	<---	OC	.970	.282	3.434	***par_3
SP	<---	OC	.925	.283	3.263	.001par_4
SDMY	<---	OC	-.834	.288	-2.898	.004par_5
SI	<---	OP	.201	.090	2.230	.026par_6

SI	<---	ODMY	.229	.118	1.943	.052par_7
SDMY	<---	ORG	-.143	.072	-1.982	.047par_14
SV	<---	OC	.503	.083	6.089	***par_17
SV	<---	OP	.015	.018	.852	.394par_18
SDMY	<---	ODMY	-.191	.099	-1.940	.052par_19
SF	<---	ORG	.069	.017	4.011	***par_22
PDMY	<---	SP	-.035	.023	-1.536	.124par_8
PC	<---	SP	.254	.061	4.189	***par_13
PDMY	<---	SDMY	.001	.023	.048	.962par_15
PDMY	<---	SV	.046	.052	.882	.378par_20
PP	<---	SI	.007	.032	.224	.823par_23
PP	<---	SP	.047	.032	1.499	.134par_24
PP	<---	SDMY	-.041	.040	-1.043	.297par_25
PC	<---	SDMY	.119	.059	2.007	.045par_26
PE	<---	SP	.039	.022	1.786	.074par_28
PDMY	<---	SF	.031	.051	.611	.541par_35
AE1	<---	PC	.738	.267	2.767	.006par_9
AE2	<---	PC	.635	.173	3.681	***par_10
AE3	<---	PC	.374	.079	4.753	***par_11
AE2	<---	PDMY	.097	.468	.208	.836par_12
AE1	<---	PDMY	.380	.723	.525	.599par_16
AV	<---	PDMY	-.164	.163	-1.010	.312par_21
ADMY	<---	PDMY	.452	.404	1.119	.263par_27
ADMY	<---	PC	-.362	.149	-2.428	.015par_29
ADMY	<---	accident	1.000			
AV	<---	accident	-.055	.033	-1.669	.095par_30
AE3	<---	accident	-.081	.043	-1.890	.059par_31

AE2	<---	accident	-.281	.078	-3.590	***par_32
AE1	<---	accident	-1.123	.097	-11.575	***par_33
ADMY	<---	PP	.152	.216	.702	.483par_34
ADMY	<---	PE	.538	.224	2.404	.016par_36

Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.191	-.834	-.143	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.010	.085	.008	.010	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.023	.136	-.017	-.024	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	-.011	.002	.000	.031	.046	-.035	.001	.000	.000	.000	.000	.000	.000
ADMY	.010	-.021	.008	.010	.014	.021	-.080	-.049	.001	1.000	.538	.152	-.362	.452
AV	.000	.002	.000	.000	-.005	-.008	.006	.000	.000	-.055	.000	.000	.000	-.164
AE2	-.014	.085	-.011	-.015	.003	.004	.158	.076	.000	-.281	.000	.000	.635	.097
AE3	-.009	.051	-.006	-.009	.000	.000	.095	.045	.000	-.081	.000	.000	.374	.000
AE1	-.017	.096	-.012	-.017	.012	.017	.174	.088	.000	-1.123	.000	.000	.738	.380

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.206	-.197	-.170	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.029	.034	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	-.034	.045	-.028	-.037	.000	.000	.348	.167	.000	.000	.000	.000	.000	.000
PDMY	-.001	-.010	.009	.002	.036	.053	-.132	.004	.000	.000	.000	.000	.000	.000
ADMY	.008	-.004	.007	.008	.003	.005	-.058	-.036	.001	.961	.123	.036	-.192	.088
AV	.000	.001	-.001	.000	-.003	-.004	.009	.000	.000	-.116	.000	.000	.000	-.071
AE2	-.010	.013	-.008	-.011	.001	.001	.100	.049	.000	-.235	.000	.000	.292	.016
AE3	-.011	.014	-.009	-.012	.000	.000	.110	.053	.000	-.125	.000	.000	.317	.000
AE1	-.008	.010	-.006	-.008	.002	.002	.072	.037	.000	-.618	.000	.000	.223	.042

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.191	-.834	-.143	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.031	.046	-.035	.001	.000	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.152	-.362	.452
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.055	.000	.000	.000	-.164
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.635	.097
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.374	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.123	.000	.000	.738	.380

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.206	-.197	-.170	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.348	.167	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.036	.053	-.132	.004	.000	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.961	.123	.036	-.192	.088
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.116	.000	.000	.000	-.071
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.235	.000	.000	.292	.016
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.125	.000	.000	.317	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.618	.000	.000	.223	.042

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.010	.085	.008	.010	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.023	.136	-.017	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PDMY	.000	-.011	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.010	-.021	.008	.010	.014	.021	-.080	-.049	.001	.000	.000	.000	.000	.000
AV	.000	.002	.000	.000	-.005	-.008	.006	.000	.000	.000	.000	.000	.000	.000
AE2	-.014	.085	-.011	-.015	.003	.004	.158	.076	.000	.000	.000	.000	.000	.000
AE3	-.009	.051	-.006	-.009	.000	.000	.095	.045	.000	.000	.000	.000	.000	.000
AE1	-.017	.096	-.012	-.017	.012	.017	.174	.088	.000	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.029	.034	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.034	.045	-.028	-.037	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	-.001	-.010	.009	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.008	-.004	.007	.008	.003	.005	-.058	-.036	.001	.000	.000	.000	.000	.000
AV	.000	.001	-.001	.000	-.003	-.004	.009	.000	.000	.000	.000	.000	.000	.000
AE2	-.010	.013	-.008	-.011	.001	.001	.100	.049	.000	.000	.000	.000	.000	.000
AE3	-.011	.014	-.009	-.012	.000	.000	.110	.053	.000	.000	.000	.000	.000	.000
AE1	-.008	.010	-.006	-.008	.002	.002	.072	.037	.000	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.350	.000

ORG	<-->	OC	4.060	.000
e3	<-->	ODMY	7.136	.000
e3	<-->	ORG	4.127	.000
e2	<-->	e3	21.139	.000
e2	<-->	e4	44.613	.000
e5	<-->	e4	52.542	.000
e1	<-->	e3	12.457	.000
e1	<-->	e4	30.906	.000
res1	<-->	ODMY	4.857	.000
e6	<-->	OC	28.552	.000
e6	<-->	e7	7.142	.000
e8	<-->	e14	15.483	.000
e8	<-->	e7	31.038	.000
e10	<-->	OC	4.088	.000
e11	<-->	e10	4.462	.000
e9	<-->	e10	13.014	.000
e9	<-->	e11	6.811	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SF	<---	SP	19.967	.094
SF	<---	SDMY	12.834	-.074
SF	<---	SI	10.648	.067
SV	<---	SP	4.206	-.041
SV	<---	SDMY	5.853	-.047
SP	<---	SF	17.403	.640

SP	<---	SV	37.352	-.940
SDMY	<---	SV	44.261	-.828
SI	<---	SF	11.538	.504
SI	<---	SV	26.034	-.760
accident	<---	ODMY	43.062	-.556
accident	<---	ORG	29.671	.417
accident	<---	OP	12.185	.288
PE	<---	PC	6.046	.074
PE	<---	PDMY	21.303	-.377
PP	<---	PDMY	24.819	-.410
PC	<---	OC	28.552	.926
PC	<---	PP	6.469	-.328
PDMY	<---	ODMY	10.603	-.047
PDMY	<---	ORG	5.454	.031
PDMY	<---	OP	5.517	.033
PDMY	<---	PE	15.243	-.198
PDMY	<---	PP	28.739	-.263
ADMY	<---	ODMY	31.598	-.359
ADMY	<---	ORG	17.214	.240
ADMY	<---	OP	7.791	.173
AE2	<---	OC	4.088	.866
AE2	<---	OP	4.389	.192
AE2	<---	SV	4.744	.730
AE2	<---	AE1	7.498	-.118
AE1	<---	SI	4.617	.270
AE1	<---	AE2	11.249	-.272
AE1	<---	AE3	6.019	-.367

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	59	416.844	112	.000	3.722
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.831	.741	.544
Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.687	.572	.750	.647	.741
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.732	.503	.543
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	304.844	246.101	371.167
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.064	1.509	1.218	1.837
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.116	.104	.128	.000
Independence model	.195	.186	.205	.000

AIC

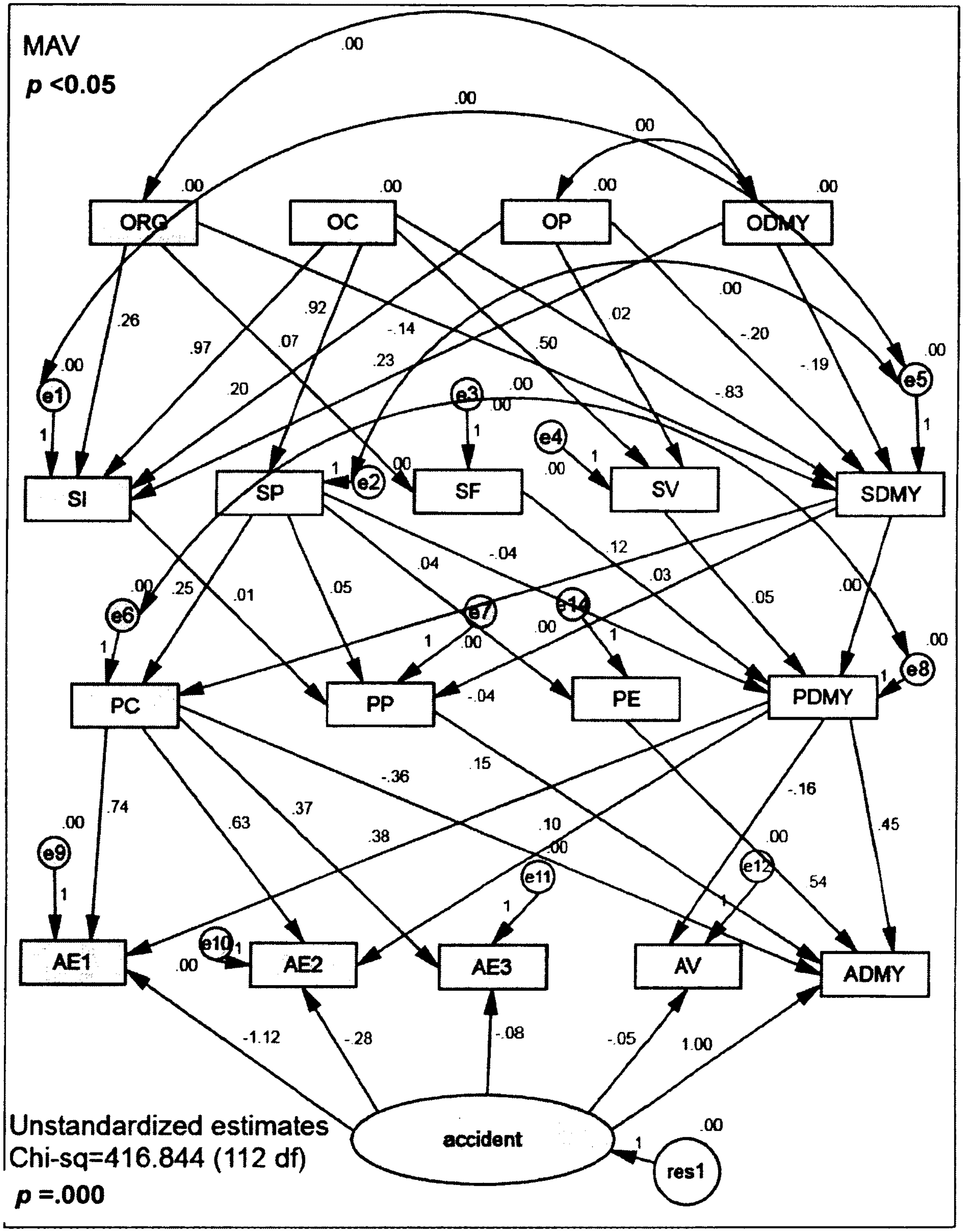
Model	AIC	BCC	BIC	CAIC
Default model	534.844	547.095	730.323	789.323
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

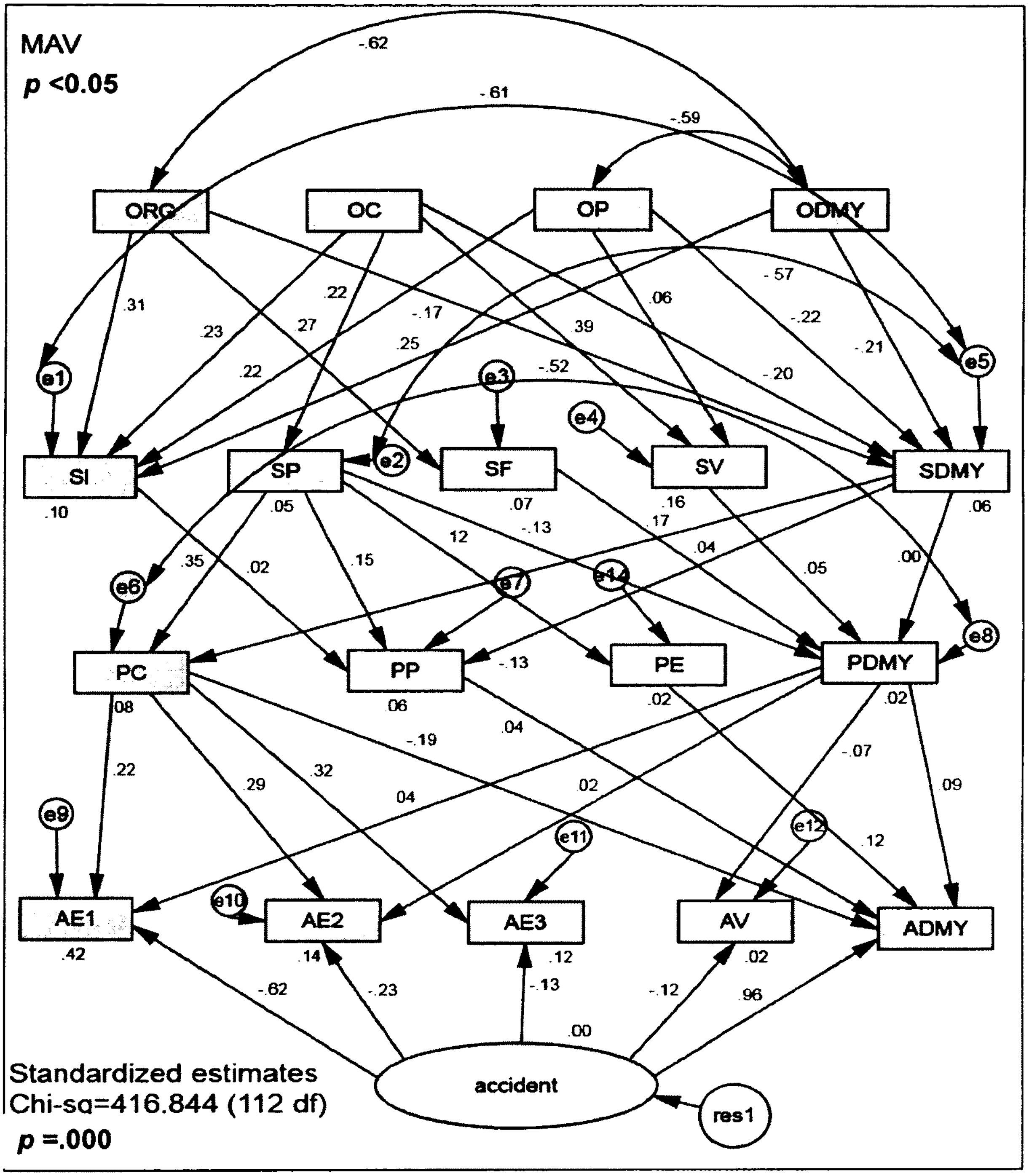
ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.648	2.357	2.976	2.708
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	67	73
Independence model	28	30


MAV
p <0.05
.00
.00
.00
ORG
OC
OP
ODMY
.00
.00
.00
.00
.26
.97
.92
.07
-.14
.23
.20
.02
.50
-.20
-.19
-.83
.00
.00
e1
1
e2
e3
1
e4
1
e5
1
SI
SP
SF
SV
SDMY
.25
.01
.05
.04
-.04
.12
.03
.05
.00
e6
1
e7
1
e14
1
e8
1
PC
PP
PE
PDMY
-.04
.74
.63
.37
-.36
.38
.15
.10
-.16
.45
.54
e9
1
e10
1
e11
1
e12
1
AE1
AE2
AE3
AV
ADMY
-1.12
-.28
-.08
-.05
1.00
accident
res1
1
Unstandardized estimates
Chi-sq=416.844 (112 df)
p =.000



MAV

$p < 0.05$

Standardized estimates

Chi-sq=416.844 (112 df)

p =.000

APPENDIX G. PATH ANALYSIS OUTPUT OF MAV MODEL C ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	34	5	18	0	0	57
Total	49	5	18	0	0	72

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 171

Number of distinct parameters to be estimated: 57

Degrees of freedom (171 - 57): 114

Result (Default model)

Minimum was achieved

Chi-square = 421.205

Degrees of freedom = 114

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.120	.063	-1.899	.058par_1
SI	<---	ORG	.135	.057	2.391	.017par_2
SI	<---	OC	.886	.285	3.110	.002par_3
SP	<---	OC	.925	.283	3.263	.001par_4

SDMY	<---	OC	-.783	.289	-2.710	.007par_5
SI	<---	OP	.074	.061	1.217	.224par_6
SDMY	<---	ORG	-.064	.060	-1.061	.289par_13
SV	<---	OC	.515	.083	6.224	***par_16
SDMY	<---	ODMY	-.050	.066	-.749	.454par_17
SF	<---	ORG	.069	.017	4.011	***par_20
PDMY	<---	SP	-.035	.023	-1.536	.125par_7
PC	<---	SP	.254	.061	4.189	***par_12
PDMY	<---	SDMY	.001	.023	.048	.962par_14
PDMY	<---	SV	.046	.052	.886	.376par_18
PP	<---	SI	.007	.032	.224	.823par_21
PP	<---	SP	.047	.032	1.499	.134par_22
PP	<---	SDMY	-.041	.040	-1.043	.297par_23
PC	<---	SDMY	.119	.060	1.998	.046par_24
PE	<---	SP	.039	.022	1.786	.074par_26
PDMY	<---	SF	.031	.051	.611	.541par_33
AE1	<---	PC	.738	.267	2.767	.006par_8
AE2	<---	PC	.635	.172	3.681	***par_9
AE3	<---	PC	.374	.079	4.753	***par_10
AE2	<---	PDMY	.097	.468	.208	.836par_11
AE1	<---	PDMY	.380	.723	.526	.599par_15
AV	<---	PDMY	-.164	.163	-1.010	.312par_19
ADMY	<---	PDMY	.452	.404	1.119	.263par_25
ADMY	<---	PC	-.362	.149	-2.429	.015par_27
ADMY	<---	accident	1.000			
AV	<---	accident	-.055	.033	-1.669	.095par_28
AE3	<---	accident	-.081	.043	-1.890	.059par_29

AE2	<---	accident	-.281	.078	-3.590	***	par_30
AE1	<---	accident	-1.123	.097	-11.575	***	par_31
ADMY	<---	PP	.152	.216	.702	.483	par_32
ADMY	<---	PE	.538	.224	2.404	.016	par_34

Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.515	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.050	-.783	-.064	-.120	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.886	.135	.074	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.002	.083	.004	.006	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.006	.142	-.008	-.014	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	-.010	.002	.000	.031	.046	-.035	.001	.000	.000	.000	.000	.000	.000
ADMY	.002	-.024	.004	.006	.014	.021	-.080	-.049	.001	1.000	.538	.152	-.362	.452
AV	.000	.002	.000	.000	-.005	-.008	.006	.000	.000	-.055	.000	.000	.000	-.164
AE2	-.004	.089	-.005	-.009	.003	.004	.158	.076	.000	-.281	.000	.000	.635	.097
AE3	-.002	.053	-.003	-.005	.000	.000	.095	.045	.000	-.081	.000	.000	.374	.000
AE1	-.004	.101	-.005	-.011	.012	.017	.174	.088	.000	-1.123	.000	.000	.738	.380

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.401	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.054	-.186	-.076	-.134	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.210	.162	.082	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.007	.061	.014	.019	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	-.009	.047	-.013	-.022	.000	.000	.348	.166	.000	.000	.000	.000	.000	.000
PDMY	.000	-.009	.010	-.001	.036	.053	-.132	.004	.000	.000	.000	.000	.000	.000
ADMY	.002	-.004	.004	.005	.003	.005	-.058	-.036	.001	.961	.123	.036	-.192	.088
AV	.000	.001	-.001	.000	-.003	-.004	.009	.000	.000	-.116	.000	.000	.000	-.071
AE2	-.003	.014	-.004	-.006	.001	.001	.100	.049	.000	-.235	.000	.000	.292	.016
AE3	-.003	.015	-.004	-.007	.000	.000	.110	.053	.000	-.125	.000	.000	.317	.000
AE1	-.002	.010	-.002	-.005	.002	.002	.072	.037	.000	-.618	.000	.000	.223	.042

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.515	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.050	-.783	-.064	-.120	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.886	.135	.074	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.031	.046	-.035	.001	.000	.000	.000	.000	.000	.000

ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.152	-.362	.452
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.055	.000	.000	.000	-.164
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.635	.097
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.374	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.123	.000	.000	.738	.380

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.401	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.054	-.186	-.076	-.134	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.210	.162	.082	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.348	.166	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.036	.053	-.132	.004	.000	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.961	.123	.036	-.192	.088
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.116	.000	.000	.000	-.071
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.235	.000	.000	.292	.016
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.125	.000	.000	.317	.000
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.618	.000	.000	.223	.042

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.002	.083	.004	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.006	.142	-.008	-.014	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.000	-.010	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.002	-.024	.004	.006	.014	.021	-.080	-.049	.001	.000	.000	.000	.000	.000
AV	.000	.002	.000	.000	-.005	-.008	.006	.000	.000	.000	.000	.000	.000	.000
AE2	-.004	.089	-.005	-.009	.003	.004	.158	.076	.000	.000	.000	.000	.000	.000
AE3	-.002	.053	-.003	-.005	.000	.000	.095	.045	.000	.000	.000	.000	.000	.000
AE1	-.004	.101	-.005	-.011	.012	.017	.174	.088	.000	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.007	.061	.014	.019	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.009	.047	-.013	-.022	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.000	-.009	.010	-.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.002	-.004	.004	.005	.003	.005	-.058	-.036	.001	.000	.000	.000	.000	.000
AV	.000	.001	-.001	.000	-.003	-.004	.009	.000	.000	.000	.000	.000	.000	.000
AE2	-.003	.014	-.004	-.006	.001	.001	.100	.049	.000	.000	.000	.000	.000	.000

AE3	-.003	.015	-.004	-.007	.000	.000	.110	.053	.000	.000	.000	.000	.000	.000
AE1	-.002	.010	-.002	-.005	.002	.002	.072	.037	.000	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.350	.000
ORG	<-->	OC	4.060	.000
e3	<-->	ODMY	7.136	.000
e3	<-->	ORG	4.127	.000
e2	<-->	e3	21.139	.000
e2	<-->	e4	44.187	.000
e5	<-->	e4	52.360	.000
e1	<-->	e3	14.058	.000
e1	<-->	e4	31.780	.000
res1	<-->	ODMY	4.857	.000
e6	<-->	OC	28.552	.000
e6	<-->	e7	7.142	.000
e8	<-->	e14	15.483	.000
e8	<-->	e7	31.038	.000
e10	<-->	OC	4.088	.000
e11	<-->	e10	4.462	.000
e9	<-->	e10	13.014	.000
e9	<-->	e11	6.811	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change

SF	<---	SP	19.967	.094
SF	<---	SDMY	12.950	-.074
SF	<---	SI	10.744	.068
SV	<---	SP	4.075	-.040
SV	<---	SDMY	6.413	-.050
SP	<---	SF	17.403	.640
SP	<---	SV	37.077	-.933
SDMY	<---	SV	43.935	-.821
SI	<---	SF	13.021	.538
SI	<---	SV	26.667	-.769
accident	<---	ODMY	43.062	-.556
accident	<---	ORG	29.671	.417
accident	<---	OP	12.185	.288
PE	<---	PC	6.046	.074
PE	<---	PDMY	21.303	-.377
PP	<---	PDMY	24.819	-.410
PC	<---	OC	28.552	.926
PC	<---	PP	6.471	-.328
PDMY	<---	ODMY	10.603	-.047
PDMY	<---	ORG	5.454	.031
PDMY	<---	OP	5.517	.033
PDMY	<---	PE	15.243	-.198
PDMY	<---	PP	28.749	-.263
ADMY	<---	ODMY	31.598	-.359
ADMY	<---	ORG	17.214	.240
ADMY	<---	OP	7.791	.173
AE2	<---	OC	4.088	.866

AE2	<---	OP	4.389	.192
AE2	<---	SV	4.709	.725
AE2	<---	AE1	7.498	-.118
AE1	<---	SI	4.658	.272
AE1	<---	AE2	11.249	-.272
AE1	<---	AE3	6.019	-.367

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	57	421.205	114	.000	3.695
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.829	.743	.552
Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.684	.575	.748	.650	.739
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.745	.509	.551
Saturated model	.000	.000	.000

Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	307.205	248.171	373.818
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.085	1.521	1.229	1.851
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.116	.104	.127	.000
Independence model	.195	.186	.205	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	535.205	547.041	724.057	781.057
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.650	2.357	2.979	2.708
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

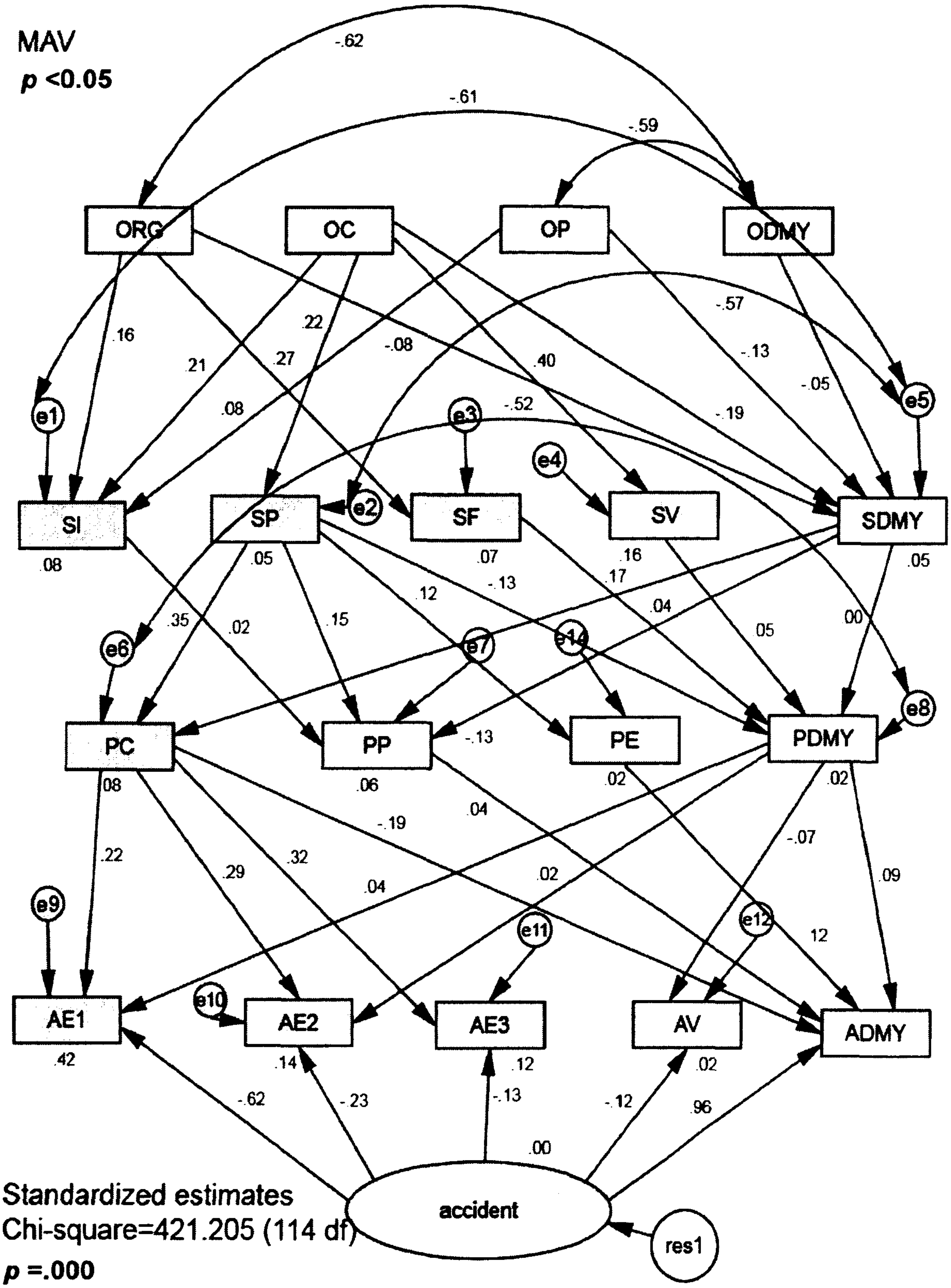
HOELTER

Model	HOELTER .05	HOELTER .01

Default model	68	73
Independence model	28	30

MAV

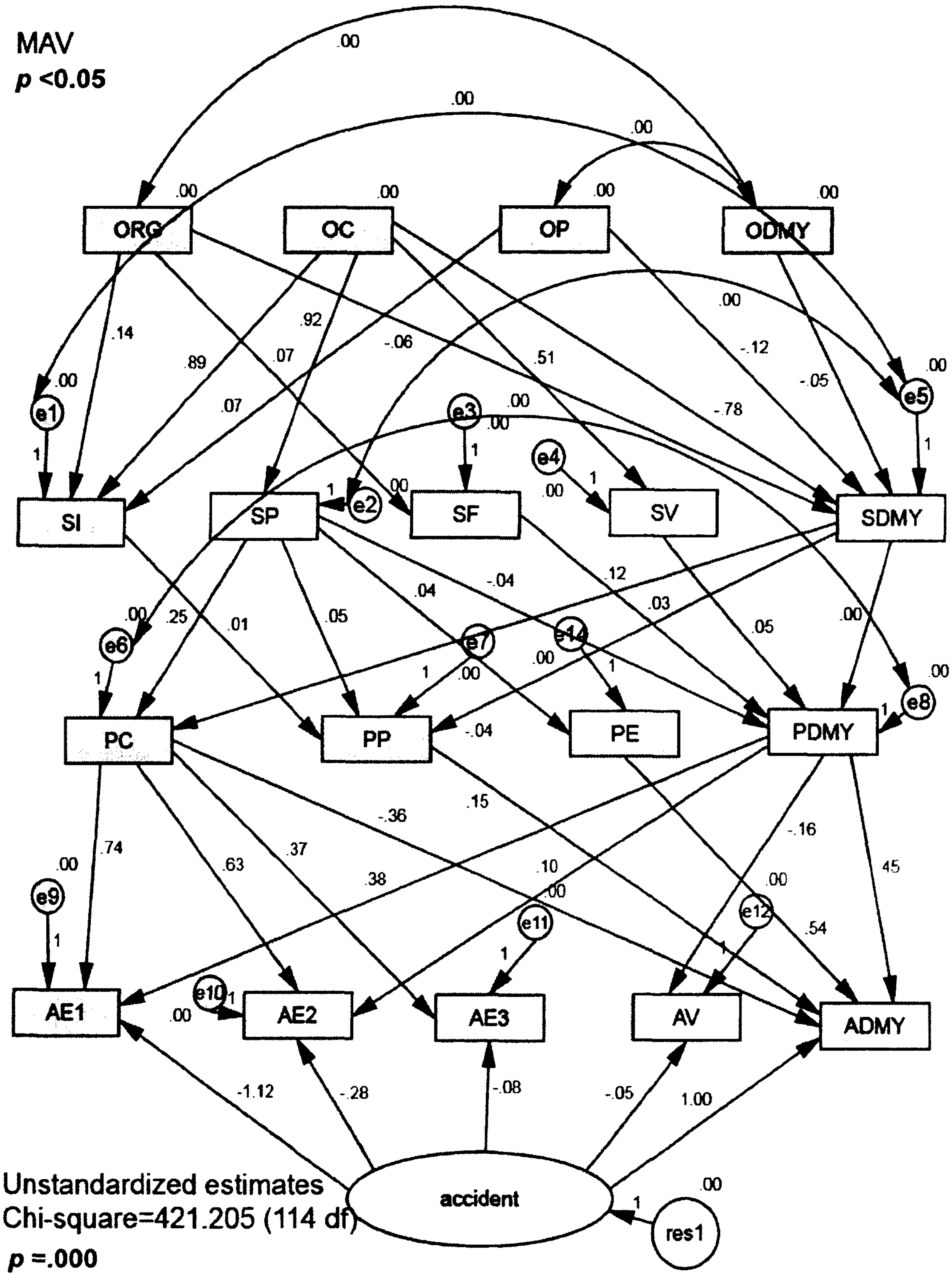
***p* <0.05**



Standardized estimates
Chi-square=421.205 (114 df)
***p* =.000**

MAV

$p < 0.05$



Unstandardized estimates

Chi-square=421.205 (114 df)

