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SYSTEM SAFETY STUDY: PEDAGOGICAL AVIATION ACTION RESEARCH

Chien-tsung Lu, Stewart Schreckengast, Timothy D. Ropp, and Brian Dillman

Abstract

Action Research (AR) is a scientific methodology whereby researchers participate in a research setting for data collection and problem resolution. Aviation researchers experience first-hand challenges in process cognition, data collection, and selection of implementation strategies. The AR think-path, or the “Look-Think-Act” loop, has been utilized in the qualitative research discipline for decades. Yet the merits of AR remain under-utilized by airport safety practitioners. The purpose of this study is to introduce AR for the development of a functional safety management system (SMS) to support airport safety education. Using documentary research, this paper reviews the process of AR and identifies a detailed set of methodological procedures in support of the recently published FAA’s Advanced Notice of Proposed Rule Making, FAA Order 1110.152, for the implementation of SMS. This study provides a tool to integrate ongoing airport safety programs which will benefit airport management and current aviation students. The core SMS safety analysis process and the Policy Research Construct (PRC) {ref} are supportive to the AR methodology along with the adoption of a proposed Aviation Safety Management Model (ASMM). The application of this study contributes a valuable research methodology to support airport managers and safety educators.

Introduction

In the traditional engineering discipline, the process of problem identification, analysis, resolution, implementation, and performance measurement is familiar to the community practitioners (Ericson, 2005; Vincoli, 1993). Often time, engineering researchers need to position themselves in the life cycle of developing a new system or a scientific product so as to resolve the salient problems and make a new system successful. In the field of social science the qualitative methodology of Action Research (AR), could be utilized for researcher’s involvement within a research setting (Stringer, 1996). The AR process of Look-Think-Act, encompasses problem identification, analysis, planning, implementation and evaluation throughout the life cycle of a project.

Since the late 1990s, the concept of system safety has been recognized by the aviation industry. This is a managerial approach to control potential risk while fostering a safety culture (Federal Aviation Administration [FAA], 2007). However, as Lu and his research associates state, without mandatory enforcement from the government, implementing any safety systems is optional (Lu 2005a; 2005b; Lu, Przetak, & Wetmore, 2006; Lu, Bos, Caldwell,

2007; Lu, 2008) and therefore the performance outcome is more challenging. This phenomenon pinpoints the importance of the rulemaking process and raises the following questions: Does the industry need a new regulation or law to enforce implementation of a new safety program? Would the industry voluntarily adopt an optional program? To what extent will the industry and government inspectors accept a new law? What are the consequences if the government maintains a non-regulatory status quo for a new optional safety program? Does the industry have enough motivation to promulgate safety without a mandatory regulation? Most importantly, how do airport authorities incorporate SMS into their existing safety programs by using AR methodology? These are representative questions aviation students and future aviation leaders must face, research and resolve.

Background of Action Research

Action Research in the U.S. has been applied to different industries such as education, business, sociology, medical services and policymaking. AR can be used in most studies seeking rapid and/or practical answers. Traditional data collection methods include observation, interview, analysis of operational application and

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procedures, survey and focus groups. Safety research often excludes the analysis of operational application and procedures simply because these are engineering-oriented and expensive undertakings. The AR concept could be extremely useful for the implementation of contemporary safety system as the timely analysis and problem resolution actions could minimize equipment damage and personnel injuries. In particular, input from end-users and people working in the industry who are directly affected by a new system are an essential resource that program designers should consider and foster a close working relationship.

Application of AR in Civil Community

Mirza (2008) and associates conducted an AR study for the resolution of program difficulties between government and local community organizations. In this 15-month study, key researchers stayed with community activists and observed their public protests against the establishment of a new charity facility for people with psychiatric disabilities. There were two reasons the local residents opposed the facility: a lack of trust due to the misperception of services provided, and a lack of public *policy* support. The onsite close partnership helped the AR researchers collect data through frequent meetings and direct observation, enabling them to analyze and discuss findings and suggest solutions. Mirza's finding indicated that the major problem of a similar project could be the miscommunication between developers and long-term residents.

Chalmers (2005) conducted an AR study in the United Kingdom associated with support for *polycymaking* related to environmental inequalities. As described in their paper, AR is an evidence-based study and intended results can rapidly be developed. In the 2-year study, pragmatist Peter Reason's model of participatory AR was utilized. This onsite participation study concluded that *AR* is well suited to generate a policy product.

