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Decision analysis techniques for adult learners: application to leadership

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DECISION ANALYSIS TECHNIQUES FOR ADULT LEARNERS – APPLICATION TO LEADERSHIP

A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Organizational Leadership

by

Farah Toosi

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Under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

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DEDICATION

I would like to dedicate this dissertation to my husband, Paul, my dad Amir and my daughter Roxana.

ACKNOWLEDGMENTS

I would like to thank and acknowledge my dissertation committee Dr. June Schmieder-Ramirez, Dr. Christie Cooper and Judge John Tobin. I want to give a special thanks to Dr. Maria Painter for her support during three years of my dissertation process.

VITA

Education

Doctorate of Organization Leadership student, ABD

Pepperdine University, Irvine CA

Master of Science, Engineering Management, August 2008
University of Southern California; Los Angeles, CA

Master of Science, Electrical Engineering (RF Communication Option), September 2005
*California State Polytechnic University Pomona; Pomona, CA, Master's thesis title "**Sense through the Wall (STTW)**"*

Bachelor of Science, Electrical Engineering, (Communication Option) March 2003
California State Polytechnic University Pomona; Pomona, CA

Industry Experience

Raytheon Corporation, Space and Airborne Systems Division
November 2014 to present (Space Parts Manager) El Segundo, CA

- Earned value certified
- Manufacturing Review Board Certified(Acting PMPCB for CORE Electronics program)
- Responsible for developing and executing the program's Parts Management Plan in accordance with the program SOW and our SAS EMS requirements. More specific responsibilities include managing the program's approved parts list (i.e., APMPL), ensuring parts and supplier standardization (i.e. RSP), managing PMPCB, and performing obsolescence management.
- Coordinate the release of part specifications, resolve GIDEP alerts, and coordinate part test and failure analyses with the component labs. Working proactively with suppliers to resolve part and supplier technical issues.
- 5 airborne and 2 space Program point of contact for Part Technical Issues
- Program Parts Management Plans & APMPL Management
- Counterfeit Parts Risk Mitigation
- Obsolescence Risk Mitigation
- EVMS reporting
- RCCC Bid & Proposal Support (Defined requirement for Consolidated BOM space program Electronics flight)
- Technical support to Design Engineering, Supply Chain Management and Operations
- Part & System Criticality Analyses

Boeing Space & Intelligence Systems
September 2014 to November 2014 (Part, Material, Process Control Board) El Segundo, CA

- Commercial satellite programs
- Revised PMP commercial plan and briefed customer with 100% customer approval
- Participated in Qualification Review Board as PMPCB chair
- GIDEP, SQIC and alert review of devices used for certain commercial satellite program

October 2006 to September 2014 (Component Engineering, RF Products)

- Applied RF/Microwave expertise as member of Component Engineering RF/Microwave team involved with selection, application, and development of high reliability, high density, and high speed advanced RF/Microwave components for space communication systems
- Participate in Development of RF/Microwave components, Critical Design Review and Product Development Review
- Define requirements, and support suppliers in developing new technologies to meet customer requirements
- Apply knowledge of controlling specifications and parts management in order to analyze applications, qualify parts, determine part drawing, specify replacement parts, and evaluate life cycle and logistics impact
- Demonstrated experience with RF/Microwave components with specific knowledge in design and fabrication of RF passive and active devices for high reliability space application
- Developed qualification plans for space applications of RF/Microwave passive devices. This includes the thermal, mechanical, and electrical stress tests to prove out long term reliability over 15 year missions. Followed through from plan inception, product design and development, test house evaluation, test execution, data analysis/reduction, and final report generation.
- Demonstrated track records to work effectively with design community, suppliers, program management, and customers to address technology selection, device development, design application, device fabrication and device/application problem resolution
- Interface effectively with product team leads and program managers. Demonstrated technical excellence while meeting cost and program schedule leading to a high level of customer satisfaction
- Led the Component Engineering Change Control Authority. Duties were to review and monitor revision of specification control drawings for high reliability devices. Duties were to ensure revision changes were interchangeable, decide on the class of the change, monitor the revision process through review with end users, and conduct final board meeting. (March 2011-Jan 2013)

Raytheon Corporation, Space and Airborne Systems Division

March 2004 to September 2006 (Antenna Component Design Engineer) Electrical Engineer

- Hardware design of RF feeds for Northrop Corp. UCAV airborne radar system antennas using HFSS and ADS software in addition to performance verification after fabrication
- Finite element model creation of individual broad-band power dividers in HFSS
- N-way feed performance cascade analysis using HFSS models with ADS
- Design of multi-stage power dividers for X and Ku band applications (with equal line lengths to get the same phase shift)
- Comprehensive design of housing and (PWB) assemblies
- Broad band design of coaxial interconnects between feeds
- Near field testing of B2 bomber modernization antenna subsystems in high power range
- Design of a performance verification tool in HFSS for analysis of dipole antennas
- Design and analysis of a circulator test fixture and Coupler
- Novel flared notch antenna radiator design for NASA airborne space program with stringent weight and frequency operation specifications. Antenna pattern prediction using Matlab software

MSO Technologies, INC. (IRWD, Edison, PacBell, Boeing contractor)
March 2003 - March 2004, Control system engineer (software engineer) Irvine, CA

- Industrial Programmable Logic Controller (PLC) development using Concept and Ladder Logic software. Experience with Wonderware programming and Maple programming using HMI's located in PLC chassis
- Hardware and wireless communication testing between the PLC's chassis

Modern Technologies Corporation (Jet Propulsion Laboratory's contractor)
March 2002 – March 2003, Test Engineer Pasadena, CA

- Performed hardware tests to control motion of Deep Space Network antenna using PLCs
- Designed circuit board test fixtures for evaluation of prototype circuits. Performed DC and AC analysis on prototype circuits. Documented all tests and recommended hardware design improvements based on the results.
- Experienced with test lab, field static, dynamic and integrated systems
- Performed in-house Acceptance Test (software and hardware) on the Antenna Logic Controller (ALC) Assembly, Tested the ALC interfaces with electronic assemblies for signal compatibility in accordance with Interface Agreement documents

Teaching Experience

Saddleback College (Division of Advanced Technology and Applied Science)

January 2009 to December 2009 (part-time faculty) Mission Viejo, CA
Instructor for "Fundamentals of AC and DC Electronics" course, including lecture and laboratory.