$p = .000$

APPENDIX H. PATH ANALYSIS OUTPUT OF MAV MODEL A ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	41	0	18	0	0	59
Total	56	0	18	0	0	74

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 171

Number of distinct parameters to be estimated: 59

Degrees of freedom (171 - 59): 112

Result (Default model)

Minimum was achieved

Chi-square = 1004.826

Degrees of freedom = 112

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.237	.064	-3.711	***par_1
SI	<---	ORG	.264	.056	4.709	***par_2
SI	<---	OC	.970	.282	3.434	***par_3
SP	<---	OC	.907	.282	3.215	.001par_4
SDMY	<---	OC	-.811	.298	-2.721	.007par_5

SI	<---	OP	.201	.060	3.335	***par_6
SI	<---	ODMY	.229	.059	3.866	***par_7
SDMY	<---	ORG	-.108	.059	-1.829	.067par_14
SV	<---	OC	.503	.083	6.089	***par_17
SV	<---	OP	.015	.018	.852	.394par_19
SDMY	<---	ODMY	-.214	.063	-3.417	***par_20
SF	<---	ORG	.069	.017	4.011	***par_23
SP	<---	ORG	-.076	.056	-1.352	.176par_35
PDMY	<---	SP	-.049	.019	-2.631	.009par_8
PC	<---	SP	.254	.049	5.158	***par_13
PDMY	<---	SDMY	-.010	.017	-.611	.541par_15
PDMY	<---	SV	-.022	.061	-.363	.717par_21
PP	<---	SI	.007	.020	.355	.723par_24
PP	<---	SP	.047	.022	2.136	.033par_25
PP	<---	SDMY	-.041	.020	-2.052	.040par_26
PC	<---	SDMY	.119	.044	2.692	.007par_27
PE	<---	SP	.039	.022	1.784	.074par_29
PDMY	<---	SI	-.006	.017	-.329	.742par_36
PDMY	<---	SF	.103	.060	1.706	.088par_41
AE1	<---	PC	.770	.221	3.490	***par_9
AE2	<---	PC	.643	.142	4.521	***par_10
AE3	<---	PC	.433	.076	5.686	***par_11
AE2	<---	PDMY	.121	.395	.307	.759par_12
AE1	<---	PDMY	.476	.612	.777	.437par_16
AE3	<---	PDMY	.294	.211	1.394	.163par_18
AV	<---	PDMY	.037	.160	.232	.816par_22
ADMY	<---	PDMY	.351	.344	1.019	.308par_28

ADMY	<---	PC	-.393	.124	-3.167	.002par_30
ADMY	<---	accident	1.000			
AV	<---	accident	-.053	.033	-1.613	.107par_31
AE3	<---	accident	-.081	.043	-1.884	.060par_32
AE2	<---	accident	-.281	.078	-3.596	***par_33
AE1	<---	accident	-1.122	.097	-11.563	***par_34
ADMY	<---	PE	.538	.224	2.404	.016par_37
AV	<---	PC	.081	.058	1.395	.163par_38
AV	<---	PP	.189	.135	1.404	.160par_39
ADMY	<---	PP	.125	.219	.568	.570par_40

Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.907	-.076	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.214	-.811	-.108	-.237	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	-.003	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.011	.084	.003	.011	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.025	.134	-.032	-.028	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.001	-.053	.010	.001	.103	-.022	-.049	-.010	-.006	.000	.000	.000	.000	.000
ADMY	.012	-.042	.015	.013	.036	-.008	-.090	-.056	-.001	1.000	.538	.125	-.393	.351
AV	.000	.025	-.002	.000	.004	-.001	.028	.001	.001	-.053	.000	.189	.081	.037
AE2	-.016	.080	-.019	-.018	.012	-.003	.157	.075	-.001	-.281	.000	.000	.643	.121
AE3	-.011	.042	-.011	-.012	.030	-.006	.095	.048	-.002	-.081	.000	.000	.433	.294

AE1	-.019	.078	-.020	-.021	.049	-.010	.172	.087	-.003	-1.122	.000	.000	.770	.476

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.220	-.092	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.221	-.176	-.118	-.240	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.239	.212	.291	.206	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.027	-.012	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.038	.063	.011	.040	.000	.000	.147	-.143	.025	.000	.000	.000	.000	.000
PC	-.039	.043	-.052	-.042	.000	.000	.336	.176	.000	.000	.000	.000	.000	.000
PDMY	.004	-.047	.047	.004	.117	-.025	-.181	-.043	-.023	.000	.000	.000	.000	.000
ADMY	.010	-.007	.013	.011	.008	-.002	-.066	-.045	-.001	.966	.123	.029	-.216	.069
AV	.000	.010	-.003	.000	.002	.000	.044	.002	.002	-.112	.000	.098	.097	.016
AE2	-.012	.012	-.015	-.013	.002	-.001	.099	.052	.000	-.234	.000	.000	.304	.021
AE3	-.014	.012	-.015	-.015	.011	-.002	.109	.061	-.002	-.122	.000	.000	.372	.091
AE1	-.009	.008	-.010	-.010	.006	-.001	.071	.040	-.001	-.612	.000	.000	.239	.053

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.907	-.076	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.214	-.811	-.108	-.237	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.103	-.022	-.049	-.010	-.006	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.125	-.393	.351
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.053	.000	.189	.081	.037
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.643	.121
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.433	.294
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.122	.000	.000	.770	.476

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.220	-.092	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.221	-.176	-.118	-.240	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.239	.212	.291	.206	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.147	-.143	.025	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.336	.176	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	.117	-.025	-.181	-.043	-.023	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.966	.123	.029	-.216	.069
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.112	.000	.098	.097	.016
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.234	.000	.000	.304	.021

AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.122	.000	.000	.372	.091
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.612	.000	.000	.239	.053

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	-.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.011	.084	.003	.011	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.025	.134	-.032	-.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.001	-.053	.010	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.012	-.042	.015	.013	.036	-.008	-.090	-.056	-.001	.000	.000	.000	.000	.000
AV	.000	.025	-.002	.000	.004	-.001	.028	.001	.001	.000	.000	.000	.000	.000
AE2	-.016	.080	-.019	-.018	.012	-.003	.157	.075	-.001	.000	.000	.000	.000	.000
AE3	-.011	.042	-.011	-.012	.030	-.006	.095	.048	-.002	.000	.000	.000	.000	.000
AE1	-.019	.078	-.020	-.021	.049	-.010	.172	.087	-.003	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.027	-.012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.038	.063	.011	.040	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.039	.043	-.052	-.042	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PD MY	.004	-.047	.047	.004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
AD MY	.010	-.007	.013	.011	.008	-.002	-.066	-.045	-.001	.000	.000	.000	.000	.000
AV	.000	.010	-.003	.000	.002	.000	.044	.002	.002	.000	.000	.000	.000	.000
AE2	-.012	.012	-.015	-.013	.002	-.001	.099	.052	.000	.000	.000	.000	.000	.000
AE3	-.014	.012	-.015	-.015	.011	-.002	.109	.061	-.002	.000	.000	.000	.000	.000
AE1	-.009	.008	-.010	-.010	.006	-.001	.071	.040	-.001	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.080	.000
ORG	<-->	ODMY	89.027	.000
OP	<-->	ODMY	82.267	.000
OP	<-->	OC	5.926	.000
e2	<-->	e3	21.197	.000
e2	<-->	e4	4.762	.000
e5	<-->	e3	10.595	.000
e5	<-->	e4	6.222	.000
e5	<-->	e2	76.060	.000
e1	<-->	e3	9.486	.000
e1	<-->	e5	84.190	.000
res1	<-->	ODMY	39.767	.000

res1	<-->	ORG	29.889	.000
res1	<-->	OP	12.455	.000
e6	<-->	OC	25.719	.000
e6	<-->	ORG	6.045	.000
e6	<-->	e14	5.888	.000
e8	<-->	ODMY	9.951	.000
e8	<-->	ORG	8.317	.000
e8	<-->	e14	21.795	.000
e8	<-->	e7	23.588	.000
e8	<-->	e6	50.403	.000
e10	<-->	OC	4.097	.000
e10	<-->	OP	4.397	.000
e11	<-->	e10	4.484	.000
e9	<-->	e1	4.630	.000
e9	<-->	e10	13.033	.000
e9	<-->	e11	6.869	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SF	<---	SP	20.004	.094
SF	<---	SDMY	10.828	-.062
SF	<---	SI	9.138	.057
SV	<---	SP	4.214	-.041
SV	<---	SDMY	4.938	-.040
SP	<---	SF	19.633	.974
SP	<---	SDMY	66.410	-.500

SDMY	<---	SF	9.814	-.728
SDMY	<---	SV	5.241	-.534
SDMY	<---	SP	71.740	-.612
SDMY	<---	SI	64.903	-.525
SI	<---	SF	8.787	.653
SI	<---	SDMY	71.398	-.519
accident	<---	ODMY	39.767	-.510
accident	<---	ORG	29.889	.419
accident	<---	OP	12.455	.291
PE	<---	PC	5.654	.069
PE	<---	PDMY	20.892	-.370
PP	<---	PDMY	24.340	-.402
PC	<---	OC	25.719	1.030
PC	<---	ORG	6.045	-.099
PC	<---	SF	4.179	-.324
PC	<---	PE	5.797	.376
PC	<---	PDMY	52.341	-1.310
PDMY	<---	ODMY	9.951	-.051
PDMY	<---	ORG	8.317	.044
PDMY	<---	PE	21.456	-.274
PDMY	<---	PP	22.520	-.274
PDMY	<---	PC	43.306	-.162
ADMY	<---	ODMY	28.846	-.328
ADMY	<---	ORG	17.231	.240
ADMY	<---	OP	7.814	.174
AE2	<---	OC	4.097	.867
AE2	<---	OP	4.397	.192

AE2	<---	SV	4.738	.730
AE2	<---	AE1	7.386	-.116
AE1	<---	AE2	11.123	-.269

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	59	1004.826	112	.000	8.972
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.708	.554	.463
Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.245	-.031	.268	-.035	.242
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.732	.180	.177
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90

Default model	892.826	795.179	997.921
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	4.974	4.420	3.937	4.940
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.199	.187	.210	.000
Independence model	.195	.186	.205	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	1122.826	1135.077	1318.305	1377.305
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

ECVI

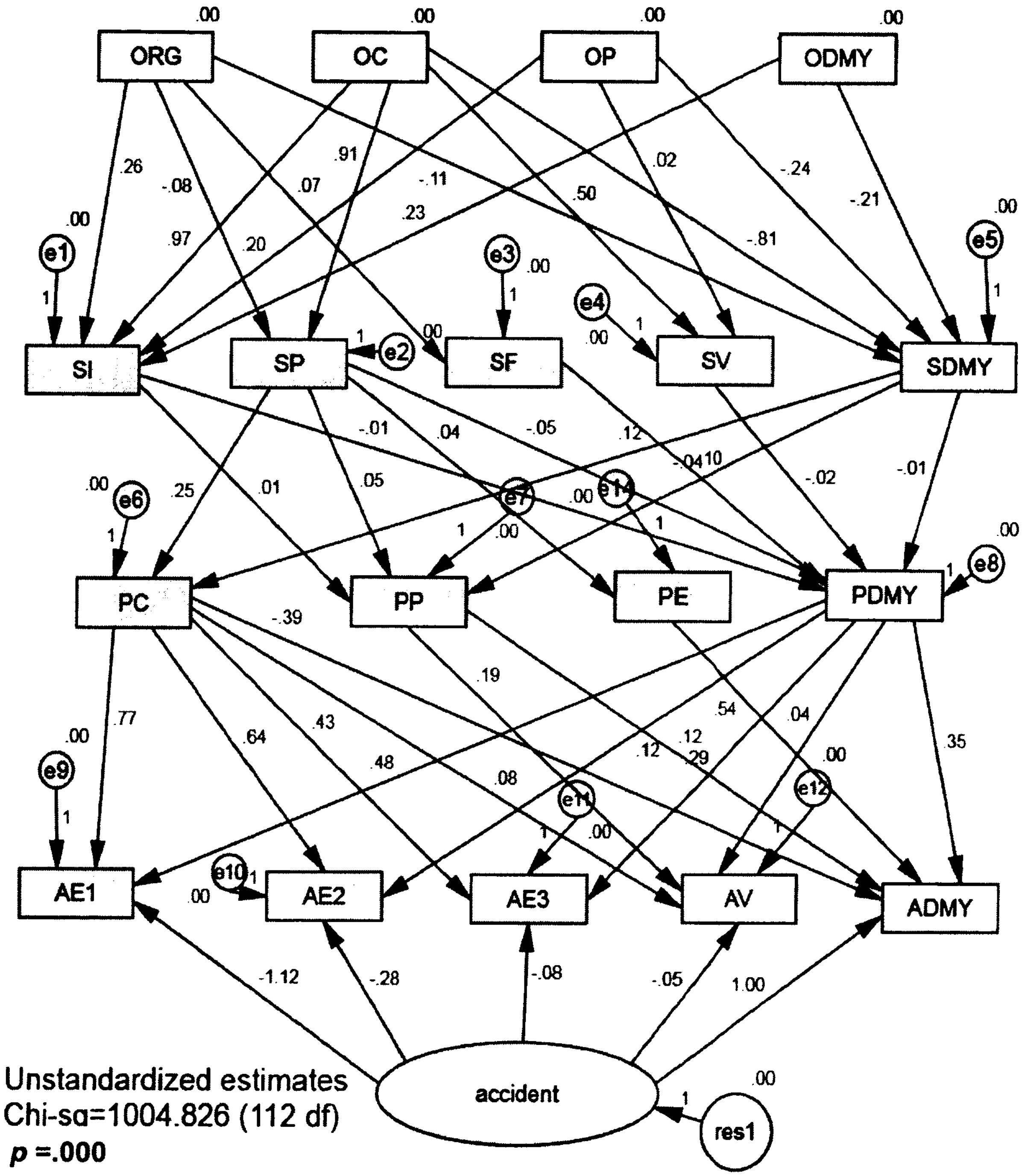
Model	ECVI	LO 90	HI 90	MECVI
Default model	5.559	5.075	6.079	5.619
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	28	31
Independence model	28	30

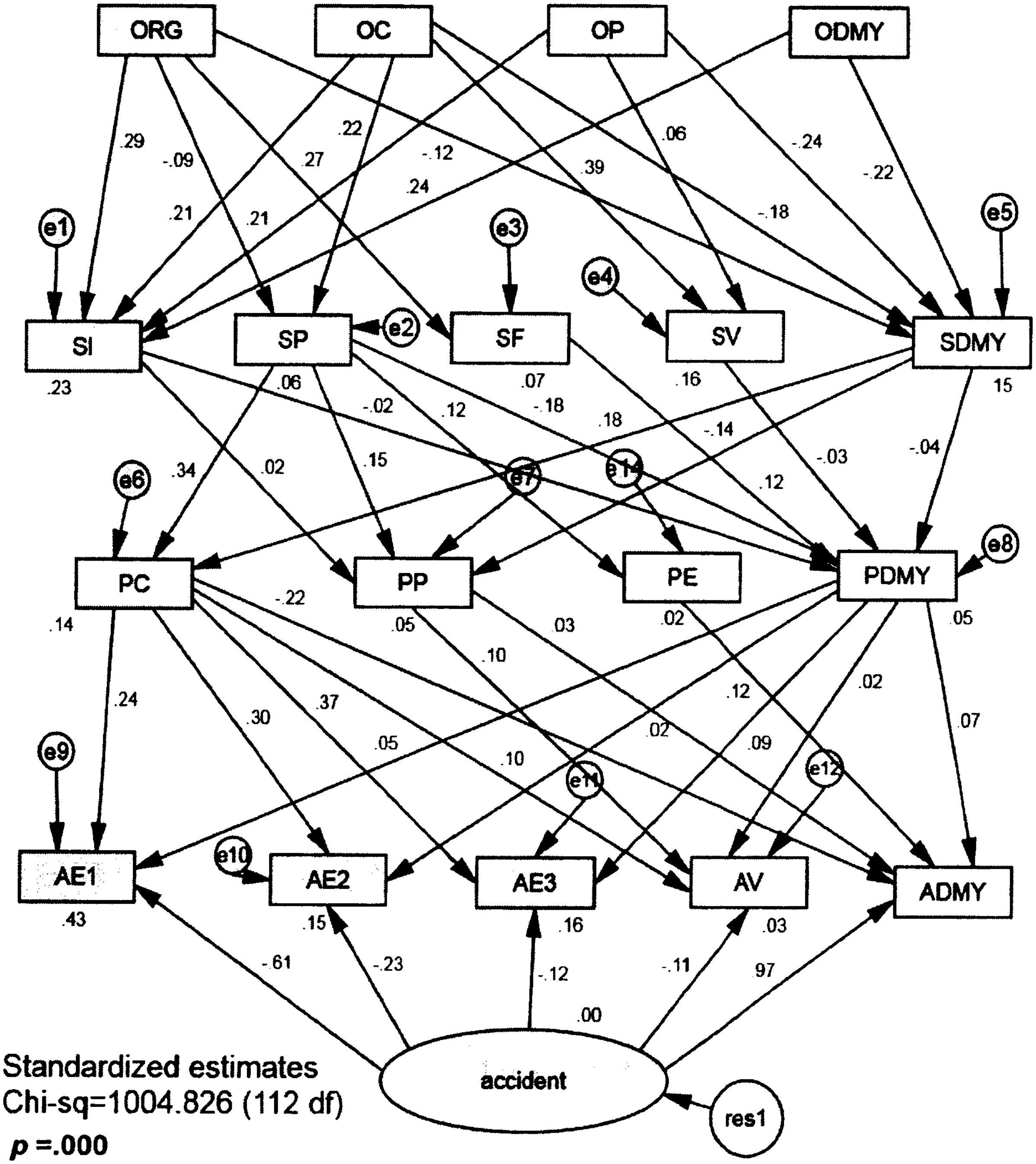
MAV

***p* <0.1**


ORG
OC
OP
ODMY
.00
.00
.00
.00
.26
-.08
.97
.20
.07
.91
-.11
.23
.02
.50
-.24
-.21
-.81
e1
.00
1
SI
SP
e2
1
SF
.00
e3
.00
1
e4
1
.00
SV
SDMY
e5
.00
1
-.01
.04
-.05
.12
-.04
.10
-.02
-.01
.25
.01
.05
e6
.00
1
e7
1
.00
e14
.00
1
PC
PP
PE
PDMY
e8
.00
1
-.39
.19
.77
.64
.43
.48
.08
.54
.12
.12
.29
.04
.00
.35
e9
.00
1
e11
1
.00
e12
1
e10
1
.00
AE1
AE2
AE3
AV
ADMY
-1.12
-.28
-.08
-.05
1.00
accident
res1
1
.00
Unstandardized estimates
Chi-sq=1004.826 (112 df)
p =.000

MAV

p <0.1



Standardized estimates
Chi-sq=1004.826 (112 df)
p =.000

APPENDIX I. PATH ANALYSIS OUTPUT OF MAV MODEL B ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	41	5	18	0	0	64
Total	56	5	18	0	0	79

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 171

Number of distinct parameters to be estimated: 64

Degrees of freedom (171 - 64): 107

Result (Default model)

Minimum was achieved

Chi-square = 407.286

Degrees of freedom = 107

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.199	.075	-2.633	.008par_1
SI	<---	ORG	.264	.086	3.058	.002par_2
SI	<---	OC	.970	.282	3.434	***par_3
SP	<---	OC	.907	.282	3.215	.001par_4
SDMY	<---	OC	-.824	.287	-2.867	.004par_5

SI	<---	OP	.201	.090	2.230	.026par_6
SI	<---	ODMY	.229	.118	1.943	.052par_7
SDMY	<---	ORG	-.099	.079	-1.249	.212par_14
SV	<---	OC	.503	.083	6.089	***par_17
SV	<---	OP	.015	.018	.852	.394par_19
SDMY	<---	ODMY	-.191	.099	-1.940	.052par_20
SF	<---	ORG	.069	.017	4.011	***par_23
SP	<---	ORG	-.076	.056	-1.352	.176par_35
PDMY	<---	SP	-.006	.026	-.244	.807par_8
PC	<---	SP	.254	.060	4.197	***par_13
PDMY	<---	SDMY	.051	.031	1.642	.101par_15
PDMY	<---	SV	.082	.052	1.590	.112par_21
PP	<---	SI	.007	.032	.224	.823par_24
PP	<---	SP	.047	.032	1.492	.136par_25
PP	<---	SDMY	-.041	.040	-1.044	.297par_26
PC	<---	SDMY	.119	.059	2.007	.045par_27
PE	<---	SP	.039	.022	1.784	.074par_29
PDMY	<---	SI	.051	.023	2.210	.027par_36
PDMY	<---	SF	-.003	.051	-.052	.959par_46
AE1	<---	PC	.770	.271	2.844	.004par_9
AE2	<---	PC	.643	.175	3.684	***par_10
AE3	<---	PC	.433	.093	4.634	***par_11
AE2	<---	PDMY	.121	.464	.261	.794par_12
AE1	<---	PDMY	.476	.719	.661	.508par_16
AE3	<---	PDMY	.294	.248	1.187	.235par_18
AV	<---	PDMY	.037	.188	.198	.843par_22
ADMY	<---	PDMY	.351	.404	.868	.385par_28

ADMY	<---	PC	-.393	.152	-2.581	.010par_30
ADMY	<---	accident	1.000			
AV	<---	accident	-.053	.033	-1.613	.107par_31
AE3	<---	accident	-.081	.043	-1.884	.060par_32
AE2	<---	accident	-.281	.078	-3.596	***par_33
AE1	<---	accident	-1.122	.097	-11.563	***par_34
ADMY	<---	PE	.538	.224	2.405	.016par_37
AV	<---	PC	.081	.071	1.136	.256par_38
AV	<---	PP	.189	.133	1.418	.156par_39
ADMY	<---	PP	.125	.217	.574	.566par_45

Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.907	-.076	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.191	-.824	-.099	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	-.003	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.010	.084	.002	.010	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.023	.132	-.031	-.024	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.002	.043	.009	.001	-.003	.082	-.006	.051	.051	.000	.000	.000	.000	.000
ADMY	.011	-.007	.014	.011	-.001	.029	-.075	-.034	.019	1.000	.538	.125	-.393	.351
AV	.000	.028	-.002	.000	.000	.003	.029	.004	.003	-.053	.000	.189	.081	.037
AE2	-.014	.090	-.019	-.015	.000	.010	.162	.083	.006	-.281	.000	.000	.643	.121
AE3	-.009	.070	-.011	-.010	-.001	.024	.108	.066	.015	-.081	.000	.000	.433	.294

AE1	-.017	.122	-.020	-.018	-.001	.039	.192	.116	.024	-1.122	.000	.000	.770	.476

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.220	-.092	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.206	-.196	-.118	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.027	-.012	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.009	.034	.000	.000	.145	-.130	.023	.000	.000	.000	.000	.000
PC	-.034	.044	-.052	-.037	.000	.000	.348	.166	.000	.000	.000	.000	.000	.000
PDMY	.008	.038	.039	.006	-.003	.093	-.023	.189	.191	.000	.000	.000	.000	.000
ADMY	.009	-.001	.012	.009	.000	.006	-.054	-.025	.014	.961	.123	.029	-.208	.070
AV	.000	.011	-.003	.000	.000	.002	.047	.006	.005	-.112	.000	.099	.094	.016
AE2	-.010	.014	-.015	-.011	.000	.002	.102	.053	.004	-.235	.000	.000	.296	.021
AE3	-.012	.020	-.015	-.013	.000	.009	.125	.079	.018	-.124	.000	.000	.367	.094
AE1	-.008	.012	-.010	-.008	.000	.005	.080	.049	.010	-.617	.000	.000	.233	.054

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.503	.000	.015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.907	-.076	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.191	-.824	-.099	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	-.003	.082	-.006	.051	.051	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.125	-.393	.351
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.053	.000	.189	.081	.037
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.643	.121
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.433	.294
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.122	.000	.000	.770	.476

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.393	.000	.055	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.220	-.092	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.206	-.196	-.118	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.145	-.130	.023	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.348	.166	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	-.003	.093	-.023	.189	.191	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.961	.123	.029	-.208	.070
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.112	.000	.099	.094	.016

AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.235	.000	.000	.296	.021
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.124	.000	.000	.367	.094
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.617	.000	.000	.233	.054

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	-.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.010	.084	.002	.010	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.023	.132	-.031	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.002	.043	.009	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.011	-.007	.014	.011	-.001	.029	-.075	-.034	.019	.000	.000	.000	.000	.000
AV	.000	.028	-.002	.000	.000	.003	.029	.004	.003	.000	.000	.000	.000	.000
AE2	-.014	.090	-.019	-.015	.000	.010	.162	.083	.006	.000	.000	.000	.000	.000
AE3	-.009	.070	-.011	-.010	-.001	.024	.108	.066	.015	.000	.000	.000	.000	.000
AE1	-.017	.122	-.020	-.018	-.001	.039	.192	.116	.024	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SD MY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.027	-.012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.009	.034	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.034	.044	-.052	-.037	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PD MY	.008	.038	.039	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
AD MY	.009	-.001	.012	.009	.000	.006	-.054	-.025	.014	.000	.000	.000	.000	.000
AV	.000	.011	-.003	.000	.000	.002	.047	.006	.005	.000	.000	.000	.000	.000
AE2	-.010	.014	-.015	-.011	.000	.002	.102	.053	.004	.000	.000	.000	.000	.000
AE3	-.012	.020	-.015	-.013	.000	.009	.125	.079	.018	.000	.000	.000	.000	.000
AE1	-.008	.012	-.010	-.008	.000	.005	.080	.049	.010	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.350	.000
ORG	<-->	OC	4.060	.000
e3	<-->	ODMY	7.136	.000
e3	<-->	ORG	4.127	.000
e2	<-->	e3	21.311	.000
e2	<-->	e4	45.233	.000
e5	<-->	e4	52.542	.000
e1	<-->	e3	12.457	.000
e1	<-->	e4	30.906	.000
res1	<-->	ODMY	4.930	.000
e6	<-->	OC	24.926	.000

e6	<-->	e7	8.179	.000
e8	<-->	e14	14.785	.000
e8	<-->	e7	31.875	.000
e10	<-->	OC	4.097	.000
e11	<-->	e10	4.484	.000
e9	<-->	e10	13.033	.000
e9	<-->	e11	6.869	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SF	<---	SP	20.004	.094
SF	<---	SDMY	12.905	-.074
SF	<---	SI	10.648	.067
SV	<---	SP	4.214	-.041
SV	<---	SDMY	5.885	-.048
SP	<---	SF	19.739	.680
SP	<---	SV	37.780	-.944
SDMY	<---	SV	44.261	-.828
SI	<---	SF	11.538	.504
SI	<---	SV	26.034	-.760
accident	<---	ODMY	43.634	-.560
accident	<---	ORG	29.889	.419
accident	<---	OP	12.455	.291
PE	<---	PC	6.045	.074
PE	<---	PDMY	20.466	-.362
PP	<---	PDMY	23.845	-.394