As addressed in Reason's paper, there are four essential components needed for an AR project: the purpose of the study, practical knowledge of the topic, tangible data collection tools, and active participation. The AR researchers need to identify the worthiness of a topic, possess personal expertise in the research area, know how to collect data/evidence, and participate in the research setting with close interactions (Reason, 1997 & 2003). Peter Reason's pragmatism philosophy also reflects American philosopher Richard Rorty's long-term belief in social

interaction and civic participation for governance (Rorty, 1982).

The Pragmatic Look-Think-Act Process

Following the theoretical vein from Mirza, Chalmers, Reason, and Rorty, the pragmatic process of AR embraces three major stages: Look, Think, and Act. Briefly noting, the AR stages are: problem encountering, situation analysis, resource review, suggestion, pilot testing, assessment, acceptance, full implementation, outcome evaluation and a recursive loop of Look, Think, and Act. Details of the three stage process of AR are provided below.

Action Research Stage I: Look

The first step for an aviation researcher to implement AR includes looking for all available sources and data from a researcher setting (for safety study, an airport is a recognized research setting). During the Look stage, the trigger is typically a problem, a situation, an argument, a conflict, a question, a concern, or any challenges. Therefore the initiator to start the Look research process could be an accident, a worker's injury, a hazardous phenomenon, a security breach, a failed program or system, an unsolved union dispute, or a socio-technical challenge. The Look component is indeed any observation collected by the researcher (physically or psychologically) both on and off the research site. With this in mind, when an airport operator believes in the merits of a comprehensive safety management system (SMS) while there is no regulatory requirement, the Look strategy often prevails and AR can be enacted to discover related information.

Action Research Stage II: Think

In preparation for the implementation of the FAA's SMS ANPRM, researchers should consider all tangible information, existing policies, and observe the history and end-users viewpoints surrounding this new policy. This activity initiates the process of the Think stage of an AR approach. To understand the Think process, researchers are encouraged to review Policy Research Construct (PRC) first appearing in the *International Journal of Applied Aviation Studies (JJAAS)* in 2004. In the PRC model (see Figure 1 below), Bowen and Lu provide a policymaking system placing a solid platform for the AR Look process (Bowen & Lu, 2004). From the airport management side, reviewing internal ongoing safety programs would reveal the gap that needs to be filled. To do so, available safety policies, rules, guidelines, programs, and manuals should be ready.

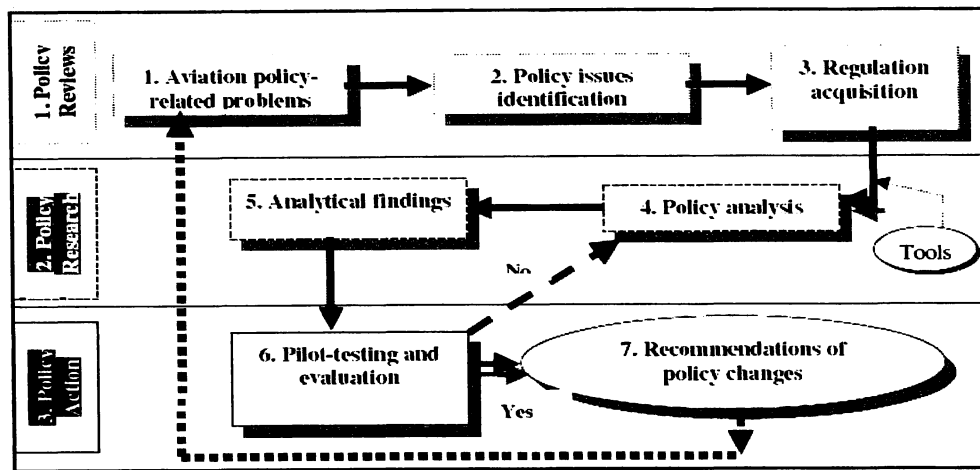


Figure 1. Flowchart for the aviation Policy Research Construct (PRC)

The PRC contains seven steps within three (3) main sections: Policy Reviews, Policy Research, and Policy Action. The Policy Review and Policy Research phases will guide researchers to revisit existing aviation-related rules after encountering a new policy challenge (Policy Review: PRC Steps 1 and 2). As Jenkins (1978) and Walker (1993) stated in terms of conventional policy analysis, policy researchers should re-study ongoing policies and locate problems such as inappropriateness, insufficiency, and obsolescence based on the needs from the policy customers. This process concurs with the traditional Management Oversight and Risk Tree (MORT) analysis from aerospace industry (Vincoli, 1993). The review of existing policies could identify deficiencies causing safety problems which is also a factor of organizational accidents (Reason, 1997). With the AR philosophy, policy researchers analyze problems and subsequently seek strategies necessary to cope with deficiencies in policymaking.

The construct regulation acquisition process (PRC Step 3) includes a review of literature primarily focusing on current public laws and documents stored in the Government Printing Office (GPO). Secondary data analysis, if needed, would be performed through analytical tools such as Content Analysis, Meta Analysis, or Historic Research in order to provide supportive information for a possible policy decision-making. These analytical tools utilize massive data regarding main subjects, primary themes, and archival information.

The Bowen-Lu PRC model for aviation

policymaking advocates the retrieval of opinions of related government organizations for a real-time reflection and update of policy information during research Phase 2 (Policy Research: PRC Steps 4 and 5). These steps contain policy analysis and generate useful findings for further application. However, researchers must be cautious about tangent policies while incorporating public participation into the AR process. There are ample opportunities for data collection via Aviation Rulemaking Advisory Committee (ARAC), public hearings/meetings/comments, the study of Federal Registers, surveys, personal interviews, symposiums, focus groups, or panel studies. AR researchers must constantly remind themselves of five critical questions during AR Phase 2: (1) Are the current available policies adequate and current? (2) What is the existing policy status and performance of implementation? (3) What would be the consequence without further revisions of related policies? (4) What could be the impact to the industry if a new law is enacted? (5) What is the cost-effect result and policy receivers degree of acceptance? A continuous verification of data creditability and reliability is recommended through the use of Delphi analysis techniques as the reciprocating interactive procedures would reflect the time and resources requirements following a policy change decision.

Policy researchers should not be constrained at any point in the PRC process. In addition, if there is a need, policy analysis (PRC step 4 and 5) should spontaneously embrace data analysis via mathematical tools (such as Niskanen [1998] policy analysis of welfare and the culture

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of poverty) and data coding (such as Haas and Springer [1998] housing policy study) in order to formulate analytical findings, contingent provisions, and tentative postulates (Bernstein, 1983). The grounded policy-change results (affiliated with policy-change recommendation) could be justified not only by simulation (Majchrzak, 1984) and economic analysis, but should also be debated by the affected individuals and groups (Bernstein, 1983; Fox & Miller, 1996; Hakim, 2000; Nyden, Figert, Shibley, & Burrows, 1997; Robson, 1993; Rorty, 1982). Therefore, in an AR study, PRC may be incorporated with quantitative information and support a qualitative decision-making process. A mixed-methodology is then applied.

The purpose of the AR Think concept is to identify the need of policy challenge, the necessity or un-necessity of a new law, or any ongoing policy or program deficiencies. For airport operations, one of the biggest challenges is always safety which imposes a persistent alert to management personnel and government authority. As a result of using AR in aviation research, researchers should first retrospect: What is the meaning of safety? How do we ensure safety without polices? What are the sources available to aviation authorities and practitioners for ensuring safety? How can we ascertain that our operation is conducted in the safest manner? With the same theoretical vein, to successfully process the AR's Think stage regarding an airport safety management system, it is necessary to understand the current nature and purpose of a safety management system.