PC	<---	OC	24.926	.849
PC	<---	PP	7.505	-.347
PDMY	<---	ODMY	8.855	-.043
PDMY	<---	ORG	4.526	.028
PDMY	<---	OP	5.058	.031
PDMY	<---	PE	14.555	-.192
PDMY	<---	PP	29.821	-.266
ADMY	<---	ODMY	31.651	-.360
ADMY	<---	ORG	17.231	.240
ADMY	<---	OP	7.814	.174
AV	<---	SDMY	4.753	.092
AE2	<---	OC	4.097	.867
AE2	<---	OP	4.397	.192
AE2	<---	SV	4.738	.730
AE2	<---	AE1	7.501	-.118
AE1	<---	SI	4.661	.271
AE1	<---	AE2	11.255	-.272
AE1	<---	AE3	6.035	-.367

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	64	407.286	107	.000	3.806
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.834	.735	.522

Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.694	.563	.755	.636	.745
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.699	.485	.521
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	300.286	242.152	365.993
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.016	1.487	1.199	1.812
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.118	.106	.130	.000
Independence model	.195	.186	.205	.000

AIC

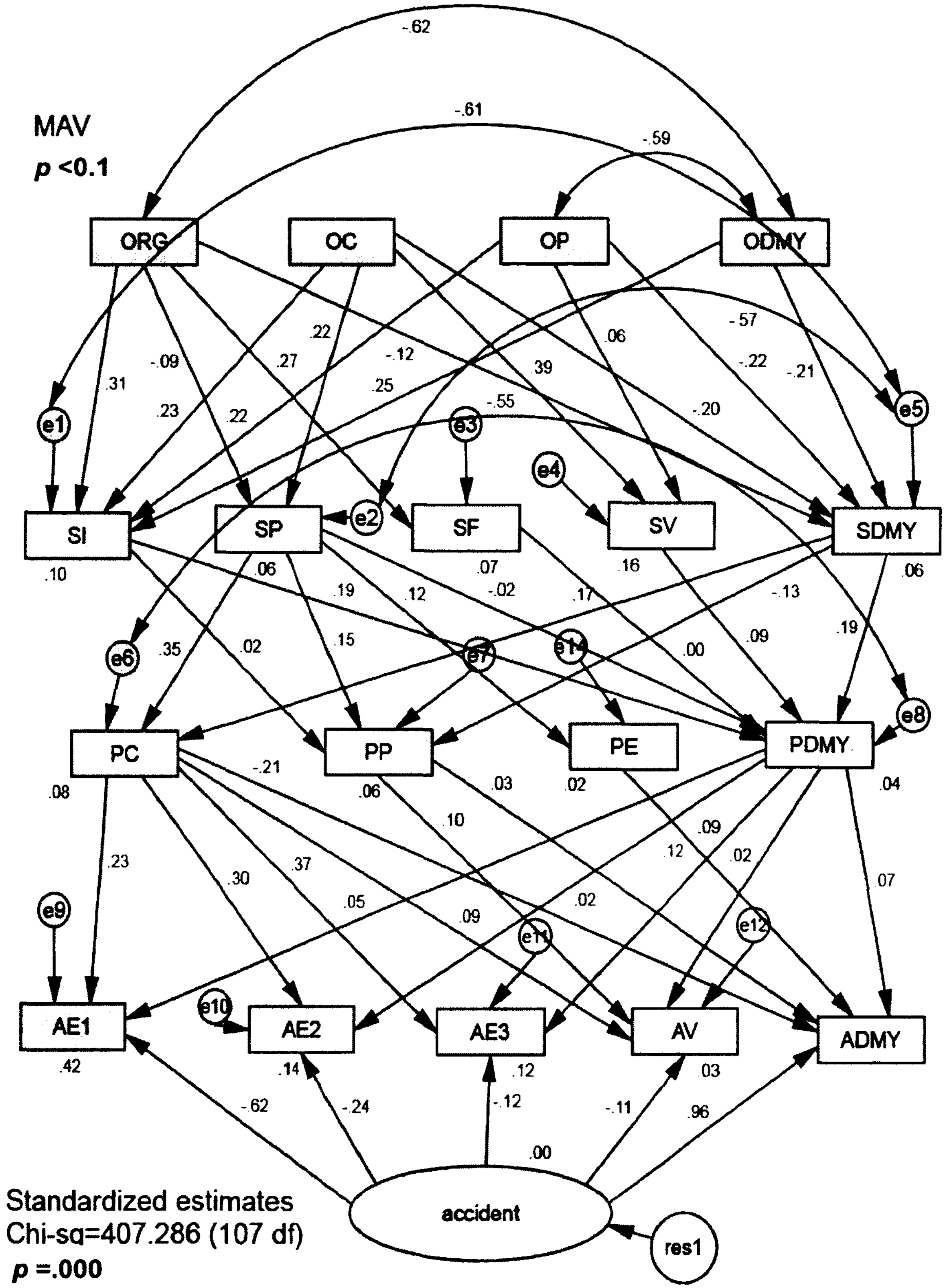
Model	AIC	BCC	BIC	CAIC
Default model	535.286	548.576	747.331	811.331
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

ECVI

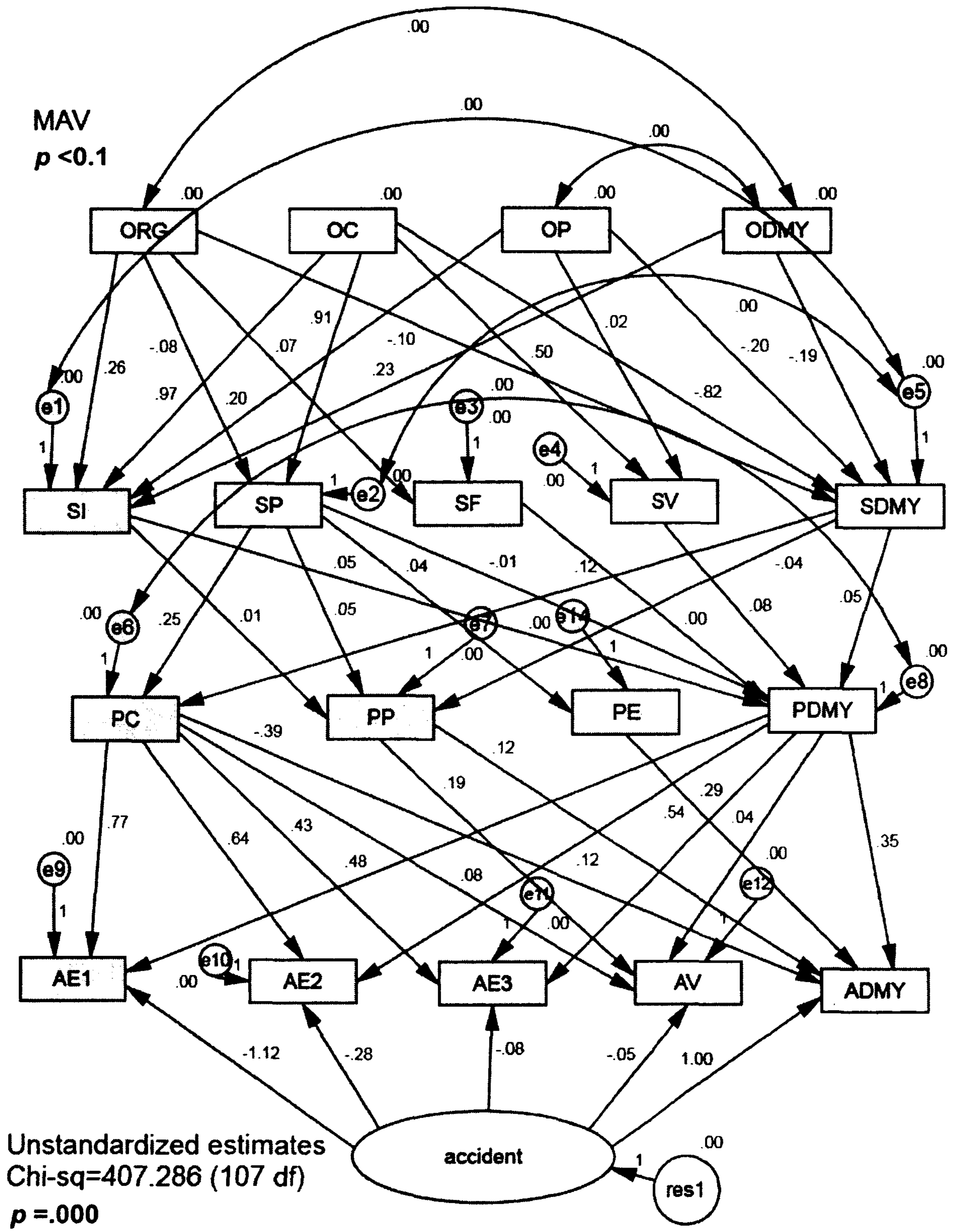
Model	ECVI	LO 90	HI 90	MECVI
Default model	2.650	2.362	2.975	2.716
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	66	72
Independence model	28	30


MAV
p <0.1

Standardized estimates
Chi-sq=407.286 (107 df)
p =.000



MAV
p <0.1

Unstandardized estimates
Chi-sq=407.286 (107 df)
p =.000

APPENDIX J. PATH ANALYSIS OUTPUT OF MAV MODEL C ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	15	0	0	0	0	15
Labeled	0	0	0	0	0	0
Unlabeled	39	5	18	0	0	62
Total	54	5	18	0	0	77

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	171
Number of distinct parameters to be estimated:	62
Degrees of freedom (171 - 62):	109

Result (Default model)

Minimum was achieved

Chi-square = 409.806

Degrees of freedom = 109

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	OP	-.199	.075	-2.633	.008par_1
SI	<---	ORG	.264	.086	3.058	.002par_2
SI	<---	OC	.970	.282	3.434	***par_3
SP	<---	OC	.925	.283	3.263	.001par_4
SDMY	<---	OC	-.834	.288	-2.898	.004par_5

SI	<---	OP	.201	.090	2.230	.026par_6
SI	<---	ODMY	.229	.118	1.943	.052par_7
SDMY	<---	ORG	-.143	.072	-1.982	.047par_14
SV	<---	OC	.515	.083	6.224	***par_17
SDMY	<---	ODMY	-.191	.099	-1.940	.052par_19
SF	<---	ORG	.069	.017	4.011	***par_22
PDMY	<---	SP	-.006	.026	-.245	.807par_8
PC	<---	SP	.254	.061	4.189	***par_13
PDMY	<---	SDMY	.051	.031	1.642	.101par_15
PDMY	<---	SV	.082	.051	1.596	.111par_20
PP	<---	SI	.007	.032	.224	.823par_23
PP	<---	SP	.047	.032	1.499	.134par_24
PP	<---	SDMY	-.041	.040	-1.043	.297par_25
PC	<---	SDMY	.119	.059	2.007	.045par_26
PE	<---	SP	.039	.022	1.786	.074par_28
PDMY	<---	SI	.051	.023	2.208	.027par_34
PDMY	<---	SF	-.003	.051	-.052	.959par_44
AE1	<---	PC	.770	.271	2.844	.004par_9
AE2	<---	PC	.643	.174	3.685	***par_10
AE3	<---	PC	.433	.093	4.635	***par_11
AE2	<---	PDMY	.121	.464	.261	.794par_12
AE1	<---	PDMY	.476	.719	.662	.508par_16
AE3	<---	PDMY	.294	.248	1.187	.235par_18
AV	<---	PDMY	.037	.188	.198	.843par_21
ADMY	<---	PDMY	.351	.404	.868	.385par_27
ADMY	<---	PC	-.393	.152	-2.581	.010par_29
ADMY	<---	accident	1.000			

AV	<---	accident	-.053	.033	-1.613	.107	par_30
AE3	<---	accident	-.081	.043	-1.884	.060	par_31
AE2	<---	accident	-.281	.078	-3.596	***	par_32
AE1	<---	accident	-1.122	.097	-11.563	***	par_33
ADMY	<---	PE	.538	.224	2.405	.016	par_35
AV	<---	PC	.081	.071	1.137	.256	par_36
AV	<---	PP	.189	.133	1.418	.156	par_37
ADMY	<---	PP	.125	.217	.574	.566	par_43

Total Effects (Group number 1 - Default model)

	ODM	OC	ORG	OP	SF	SV	SP	SDM	SI	accident	PE	PP	PC	PDM
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.515	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDM	-.191	-.834	-.143	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.010	.085	.008	.010	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	-.023	.136	-.017	-.024	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDM	.002	.043	.006	.000	-.003	.082	-.006	.051	.051	.000	.000	.000	.000	.000
AD	.011	-.008	.010	.011	-.001	.029	-.075	-.034	.019	1.000	.538	.125	-.393	.351
AV	.000	.029	.000	.000	.000	.003	.029	.004	.003	-.053	.000	.189	.081	.037
AE2	-.014	.092	-.010	-.015	.000	.010	.162	.083	.006	-.281	.000	.000	.643	.121
AE3	-.009	.071	-.006	-.010	-.001	.024	.108	.066	.015	-.081	.000	.000	.433	.294
AE1	-.017	.125	-.010	-.018	-.001	.039	.192	.116	.024	-1.122	.000	.000	.770	.476

Standardized Total Effects (Group number 1 - Default model)

	ODM	OC	ORG	OP	SF	SV	SP	SDM	SI	accident	PE	PP	PC	PDM
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.401	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDM	-.206	-.197	-.170	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.029	.034	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	-.034	.045	-.028	-.037	.000	.000	.348	.167	.000	.000	.000	.000	.000	.000
PDM	.008	.038	.027	.001	-.003	.093	-.023	.190	.191	.000	.000	.000	.000	.000
AD	.009	-.001	.009	.009	.000	.006	-.054	-.025	.014	.961	.123	.029	-.208	.070
AV	.000	.011	.001	.000	.000	.002	.047	.006	.005	-.112	.000	.099	.094	.016
AE2	-.010	.014	-.008	-.011	.000	.002	.102	.053	.004	-.235	.000	.000	.296	.021
AE3	-.012	.020	-.008	-.013	.000	.009	.126	.079	.018	-.124	.000	.000	.367	.094
AE1	-.008	.013	-.005	-.009	.000	.005	.080	.049	.010	-.617	.000	.000	.233	.054

Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.069	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.515	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.925	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.191	-.834	-.143	-.199	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.229	.970	.264	.201	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PE	.000	.000	.000	.000	.000	.000	.039	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.047	-.041	.007	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.254	.119	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	-.003	.082	-.006	.051	.051	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.538	.125	-.393	.351
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.053	.000	.189	.081	.037
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.281	.000	.000	.643	.121
AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.081	.000	.000	.433	.294
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.122	.000	.000	.770	.476

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.272	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.401	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.224	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.206	-.197	-.170	-.220	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.246	.229	.314	.222	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.000	.000	.000	.000	.000	.125	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.000	.000	.146	-.130	.023	.000	.000	.000	.000	.000
PC	.000	.000	.000	.000	.000	.000	.348	.167	.000	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.000	-.003	.093	-.023	.190	.191	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.961	.123	.029	-.208	.070
AV	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.112	.000	.099	.094	.016
AE2	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.235	.000	.000	.296	.021

AE3	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.124	.000	.000	.367	.094
AE1	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.617	.000	.000	.233	.054

Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.036	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.010	.085	.008	.010	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.023	.136	-.017	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PDMY	.002	.043	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	.011	-.008	.010	.011	-.001	.029	-.075	-.034	.019	.000	.000	.000	.000	.000
AV	.000	.029	.000	.000	.000	.003	.029	.004	.003	.000	.000	.000	.000	.000
AE2	-.014	.092	-.010	-.015	.000	.010	.162	.083	.006	.000	.000	.000	.000	.000
AE3	-.009	.071	-.006	-.010	-.001	.024	.108	.066	.015	.000	.000	.000	.000	.000
AE1	-.017	.125	-.010	-.018	-.001	.039	.192	.116	.024	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OC	ORG	OP	SF	SV	SP	SDMY	SI	accident	PE	PP	PC	PDMY
SF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SD MY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PE	.000	.028	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.032	.063	.029	.034	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PC	-.034	.045	-.028	-.037	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PD MY	.008	.038	.027	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
AD MY	.009	-.001	.009	.009	.000	.006	-.054	-.025	.014	.000	.000	.000	.000	.000
AV	.000	.011	.001	.000	.000	.002	.047	.006	.005	.000	.000	.000	.000	.000
AE2	-.010	.014	-.008	-.011	.000	.002	.102	.053	.004	.000	.000	.000	.000	.000
AE3	-.012	.020	-.008	-.013	.000	.009	.126	.079	.018	.000	.000	.000	.000	.000
AE1	-.008	.013	-.005	-.009	.000	.005	.080	.049	.010	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OC	<-->	ODMY	4.350	.000
ORG	<-->	OC	4.060	.000
e3	<-->	ODMY	7.136	.000
e3	<-->	ORG	4.127	.000
e2	<-->	e3	21.139	.000
e2	<-->	e4	44.187	.000
e5	<-->	e4	52.360	.000
e1	<-->	e3	12.457	.000
e1	<-->	e4	30.798	.000
res1	<-->	ODMY	4.930	.000
e6	<-->	OC	24.926	.000

e6	<-->	e7	8.179	.000
e8	<-->	e14	14.785	.000
e8	<-->	e7	31.875	.000
e10	<-->	OC	4.097	.000
e11	<-->	e10	4.484	.000
e9	<-->	e10	13.033	.000
e9	<-->	e11	6.869	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SF	<---	SP	19.967	.094
SF	<---	SDMY	12.834	-.074
SF	<---	SI	10.648	.067
SV	<---	SP	4.075	-.040
SV	<---	SDMY	6.355	-.049
SP	<---	SF	17.403	.640
SP	<---	SV	37.077	-.933
SDMY	<---	SV	43.935	-.821
SI	<---	SF	11.538	.504
SI	<---	SV	25.843	-.754
accident	<---	ODMY	43.634	-.560
accident	<---	ORG	29.889	.419
accident	<---	OP	12.455	.291
PE	<---	PC	6.046	.074
PE	<---	PDMY	20.476	-.363
PP	<---	PDMY	23.856	-.394

PC	<---	OC	24.926	.849
PC	<---	PP	7.501	-.346
PDMY	<---	ODMY	8.855	-.043
PDMY	<---	ORG	4.526	.028
PDMY	<---	OP	5.058	.031
PDMY	<---	PE	14.555	-.192
PDMY	<---	PP	29.806	-.265
ADMY	<---	ODMY	31.651	-.360
ADMY	<---	ORG	17.231	.240
ADMY	<---	OP	7.814	.174
AV	<---	SDMY	4.726	.092
AE2	<---	OC	4.097	.867
AE2	<---	OP	4.397	.192
AE2	<---	SV	4.703	.724
AE2	<---	AE1	7.501	-.118
AE1	<---	SI	4.661	.271
AE1	<---	AE2	11.255	-.272
AE1	<---	AE3	6.034	-.367

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	62	409.806	109	.000	3.760
Saturated model	171	.000	0		
Independence model	18	1331.327	153	.000	8.701

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.834	.739	.531

Saturated model	.000	1.000		
Independence model	.000	.614	.569	.549

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.692	.568	.754	.642	.745
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.712	.493	.531
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	300.806	242.542	366.647
Saturated model	.000	.000	.000
Independence model	1178.327	1065.473	1298.619

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.029	1.489	1.201	1.815
Saturated model	.000	.000	.000	.000
Independence model	6.591	5.833	5.275	6.429

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.117	.105	.129	.000
Independence model	.195	.186	.205	.000

AIC

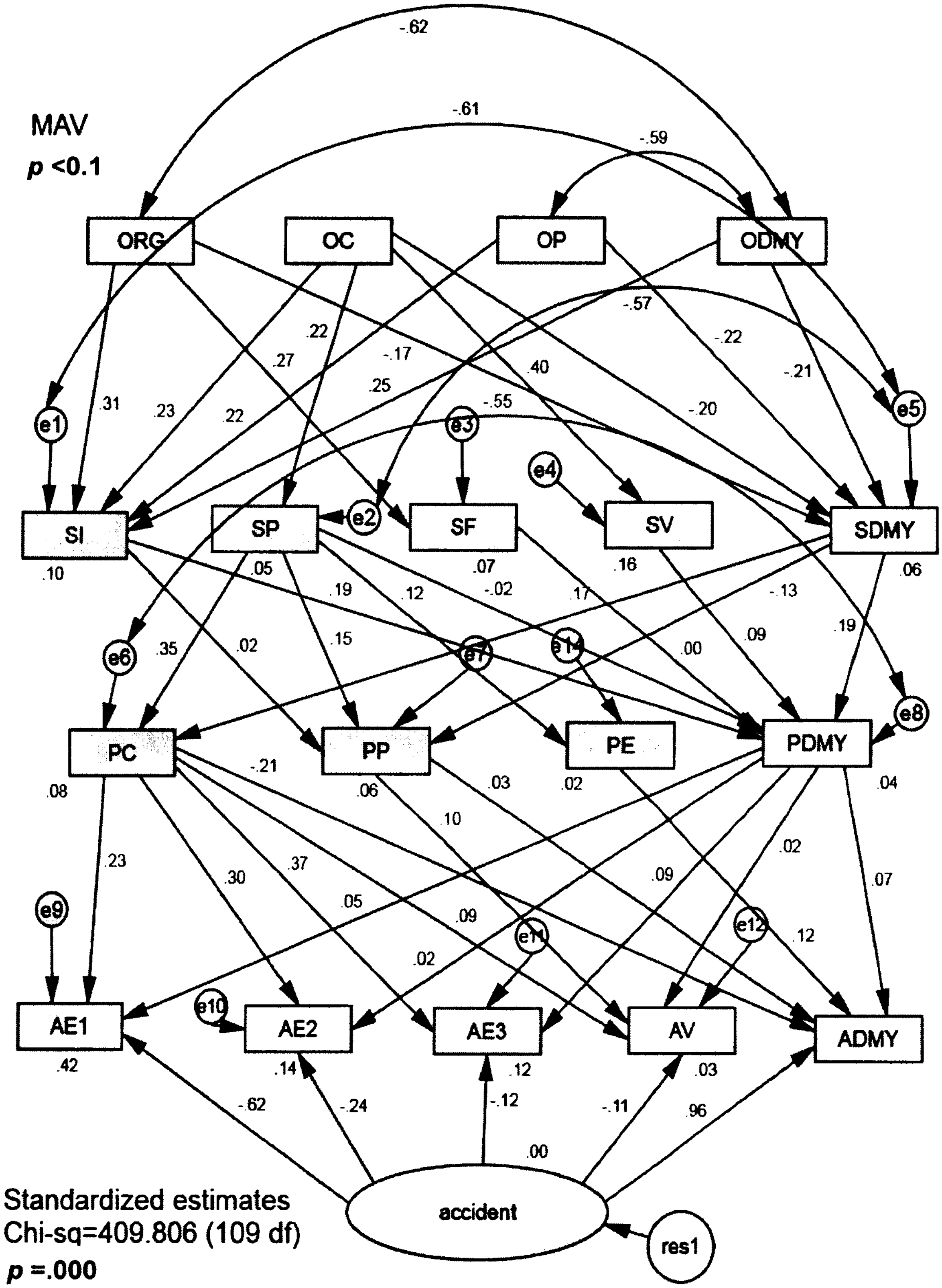
Model	AIC	BCC	BIC	CAIC
Default model	533.806	546.680	739.225	801.225
Saturated model	342.000	377.508	908.558	1079.558
Independence model	1367.327	1371.064	1426.964	1444.964

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	2.643	2.354	2.969	2.706
Saturated model	1.693	1.693	1.693	1.869
Independence model	6.769	6.210	7.364	6.787

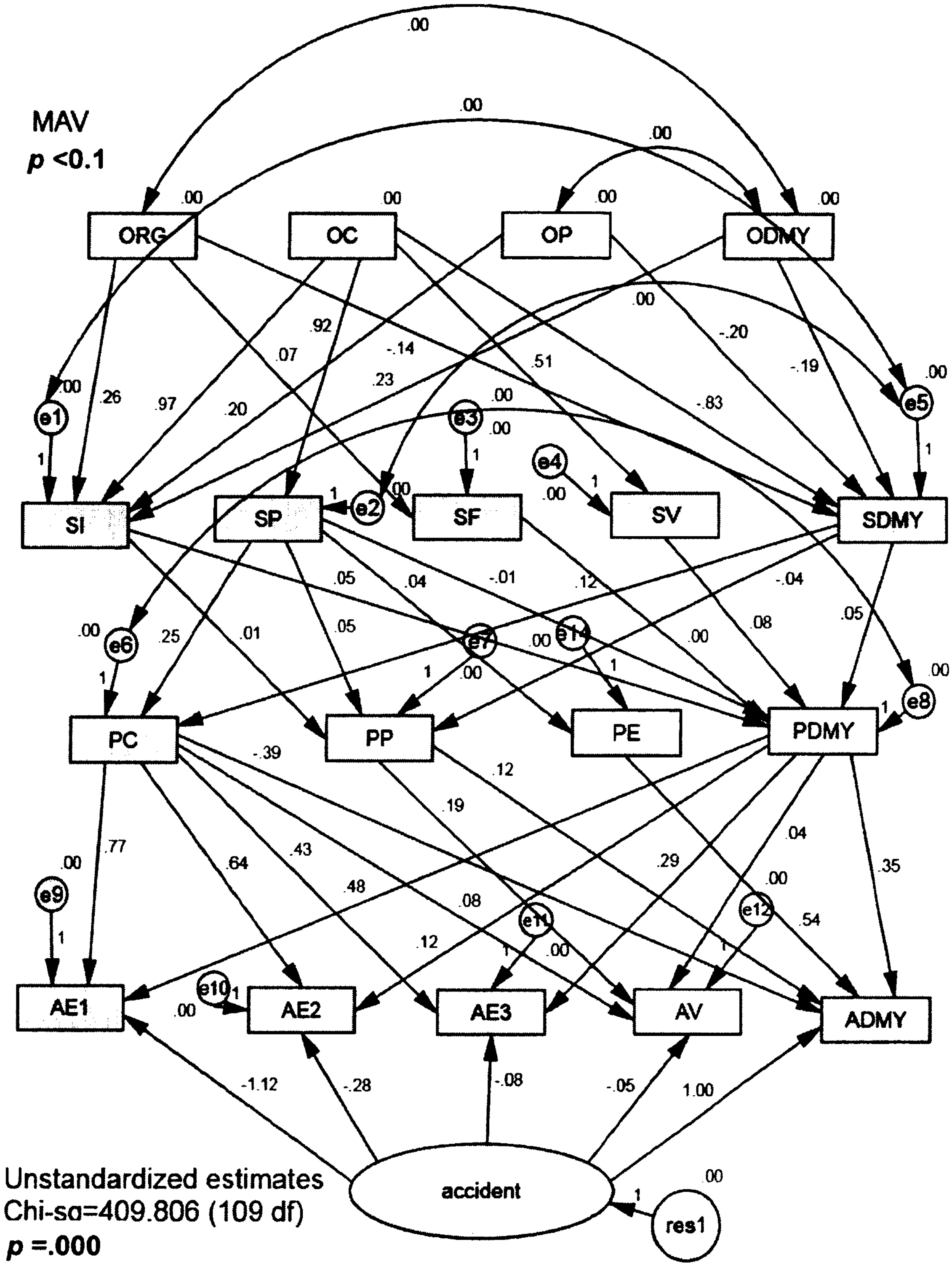
HOELTER

Model	HOELTER .05	HOELTER .01
Default model	67	73
Independence model	28	30



MAV
p <0.1

Standardized estimates
Chi-sq=409.806 (109 df)
p =.000



MAV
p <0.1

Unstandardized estimates
Chi-sq=409.806 (109 df)
p =.000

APPENDIX K. PATH ANALYSIS OUTPUT OF UAV MODEL A ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 60

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	24	0	14	0	0	38
Total	36	0	14	0	0	50

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	38
Degrees of freedom (105 - 38):	67

Result (Default model)

Minimum was achieved

Chi-square = 325.983

Degrees of freedom = 67

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.122	.144	.848	.396par_1
SI	<---	OP	.054	.080	.673	.501par_5
SI	<---	ODMY	-.179	.098	-1.836	.066par_6
SDMY	<---	ODMY	.273	.111	2.450	.014par_7
SV	<---	ODMY	-.072	.048	-1.503	.133par_22
PDMY	<---	SDMY	.012	.030	.392	.695par_2

PC	<---	SDMY	.123	.093	1.326	.185par_3
PP	<---	SI	.161	.066	2.456	.014par_9
PDMY	<---	SI	.000	.035	.000	1.000par_10
PDMY	<---	SV	.054	.071	.754	.451par_13
PP	<---	SDMY	.012	.056	.208	.835par_14
AE1	<---	PDMY	-.061	1.257	-.048	.962par_4
AE2	<---	PDMY	.197	.969	.203	.839par_8
AE3	<---	PDMY	-.084	.475	-.176	.860par_11
AV	<---	PDMY	-.138	.210	-.658	.511par_12
AE1	<---	PC	1.628	.396	4.111	***par_15
AE2	<---	PC	1.463	.307	4.768	***par_16
AE3	<---	PP	.479	.236	2.029	.043par_17
AE1	<---	Accident	-1.108	.174	-6.377	***par_18
AE2	<---	Accident	-.545	.159	-3.428	***par_19
AE3	<---	Accident	-.132	.084	-1.584	.113par_20
AV	<---	Accident	-.022	.038	-.571	.568par_21
ADMY	<---	PC	-.326	.225	-1.450	.147par_23
ADMY	<---	PDMY	.641	.725	.885	.376par_24
ADMY	<---	Accident	1.000			

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.273	.000	.122	.000	.000	.000	.000	.000	.000	.000
SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.026	.009	.001	.000	.012	.161	.000	.000	.000	.000
PC	.034	.000	.015	.000	.123	.000	.000	.000	.000	.000

PDMY	-.001	.000	.001	.054	.012	.000	.000	.000	.000	.000
ADMY	-.011	.000	-.004	.034	-.033	.000	1.000	.000	-.326	.641
AE3	-.012	.004	.001	-.005	.005	.077	-.132	.479	.000	-.084
AV	.000	.000	.000	-.007	-.002	.000	-.022	.000	.000	-.138
AE2	.049	.000	.022	.011	.182	.000	-.545	.000	1.463	.197
AE1	.055	.000	.024	-.003	.199	.000	-1.108	.000	1.628	-.061

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.192	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.302	.000	.105	.000	.000	.000	.000	.000	.000	.000
SI	-.232	.085	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.063	.026	.003	.000	.026	.305	.000	.000	.000	.000
PC	.051	.000	.018	.000	.170	.000	.000	.000	.000	.000
PDMY	-.003	.000	.005	.098	.051	.000	.000	.000	.000	.000
ADMY	-.010	.000	-.003	.011	-.025	.000	.977	.000	-.180	.113
AE3	-.016	.006	.001	-.002	.005	.076	-.195	.250	.000	-.022
AV	.000	.000	.000	-.008	-.004	.000	-.074	.000	.000	-.085
AE2	.027	.000	.009	.002	.091	.000	-.347	.000	.526	.022
AE1	.024	.000	.008	-.001	.079	.000	-.564	.000	.468	-.006

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.273	.000	.122	.000	.000	.000	.000	.000	.000	.000

SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.012	.161	.000	.000	.000	.000
PC	.000	.000	.000	.000	.123	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.054	.012	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.000	-.326	.641
AE3	.000	.000	.000	.000	.000	.000	-.132	.479	.000	-.084
AV	.000	.000	.000	.000	.000	.000	-.022	.000	.000	-.138
AE2	.000	.000	.000	.000	.000	.000	-.545	.000	1.463	.197
AE1	.000	.000	.000	.000	.000	.000	-1.108	.000	1.628	-.061

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.192	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.302	.000	.105	.000	.000	.000	.000	.000	.000	.000
SI	-.232	.085	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.026	.305	.000	.000	.000	.000
PC	.000	.000	.000	.000	.170	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.098	.051	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.977	.000	-.180	.113
AE3	.000	.000	.000	.000	.000	.000	-.195	.250	.000	-.022
AV	.000	.000	.000	.000	.000	.000	-.074	.000	.000	-.085
AE2	.000	.000	.000	.000	.000	.000	-.347	.000	.526	.022
AE1	.000	.000	.000	.000	.000	.000	-.564	.000	.468	-.006

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.026	.009	.001	.000	.000	.000	.000	.000	.000	.000
PC	.034	.000	.015	.000	.000	.000	.000	.000	.000	.000
PDMY	-.001	.000	.001	.000	.000	.000	.000	.000	.000	.000
ADMY	-.011	.000	-.004	.034	-.033	.000	.000	.000	.000	.000
AE3	-.012	.004	.001	-.005	.005	.077	.000	.000	.000	.000
AV	.000	.000	.000	-.007	-.002	.000	.000	.000	.000	.000
AE2	.049	.000	.022	.011	.182	.000	.000	.000	.000	.000
AE1	.055	.000	.024	-.003	.199	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.063	.026	.003	.000	.000	.000	.000	.000	.000	.000
PC	.051	.000	.018	.000	.000	.000	.000	.000	.000	.000
PDMY	-.003	.000	.005	.000	.000	.000	.000	.000	.000	.000
ADMY	-.010	.000	-.003	.011	-.025	.000	.000	.000	.000	.000

AE3	-.016	.006	.001	-.002	.005	.076	.000	.000	.000	.000
AV	.000	.000	.000	-.008	-.004	.000	.000	.000	.000	.000
AE2	.027	.000	.009	.002	.091	.000	.000	.000	.000	.000
AE1	.024	.000	.008	-.001	.079	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OP	<-->	ODMY	25.066	.000
ORG	<-->	ODMY	14.158	.000
e5	<-->	e4	4.760	.000
e1	<-->	e4	8.456	.000
e1	<-->	e5	37.083	.000
res1	<-->	e5	5.860	.000
res1	<-->	e1	6.015	.000
e6	<-->	e7	6.031	.000
e8	<-->	ORG	4.168	.000
e8	<-->	e7	5.219	.000
e8	<-->	e6	9.960	.000
e11	<-->	e4	20.439	.000
e12	<-->	e4	27.485	.000
e12	<-->	e11	10.225	.000
e9	<-->	e12	5.339	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	4.912	-.118

SV	<---	SI	8.180	.178
SDMY	<---	SV	4.585	-.632
SDMY	<---	SI	34.398	-.845
SI	<---	SV	8.144	.738
SI	<---	SDMY	34.008	-.630
Accident	<---	SDMY	4.945	.370
Accident	<---	SI	4.840	-.428
PP	<---	PC	5.857	.188
PP	<---	PDMY	5.921	-.594
PC	<---	PP	5.373	.475
PC	<---	PDMY	9.496	-1.244
PDMY	<---	ORG	4.168	.071
PDMY	<---	PP	4.735	-.143
PDMY	<---	PC	9.671	-.128
ADMY	<---	SDMY	5.382	.278
ADMY	<---	SI	4.697	-.303
AE3	<---	SV	20.194	1.150
AE3	<---	AV	10.095	.912
AV	<---	SV	29.010	.621
AV	<---	SI	4.475	.119
AV	<---	AE3	8.111	.158
AE1	<---	AV	5.271	-1.370

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	38	325.983	67	.000	4.865
Saturated model	105	.000	0		

Independence model	14	433.300	91	.000	4.762

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.625	.412	.399
Saturated model	.000	1.000		
Independence model	.000	.521	.447	.451

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.248	-.022	.293	-.028	.243
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.736	.182	.179
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	258.983	206.441	319.058
Saturated model	.000	.000	.000
Independence model	342.300	281.240	410.893

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	5.525	4.390	3.499	5.408
Saturated model	.000	.000	.000	.000
Independence model	7.344	5.802	4.767	6.964

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.256	.229	.284	.000
Independence model	.252	.229	.277	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	401.983	427.892	481.568	519.568
Saturated model	210.000	281.591	429.906	534.906
Independence model	461.300	470.846	490.621	504.621

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	6.813	5.923	7.831	7.252
Saturated model	3.559	3.559	3.559	4.773
Independence model	7.819	6.784	8.981	7.980

HOELTER

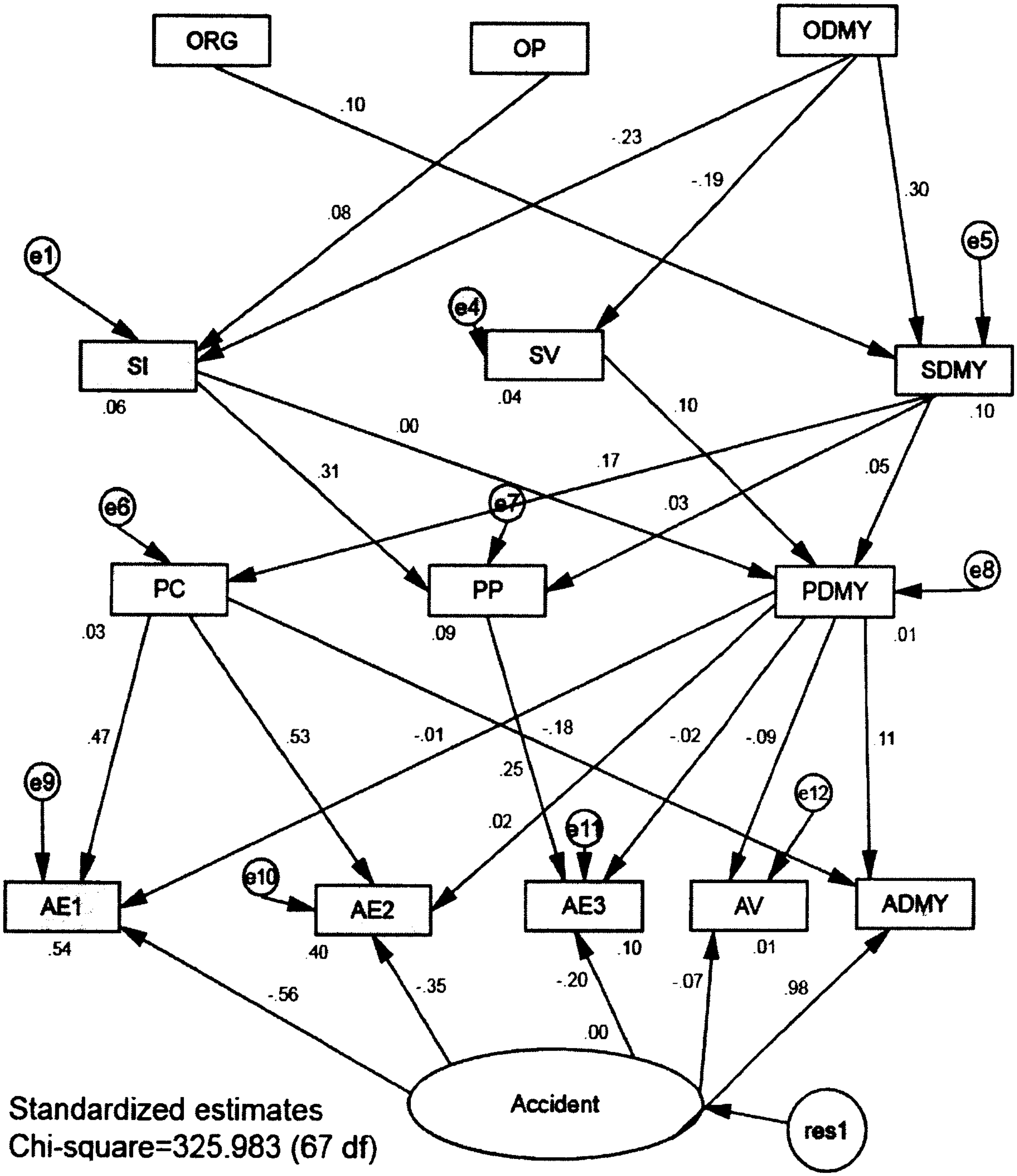
Model	HOELTER .05	HOELTER .01
Default model	16	18
Independence model	16	18

Execution time summary

Minimization:	.004
Miscellaneous:	1.517
Bootstrap:	.000
Total:	1.521

UAV

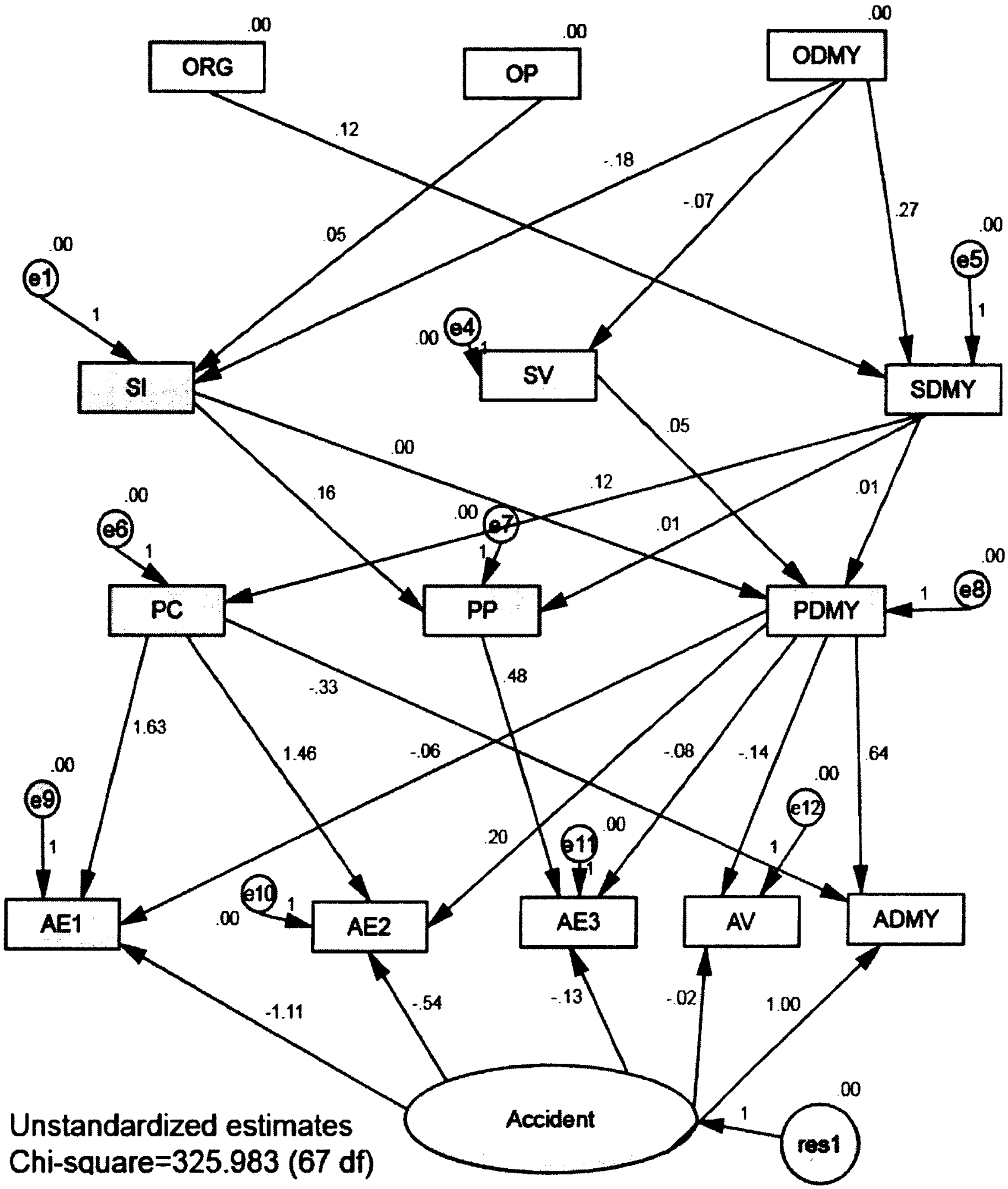
$p < 0.05$



Standardized estimates
Chi-square=325.983 (67 df)
$p = .000$

UAV

***p* <0.05**



Unstandardized estimates
Chi-square=325.983 (67 df)
***p* =.000**

APPENDIX L. PATH ANALYSIS OUTPUT OF UAV MODEL B ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 60

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	24	4	14	0	0	42
Total	36	4	14	0	0	54

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	42
Degrees of freedom (105 - 42):	63

Result (Default model)

Minimum was achieved

Chi-square = 141.906

Degrees of freedom = 63

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.051	.140	.361	.718par_1
SI	<---	OP	.071	.090	.794	.427par_5
SI	<---	ODMY	-.165	.112	-1.473	.141par_6
SDMY	<---	ODMY	.246	.116	2.123	.034par_7
SV	<---	ODMY	-.072	.043	-1.678	.093par_22
PDMY	<---	SDMY	.010	.049	.198	.843par_2

PC	<---	SDMY	.123	.094	1.312	.190par_3
PP	<---	SI	.161	.110	1.465	.143par_9
PDMY	<---	SI	-.007	.053	-.134	.893par_10
PDMY	<---	SV	.075	.065	1.162	.245par_13
PP	<---	SDMY	.012	.098	.120	.905par_14
AE1	<---	PDMY	-.061	1.358	-.045	.964par_4
AE2	<---	PDMY	.197	1.047	.188	.851par_8
AE3	<---	PDMY	-.084	.473	-.177	.859par_11
AV	<---	PDMY	-.138	.209	-.662	.508par_12
AE1	<---	PC	1.628	.431	3.777	***par_15
AE2	<---	PC	1.463	.334	4.381	***par_16
AE3	<---	PP	.479	.237	2.021	.043par_17
AE1	<---	Accident	-1.108	.174	-6.377	***par_18
AE2	<---	Accident	-.545	.159	-3.428	***par_19
AE3	<---	Accident	-.132	.084	-1.584	.113par_20
AV	<---	Accident	-.022	.038	-.571	.568par_21
ADMY	<---	PC	-.326	.245	-1.332	.183par_23
ADMY	<---	PDMY	.641	.781	.821	.412par_24
ADMY	<---	Accident	1.000			

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.246	.000	.051	.000	.000	.000	.000	.000	.000	.000
SI	-.165	.071	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.024	.011	.001	.000	.012	.161	.000	.000	.000	.000
PC	.030	.000	.006	.000	.123	.000	.000	.000	.000	.000

PDMY	-.002	-.001	.000	.075	.010	-.007	.000	.000	.000	.000
ADMY	-.011	.000	-.002	.048	-.034	-.005	1.000	.000	-.326	.641
AE3	-.011	.006	.000	-.006	.005	.078	-.132	.479	.000	-.084
AV	.000	.000	.000	-.010	-.001	.001	-.022	.000	.000	-.138
AE2	.044	.000	.009	.015	.182	-.001	-.545	.000	1.463	.197
AE1	.049	.000	.010	-.005	.199	.000	-1.108	.000	1.628	-.061

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.213	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.307	.000	.044	.000	.000	.000	.000	.000	.000	.000
SI	-.233	.110	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.065	.034	.001	.000	.026	.314	.000	.000	.000	.000
PC	.052	.000	.007	.000	.168	.000	.000	.000	.000	.000
PDMY	-.010	-.003	.002	.137	.041	-.027	.000	.000	.000	.000
ADMY	-.010	.000	-.001	.015	-.025	-.003	.969	.000	-.179	.112
AE3	-.016	.009	.000	-.003	.005	.079	-.196	.249	.000	-.022
AV	.001	.000	.000	-.012	-.004	.002	-.074	.000	.000	-.086
AE2	.027	.000	.004	.003	.090	-.001	-.348	.000	.528	.023
AE1	.024	.000	.003	-.001	.079	.000	-.564	.000	.468	-.006

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.246	.000	.051	.000	.000	.000	.000	.000	.000	.000

SI	-.165	.071	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.012	.161	.000	.000	.000	.000
PC	.000	.000	.000	.000	.123	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.075	.010	-.007	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.000	-.326	.641
AE3	.000	.000	.000	.000	.000	.000	-.132	.479	.000	-.084
AV	.000	.000	.000	.000	.000	.000	-.022	.000	.000	-.138
AE2	.000	.000	.000	.000	.000	.000	-.545	.000	1.463	.197
AE1	.000	.000	.000	.000	.000	.000	-1.108	.000	1.628	-.061

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.213	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.307	.000	.044	.000	.000	.000	.000	.000	.000	.000
SI	-.233	.110	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.026	.314	.000	.000	.000	.000
PC	.000	.000	.000	.000	.168	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.137	.041	-.027	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.969	.000	-.179	.112
AE3	.000	.000	.000	.000	.000	.000	-.196	.249	.000	-.022
AV	.000	.000	.000	.000	.000	.000	-.074	.000	.000	-.086
AE2	.000	.000	.000	.000	.000	.000	-.348	.000	.528	.023
AE1	.000	.000	.000	.000	.000	.000	-.564	.000	.468	-.006

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.024	.011	.001	.000	.000	.000	.000	.000	.000	.000
PC	.030	.000	.006	.000	.000	.000	.000	.000	.000	.000
PDMY	-.002	-.001	.000	.000	.000	.000	.000	.000	.000	.000
ADMY	-.011	.000	-.002	.048	-.034	-.005	.000	.000	.000	.000
AE3	-.011	.006	.000	-.006	.005	.078	.000	.000	.000	.000
AV	.000	.000	.000	-.010	-.001	.001	.000	.000	.000	.000
AE2	.044	.000	.009	.015	.182	-.001	.000	.000	.000	.000
AE1	.049	.000	.010	-.005	.199	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.065	.034	.001	.000	.000	.000	.000	.000	.000	.000
PC	.052	.000	.007	.000	.000	.000	.000	.000	.000	.000
PDMY	-.010	-.003	.002	.000	.000	.000	.000	.000	.000	.000
ADMY	-.010	.000	-.001	.015	-.025	-.003	.000	.000	.000	.000

AE3	-.016	.009	.000	-.003	.005	.079	.000	.000	.000	.000
AV	.001	.000	.000	-.012	-.004	.002	.000	.000	.000	.000
AE2	.027	.000	.004	.003	.090	-.001	.000	.000	.000	.000
AE1	.024	.000	.003	-.001	.079	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e11	<-->	e4	20.439	.000
e12	<-->	e4	27.485	.000
e12	<-->	e11	10.225	.000
e9	<-->	e12	5.339	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	5.017	-.121
SV	<---	SI	7.806	.170
Accident	<---	SDMY	5.051	.378
Accident	<---	SI	4.619	-.408
PP	<---	PC	5.860	.188
PP	<---	PDMY	5.852	-.588
ADMY	<---	SDMY	5.498	.283
ADMY	<---	SI	4.482	-.289
AE3	<---	SV	20.012	1.140
AE3	<---	AV	10.094	.912
AV	<---	SV	28.748	.616
AV	<---	SI	4.271	.114

AV	<---	AE3	8.113	.158
AE1	<---	AV	5.270	-1.370

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	42	141.906	63	.000	2.252
Saturated model	105	.000	0		
Independence model	14	433.300	91	.000	4.762

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.748	.580	.449
Saturated model	.000	1.000		
Independence model	.000	.521	.447	.451

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.672	.527	.787	.667	.769
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.692	.466	.533
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	78.906	48.138	117.403

Saturated model	.000	.000	.000
Independence model	342.300	281.240	410.893

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.405	1.337	.816	1.990
Saturated model	.000	.000	.000	.000
Independence model	7.344	5.802	4.767	6.964

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.146	.114	.178	.000
Independence model	.252	.229	.277	.000

AIC

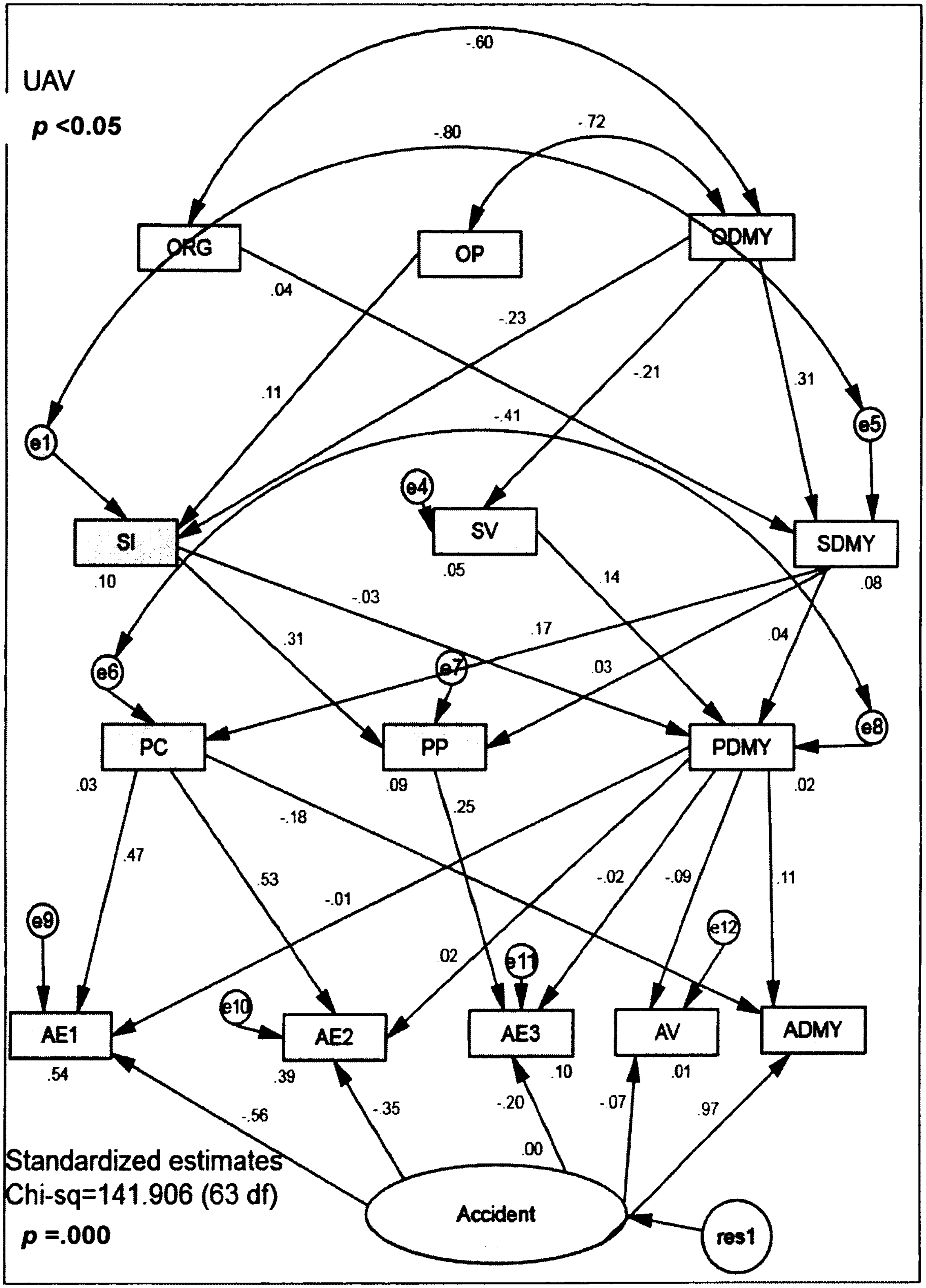
Model	AIC	BCC	BIC	CAIC
Default model	225.906	254.543	313.869	355.869
Saturated model	210.000	281.591	429.906	534.906
Independence model	461.300	470.846	490.621	504.621

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.829	3.307	4.481	4.314
Saturated model	3.559	3.559	3.559	4.773
Independence model	7.819	6.784	8.981	7.980

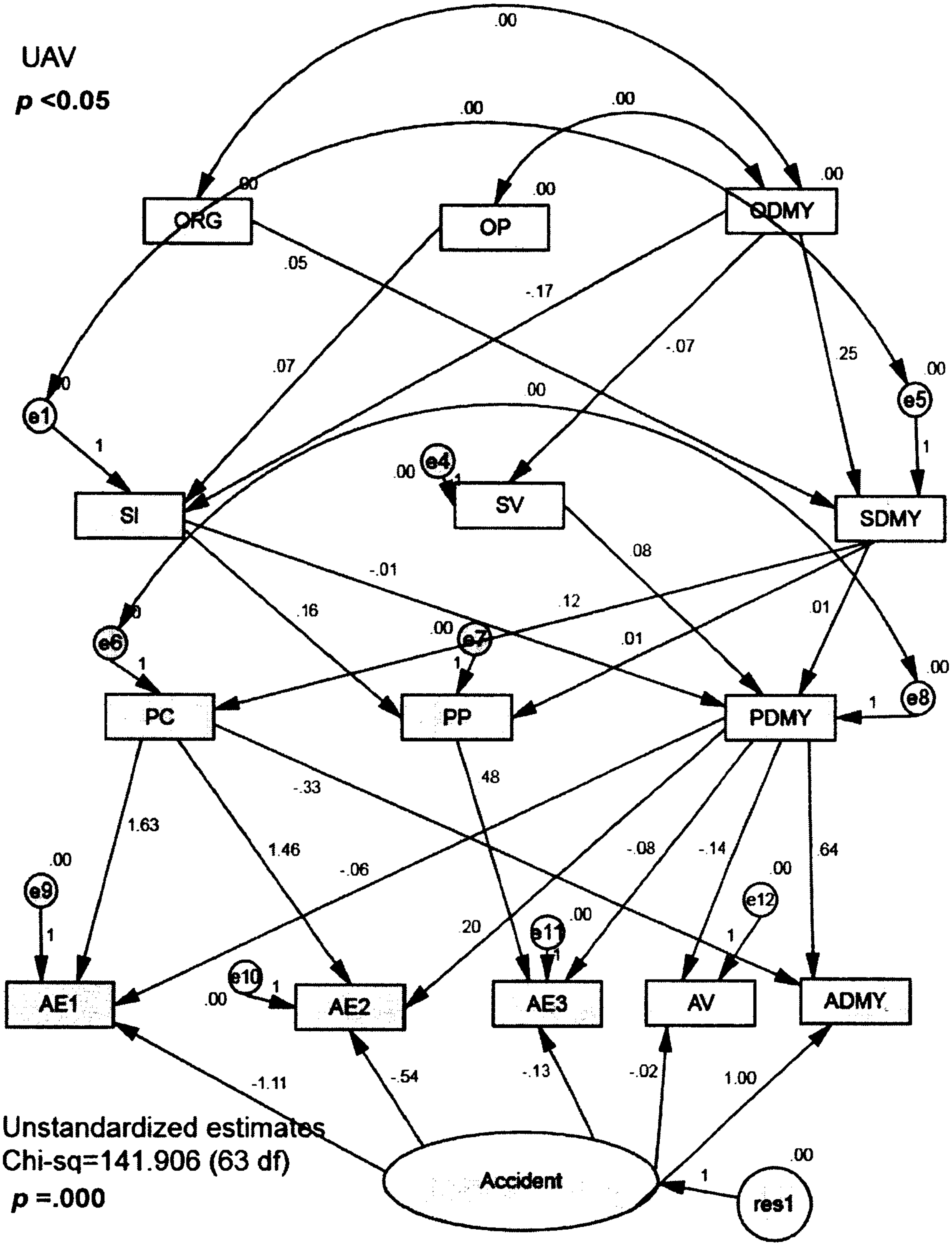
HOELTER

Model	HOELTER .05	HOELTER .01
Default model	35	39
Independence model	16	18


UAV
p <0.05
-.60
-.72
-.80
ORG
OP
ODMY
.04
-.23
-.21
.31
.11
-.41
e1
e5
e4
SI
SV
SDMY
.10
.05
.08
.14
-.03
.17
.04
.31
.03
e6
e7
e8
PC
PP
PDMY
.03
.09
.02
.25
-.18
.47
.53
-.01
-.02
-.09
.11
e9
e12
.02
e11
e10
AE1
AE2
AE3
AV
ADMY
.54
.39
.10
.01
-.56
-.35
-.20
-.07
.97
.00
Standardized estimates
Chi-sq=141.906 (63 df)
p =.000
Accident
res1