Think: Safety and policy challenges

Safety is the mission priority and universal norm for the worldwide aviation industry including airlines, airports, air traffic control, fixed base operators and related sectors. The 9/11 terrorist attacks in 2001 provided the impetus for air transportation security measures. Aviation safety and airport security has become the utmost importance and, to a great extent, has triggered numerous studies and research involving operational performance. In the official 9/11 Commission Report, a multi-layer redundant system is recommended to effectively secure needed safety, quality and security levels (National Commission on Terrorist Attacks, 2004). As addressed in the Report:

“The FAA set and enforced aviation security rules, which airlines and airports were required to implement. The rules were supposed to produce a “layered” system of defense. This means that the failure of any one layer of security would not be fatal, because additional layers would provide backup security.” (National Commission on Terrorist Attacks, 2004, p. 81)

Since 1996, the System Safety's philosophy of redundancy and incorporation of mitigating reactive

recovery actions for hazardous events has encouraged the U.S. government to promulgate enhancements to its aviation safety program. Originally the FAA's Office of System Safety was empowered to lead Aviation System Safety research through Administrative Order 8040-1. The Order requires the Office of System Safety to incorporate a risk management process for all high-consequence decisions including airlines and airports, and to provide a handbook or manual of System Risk Management (SRM), which recommends tools of System Safety to all US-based airlines. To accomplish the appointed tasks and promote SRM to the industry, an annual System Safety Conference and workshop was provided for airline and airport managers since 1999. Research efforts from the FAA, project contractors and conference participants collaborated on conferred on many issues and during each workshop. Although the FAA has started to promote the new scientific and systemic trouble-shooting procedure extracted from System Safety for integrating aviation safety and airport security programs to date, most air carriers or airports have not fully implemented a System Safety program. In addition to the absence of regulations, the incomplete System Safety implementation is hampered by insufficient data to determine the true cost and benefit of System Safety. This situation generates a policymaking challenge. While applying the merits of System Safety to the aviation industry remains optional at the writing of this paper, academia possesses the tools to embrace this dilemma and demonstrate its safety leadership potential.

Think: Existing SMS manuals and guidelines

FAA AC 150/5200-37. The AC 150/5200-37 was published by the FAA on Feb. 28, 2007 which provides a concept to airport operators under FAR 139 regarding SMS. For safety culture, the AC advocates the criticality of top management commitment and an attitudinal and structural approach for culture change (FAA, 2007, p.2). In order to accomplish the safety goals, safety policies and objectives must be clearly defined, safety risk management is recommended, safety assurance should be conducted, and safety promotion strategies needs to be in place. From the interpretation of AC 150/5200-37, utilizing risk matrix to enrich the proposed SMS Lifecycle Overview is highly recommended (p.5, p.12).

FAA System Safety Handbook. This handbook notes that system safety management - adopts techniques of system theory, statistical analysis, behavioral sciences and the continuous improvement concept (FAA, 2000, p.3-15). The handbook provides more detailed procedures and guidelines for the airport operators to tailor the design of their own SMS to fit their unique operational needs. This handbook is similar to ICAO *Safety Management Manual* and provides guidance material for systems safety management system.

To assist airport operators implement SMS to their

daily high value operations, the researchers at Purdue University, University of Central Missouri and Southern Illinois University at Carbondale embraced the safety theories and system safety culture and proposed a, aviation safety management model (ASMM) in 2007 (Lu, Bos, & Caldwell, 2007). The Lu-Bos-Caldwell ASMM model echoed the traditional supports of MIL-STD-882, FAA safety guidance material, and ICAO standards regarding system safety concept, hazard analytical tools, risk matrix application, safety culture promotion and generated a comprehensive safety management system for the needed aviation industry. The ASMM can be applied to perform safety enhancement in relation to airline operation, airport management, manufacturer safety survey, or a FBO hazard prevention program.

Action Research Stage III: Act

With the safety culture in mind, the proposed "Lu-Bos-Caldwell" ASMM is a hybrid program, pulling together the useful System Safety techniques, qualitative procedures, and quantitative tools to form a comprehensive model and to support a positive safety culture within an organization (see Appendix A). Initial results from countries and service providers that have implemented SMS report positive benefits (ICAO, 2008). In order to be successful and practical for an organization, the ASMM must meet the following criterion: be administratively practical, allow quantifiable as well as qualifiable measurement, be valid so that measurements capture data and present it in a useful format, be functional so that system safety tools are understandable, be user-friendly and sensitive to situational change, are timely so that deficiencies can be identified and mitigated prior to adverse occurrences, and enable rapid discrimination of results (Wood, 2003). The AR-oriented SMS model promotes the core components of the FAA's safety management program in safety policy, quality assurance, risk management, and safety promotion and education.