UAV

p <0.05



Unstandardized estimates
Chi-sq=141.906 (63 df)
p =.000

APPENDIX M. PATH ANALYSIS OUTPUT OF UAV MODEL A ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 60

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	27	0	14	0	0	41
Total	39	0	14	0	0	53

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	41
Degrees of freedom (105 - 41):	64

Result (Default model)

Minimum was achieved

Chi-square = 322.441

Degrees of freedom = 64

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.367	.143	2.572	.010par_1
SI	<---	OP	.054	.080	.673	.501par_5
SI	<---	ODMY	-.179	.098	-1.836	.066par_6
SDMY	<---	ODMY	.537	.110	4.866	***par_7
SV	<---	ODMY	-.045	.048	-.946	.344par_22
SV	<---	OP	.034	.039	.863	.388par_26

SDMY	<---	OP	.216	.091	2.384	.017par_27
PDMY	<---	SDMY	.012	.025	.466	.641par_2
PC	<---	SDMY	.123	.078	1.580	.114par_3
PP	<---	SI	.161	.066	2.451	.014par_9
PDMY	<---	SI	.000	.035	.000	1.000par_10
PDMY	<---	SV	.054	.072	.748	.454par_13
PP	<---	SDMY	.012	.047	.247	.805par_14
AE1	<---	PDMY	-.062	1.257	-.049	.961par_4
AE2	<---	PDMY	.196	.968	.203	.839par_8
AE3	<---	PDMY	-.052	.475	-.110	.913par_11
AV	<---	PDMY	-.138	.210	-.658	.510par_12
AE1	<---	PC	1.627	.393	4.136	***par_15
AE2	<---	PC	1.463	.305	4.797	***par_16
AE3	<---	PP	.532	.239	2.229	.026par_17
AE1	<---	Accident	-1.130	.174	-6.502	***par_18
AE2	<---	Accident	-.550	.160	-3.430	***par_19
AE3	<---	Accident	-.134	.084	-1.585	.113par_20
AV	<---	Accident	-.026	.038	-.687	.492par_21
ADMY	<---	PC	-.283	.222	-1.278	.201par_23
ADMY	<---	PDMY	.450	.719	.626	.532par_24
ADMY	<---	Accident	1.000			
ADMY	<---	PP	-.411	.263	-1.562	.118par_25

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.045	.034	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.537	.216	.367	.000	.000	.000	.000	.000	.000	.000

SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.023	.011	.004	.000	.012	.161	.000	.000	.000	.000
PC	.066	.027	.045	.000	.123	.000	.000	.000	.000	.000
PDMY	.004	.004	.004	.054	.012	.000	.000	.000	.000	.000
ADMY	-.008	-.010	-.013	.024	-.034	-.066	1.000	-.411	-.283	.450
AE3	-.012	.006	.002	-.003	.006	.086	-.134	.532	.000	-.052
AV	-.001	-.001	-.001	-.007	-.002	.000	-.026	.000	.000	-.138
AE2	.097	.040	.067	.011	.182	.000	-.550	.000	1.463	.196
AE1	.107	.043	.073	-.003	.199	.000	-1.130	.000	1.627	-.062

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.121	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.499	.245	.264	.000	.000	.000	.000	.000	.000	.000
SI	-.232	.085	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.055	.033	.008	.000	.031	.305	.000	.000	.000	.000
PC	.101	.049	.053	.000	.201	.000	.000	.000	.000	.000
PDMY	.018	.026	.016	.097	.061	.000	.000	.000	.000	.000
ADMY	-.007	-.011	-.008	.008	-.031	-.044	.974	-.143	-.158	.079
AE3	-.016	.009	.002	-.001	.008	.084	-.194	.276	.000	-.014
AV	-.002	-.002	-.001	-.008	-.005	.000	-.089	.000	.000	-.085
AE2	.054	.027	.028	.002	.108	.000	-.346	.000	.528	.022
AE1	.047	.023	.025	-.001	.094	.000	-.570	.000	.470	-.006

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDM	SI	Accident	PP	PC	PDMY

					Y					
SV	-.045	.034	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.537	.216	.367	.000	.000	.000	.000	.000	.000	.000
SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.012	.161	.000	.000	.000	.000
PC	.000	.000	.000	.000	.123	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.054	.012	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	-.411	-.283	.450
AE3	.000	.000	.000	.000	.000	.000	-.134	.532	.000	-.052
AV	.000	.000	.000	.000	.000	.000	-.026	.000	.000	-.138
AE2	.000	.000	.000	.000	.000	.000	-.550	.000	1.463	.196
AE1	.000	.000	.000	.000	.000	.000	-1.130	.000	1.627	-.062

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.121	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.499	.245	.264	.000	.000	.000	.000	.000	.000	.000
SI	-.232	.085	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.031	.305	.000	.000	.000	.000
PC	.000	.000	.000	.000	.201	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.097	.061	.000	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.974	-.143	-.158	.079
AE3	.000	.000	.000	.000	.000	.000	-.194	.276	.000	-.014

AV	.000	.000	.000	.000	.000	.000	-.089	.000	.000	-.085
AE2	.000	.000	.000	.000	.000	.000	-.346	.000	.528	.022
AE1	.000	.000	.000	.000	.000	.000	-.570	.000	.470	-.006

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.023	.011	.004	.000	.000	.000	.000	.000	.000	.000
PC	.066	.027	.045	.000	.000	.000	.000	.000	.000	.000
PDMY	.004	.004	.004	.000	.000	.000	.000	.000	.000	.000
ADMY	-.008	-.010	-.013	.024	-.034	-.066	.000	.000	.000	.000
AE3	-.012	.006	.002	-.003	.006	.086	.000	.000	.000	.000
AV	-.001	-.001	-.001	-.007	-.002	.000	.000	.000	.000	.000
AE2	.097	.040	.067	.011	.182	.000	.000	.000	.000	.000
AE1	.107	.043	.073	-.003	.199	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.055	.033	.008	.000	.000	.000	.000	.000	.000	.000
PC	.101	.049	.053	.000	.000	.000	.000	.000	.000	.000

PDMY	.018	.026	.016	.000	.000	.000	.000	.000	.000	.000
ADMY	-.007	-.011	-.008	.008	-.031	-.044	.000	.000	.000	.000
AE3	-.016	.009	.002	-.001	.008	.084	.000	.000	.000	.000
AV	-.002	-.002	-.001	-.008	-.005	.000	.000	.000	.000	.000
AE2	.054	.027	.028	.002	.108	.000	.000	.000	.000	.000
AE1	.047	.023	.025	-.001	.094	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OP	<-->	ODMY	25.066	.000
ORG	<-->	ODMY	14.158	.000
e5	<-->	e4	4.175	.000
e1	<-->	e4	8.518	.000
e1	<-->	e5	36.124	.000
res1	<-->	e5	4.356	.000
res1	<-->	e1	4.545	.000
e6	<-->	e7	6.031	.000
e8	<-->	ORG	4.168	.000
e8	<-->	e7	5.219	.000
e8	<-->	e6	9.960	.000
e11	<-->	e4	20.916	.000
e12	<-->	e4	27.113	.000
e12	<-->	e11	10.230	.000
e9	<-->	e12	5.927	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SI	7.999	.176
SDMY	<---	SV	4.062	-.595
SDMY	<---	SI	33.924	-.832
SI	<---	SV	8.287	.751
SI	<---	SDMY	23.943	-.444
PP	<---	PC	5.787	.186
PP	<---	PDMY	5.914	-.594
PC	<---	PP	5.375	.475
PC	<---	PDMY	9.485	-1.242
PDMY	<---	ORG	4.168	.071
PDMY	<---	PP	4.737	-.143
PDMY	<---	PC	9.555	-.126
AE3	<---	SV	20.523	1.169
AE3	<---	AV	10.075	.911
AV	<---	SV	29.314	.629
AV	<---	SI	4.475	.119
AV	<---	AE3	7.999	.156
AE1	<---	AV	5.838	-1.430

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	41	322.441	64	.000	5.038
Saturated model	105	.000	0		
Independence model	14	433.300	91	.000	4.762

RMR, GFI

Model	RMR	GFI	AGFI	PGFI

Default model	.000	.631	.394	.384
Saturated model	.000	1.000		
Independence model	.000	.521	.447	.451

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.256	-.058	.300	-.074	.245
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.703	.180	.172
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	258.441	206.093	318.317
Saturated model	.000	.000	.000
Independence model	342.300	281.240	410.893

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	5.465	4.380	3.493	5.395
Saturated model	.000	.000	.000	.000
Independence model	7.344	5.802	4.767	6.964

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.262	.234	.290	.000

Independence model	.252	.229	.277	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	404.441	432.396	490.309	531.309
Saturated model	210.000	281.591	429.906	534.906
Independence model	461.300	470.846	490.621	504.621

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	6.855	5.968	7.870	7.329
Saturated model	3.559	3.559	3.559	4.773
Independence model	7.819	6.784	8.981	7.980

HOELTER

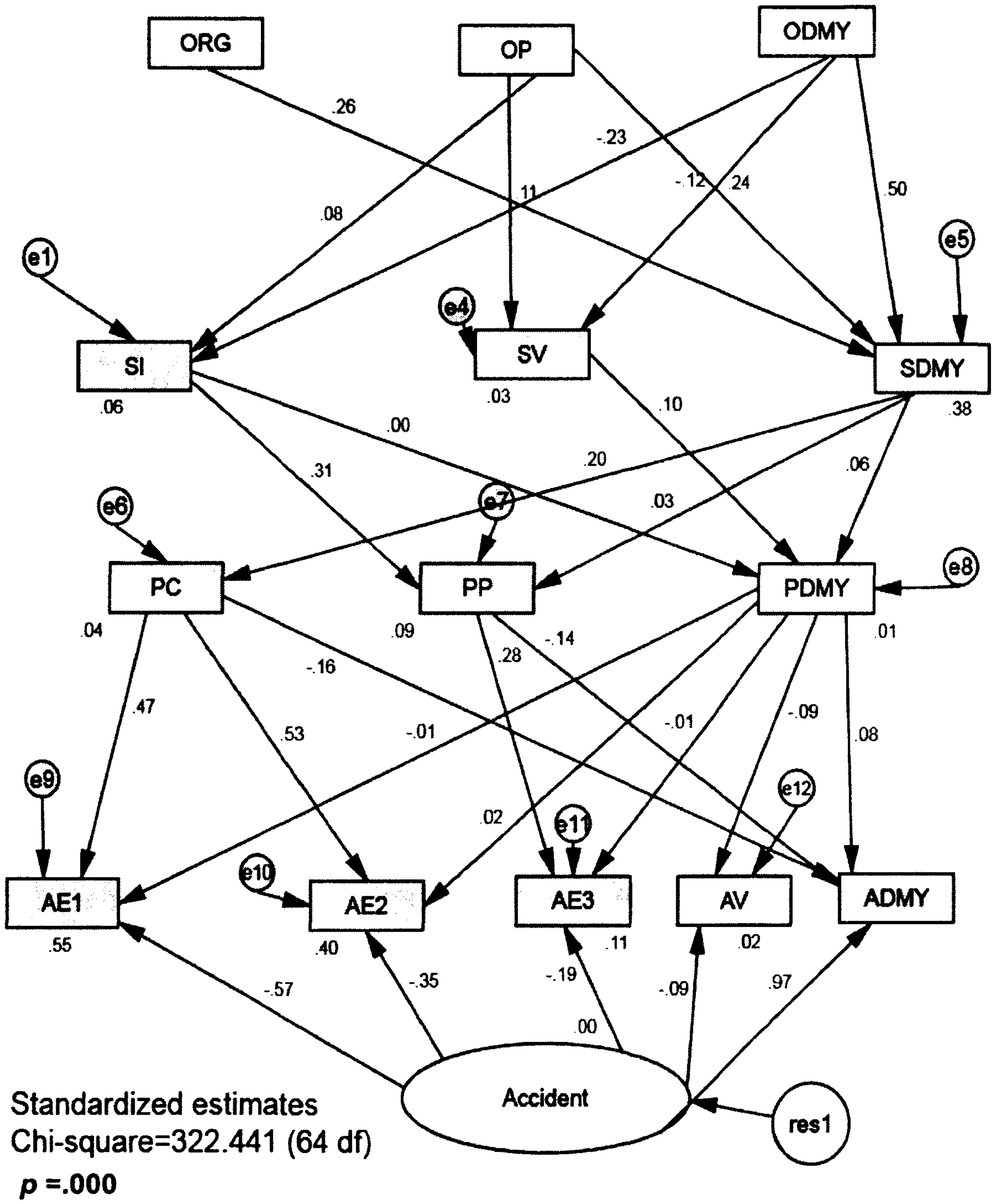
Model	HOELTER .05	HOELTER .01
Default model	16	18
Independence model	16	18

Execution time summary

Minimization:	.047
Miscellaneous:	1.719
Bootstrap:	.000
Total:	1.766

UAV

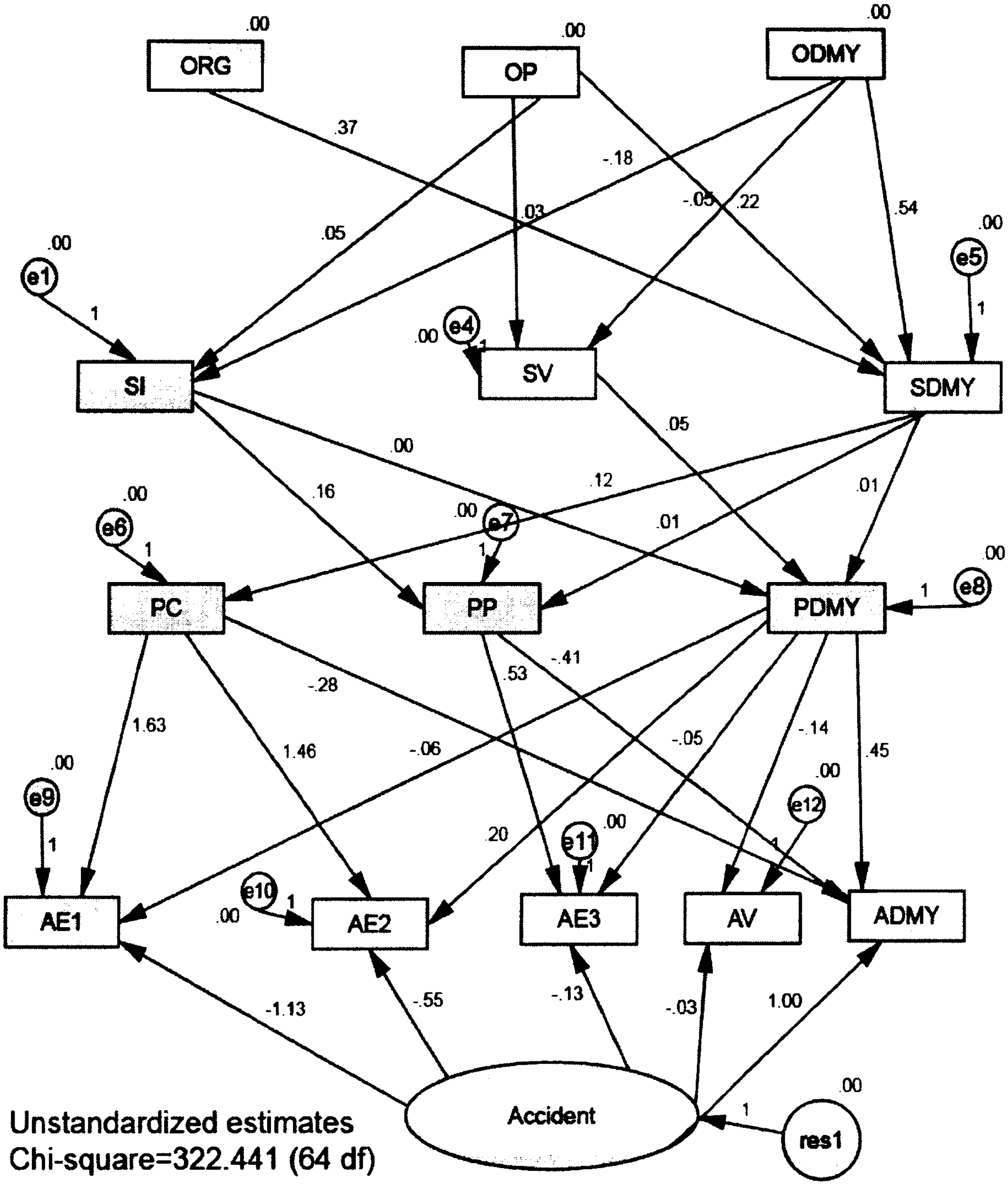
***p* <0.01**



Standardized estimates
Chi-square=322.441 (64 df)
***p* =.000**

UAV

p **<0.1**



Unstandardized estimates
Chi-square=322.441 (64 df)
p **=.000**

APPENDIX N. PATH ANALYSIS OUTPUT OF UAV MODEL B ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 60

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	27	4	14	0	0	45
Total	39	4	14	0	0	57

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	45
Degrees of freedom (105 - 45):	60

Result (Default model)

Minimum was achieved

Chi-square = 139.308

Degrees of freedom = 60

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.084	.177	.476	.634par_1
SI	<---	OP	.054	.116	.466	.641par_5
SI	<---	ODMY	-.179	.126	-1.421	.155par_6
SDMY	<---	ODMY	.294	.211	1.398	.162par_7
SV	<---	ODMY	-.045	.062	-.732	.464par_22
SV	<---	OP	.034	.057	.598	.550par_30

SDMY	<---	OP	.045	.167	.271	.786par_31
PDMY	<---	SDMY	.010	.049	.198	.843par_2
PC	<---	SDMY	.123	.094	1.308	.191par_3
PP	<---	SI	.161	.110	1.470	.142par_9
PDMY	<---	SI	-.007	.053	-.135	.893par_10
PDMY	<---	SV	.075	.065	1.161	.246par_13
PP	<---	SDMY	.012	.097	.120	.904par_14
AE1	<---	PDMY	-.062	1.358	-.045	.964par_4
AE2	<---	PDMY	.196	1.047	.187	.851par_8
AE3	<---	PDMY	-.052	.472	-.110	.912par_11
AV	<---	PDMY	-.138	.209	-.662	.508par_12
AE1	<---	PC	1.627	.431	3.777	***par_15
AE2	<---	PC	1.463	.334	4.381	***par_16
AE3	<---	PP	.532	.240	2.221	.026par_17
AE1	<---	Accident	-1.130	.174	-6.502	***par_18
AE2	<---	Accident	-.550	.160	-3.430	***par_19
AE3	<---	Accident	-.134	.084	-1.585	.113par_20
AV	<---	Accident	-.026	.038	-.687	.492par_21
ADMY	<---	PC	-.283	.243	-1.167	.243par_23
ADMY	<---	PDMY	.450	.775	.580	.562par_24
ADMY	<---	Accident	1.000			
ADMY	<---	PP	-.411	.264	-1.555	.120par_29

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.045	.034	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.294	.045	.084	.000	.000	.000	.000	.000	.000	.000

SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.025	.009	.001	.000	.012	.161	.000	.000	.000	.000
PC	.036	.006	.010	.000	.123	.000	.000	.000	.000	.000
PDMY	.001	.003	.001	.075	.010	-.007	.000	.000	.000	.000
ADMY	.001	-.004	-.003	.034	-.035	-.070	1.000	-.411	-.283	.450
AE3	-.014	.005	.000	-.004	.006	.086	-.134	.532	.000	-.052
AV	.000	.000	.000	-.010	-.001	.001	-.026	.000	.000	-.138
AE2	.053	.009	.015	.015	.182	-.001	-.550	.000	1.463	.196
AE1	.059	.009	.017	-.005	.199	.000	-1.130	.000	1.627	-.062

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.134	.109	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.369	.062	.073	.000	.000	.000	.000	.000	.000	.000
SI	-.253	.083	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.070	.028	.002	.000	.026	.313	.000	.000	.000	.000
PC	.062	.010	.012	.000	.168	.000	.000	.000	.000	.000
PDMY	.004	.015	.003	.136	.041	-.027	.000	.000	.000	.000
ADMY	.001	-.004	-.002	.011	-.027	-.047	.970	-.142	-.156	.079
AE3	-.019	.007	.000	-.002	.006	.087	-.194	.275	.000	-.014
AV	.000	-.001	.000	-.012	-.004	.002	-.089	.000	.000	-.086
AE2	.033	.006	.007	.003	.090	-.001	-.348	.000	.528	.023
AE1	.029	.005	.006	-.001	.078	.000	-.570	.000	.468	-.006

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.045	.034	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.294	.045	.084	.000	.000	.000	.000	.000	.000	.000
SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.012	.161	.000	.000	.000	.000
PC	.000	.000	.000	.000	.123	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.075	.010	-.007	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	-.411	-.283	.450
AE3	.000	.000	.000	.000	.000	.000	-.134	.532	.000	-.052
AV	.000	.000	.000	.000	.000	.000	-.026	.000	.000	-.138
AE2	.000	.000	.000	.000	.000	.000	-.550	.000	1.463	.196
AE1	.000	.000	.000	.000	.000	.000	-1.130	.000	1.627	-.062

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.134	.109	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.369	.062	.073	.000	.000	.000	.000	.000	.000	.000
SI	-.253	.083	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.026	.313	.000	.000	.000	.000
PC	.000	.000	.000	.000	.168	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.136	.041	-.027	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.970	-.142	-.156	.079

AE3	.000	.000	.000	.000	.000	.000	-.194	.275	.000	-.014
AV	.000	.000	.000	.000	.000	.000	-.089	.000	.000	-.086
AE2	.000	.000	.000	.000	.000	.000	-.348	.000	.528	.023
AE1	.000	.000	.000	.000	.000	.000	-.570	.000	.468	-.006

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.025	.009	.001	.000	.000	.000	.000	.000	.000	.000
PC	.036	.006	.010	.000	.000	.000	.000	.000	.000	.000
PDMY	.001	.003	.001	.000	.000	.000	.000	.000	.000	.000
ADMY	.001	-.004	-.003	.034	-.035	-.070	.000	.000	.000	.000
AE3	-.014	.005	.000	-.004	.006	.086	.000	.000	.000	.000
AV	.000	.000	.000	-.010	-.001	.001	.000	.000	.000	.000
AE2	.053	.009	.015	.015	.182	-.001	.000	.000	.000	.000
AE1	.059	.009	.017	-.005	.199	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.070	.028	.002	.000	.000	.000	.000	.000	.000	.000

PC	.062	.010	.012	.000	.000	.000	.000	.000	.000	.000
PDMY	.004	.015	.003	.000	.000	.000	.000	.000	.000	.000
ADMY	.001	-.004	-.002	.011	-.027	-.047	.000	.000	.000	.000
AE3	-.019	.007	.000	-.002	.006	.087	.000	.000	.000	.000
AV	.000	-.001	.000	-.012	-.004	.002	.000	.000	.000	.000
AE2	.033	.006	.007	.003	.090	-.001	.000	.000	.000	.000
AE1	.029	.005	.006	-.001	.078	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e11	<-->	e4	20.916	.000
e12	<-->	e4	27.113	.000
e12	<-->	e11	10.230	.000
e9	<-->	e12	5.927	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	5.061	-.121
SV	<---	SI	7.655	.168
PP	<---	PC	5.861	.188
PP	<---	PDMY	5.853	-.588
AE3	<---	SV	20.017	1.140
AE3	<---	AV	10.074	.911
AV	<---	SV	28.590	.614
AV	<---	SI	4.283	.114

AV	<---	AE3	8.002	.156
AE1	<---	AV	5.837	-1.430

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	45	139.308	60	.000	2.322
Saturated model	105	.000	0		
Independence model	14	433.300	91	.000	4.762

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.750	.563	.429
Saturated model	.000	1.000		
Independence model	.000	.521	.447	.451

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.678	.512	.788	.649	.768
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.659	.447	.507
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	79.308	48.706	117.628

Saturated model	.000	.000	.000
Independence model	342.300	281.240	410.893

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.361	1.344	.826	1.994
Saturated model	.000	.000	.000	.000
Independence model	7.344	5.802	4.767	6.964

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.150	.117	.182	.000
Independence model	.252	.229	.277	.000

AIC

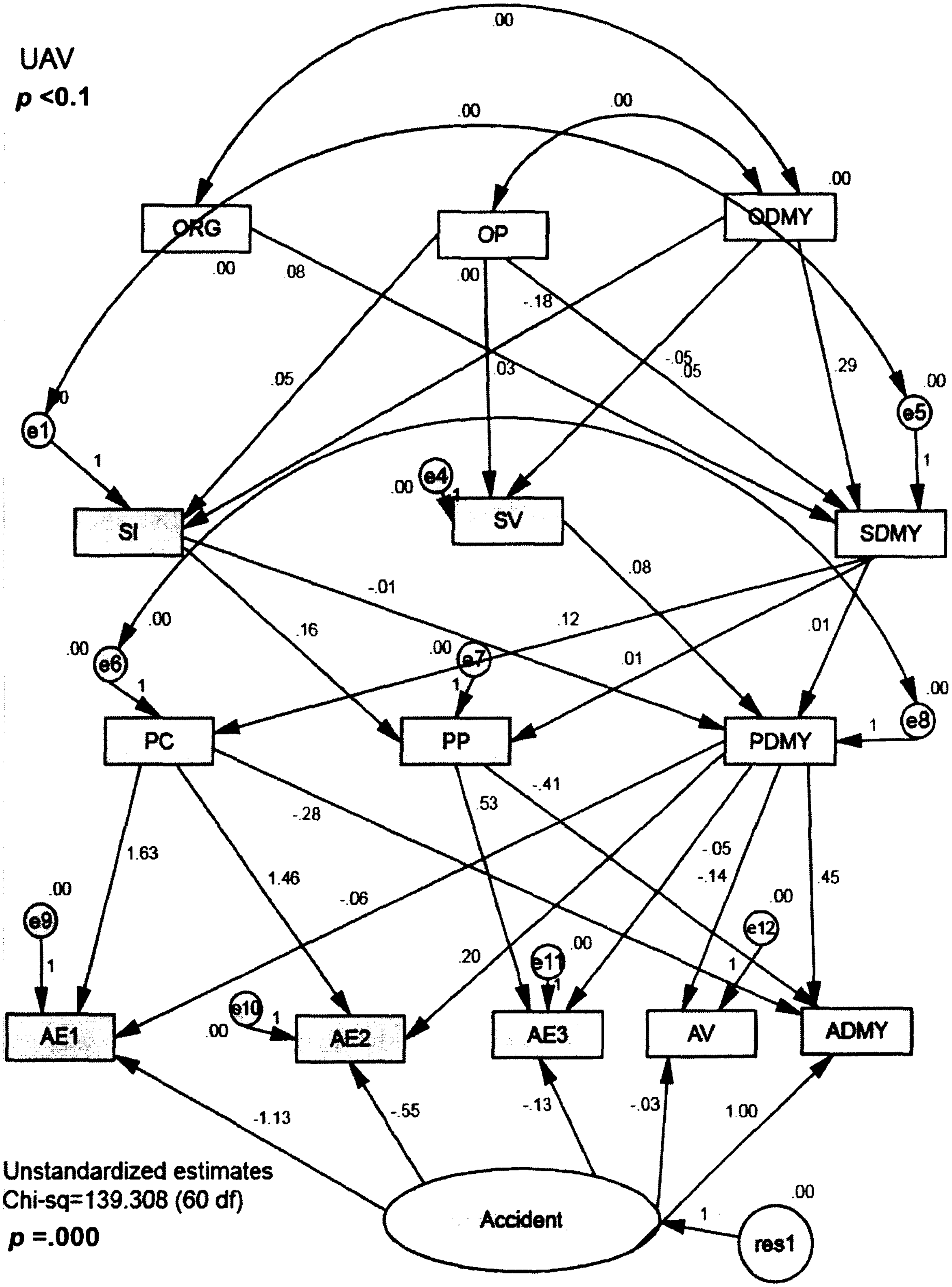
Model	AIC	BCC	BIC	CAIC
Default model	229.308	259.990	323.554	368.554
Saturated model	210.000	281.591	429.906	534.906
Independence model	461.300	470.846	490.621	504.621