The proposed Lu-Bos-Caldwell management model contains nine major steps: Data Collection, Risk Identification, Data Analysis, Risk Matrix Calculation & Response, System Safety Tools Implementation & Regulatory Compliance, Reports & Feedback, Result Monitoring, Information Distribution, and Problem-Solving Meeting.

Table 1 Risk Index

Likelihood severity	Frequent (1)	Probable (2)	Occasional (3)	Remote (4)	Improbable (5)
Catastrophic (1)	2	3	4	5	6
Critical (2)	3	4	5	6	7
Marginal (3)	4	5	6	7	8
Negligible (4)	5	6	7	8	9

Data collection. Data associated with airport hazards can be retrieved from the current ongoing risk/hazard reporting programs such as Enforcement Action database, Runway Incursion Incident, Aviation Safety Action Program, Internal Evaluation Program, or Aviation Safety Reporting System automatically. The data of potential Risk can be: 1) reported by employees, 2) downloaded from self-maintained databases, or 3) from government's documentary reviews. Information derived from the analysis of such data supports the need for a mechanism to provide open reporting access to all workers and allow workers and managers to receive safety information from field specialists or anyone who would like to contribute. This collection must meet several requirements in order to encourage contributions: 1) penalty-free, 2) anonymous, 3) confidential, 4) easy-to-report 5) maintaining an open-door policy, and 6) promising feedback and solutions.

Risk identification. The purpose of Risk identification is twofold: risk definition and categorization. The criticality of risk identification focuses on the review of reports from frontline experts to see if it is a reportable risk (not blackmail or alike) and requires prompt internal analysis. In addition, collected data should be categorized and prepared for an immediate analysis and risk study.

Data analysis. This is the first analytical output of review focused on identifying and reporting risk prioritization associated with a quick solution or immediate automatic safety alert. Data analysis should contain, but not be limited to some basic hazardous information such as trend study, hazard ranking, and preliminary reports during specific time. Regulatory compliance must be reviewed and this part of information can be distributed to employees for self-alert and as weekly safety/security brief/educational materials.

Risk matrix calculation and response. During this phase of airport SMS, the formation of a Risk Index Matrix (TIX) can be generated. Table 1 below provides an example of the TIX utilizing an addition method instead of a multiplication method providing an easier way of risk calculation and interpretation ranging between 2 and 10, the lower the number the more risk and the larger the number the less risk to the process. These allow a prioritization based upon risk.

In this proposed model, the risk index (2~4) is qualitatively defined as an Emergency risk that needs immediate response and resolution. The risk index (5~7) indicates a Caution risk situation needing a fast review and enhanced management attention in order to minimize any adverse events. Caution risk resolution may require additional information and analysis to determine the level of mitigation resources needed. Lastly, the Supervisory risk index (8~9) represents an acceptable risk and the reported risk needs to be monitored to ensure it remains within this range in the future. In the above matrix for the aviation industry, although the risk probability is extremely low, any possible fatality ("Catastrophe" 1) is unacceptable thus it is categorized as "Cautious" instead of "Supervisory". In addition, "Frequent" (1) of risk probability with "Negligible" (4) risk severity is also unacceptable because the risk could be immediately mitigated with a very low cost (i.e., lack of knowledge) otherwise risk accumulation (i.e., overlook) may lead to a larger scale of damage (i.e., from HAZMAT, in-flight fire, fatigue, aircraft deviation, debris, runway incursion, miscommunication, likeliness of regulatory violation, etc.). Equally important, the risk probability levels should be manipulated based on an individual airport's operational nature (see Appendix B). Additionally, a color-coded index can be superimposed upon the matrix to indicate the risk level reported by employees.

System safety tools implementation and regulatory compliance. In this phase, information and reports are received along with the hazard probability from the previous processing stage. The exemplary reporting forms using Fault Tree Analysis (FTA), Management Oversight and Risk Analysis (MORT), Failure Mode and Effect Criticality Analysis (FMECA), and Operating & Supplemental Hazard Analysis (O&SHA) provide a conceptual demonstration. The genuine value of this step is to apply Systems Safety tools to conduct a detailed risk/incident/accident analysis and suggest countermeasures. Besides, regulatory compliance is critical to employment orientation, routine safety education, recurrent training, and an accident-prevention course and thus helps identify safety gaps within an operational system.