ECVI

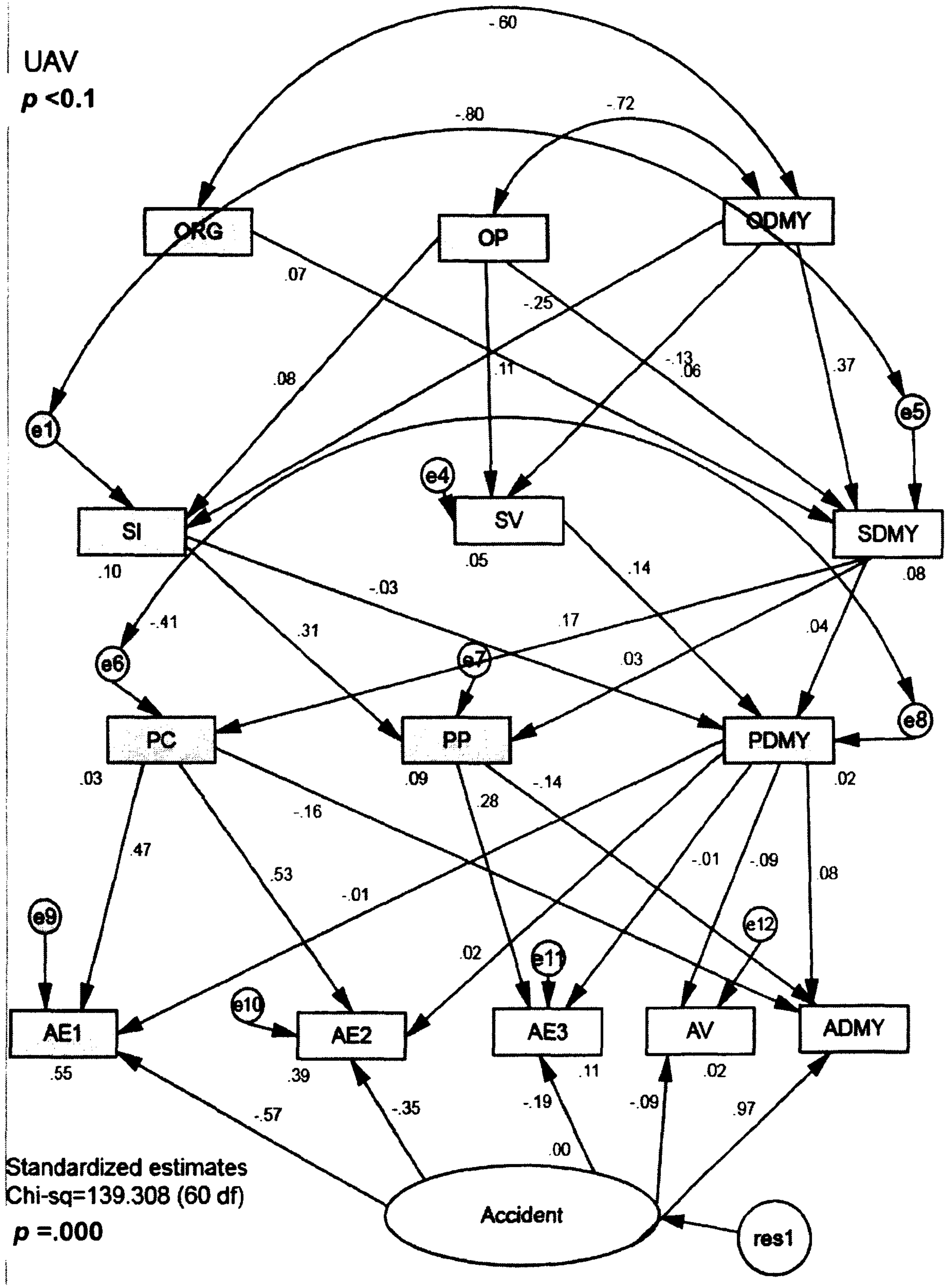
Model	ECVI	LO 90	HI 90	MECVI
Default model	3.887	3.368	4.536	4.407
Saturated model	3.559	3.559	3.559	4.773
Independence model	7.819	6.784	8.981	7.980

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	34	38
Independence model	16	18



Unstandardized estimates
Chi-sq=139.308 (60 df)
p =.000


UAV
p <0.1
-.60
-.72
-.80
ORG
OP
ODMY
.07
-.25
.08
.11
-.13
.06
.37
e1
e4
e5
SI
SV
SDMY
.10
.05
.08
.14
-.03
-.41
.31
.17
.04
.03
e6
e7
e8
PC
PP
PDMY
.03
.09
.02
-.14
.28
-.16
.47
.53
-.01
-.01
-.09
.08
e9
e12
.02
e11
e10
AE1
AE2
AE3
AV
ADMY
.55
.39
.11
.02
-.57
-.35
-.19
-.09
.97
.00
Standardized estimates
Chi-sq=139.308 (60 df)
p =.000
Accident
res1

APPENDIX O. PATH ANALYSIS OUTPUT OF UAV MODEL C ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 60

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	26	4	14	0	0	44
Total	38	4	14	0	0	56

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	44
Degrees of freedom (105 - 44):	61

Result (Default model)

Minimum was achieved

Chi-square = 139.735

Degrees of freedom = 61

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.084	.177	.476	.634par_1
SI	<---	OP	.054	.116	.466	.641par_5
SI	<---	ODMY	-.179	.126	-1.421	.155par_6
SDMY	<---	ODMY	.294	.211	1.398	.162par_7
SV	<---	ODMY	-.072	.043	-1.678	.093par_22
SDMY	<---	OP	.045	.167	.271	.786par_30

PDMY	<---	SDMY	.010	.049	.198	.843par_2
PC	<---	SDMY	.123	.094	1.308	.191par_3
PP	<---	SI	.161	.110	1.470	.142par_9
PDMY	<---	SI	-.007	.053	-.135	.893par_10
PDMY	<---	SV	.075	.065	1.162	.245par_13
PP	<---	SDMY	.012	.097	.120	.904par_14
AE1	<---	PDMY	-.062	1.358	-.045	.964par_4
AE2	<---	PDMY	.196	1.047	.187	.851par_8
AE3	<---	PDMY	-.052	.472	-.110	.912par_11
AV	<---	PDMY	-.138	.209	-.662	.508par_12
AE1	<---	PC	1.627	.431	3.777	***par_15
AE2	<---	PC	1.463	.334	4.381	***par_16
AE3	<---	PP	.532	.240	2.220	.026par_17
AE1	<---	Accident	-1.130	.174	-6.502	***par_18
AE2	<---	Accident	-.550	.160	-3.430	***par_19
AE3	<---	Accident	-.134	.084	-1.585	.113par_20
AV	<---	Accident	-.026	.038	-.687	.492par_21
ADMY	<---	PC	-.283	.243	-1.167	.243par_23
ADMY	<---	PDMY	.450	.775	.580	.562par_24
ADMY	<---	Accident	1.000			
ADMY	<---	PP	-.411	.264	-1.555	.120par_29

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.294	.045	.084	.000	.000	.000	.000	.000	.000	.000
SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000

PP	-.025	.009	.001	.000	.012	.161	.000	.000	.000	.000
PC	.036	.006	.010	.000	.123	.000	.000	.000	.000	.000
PDMY	-.001	.000	.001	.075	.010	-.007	.000	.000	.000	.000
ADMY	.000	-.005	-.003	.034	-.035	-.070	1.000	-.411	-.283	.450
AE3	-.013	.005	.000	-.004	.006	.086	-.134	.532	.000	-.052
AV	.000	.000	.000	-.010	-.001	.001	-.026	.000	.000	-.138
AE2	.053	.008	.015	.015	.182	-.001	-.550	.000	1.463	.196
AE1	.059	.009	.017	-.005	.199	.000	-1.130	.000	1.627	-.062

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.213	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.369	.062	.073	.000	.000	.000	.000	.000	.000	.000
SI	-.253	.083	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.070	.028	.002	.000	.026	.313	.000	.000	.000	.000
PC	.062	.010	.012	.000	.168	.000	.000	.000	.000	.000
PDMY	-.007	.000	.003	.137	.041	-.027	.000	.000	.000	.000
ADMY	.000	-.006	-.002	.011	-.027	-.047	.970	-.142	-.156	.079
AE3	-.019	.008	.000	-.002	.006	.087	-.194	.275	.000	-.014
AV	.001	.000	.000	-.012	-.004	.002	-.089	.000	.000	-.086
AE2	.033	.005	.007	.003	.090	-.001	-.348	.000	.528	.023
AE1	.029	.005	.006	-.001	.078	.000	-.570	.000	.468	-.006

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY

SV	-.072	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.294	.045	.084	.000	.000	.000	.000	.000	.000	.000
SI	-.179	.054	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.012	.161	.000	.000	.000	.000
PC	.000	.000	.000	.000	.123	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.075	.010	-.007	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	-.411	-.283	.450
AE3	.000	.000	.000	.000	.000	.000	-.134	.532	.000	-.052
AV	.000	.000	.000	.000	.000	.000	-.026	.000	.000	-.138
AE2	.000	.000	.000	.000	.000	.000	-.550	.000	1.463	.196
AE1	.000	.000	.000	.000	.000	.000	-1.130	.000	1.627	-.062

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.213	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.369	.062	.073	.000	.000	.000	.000	.000	.000	.000
SI	-.253	.083	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	.026	.313	.000	.000	.000	.000
PC	.000	.000	.000	.000	.168	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.137	.041	-.027	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.970	-.142	-.156	.079
AE3	.000	.000	.000	.000	.000	.000	-.194	.275	.000	-.014
AV	.000	.000	.000	.000	.000	.000	-.089	.000	.000	-.086
AE2	.000	.000	.000	.000	.000	.000	-.348	.000	.528	.023

AE1	.000	.000	.000	.000	.000	.000	-.570	.000	.468	-.006

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.025	.009	.001	.000	.000	.000	.000	.000	.000	.000
PC	.036	.006	.010	.000	.000	.000	.000	.000	.000	.000
PDMY	-.001	.000	.001	.000	.000	.000	.000	.000	.000	.000
ADMY	.000	-.005	-.003	.034	-.035	-.070	.000	.000	.000	.000
AE3	-.013	.005	.000	-.004	.006	.086	.000	.000	.000	.000
AV	.000	.000	.000	-.010	-.001	.001	.000	.000	.000	.000
AE2	.053	.008	.015	.015	.182	-.001	.000	.000	.000	.000
AE1	.059	.009	.017	-.005	.199	.000	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.070	.028	.002	.000	.000	.000	.000	.000	.000	.000
PC	.062	.010	.012	.000	.000	.000	.000	.000	.000	.000
PDMY	-.007	.000	.003	.000	.000	.000	.000	.000	.000	.000

ADMY	.000	-.006	-.002	.011	-.027	-.047	.000	.000	.000	.000
AE3	-.019	.008	.000	-.002	.006	.087	.000	.000	.000	.000
AV	.001	.000	.000	-.012	-.004	.002	.000	.000	.000	.000
AE2	.033	.005	.007	.003	.090	-.001	.000	.000	.000	.000
AE1	.029	.005	.006	-.001	.078	.000	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e11	<-->	e4	20.401	.000
e12	<-->	e4	27.239	.000
e12	<-->	e11	10.230	.000
e9	<-->	e12	5.927	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	5.042	-.121
SV	<---	SI	7.828	.171
PP	<---	PC	5.861	.188
PP	<---	PDMY	5.852	-.588
AE3	<---	SV	19.987	1.139
AE3	<---	AV	10.074	.911
AV	<---	SV	28.548	.613
AV	<---	SI	4.283	.114
AV	<---	AE3	8.002	.156
AE1	<---	AV	5.837	-1.430

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	44	139.735	61	.000	2.291
Saturated model	105	.000	0		
Independence model	14	433.300	91	.000	4.762

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.749	.569	.435
Saturated model	.000	1.000		
Independence model	.000	.521	.447	.451

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.678	.519	.789	.657	.770
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.670	.454	.516
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	78.735	48.147	117.045
Saturated model	.000	.000	.000
Independence model	342.300	281.240	410.893

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.368	1.334	.816	1.984
Saturated model	.000	.000	.000	.000
Independence model	7.344	5.802	4.767	6.964

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.148	.116	.180	.000
Independence model	.252	.229	.277	.000

AIC

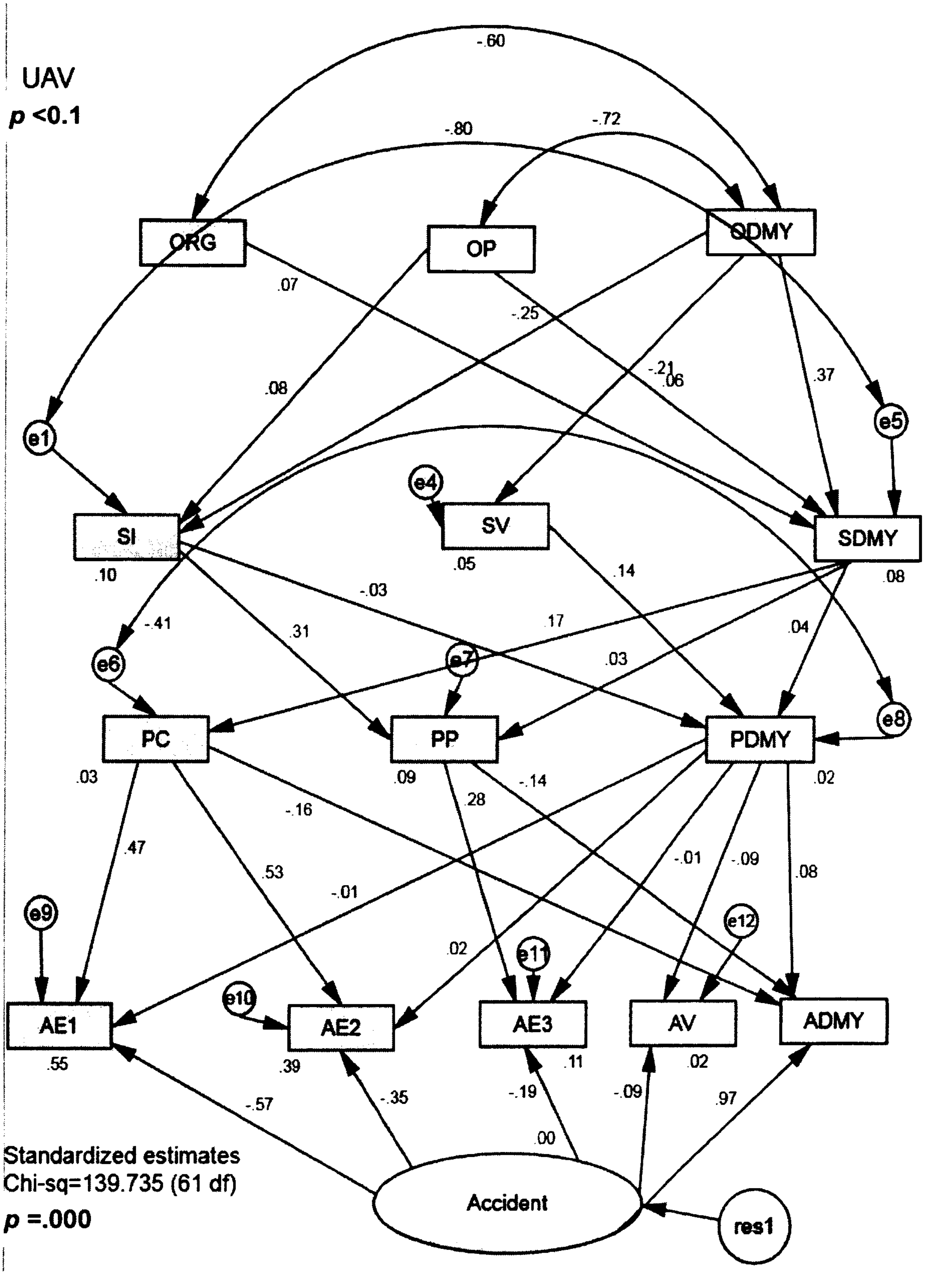
Model	AIC	BCC	BIC	CAIC
Default model	227.735	257.735	319.886	363.886
Saturated model	210.000	281.591	429.906	534.906
Independence model	461.300	470.846	490.621	504.621

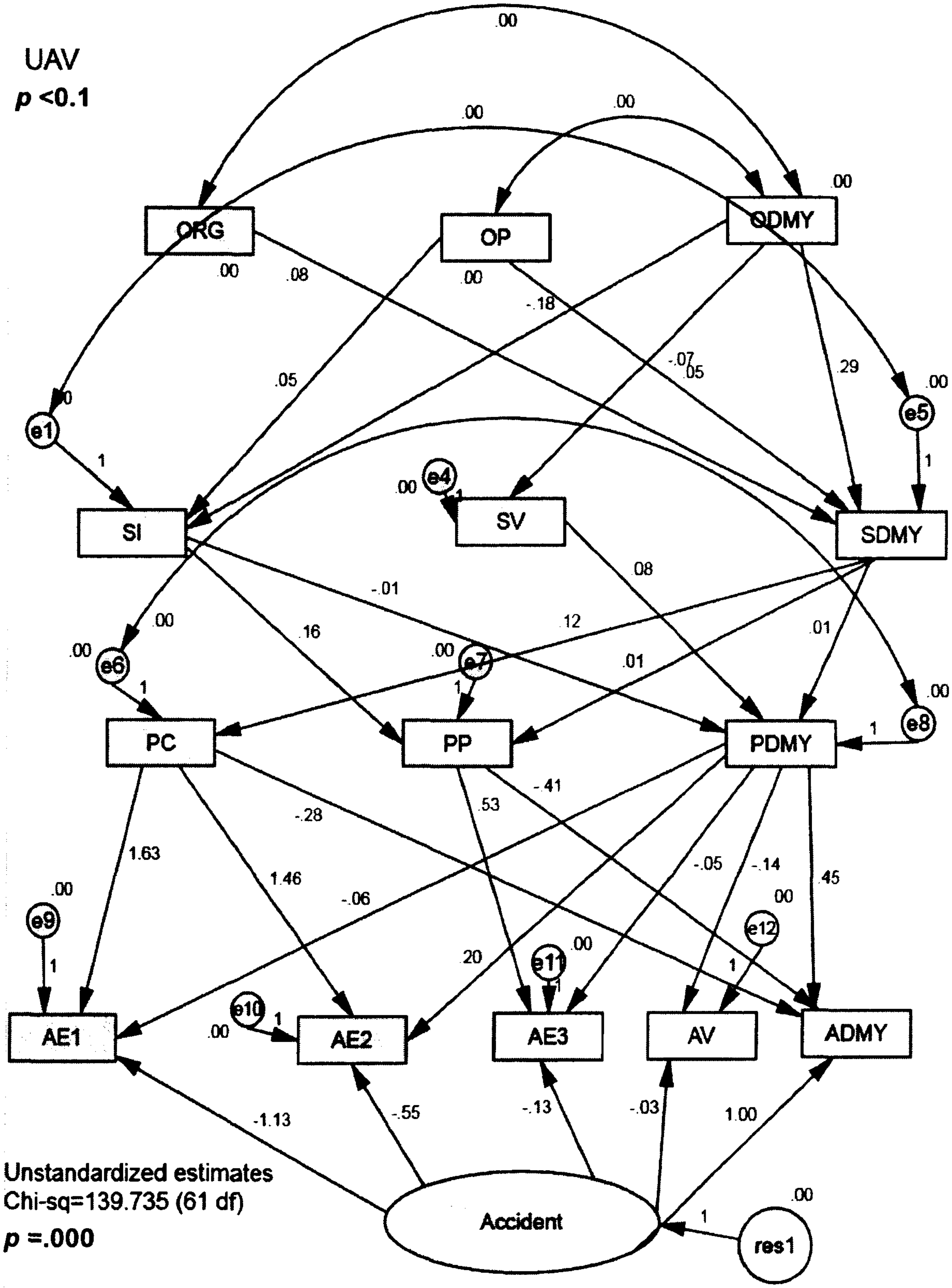
ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.860	3.341	4.509	4.368
Saturated model	3.559	3.559	3.559	4.773
Independence model	7.819	6.784	8.981	7.980

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	34	38
Independence model	16	18


UAV
p <0.1
-.60
-.80
-.72
ORG
OP
ODMY
.07
-.25
.08
-.21
.06
.37
e5
e1
e4
SI
SV
SDMY
.10
.05
.08
.14
-.03
-.41
.31
.17
.04
.03
e6
e7
e8
PC
PP
PDMY
.03
.09
-.14
.02
.28
-.16
.47
.53
-.01
-.01
-.09
.08
e9
e12
.02
e11
e10
AE1
AE2
AE3
AV
ADMY
.55
.39
.11
.02
-.57
-.35
-.19
-.09
.97
.00
Standardized estimates
Chi-sq=139.735 (61 df)
p =.000
Accident
res1


UAV
p <0.1
ORG
OP
ODMY
e1
SI
e4
SV
e5
SDMY
e6
PC
e7
PP
PDMY
e8
e9
AE1
e10
AE2
e11
AE3
AV
e12
ADMY
Accident
res1
.00
.00
.00
.00
.00
.08
.00
-.18
.05
-.07
.05
.29
.00
1
1
1
.00
.08
-.01
.00
.16
.12
.01
.00
.00
.01
.00
1
1
1
-.41
.53
-.28
1.63
1.46
-.06
-.05
-.14
.45
.00
.00
.20
.00
1
1
1
.00
-1.13
-.55
-.13
-.03
1.00
.00
1
Unstandardized estimates
Chi-sq=139.735 (61 df)
p =.000

APPENDIX P. PATH ANALYSIS OUTPUT OF UAV MODEL WITH MAV DATA A ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	24	0	14	0	0	38
Total	36	0	14	0	0	50

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 105

Number of distinct parameters to be estimated: 38

Degrees of freedom (105 - 38): 67

Result (Default model)

Minimum was achieved

Chi-square = 701.235

Degrees of freedom = 67

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.046	.061	.749	.454par_1
SI	<---	OP	.091	.063	1.445	.148par_5
SI	<---	ODMY	-.054	.062	-.878	.380par_6
SDMY	<---	ODMY	.067	.065	1.032	.302par_7

SV	<---	ODMY	-.024	.019	-1.251	.211par_22
PDMY	<---	SDMY	.034	.018	1.905	.057par_2
PC	<---	SDMY	-.031	.048	-.647	.518par_3
PP	<---	SI	-.015	.022	-.690	.490par_9
PDMY	<---	SI	.025	.018	1.373	.170par_10
PDMY	<---	SV	.012	.061	.194	.846par_13
PP	<---	SDMY	-.084	.021	-3.991	***par_14
AE1	<---	PDMY	.295	.613	.481	.630par_4
AE2	<---	PDMY	.073	.395	.186	.853par_8
AE3	<---	PDMY	-.455	.221	-2.056	.040par_11
AV	<---	PDMY	-.162	.161	-1.002	.316par_12
AE1	<---	PC	.643	.227	2.838	.005par_15
AE2	<---	PC	.609	.147	4.148	***par_16
AE3	<---	PP	-.296	.180	-1.643	.100par_17
AE1	<---	Accident	-1.100	.096	-11.432	***par_18
AE2	<---	Accident	-.290	.077	-3.769	***par_19
AE3	<---	Accident	-.098	.044	-2.225	.026par_20
AV	<---	Accident	-.057	.032	-1.778	.075par_21
ADMY	<---	PC	-.281	.127	-2.201	.028par_23
ADMY	<---	PDMY	.243	.349	.695	.487par_24
ADMY	<---	Accident	1.000			

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.067	.000	.046	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000

PP	-.005	-.001	-.004	.000	-.084	-.015	.000	.000	.000	.000
PC	-.002	.000	-.001	.000	-.031	.000	.000	.000	.000	.000
PDMY	.001	.002	.002	.012	.034	.025	.000	.000	.000	.000
ADMY	.001	.001	.001	.003	.017	.006	1.000	.000	-.281	.243
AE3	.001	-.001	.000	-.005	.009	-.007	-.098	-.296	.000	-.455
AV	.000	.000	.000	-.002	-.005	-.004	-.057	.000	.000	-.162
AE2	-.001	.000	-.001	.001	-.016	.002	-.290	.000	.609	.073
AE1	-.001	.001	.000	.003	-.010	.007	-1.100	.000	.643	.295

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.088	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.072	.000	.053	.000	.000	.000	.000	.000	.000	.000
SI	-.061	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.017	-.005	-.014	.000	-.270	-.047	.000	.000	.000	.000
PC	-.003	.000	-.002	.000	-.045	.000	.000	.000	.000	.000
PDMY	.003	.010	.007	.013	.132	.095	.000	.000	.000	.000
ADMY	.001	.000	.001	.001	.013	.005	.987	.000	-.150	.048
AE3	.002	-.001	.001	-.002	.012	-.008	-.152	-.113	.000	-.142
AV	.000	-.001	.000	-.001	-.009	-.007	-.124	.000	.000	-.070
AE2	-.001	.000	-.001	.000	-.011	.001	-.246	.000	.280	.013
AE1	-.001	.000	.000	.000	-.004	.003	-.614	.000	.194	.033

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000

SDMY	.067	.000	.046	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.084	-.015	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.031	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.012	.034	.025	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.000	-.281	.243
AE3	.000	.000	.000	.000	.000	.000	-.098	-.296	.000	-.455
AV	.000	.000	.000	.000	.000	.000	-.057	.000	.000	-.162
AE2	.000	.000	.000	.000	.000	.000	-.290	.000	.609	.073
AE1	.000	.000	.000	.000	.000	.000	-1.100	.000	.643	.295

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.088	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.072	.000	.053	.000	.000	.000	.000	.000	.000	.000
SI	-.061	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.270	-.047	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.045	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.013	.132	.095	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.987	.000	-.150	.048
AE3	.000	.000	.000	.000	.000	.000	-.152	-.113	.000	-.142
AV	.000	.000	.000	.000	.000	.000	-.124	.000	.000	-.070
AE2	.000	.000	.000	.000	.000	.000	-.246	.000	.280	.013
AE1	.000	.000	.000	.000	.000	.000	-.614	.000	.194	.033

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.005	-.001	-.004	.000	.000	.000	.000	.000	.000	.000
PC	-.002	.000	-.001	.000	.000	.000	.000	.000	.000	.000
PDMY	.001	.002	.002	.000	.000	.000	.000	.000	.000	.000
ADMY	.001	.001	.001	.003	.017	.006	.000	.000	.000	.000
AE3	.001	-.001	.000	-.005	.009	-.007	.000	.000	.000	.000
AV	.000	.000	.000	-.002	-.005	-.004	.000	.000	.000	.000
AE2	-.001	.000	-.001	.001	-.016	.002	.000	.000	.000	.000
AE1	-.001	.001	.000	.003	-.010	.007	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.017	-.005	-.014	.000	.000	.000	.000	.000	.000	.000
PC	-.003	.000	-.002	.000	.000	.000	.000	.000	.000	.000
PDMY	.003	.010	.007	.000	.000	.000	.000	.000	.000	.000
ADMY	.001	.000	.001	.001	.013	.005	.000	.000	.000	.000

AE3	.002	-.001	.001	-.002	.012	-.008	.000	.000	.000	.000
AV	.000	-.001	.000	-.001	-.009	-.007	.000	.000	.000	.000
AE2	-.001	.000	-.001	.000	-.011	.001	.000	.000	.000	.000
AE1	-.001	.000	.000	.000	-.004	.003	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OP	<-->	ODMY	82.267	.000
ORG	<-->	ODMY	89.027	.000
e5	<-->	e4	10.195	.000
e1	<-->	e5	86.701	.000
res1	<-->	ODMY	38.837	.000
res1	<-->	OP	11.350	.000
res1	<-->	ORG	30.634	.000
e6	<-->	ORG	8.185	.000
e8	<-->	ODMY	9.896	.000
e8	<-->	ORG	11.093	.000
e8	<-->	e7	25.913	.000
e8	<-->	e6	56.426	.000
e11	<-->	e6	12.712	.000
e10	<-->	OP	4.518	.000
e10	<-->	e4	4.165	.000
e9	<-->	e1	4.678	.000
e9	<-->	e11	6.211	.000
e9	<-->	e10	13.739	.000

Variances: (Group number 1 - Default model)

M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	10.670	-.067
SDMY	<---	SV	10.116	-.763
SDMY	<---	SI	88.532	-.687
SI	<---	SDMY	84.499	-.616
Accident	<---	ODMY	38.837	-.511
Accident	<---	OP	11.350	.281
Accident	<---	ORG	30.634	.430
PP	<---	PDMY	25.456	-.415
PC	<---	ORG	8.185	-.120
PC	<---	PDMY	54.747	-1.396
PDMY	<---	ODMY	9.896	-.051
PDMY	<---	ORG	11.093	.051
PDMY	<---	PP	23.969	-.280
PDMY	<---	PC	56.309	-.194
ADMY	<---	ODMY	28.652	-.331
ADMY	<---	OP	7.487	.172
ADMY	<---	ORG	17.557	.245
AE3	<---	PC	12.368	.286
AE3	<---	AE2	7.379	.102
AE2	<---	OP	4.518	.194
AE2	<---	SV	4.558	.711
AE2	<---	AE1	8.018	-.122
AE1	<---	SI	4.600	.272
AE1	<---	AE3	6.457	-.380
AE1	<---	AE2	11.830	-.281

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	38	701.235	67	.000	10.466
Saturated model	105	.000	0		
Independence model	14	885.280	91	.000	9.728

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.713	.550	.455
Saturated model	.000	1.000		
Independence model	.000	.639	.583	.554

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.208	-.076	.225	-.085	.201
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.736	.153	.148
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	634.235	552.911	723.006
Saturated model	.000	.000	.000
Independence model	794.280	702.634	893.374

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	3.471	3.140	2.737	3.579
Saturated model	.000	.000	.000	.000
Independence model	4.383	3.932	3.478	4.423

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.216	.202	.231	.000
Independence model	.208	.196	.220	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	777.235	783.331	903.137	941.137
Saturated model	210.000	226.845	557.887	662.887
Independence model	913.280	915.526	959.665	973.665