Reports and feedback. The purpose of hazard/incident/accident investigation is to identify the problems, provide safety measures, and prevent similar problems from happening again. With this in mind, the analytical reports will be sent to a safety committee for review if the calculation of Risk Index indicates a need. Also, the result and resolution needs to be distributed to the submitters, if known. Ultimately, the result of hazard analysis should be posted onto safety/security bulletin board or to a monitoring system for review. The database of reports should be made available to safety managers or

related users for references. A risk tracking system is equally important for two counts: 1) it will help the safety manager identify the status of a risk report, and 2) it will show risk submitters the importance of their input and further motivate participation.

Real-time safety alert. Qualitative risk alert index of this proposed ASMM provides a visionary image to safety managers or system users who need up-to-date information for prompt understanding. The author suggests a color-coded (at least three colors, red, yellow, and green or more) information indicating design for informative risk alert and identification. To accomplish this goal, a sufficient database is extremely crucial.

Information distribution. This process should inform all employees about the status of safety level periodically as well as those symbolic cases identified from employees, peer airports, trade associations, or governments. A risk to safety at one airport would quickly raise cautiousness from other airports. Further, information critical information should be distributed to employees and the distribution is accomplished by utilizing several formats such as briefing, internal email, auto-voicemail, circulations, flight crew briefings, ground crew discussions, maintenance safety notices, airport NOTAMs or recurrent/routine training/orientation.

Problem-solving meeting and system audit. Members of safety committee receive routine, at least daily, risk analysis and provide comments and recommendations to upper management for further decision-making reviews (action or non-action) if necessary. The safety committee generates solutions and mitigates potential hazards based on the magnitude of an analyzed risk/hazard report. Frontline managers, employees, or union representatives should be invited to participate in the safety meeting, attend Focus Group discussion, and jointly conduct system audits periodically so as to reveal suggested trainings or resolutions because of their daily activities, observation, and career specialty.

At this point of AR introduction and possible application in aviation safety, the author will provide a case study to show AR practicality in forming a safety management system. The program design is based on intensive theoretical reviews and consequently introduces the airport industry a malleable safety program with a thorough and solid research foundation (from the Cook-Think loop). The proposed safety program is reviewed by airport managers and safety experts so the validity and reliability of the proposed safety program can be secured. This process is the AR 1st step.

Conclusion & Future Study

The 2009 aircraft accidents of US Airways AB 320 Flight 1549 in New York City, New York, Continental DHC8 Flight 3407 in Buffalo, New York, and FedEx MD-

11 Flight 80 in Narita Airport, Japan shocked the global aviation community and raised a critical question: How safe is air transportation? The answer is simple: air transportation is very safe as long as we continue improving safety programs and provide safety training for pilots, airport managers, maintenance crews and all aviation-related workers. Safety research is an integral part of the foundation for improving safety programs and providing safety trainings. The safety management system (SMS) targets the development of a safety culture so the hidden hazards can be uncovered. As a result, accidents or incidents will be unlikely to occur due to hazard mitigation procedures. This

study has introduced a systemic approach, namely AR, for a safety program development that could help with the further design for safety management and enhancement. This study applies the philosophy of AR for an airport SMS. In conjunction with the usage of Bowen-Lu's PRC model, AR presents its utility in program analysis and policy research by going through the Look-Think-Act loop. A follow-up study (The Airport SMS Survey Using Pedagogical Aviation Action Research) will focus on the ongoing application of AR procedures toward the implementation of aviation SMS. ➔

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Timothy D. Ropp is an assistant professor in the Department of Aviation Technology at Purdue University. His research interests are safety resource management, maintenance management, NextGen aircraft maintenance, and human factors in maintenance facility design.