ECVI

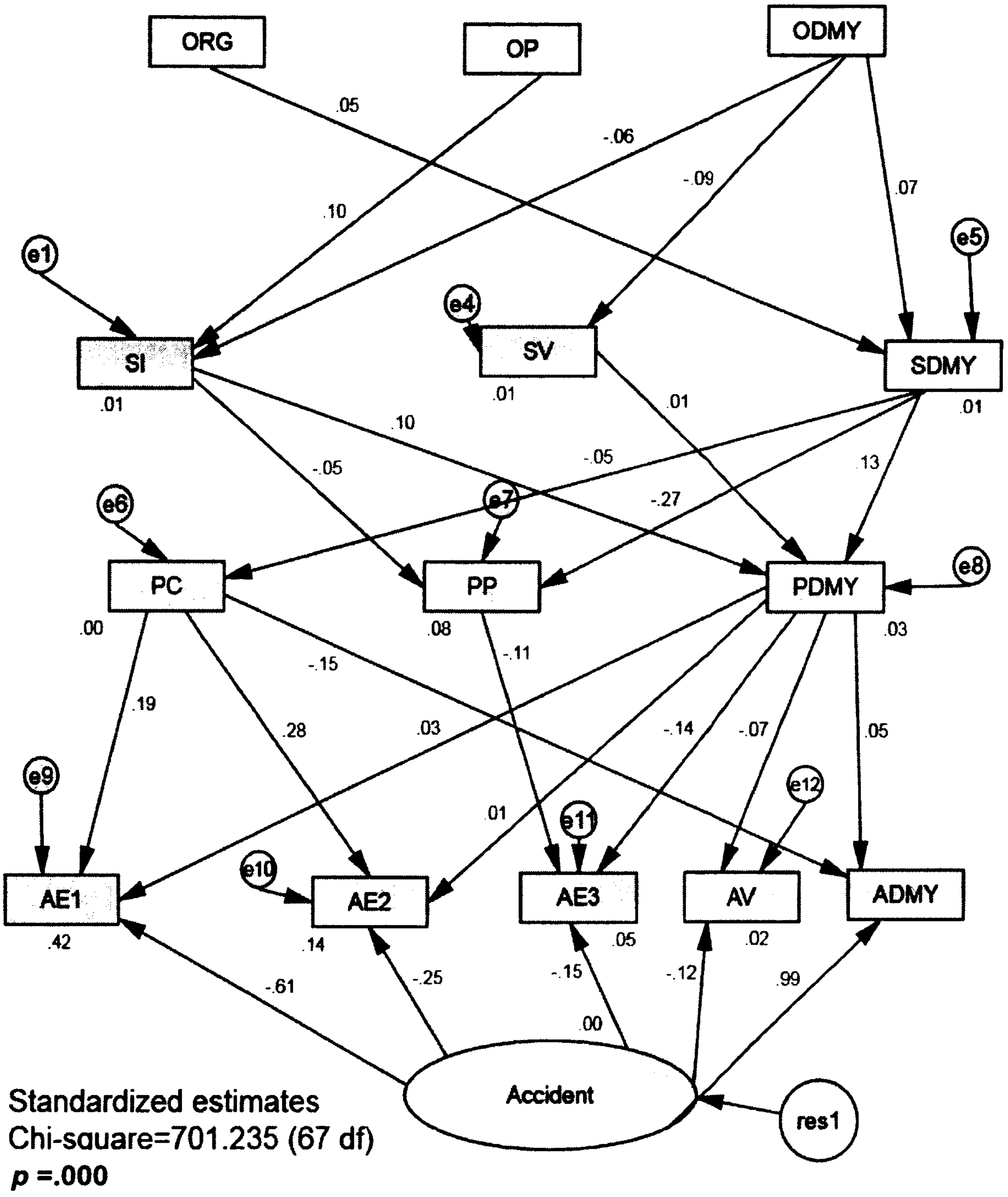
Model	ECVI	LO 90	HI 90	MECVI
Default model	3.848	3.445	4.287	3.878
Saturated model	1.040	1.040	1.040	1.123
Independence model	4.521	4.067	5.012	4.532

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	26	28
Independence model	27	29

UAV model with MAV data

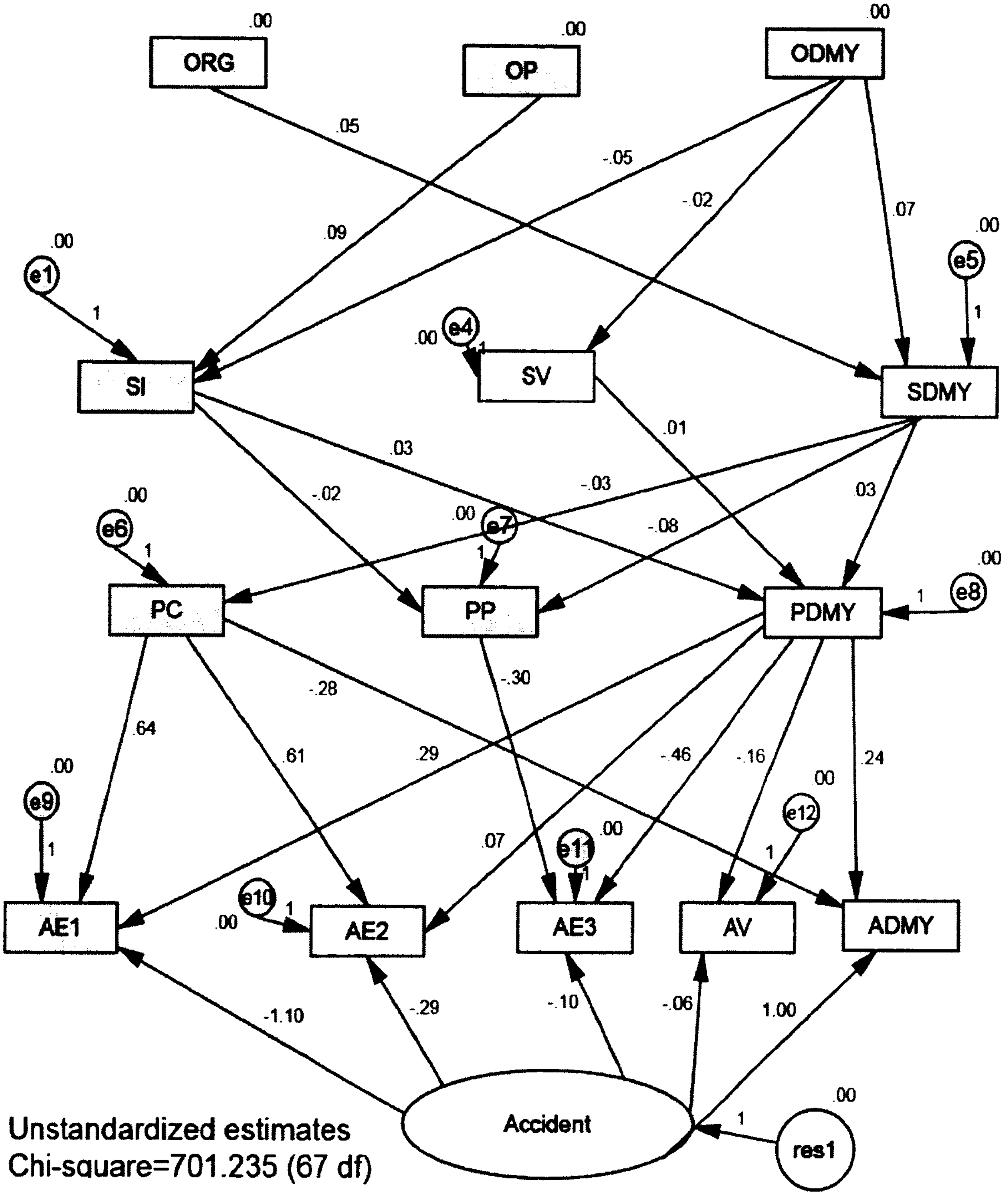
$p < 0.05$



Standardized estimates
Chi-square=701.235 (67 df)
$p = .000$

UAV model with MAV data

p <0.05



Unstandardized estimates
Chi-square=701.235 (67 df)
p =.000

APPENDIX Q. PATH ANALYSIS OUTPUT OF UAV MODEL WITH MAV DATA B ($p < 0.05$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	24	4	14	0	0	42
Total	36	4	14	0	0	54

Models

Default model (Default model)

Notes for Model (Default model)

Computation of degrees of freedom (Default model)

Number of distinct sample moments: 105

Number of distinct parameters to be estimated: 42

Degrees of freedom (105 - 42): 63

Result (Default model)

Minimum was achieved

Chi-square = 238.399

Degrees of freedom = 63

Probability level = .000

Group number 1 (Group number 1 - Default model)

Estimates (Group number 1 - Default model)

Scalar Estimates (Group number 1 - Default model)

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.131	.062	2.095	.036par_1

SI	<---	OP	.005	.062	.074	.941par_5
SI	<---	ODMY	-.108	.075	-1.445	.148par_6
SDMY	<---	ODMY	.126	.080	1.576	.115par_7
SV	<---	ODMY	-.024	.020	-1.194	.232par_22
PDMY	<---	SDMY	.037	.022	1.667	.095par_2
PC	<---	SDMY	-.031	.048	-.651	.515par_3
PP	<---	SI	-.015	.029	-.516	.606par_9
PDMY	<---	SI	.027	.021	1.285	.199par_10
PDMY	<---	SV	.042	.051	.823	.411par_13
PP	<---	SDMY	-.084	.028	-2.998	.003par_14
AE1	<---	PDMY	.295	.725	.407	.684par_4
AE2	<---	PDMY	.073	.468	.157	.875par_8
AE3	<---	PDMY	-.455	.223	-2.045	.041par_11
AV	<---	PDMY	-.162	.162	-.996	.319par_12
AE1	<---	PC	.643	.267	2.408	.016par_15
AE2	<---	PC	.609	.173	3.519	***par_16
AE3	<---	PP	-.296	.181	-1.631	.103par_17
AE1	<---	Accident	-1.100	.096	-11.432	***par_18
AE2	<---	Accident	-.290	.077	-3.769	***par_19
AE3	<---	Accident	-.098	.044	-2.225	.026par_20
AV	<---	Accident	-.057	.032	-1.778	.075par_21
ADMY	<---	PC	-.281	.150	-1.867	.062par_23
ADMY	<---	PDMY	.243	.412	.589	.556par_24
ADMY	<---	Accident	1.000			

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000

SDMY	.126	.000	.131	.000	.000	.000	.000	.000	.000	.000
SI	-.108	.005	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.009	.000	-.011	.000	-.084	-.015	.000	.000	.000	.000
PC	-.004	.000	-.004	.000	-.031	.000	.000	.000	.000	.000
PDMY	.001	.000	.005	.042	.037	.027	.000	.000	.000	.000
ADMY	.001	.000	.002	.010	.018	.007	1.000	.000	-.281	.243
AE3	.002	.000	.001	-.019	.008	-.008	-.098	-.296	.000	-.455
AV	.000	.000	-.001	-.007	-.006	-.004	-.057	.000	.000	-.162
AE2	-.002	.000	-.002	.003	-.016	.002	-.290	.000	.609	.073
AE1	-.002	.000	-.001	.012	-.009	.008	-1.100	.000	.643	.295

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.084	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.130	.000	.149	.000	.000	.000	.000	.000	.000	.000
SI	-.117	.005	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.030	.000	-.041	.000	-.274	-.047	.000	.000	.000	.000
PC	-.006	.000	-.007	.000	-.046	.000	.000	.000	.000	.000
PDMY	.003	.001	.022	.049	.146	.102	.000	.000	.000	.000
ADMY	.001	.000	.002	.002	.014	.005	.984	.000	-.149	.048
AE3	.003	.000	.001	-.007	.010	-.009	-.152	-.112	.000	-.142
AV	.000	.000	-.002	-.003	-.010	-.007	-.124	.000	.000	-.070
AE2	-.002	.000	-.002	.001	-.011	.001	-.247	.000	.280	.013
AE1	-.001	.000	-.001	.002	-.004	.003	-.617	.000	.195	.033

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.024	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.126	.000	.131	.000	.000	.000	.000	.000	.000	.000
SI	-.108	.005	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.084	-.015	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.031	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.042	.037	.027	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.000	-.281	.243
AE3	.000	.000	.000	.000	.000	.000	-.098	-.296	.000	-.455
AV	.000	.000	.000	.000	.000	.000	-.057	.000	.000	-.162
AE2	.000	.000	.000	.000	.000	.000	-.290	.000	.609	.073
AE1	.000	.000	.000	.000	.000	.000	-1.100	.000	.643	.295

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.084	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.130	.000	.149	.000	.000	.000	.000	.000	.000	.000
SI	-.117	.005	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.274	-.047	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.046	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.049	.146	.102	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.984	.000	-.149	.048
AE3	.000	.000	.000	.000	.000	.000	-.152	-.112	.000	-.142

AV	.000	.000	.000	.000	.000	.000	-.124	.000	.000	-.070
AE2	.000	.000	.000	.000	.000	.000	-.247	.000	.280	.013
AE1	.000	.000	.000	.000	.000	.000	-.617	.000	.195	.033

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.009	.000	-.011	.000	.000	.000	.000	.000	.000	.000
PC	-.004	.000	-.004	.000	.000	.000	.000	.000	.000	.000
PDMY	.001	.000	.005	.000	.000	.000	.000	.000	.000	.000
ADMY	.001	.000	.002	.010	.018	.007	.000	.000	.000	.000
AE3	.002	.000	.001	-.019	.008	-.008	.000	.000	.000	.000
AV	.000	.000	-.001	-.007	-.006	-.004	.000	.000	.000	.000
AE2	-.002	.000	-.002	.003	-.016	.002	.000	.000	.000	.000
AE1	-.002	.000	-.001	.012	-.009	.008	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	-.030	.000	-.041	.000	.000	.000	.000	.000	.000	.000
PC	-.006	.000	-.007	.000	.000	.000	.000	.000	.000	.000

PDMY	.003	.001	.022	.000	.000	.000		.000	.000	.000	.000
ADMY	.001	.000	.002	.002	.014	.005		.000	.000	.000	.000
AE3	.003	.000	.001	-.007	.010	-.009		.000	.000	.000	.000
AV	.000	.000	-.002	-.003	-.010	-.007		.000	.000	.000	.000
AE2	-.002	.000	-.002	.001	-.011	.001		.000	.000	.000	.000
AE1	-.001	.000	-.001	.002	-.004	.003		.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e5	<-->	e4	11.841	.000
res1	<-->	ODMY	4.716	.000
e6	<-->	e7	5.315	.000
e8	<-->	e7	30.072	.000
e11	<-->	e6	16.624	.000
e10	<-->	e4	4.165	.000
e9	<-->	e11	6.211	.000
e9	<-->	e10	13.739	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	10.536	-.066
SDMY	<---	SV	11.758	-.612
Accident	<---	ODMY	42.614	-.561
Accident	<---	OP	11.350	.281
Accident	<---	ORG	30.634	.430

PP	<---	PDMY	25.748	-.420
PC	<---	PP	4.995	-.297
PDMY	<---	ODMY	9.671	-.045
PDMY	<---	OP	5.118	.032
PDMY	<---	ORG	4.638	.028
PDMY	<---	PP	28.265	-.260
ADMY	<---	ODMY	31.438	-.363
ADMY	<---	OP	7.487	.172
ADMY	<---	ORG	17.557	.245
AE3	<---	PC	12.367	.286
AE3	<---	AE2	7.406	.102
AE2	<---	OP	4.518	.194
AE2	<---	SV	4.561	.711
AE2	<---	AE1	8.073	-.123
AE1	<---	SI	4.573	.270
AE1	<---	AE3	6.456	-.380
AE1	<---	AE2	11.873	-.282

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	42	238.399	63	.000	3.784
Saturated model	105	.000	0		
Independence model	14	885.280	91	.000	9.728

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.867	.778	.520
Saturated model	.000	1.000		

Independence model	.000	.639	.583	.554

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.731	.611	.787	.681	.779
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.692	.506	.539
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	175.399	131.815	226.560
Saturated model	.000	.000	.000
Independence model	794.280	702.634	893.374

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.180	.868	.653	1.122
Saturated model	.000	.000	.000	.000
Independence model	4.383	3.932	3.478	4.423

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.117	.102	.133	.000
Independence model	.208	.196	.220	.000

AIC

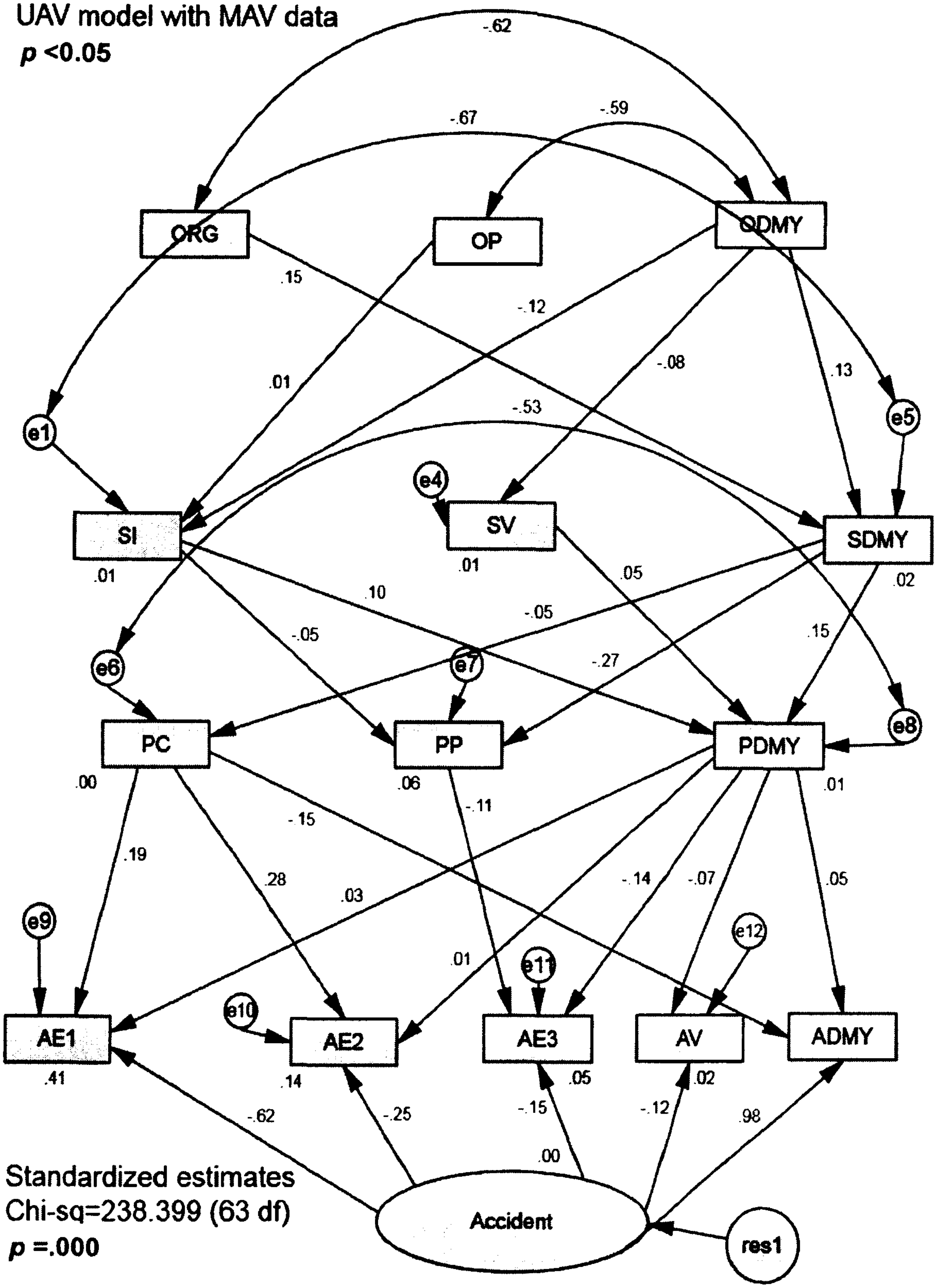
Model	AIC	BCC	BIC	CAIC
Default model	322.399	329.137	461.553	503.553
Saturated model	210.000	226.845	557.887	662.887
Independence model	913.280	915.526	959.665	973.665

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	1.596	1.380	1.849	1.629
Saturated model	1.040	1.040	1.040	1.123
Independence model	4.521	4.067	5.012	4.532

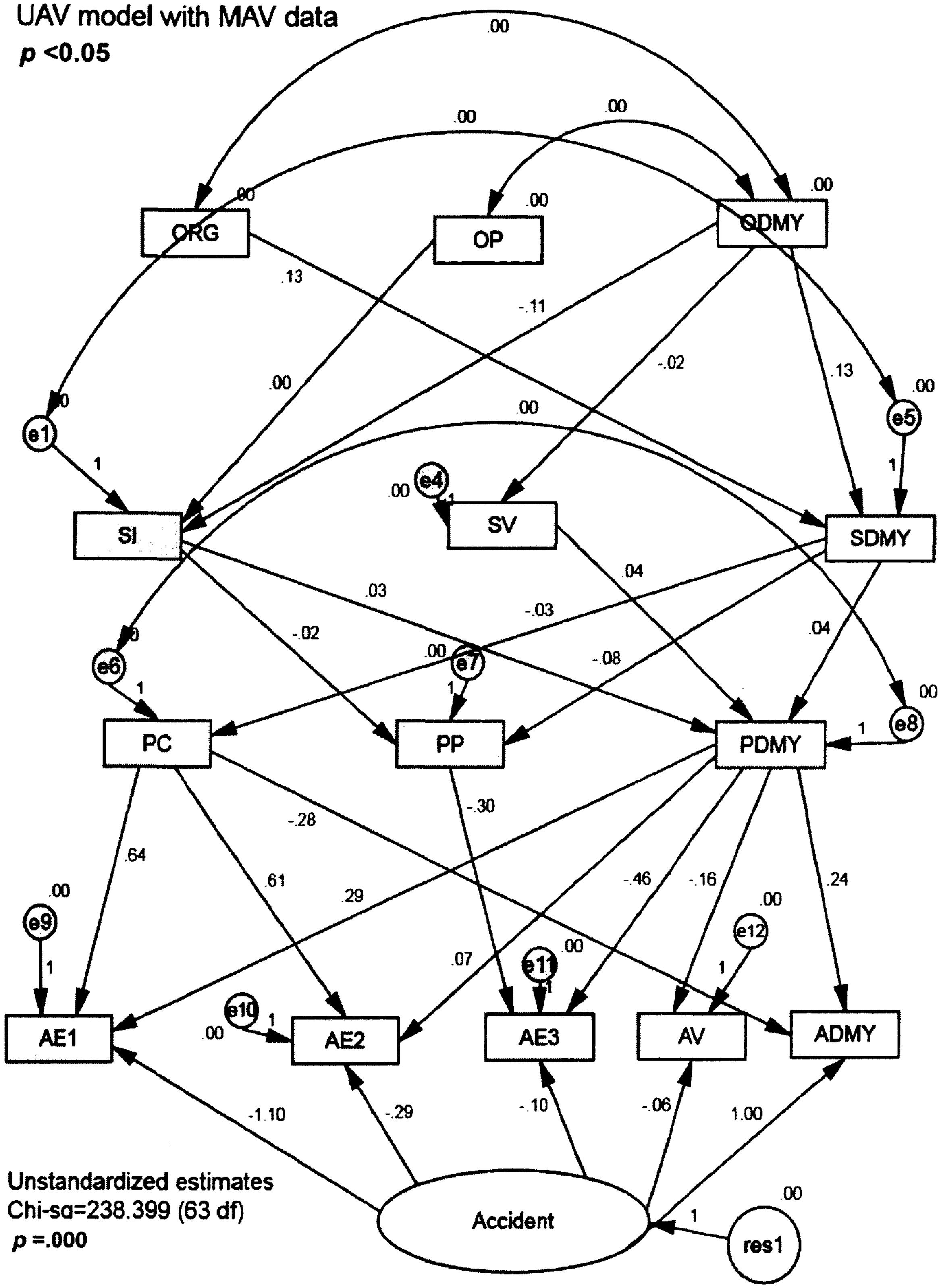
HOELTER

Model	HOELTER .05	HOELTER .01
Default model	70	78
Independence model	27	29



UAV model with MAV data
p <0.05

Standardized estimates
Chi-sq=238.399 (63 df)
p =.000


UAV model with MAV data
p <0.05
ORG
OP
ODMY
SI
SV
SDMY
PC
PP
PDMY
AE1
AE2
AE3
AV
ADMY
Accident
e1
e4
e5
e6
e7
e8
e9
e10
e11
e12
res1
.00
.13
-.11
-.02
.13
1
.04
.03
-.03
.04
-.02
-.08
-.30
-.28
.64
.61
.29
-.46
-.16
.24
.07
-1.10
-.29
-.10
-.06
1.00
Unstandardized estimates
Chi-sq=238.399 (63 df)
p =.000

APPENDIX R. PATH ANALYSIS OUTPUT OF UAV MODEL WITH MAV DATA A ($p < 0.1$)

Analysis Summary

```
The model is recursive.
Sample size = 203
```

Parameter Summary (Group number 1)

```
              Weights   Covariances   Variances  Means   Intercepts  Total

      Fixed      12           0            0       0          0        12

    Labeled       0           0            0       0          0         0

  Unlabeled      27           0           14       0          0        41

      Total      39           0           14       0          0        53
```

Models

Default model (Default model)

Notes for Model (Default model)

Computation of degrees of freedom (Default model)

```
                     Number of distinct sample moments:  105

          Number of distinct parameters to be estimated:   41

                          Degrees of freedom (105 - 41):   64
```

Result (Default model)

```
Minimum was achieved
Chi-square = 693.587
Degrees of freedom = 64
Probability level = .000
```

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

```
                          Estimate   S.E.       C.R.     PLabel

SDMY <---    ORG            -.069    .060     -1.149   .251par_1

SI     <---  OP              .091    .063      1.445   .148par_5

SI     <---  ODMY           -.054    .062      -.878   .380par_6

SDMY <---    ODMY           -.164    .064     -2.578   .010par_7
```

SV	<---	ODMY	-.004	.019	-.239	.811par_22
SV	<---	OP	.031	.019	1.594	.111par_26
SDMY	<---	OP	-.240	.065	-3.695	***par_27
PDMY	<---	SDMY	.034	.017	1.966	.049par_2
PC	<---	SDMY	-.031	.047	-.668	.504par_3
PP	<---	SI	-.015	.022	-.689	.491par_9
PDMY	<---	SI	.025	.018	1.373	.170par_10
PDMY	<---	SV	.012	.061	.193	.847par_13
PP	<---	SDMY	-.084	.020	-4.121	***par_14
AE1	<---	PDMY	.293	.612	.479	.632par_4
AE2	<---	PDMY	.073	.395	.186	.853par_8
AE3	<---	PDMY	-.460	.221	-2.076	.038par_11
AV	<---	PDMY	-.162	.161	-1.003	.316par_12
AE1	<---	PC	.642	.226	2.834	.005par_15
AE2	<---	PC	.609	.147	4.148	***par_16
AE3	<---	PP	-.306	.181	-1.691	.091par_17
AE1	<---	Accident	-1.102	.096	-11.471	***par_18
AE2	<---	Accident	-.288	.077	-3.743	***par_19
AE3	<---	Accident	-.099	.044	-2.245	.025par_20
AV	<---	Accident	-.058	.032	-1.808	.071par_21
ADMY	<---	PC	-.271	.128	-2.125	.034par_23
ADMY	<---	PDMY	.302	.349	.865	.387par_24
ADMY	<---	Accident	1.000			
ADMY	<---	PP	.103	.218	.474	.635par_25

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY

SV	-.004	.031	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.164	-.240	-.069	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000
PP	.015	.019	.006	.000	-.084	-.015	.000	.000	.000	.000
PC	.005	.007	.002	.000	-.031	.000	.000	.000	.000	.000
PDMY	-.007	-.005	-.002	.012	.034	.025	.000	.000	.000	.000
ADMY	-.002	-.002	-.001	.004	.010	.006	1.000	.103	-.271	.302
AE3	-.001	-.003	-.001	-.005	.010	-.007	-.099	-.306	.000	-.460
AV	.001	.001	.000	-.002	-.005	-.004	-.058	.000	.000	-.162
AE2	.003	.004	.001	.001	-.016	.002	-.288	.000	.609	.073
AE1	.001	.003	.001	.003	-.010	.007	-1.102	.000	.642	.293

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.017	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.172	-.247	-.077	.000	.000	.000	.000	.000	.000	.000
SI	-.061	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	.051	.064	.021	.000	-.278	-.047	.000	.000	.000	.000
PC	.008	.012	.004	.000	-.047	.000	.000	.000	.000	.000
PDMY	-.030	-.023	-.010	.013	.136	.095	.000	.000	.000	.000
ADMY	-.002	-.001	-.001	.001	.008	.005	.987	.025	-.145	.060
AE3	-.002	-.004	-.001	-.002	.013	-.008	-.153	-.116	.000	-.144
AV	.002	.002	.001	-.001	-.010	-.007	-.126	.000	.000	-.070
AE2	.002	.003	.001	.000	-.011	.001	-.245	.000	.280	.013

AE1	.001	.002	.000	.000	-.005	.003	-.616	.000	.194	.033

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.004	.031	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.164	-.240	-.069	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.084	-.015	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.031	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.012	.034	.025	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.103	-.271	.302
AE3	.000	.000	.000	.000	.000	.000	-.099	-.306	.000	-.460
AV	.000	.000	.000	.000	.000	.000	-.058	.000	.000	-.162
AE2	.000	.000	.000	.000	.000	.000	-.288	.000	.609	.073
AE1	.000	.000	.000	.000	.000	.000	-1.102	.000	.642	.293

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.017	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.172	-.247	-.077	.000	.000	.000	.000	.000	.000	.000
SI	-.061	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.278	-.047	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.047	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.013	.136	.095	.000	.000	.000	.000

ADMY	.000	.000	.000	.000	.000	.000	.987	.025	-.145	.060
AE3	.000	.000	.000	.000	.000	.000	-.153	-.116	.000	-.144
AV	.000	.000	.000	.000	.000	.000	-.126	.000	.000	-.070
AE2	.000	.000	.000	.000	.000	.000	-.245	.000	.280	.013
AE1	.000	.000	.000	.000	.000	.000	-.616	.000	.194	.033

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.015	.019	.006	.000	.000	.000	.000	.000	.000	.000
PC	.005	.007	.002	.000	.000	.000	.000	.000	.000	.000
PDMY	-.007	-.005	-.002	.000	.000	.000	.000	.000	.000	.000
ADMY	-.002	-.002	-.001	.004	.010	.006	.000	.000	.000	.000
AE3	-.001	-.003	-.001	-.005	.010	-.007	.000	.000	.000	.000
AV	.001	.001	.000	-.002	-.005	-.004	.000	.000	.000	.000
AE2	.003	.004	.001	.001	-.016	.002	.000	.000	.000	.000
AE1	.001	.003	.001	.003	-.010	.007	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PP	.051	.064	.021	.000	.000	.000	.000	.000	.000	.000
PC	.008	.012	.004	.000	.000	.000	.000	.000	.000	.000
PDMY	-.030	-.023	-.010	.000	.000	.000	.000	.000	.000	.000
ADMY	-.002	-.001	-.001	.001	.008	.005	.000	.000	.000	.000
AE3	-.002	-.004	-.001	-.002	.013	-.008	.000	.000	.000	.000
AV	.002	.002	.001	-.001	-.010	-.007	.000	.000	.000	.000
AE2	.002	.003	.001	.000	-.011	.001	.000	.000	.000	.000
AE1	.001	.002	.000	.000	-.005	.003	.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
OP	<-->	ODMY	82.267	.000
ORG	<-->	ODMY	89.027	.000
e5	<-->	e4	10.424	.000
e1	<-->	e5	85.393	.000
res1	<-->	ODMY	38.787	.000
res1	<-->	OP	11.335	.000
res1	<-->	ORG	30.541	.000
e6	<-->	ORG	8.185	.000
e8	<-->	ODMY	9.896	.000
e8	<-->	ORG	11.093	.000
e8	<-->	e7	25.913	.000
e8	<-->	e6	56.426	.000
e11	<-->	e6	12.654	.000
e10	<-->	OP	4.487	.000
e9	<-->	e1	4.512	.000

e9	<-->	e11	6.295	.000
e9	<-->	e10	13.665	.000

Variances: (Group number 1 - Default model)

M.I. Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	8.864	-.059
SDMY	<---	SV	10.292	-.759
SDMY	<---	SI	84.202	-.660
SI	<---	SDMY	79.251	-.578
Accident	<---	ODMY	38.787	-.511
Accident	<---	OP	11.335	.281
Accident	<---	ORG	30.541	.429
PP	<---	PDMY	25.435	-.414
PC	<---	ORG	8.185	-.120
PC	<---	PDMY	54.700	-1.395
PDMY	<---	ODMY	9.896	-.051
PDMY	<---	ORG	11.093	.051
PDMY	<---	PP	23.860	-.278
PDMY	<---	PC	56.301	-.194
ADMY	<---	ODMY	28.589	-.331
ADMY	<---	OP	7.447	.172
ADMY	<---	ORG	17.477	.245
AE3	<---	PC	12.308	.286
AE3	<---	AE2	7.344	.101
AE2	<---	OP	4.487	.194
AE2	<---	SV	4.592	.715

AE2	<---	AE1	7.955	-.121
AE1	<---	SI	4.440	.267
AE1	<---	AE3	6.409	-.378
AE1	<---	AE2	11.776	-.280

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	41	693.587	64	.000	10.837
Saturated model	105	.000	0		
Independence model	14	885.280	91	.000	9.728

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.715	.533	.436
Saturated model	.000	1.000		
Independence model	.000	.639	.583	.554

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.217	-.114	.233	-.127	.207
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.703	.152	.146
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	629.587	548.656	717.965
Saturated model	.000	.000	.000
Independence model	794.280	702.634	893.374

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	3.434	3.117	2.716	3.554
Saturated model	.000	.000	.000	.000
Independence model	4.383	3.932	3.478	4.423

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.221	.206	.236	.000
Independence model	.208	.196	.220	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	775.587	782.165	911.428	952.428
Saturated model	210.000	226.845	557.887	662.887
Independence model	913.280	915.526	959.665	973.665

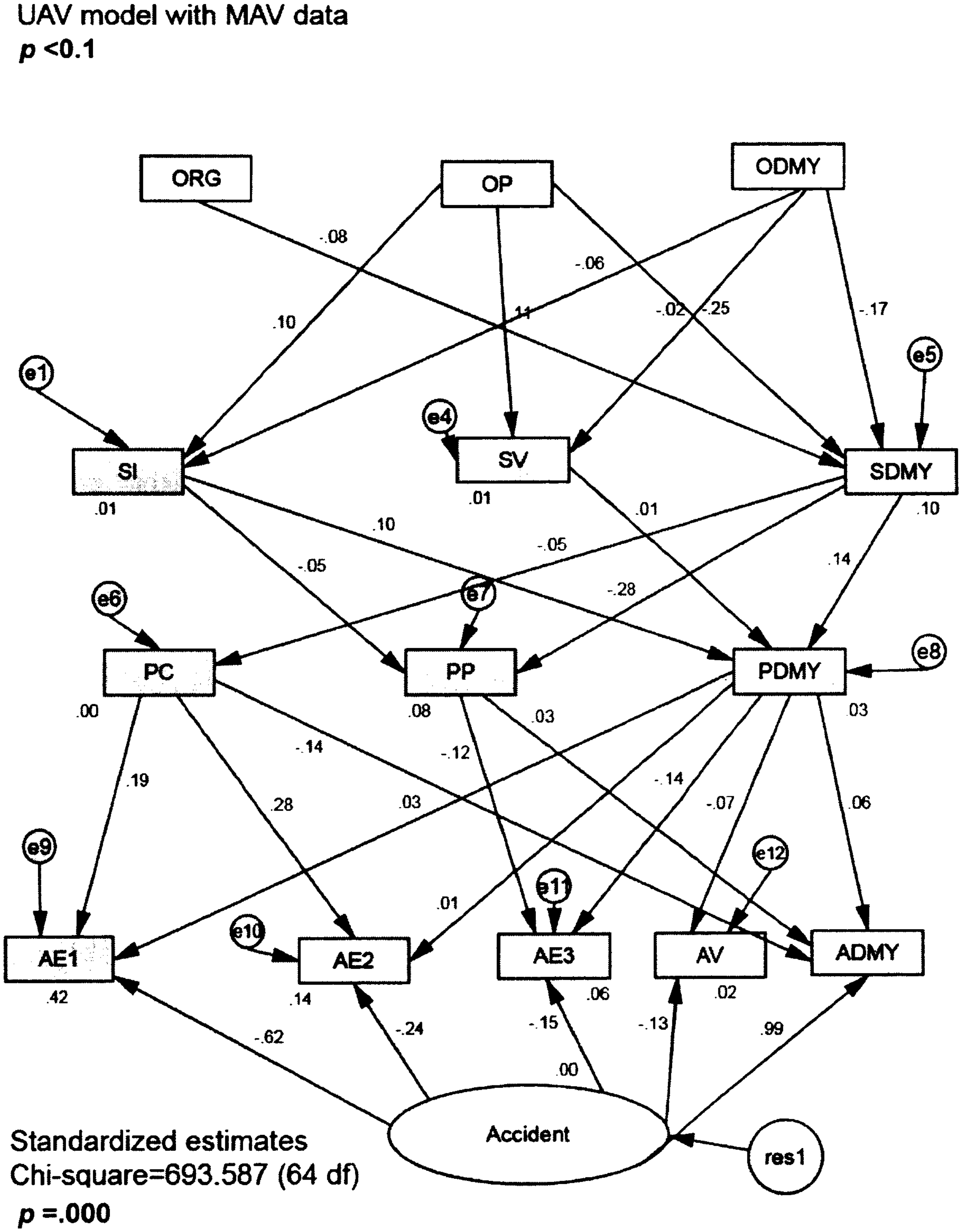
ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.840	3.439	4.277	3.872
Saturated model	1.040	1.040	1.040	1.123
Independence model	4.521	4.067	5.012	4.532

HOELTER

Model	HOELTER .05	HOELTER .01

Default model	25	28
Independence model	27	29

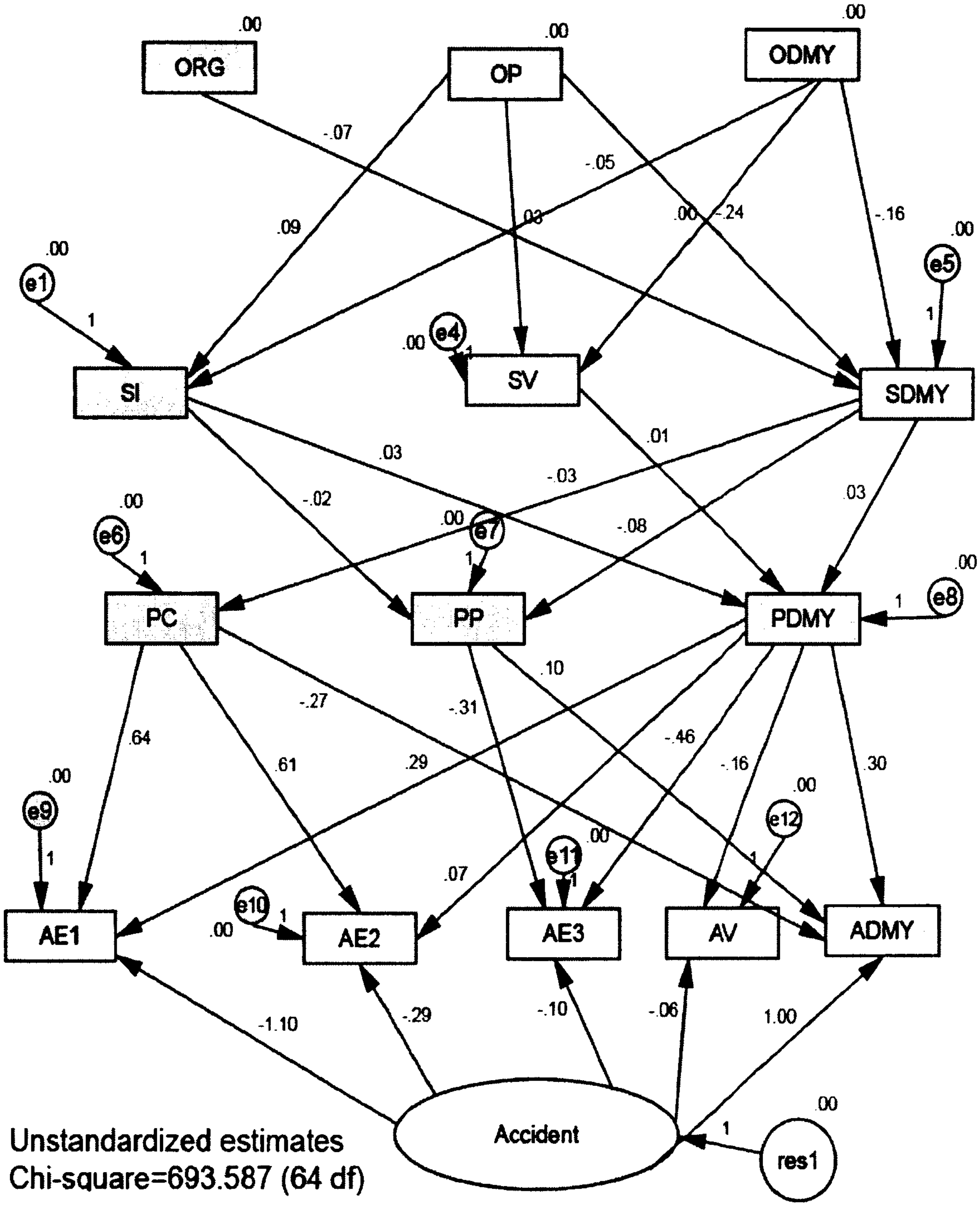


UAV model with MAV data
$p < 0.1$

Standardized estimates
Chi-square=693.587 (64 df)
$p = .000$

UAV model with MAV data

***p* <0.1**



Unstandardized estimates
Chi-square=693.587 (64 df)
***p* =.000**

APPENDIX S. PATH ANALYSIS OUTPUT OF UAV MODEL WITH MAV DATA B ($p < 0.1$)

Analysis Summary

The model is recursive.

Sample size = 203

Parameter Summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	12	0	0	0	0	12
Labeled	0	0	0	0	0	0
Unlabeled	27	4	14	0	0	45
Total	39	4	14	0	0	57

Models

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	105
Number of distinct parameters to be estimated:	45
Degrees of freedom (105 - 45):	60

Result (Default model)

Minimum was achieved

Chi-square = 233.737

Degrees of freedom = 60

Probability level = .000

Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	PLabel
SDMY	<---	ORG	.081	.070	1.158	.247par_1
SI	<---	OP	.091	.078	1.172	.241par_5
SI	<---	ODMY	-.054	.080	-.680	.497par_6
SDMY	<---	ODMY	-.010	.110	-.088	.930par_7
SV	<---	ODMY	-.004	.024	-.185	.854par_22

SV	<---	OP	.031	.024	1.292	.196par_30
SDMY	<---	OP	-.161	.090	-1.780	.075par_31
PDMY	<---	SDMY	.037	.022	1.668	.095par_2
PC	<---	SDMY	-.031	.048	-.651	.515par_3
PP	<---	SI	-.015	.029	-.517	.605par_9
PDMY	<---	SI	.027	.021	1.287	.198par_10
PDMY	<---	SV	.042	.051	.823	.411par_13
PP	<---	SDMY	-.084	.028	-3.001	.003par_14
AE1	<---	PDMY	.293	.725	.404	.686par_4
AE2	<---	PDMY	.073	.468	.157	.875par_8
AE3	<---	PDMY	-.460	.223	-2.065	.039par_11
AV	<---	PDMY	-.162	.162	-.996	.319par_12
AE1	<---	PC	.642	.267	2.403	.016par_15
AE2	<---	PC	.609	.173	3.519	***par_16
AE3	<---	PP	-.306	.183	-1.674	.094par_17
AE1	<---	Accident	-1.102	.096	-11.471	***par_18
AE2	<---	Accident	-.288	.077	-3.743	***par_19
AE3	<---	Accident	-.099	.044	-2.245	.025par_20
AV	<---	Accident	-.058	.032	-1.808	.071par_21
ADMY	<---	PC	-.271	.150	-1.802	.072par_23
ADMY	<---	PDMY	.302	.412	.734	.463par_24
ADMY	<---	Accident	1.000			
ADMY	<---	PP	.103	.220	.470	.639par_29

Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.004	.031	.000	.000	.000	.000	.000	.000	.000	.000

SDMY	-.010	-.161	.081	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000
PP	.002	.012	-.007	.000	-.084	-.015	.000	.000	.000	.000
PC	.000	.005	-.003	.000	-.031	.000	.000	.000	.000	.000
PDMY	-.002	-.002	.003	.042	.037	.027	.000	.000	.000	.000
ADMY	-.001	-.001	.001	.013	.011	.007	1.000	.103	-.271	.302
AE3	.000	-.003	.001	-.019	.009	-.008	-.099	-.306	.000	-.460
AV	.000	.000	.000	-.007	-.006	-.004	-.058	.000	.000	-.162
AE2	.000	.003	-.001	.003	-.016	.002	-.288	.000	.609	.073
AE1	.000	.003	-.001	.012	-.009	.008	-1.102	.000	.642	.293

Standardized Total Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.016	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.010	-.170	.092	.000	.000	.000	.000	.000	.000	.000
SI	-.058	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	.005	.042	-.025	.000	-.274	-.047	.000	.000	.000	.000
PC	.000	.008	-.004	.000	-.046	.000	.000	.000	.000	.000
PDMY	-.008	-.009	.013	.049	.146	.102	.000	.000	.000	.000
ADMY	.000	-.001	.001	.003	.009	.005	.983	.025	-.144	.059
AE3	.001	-.004	.001	-.007	.011	-.009	-.153	-.115	.000	-.143
AV	.001	.001	-.001	-.003	-.010	-.007	-.126	.000	.000	-.070
AE2	.000	.002	-.001	.001	-.011	.001	-.245	.000	.280	.012
AE1	.000	.001	.000	.002	-.004	.003	-.618	.000	.195	.033

Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.004	.031	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.010	-.161	.081	.000	.000	.000	.000	.000	.000	.000
SI	-.054	.091	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.084	-.015	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.031	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.042	.037	.027	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	1.000	.103	-.271	.302
AE3	.000	.000	.000	.000	.000	.000	-.099	-.306	.000	-.460
AV	.000	.000	.000	.000	.000	.000	-.058	.000	.000	-.162
AE2	.000	.000	.000	.000	.000	.000	-.288	.000	.609	.073
AE1	.000	.000	.000	.000	.000	.000	-1.102	.000	.642	.293

Standardized Direct Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	-.016	.111	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	-.010	-.170	.092	.000	.000	.000	.000	.000	.000	.000
SI	-.058	.101	.000	.000	.000	.000	.000	.000	.000	.000
PP	.000	.000	.000	.000	-.274	-.047	.000	.000	.000	.000
PC	.000	.000	.000	.000	-.046	.000	.000	.000	.000	.000
PDMY	.000	.000	.000	.049	.146	.102	.000	.000	.000	.000
ADMY	.000	.000	.000	.000	.000	.000	.983	.025	-.144	.059
AE3	.000	.000	.000	.000	.000	.000	-.153	-.115	.000	-.143

AV	.000	.000	.000	.000	.000	.000	-.126	.000	.000	-.070
AE2	.000	.000	.000	.000	.000	.000	-.245	.000	.280	.012
AE1	.000	.000	.000	.000	.000	.000	-.618	.000	.195	.033

Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.002	.012	-.007	.000	.000	.000	.000	.000	.000	.000
PC	.000	.005	-.003	.000	.000	.000	.000	.000	.000	.000
PDMY	-.002	-.002	.003	.000	.000	.000	.000	.000	.000	.000
ADMY	-.001	-.001	.001	.013	.011	.007	.000	.000	.000	.000
AE3	.000	-.003	.001	-.019	.009	-.008	.000	.000	.000	.000
AV	.000	.000	.000	-.007	-.006	-.004	.000	.000	.000	.000
AE2	.000	.003	-.001	.003	-.016	.002	.000	.000	.000	.000
AE1	.000	.003	-.001	.012	-.009	.008	.000	.000	.000	.000

Standardized Indirect Effects (Group number 1 - Default model)

	ODMY	OP	ORG	SV	SDMY	SI	Accident	PP	PC	PDMY
SV	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SDMY	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SI	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
PP	.005	.042	-.025	.000	.000	.000	.000	.000	.000	.000
PC	.000	.008	-.004	.000	.000	.000	.000	.000	.000	.000

PDMY	-.008	-.009	.013	.000	.000	.000		.000	.000	.000	.000
ADMY	.000	-.001	.001	.003	.009	.005		.000	.000	.000	.000
AE3	.001	-.004	.001	-.007	.011	-.009		.000	.000	.000	.000
AV	.001	.001	-.001	-.003	-.010	-.007		.000	.000	.000	.000
AE2	.000	.002	-.001	.001	-.011	.001		.000	.000	.000	.000
AE1	.000	.001	.000	.002	-.004	.003		.000	.000	.000	.000

Modification Indices (Group number 1 - Default model)

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e5	<-->	e4	12.043	.000
res1	<-->	ODMY	4.734	.000
e6	<-->	e7	5.315	.000
e8	<-->	e7	30.072	.000
e11	<-->	e6	16.544	.000
e9	<-->	e11	6.295	.000
e9	<-->	e10	13.665	.000

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
SV	<---	SDMY	9.332	-.062
SDMY	<---	SV	11.866	-.612
Accident	<---	ODMY	42.559	-.561
Accident	<---	OP	11.335	.281
Accident	<---	ORG	30.541	.429
PP	<---	PDMY	25.751	-.420

PC	<---	PP	4.995	-.297
PDMY	<---	ODMY	9.671	-.045
PDMY	<---	OP	5.118	.032
PDMY	<---	ORG	4.638	.028
PDMY	<---	PP	28.265	-.260
ADMY	<---	ODMY	31.369	-.363
ADMY	<---	OP	7.447	.172
ADMY	<---	ORG	17.477	.245
AE3	<---	PC	12.309	.286
AE3	<---	AE2	7.371	.102
AE2	<---	OP	4.487	.194
AE2	<---	SV	4.583	.713
AE2	<---	AE1	8.008	-.122
AE1	<---	SI	4.411	.265
AE1	<---	AE3	6.408	-.377
AE1	<---	AE2	11.820	-.281

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	45	233.737	60	.000	3.896
Saturated model	105	.000	0		
Independence model	14	885.280	91	.000	9.728

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.000	.870	.772	.497
Saturated model	.000	1.000		
Independence model	.000	.639	.583	.554

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.736	.600	.789	.668	.781
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.659	.485	.515
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	173.737	130.512	224.533
Saturated model	.000	.000	.000
Independence model	794.280	702.634	893.374

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	1.157	.860	.646	1.112
Saturated model	.000	.000	.000	.000
Independence model	4.383	3.932	3.478	4.423

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.120	.104	.136	.000
Independence model	.208	.196	.220	.000

AIC

Model	AIC	BCC	BIC	CAIC

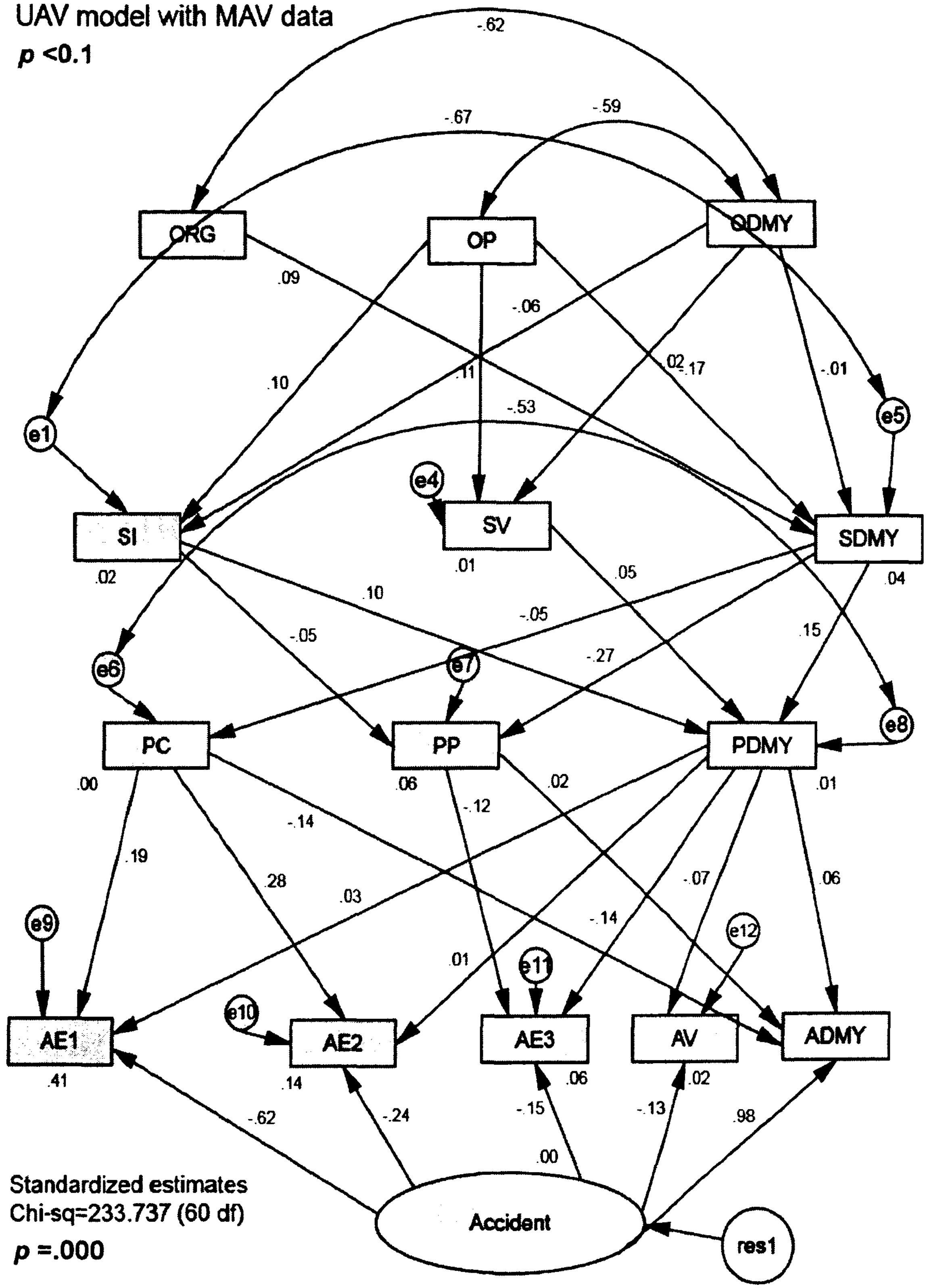
Default model	323.737	330.956	472.831	517.831
Saturated model	210.000	226.845	557.887	662.887
Independence model	913.280	915.526	959.665	973.665

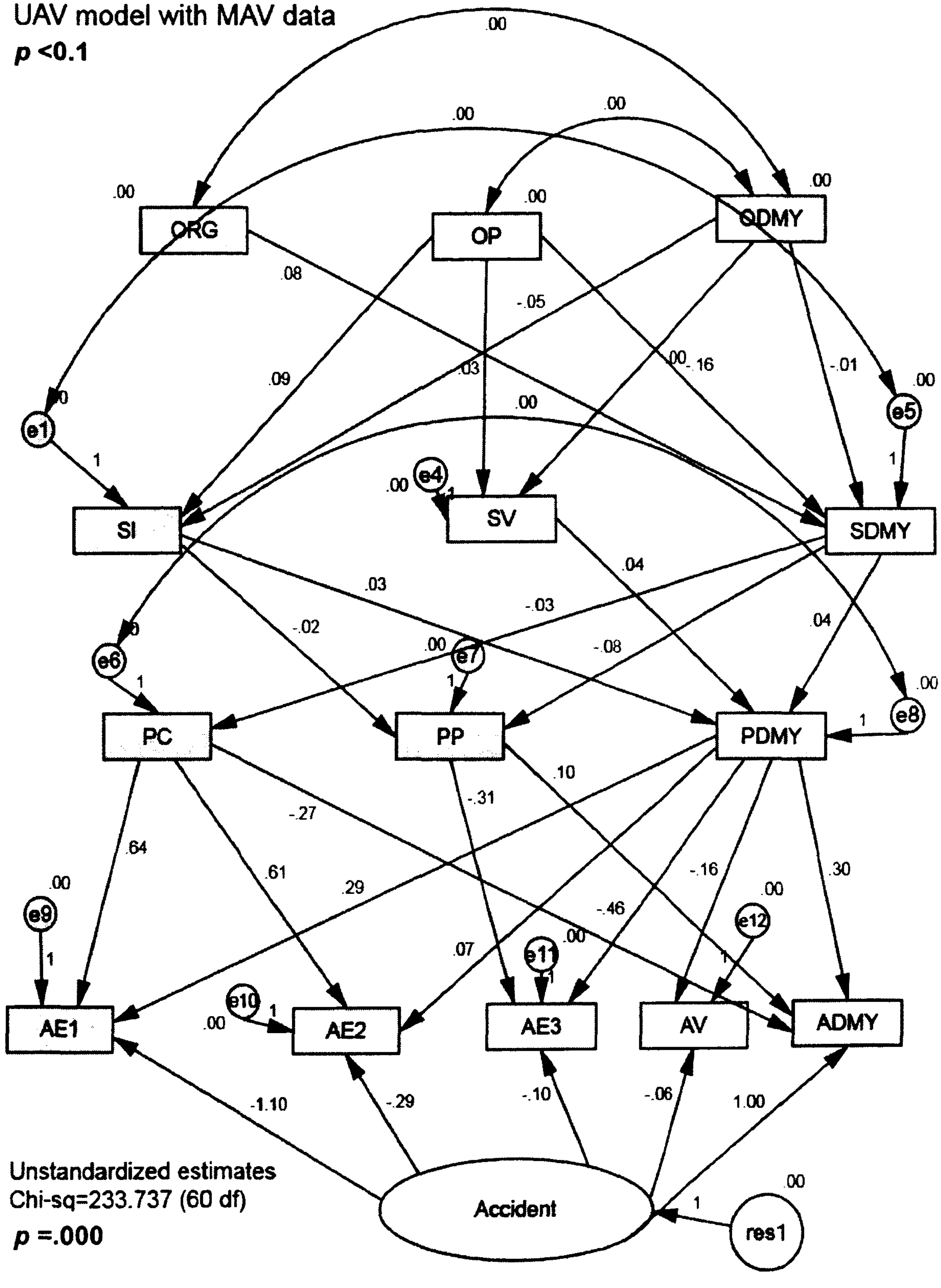
ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	1.603	1.389	1.854	1.638
Saturated model	1.040	1.040	1.040	1.123
Independence model	4.521	4.067	5.012	4.532

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	69	77
Independence model	27	29


UAV model with MAV data
p <0.1
-.62
-.67
-.59
ORG
OP
ODMY
.09
-.06
.10
.11
.02
-.17
-.01
-.53
e1
e4
e5
SI
SV
SDMY
.02
.01
.04
.10
.05
-.05
-.05
.15
-.27
e6
e7
e8
PC
PP
PDMY
.00
.06
.01
.02
-.12
-.14
.19
.28
.03
-.07
.06
-.14
.01
e9
e10
e11
e12
AE1
AE2
AE3
AV
ADMY
.41
.14
.06
.02
-.62
-.24
-.15
-.13
.98
.00
Accident
res1
Standardized estimates
Chi-sq=233.737 (60 df)
p =.000



UAV model with MAV data

***p* <0.1**

Unstandardized estimates
Chi-sq=233.737 (60 df)
***p* =.000**

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