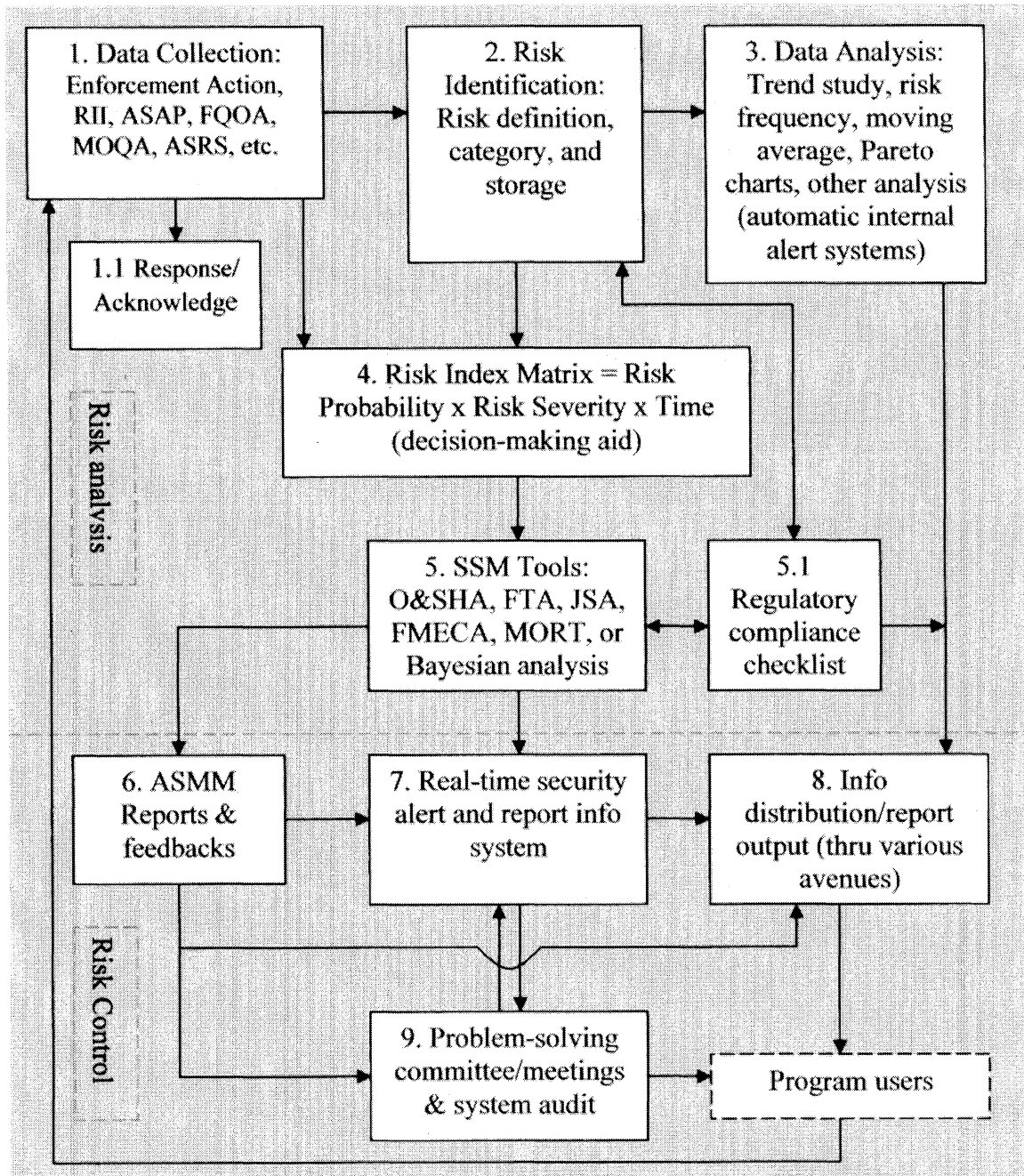
References

- Bernstein, R. J. (1983). *Beyond objectivism and relativism: Science, hermeneutics, and praxis*. Philadelphia, PA: University of Pennsylvania Press
- Bowen, B., & Lu, C-t. (2004). Enhancing the policymaking process in air transportation: Application of Policy research construct. *International Journal of Applied Aviation Studies*, 4(1), 31-44.
- Chalmers, C. (2005). Addressing environmental inequalities in UK policy An action research perspective. *Environment Policy*, 10(4), 333-360.
- DoD. (2000). *MIL-STD-882D Standard Practice for system safety*. Author.
- Ericson, C. A., II (2005). *Hazard analysis techniques for system safety*. Hoboken, NJ: John Wiley & Sons.
- FAA. (2007). *Advisory Circular 150/5200-37. Introduction to safety management systems (SMS) for airport operators*. (NTIS No. DOT/FAA/AC150-5200-37) Washington DC: U.S. Government Printing Office.
- Fox, C. J. & Miller, H. T. (1996). *Postmodern public administration: Toward discourse*. Thousand Oaks, CA: Sage.
- Hakim, C. (2000). *Research design: A successful design for social and economic research*. New York, NY: Routledge.
- ICAO (2008). *Doc 9859. Safety Management Manual*. (2nd ed.). Author.
- Jenkins, W. I. (1978). *Policy analysis: A political and organizational perspective*. London, Martin Robertson.
- Lu, C-t. (Fall, 2005a). An assessment of intensive/weekend teaching format of aviation education: A case of aviation law. *Journal of Aviation/Aerospace Education and Research*, 15(1), 17-30.
- Lu, C-t. (Oct. 2005b). Discovering the regulatory rationale of the Federal Aviation Administration (FAA): A study of maintenance resource management (MRM) training. *Journal of Air Transportation*, 10(3), 32-49.
- Lu, C-t. (June, 2008). *Aviation Security Management Model*, Aviation Security Management (A. R. Thomas, eds.). University of Akron.
- Lu, C-t., Bos, P., & Caldwell, W. (2007). System safety application: Constructing a comprehensive aviation system safety management model (ASSMM). *International Journal of Applied Aviation Studies*, 7(1), 28-45.
- Lu, C-t, Przetak, R., & Wetmore, M. (June, 2005). Discovering the non-flight hazards and suggesting a safety training model. *International Journal of Applied Aviation Science*, 5(1), 135-152.
- Lu, C-t., Wetmore, M., & Przetak, R, (Oct., 2006). A new approach to enhance airline safety: Using system safety techniques. *Journal of Air Transportation*, 11(2), 113-139.
- Majchrzak, A. (1984). *Methods for policy research*. Beverly Hills, CA: Sage.
- Mirza, M. et al. (2008). Community reintegration for people with psychiatric disabilities: challenging systemic barriers to service provision and public policy through participatory action research. *Disability & Society*, 23(4), 323-336.
- National Commission on Terrorist Attacks. (2004). *The 9/11 commission report*. NY: W. W. Norton & Company.

- Nyden, P., Figert, A., Shibley, M., & Burrows, D. (1997). *Building community: Social science in action*. Thousand Oaks, CA: Pine Forge
- Reason, P. (1997). Revisioning inquiry for action: A participatory view. Conference proceeding. *American Academy of Management*. Boston.
- Reason, P. (2003) *Choice and quality in action research practice*. Bath, University of Bath.
- Robson, C. (1993). *Research world research: A resource for social scientific and practitioner-researchers*. Cambridge, MA: Blackwell
- Rorty, R. (1982). *Pragmatism, relativism, and irrationalism*. United Kingdom: Cambridge University Press
- Stringer, E. T. (1996). *Action research: A handbook for practitioners*. Thousand Oaks, CA: Sage.
- Vincoli, J. W. (1993). *Basic guide to system safety*. New York: Van Nostrand Reinhold
- Walker, W. E. (1993). *Policy analysis and public administration*. Santa Monica, CA: Rand.
- Wood, R. H. (2003). *Aviation safety programs: a management handbook*. (3rd ed.). Englewood, CO: Jeppesen Sanderson.

Appendix A

Proposed Aviation Safety Management Model (via AR's "Look-Think-Act" path)



Appendix B

Risk Matrix (via AR's "Think" path)

Frequency of Occurrence	Severity			
	(1) Catastrophic	(2) Critical	(3) Marginal	(4) Negligible
(A) Frequent	High	High	3A	4A
(B) Probable			3B	4B
(C) Occasional	High	2C	3C	4C
(D) Remote		1D	2D	3D
(E) Improbable	1E	2E	3E	4E

Risk Categories:



Description	Category	Mishap Definition
Catastrophic	I	Death or system loss/failure
Critical	II	Severity injury, occupational illness, or system damage
Marginal	III	Minor injury, occupational illness, or system damage
Negligible	IV	Other

Description	Level	Mishap Definition
Frequent	A	Likely to occur frequently
Probable	B	Will occur several times during the life of an item
Occasional	C	Likely to occur sometimes in the life of an item
Remote	D	Unlikely, but may possibly occur in life of an item
Impossible	E	So unlikely, assumed that hazard will not occur at all

Source: MIL-STD-882 (DoD, 2000)