Skills, Training and Related Studies

- Satellite Attitude Control, Astrodynamics & Mission Operations, Antenna Analysis and Design, Integrated Circuit Analysis and Design, Digital Communication Systems, Signal Image Processing, Advanced Digital Signal Processing, Communication System Theory, Amplifier and Transistor Devices design, Wireless Communication, Microwave Engineering, MEMS, Field and Wave RF electronics, Microprocessors, Satellite Communication Systems, Solid State Microwave Devices and Circuit design, Wavelet Theory and Filter Banks, Matrix Methods in Engineering, FPGA Design Laboratory
- Management of Engineering teams, Design of Experiments, Strategic Management of Technology, Value and decision making, Financial Accounting Analysis for Engineering, Systems Engineering Theory and Practice, Advanced Data Analysis & Interpretation, Learning Course Design and Evaluation, Economic and Political System, Strategic Leadership and Change, Leadership, Advocacy, and Policy, Law and Dispute Resolution,
- Design of High-Performance RF and Microwave Antenna components. Proficient in Microwave Measurement and Characterization Instruments (VNA, SNA, Spectrum Analyzer, Sampling Oscilloscopes)
- Matlab, C++, Design Experience with Various CAD Packages (PSpice, Matlab, MathCAD, System View, Wonderware, AutoCAD, HFSS, ADS, CST (Design, EM Microwave and Particle studio), JMP, AWR

Projects

Sense through the Wall (STTW; Graduate Project)

- The project was to make a human detection sensor using flared notch array antenna. Investigation through literature research and the principles of "printed end-fire flared notch element". The design was researched, fabricated and tested.

Image Compression (undergraduate Senior Project)

- Image compression and processing. Simulated new version of JPEG compression using generated DCT code with Matlab and Run length / Huffman code in C. Analysis of the Synthetic discriminant Function Filter and the Maximum Average Correlation-Height Filter in image Recognition applications

Certified Trainings and Presentations:

- Noon-time Seminar Presentation, Boeing Space and Intelligence Systems, Specialty Engineering Lunch-and-Learn Series, El Segundo, CA (2008), "Isolators, design, reliability and performance"
- Celebration of Women in Technology conference Presentation, Boeing Space and Intelligence Systems, CWIT Series, El Segundo, CA (2009). ASEM conference Presentation Nominee (Abstract approved- paper in progress), "High-Reliability Component Supplier Selection using Decision Analysis Techniques"
- Introduction to Radar Systems, Laser Radar Systems (Ladar), Electrostatic Discharge, Laboratory Electrical Safety, Hazardous RF Communications, An Introduction to Astrodynamics and Space Systems

Professional Memberships and Accomplishments

Institute of Electrical and Electronics Engineers (IEEE), Member since 2002; Society of Women Engineers (SWE), Member since 2001; American Society of Engineering Management(ASME), Member since 2007; Boeing Women in Leadership (BWIL), Member since 2006, Volunteer work: Metrics lead (2009), event lead (financial seminar 2011); Dean's List at California State Polytechnic University, Pomona ; Certified Engineer In-Training (Professional Engineering Certificate, Pending)

ABSTRACT

Most decision analysis techniques are not taught at higher education institutions. Leaders, project managers and procurement agents in industry have strong technical knowledge, and it is crucial for them to apply this knowledge at the right time to make critical decisions. There are uncertainties, problems, and risks involved in business processes. Decisions must be made by responsible parties to address these problems in order to sustain and grow the company business.

This study investigates some of the most recognized decision analysis techniques applied by global leaders from 2006 to 2016. Several decision analysis tools are introduced such as heuristic decisions, multi-attribute rating, decision trees, Monte-Carlo simulations and influence diagrams. The theoretical development framework is presented. The approach for this research is Analyze, Design, Develop, Implement, and Evaluate (ADDIE), which included cognitive, behavioral, and constructive learning theories. Some of the top decision analysis skills needed for today's leaders and managers from literature review over the past decade (2006 to 2016), were taught to organization leadership doctorate students. Research scheme, the method chosen for selecting the topic, group of contributors, and the method selected for collecting the data are offered.

The learners were in their senior year of a leadership doctorate program and they did not need leadership training along with decision analysis technique training. Older learners had more interest in learning the fishbone and influence diagrams prior to the training. Students with intermediate math were more interested in learning about strategic planning techniques before training. The trainees with more computer skills were interested in learning the Zachman framework technique, which was surprising to the researcher since this tool does not require extensive computer skills.

After the training, the researcher observed that learners with higher computer skills showed more interest in learning about group decision-making (consensus versus analytic hierarchy process). That students with intermediate math skills were more interested in top-down induction of decision trees, algorithm decision making (data mining and knowledge discovery), and strategic planning techniques.

Spearman correlations with a moderate strength showed that older respondents tended to be more interested in the analytical hierarchy process, fishbone diagram, and risk analysis tool. After the training, students with stronger computer skills showed greater curiosity about learning more about the decision tree analysis, Zachman framework, and risk analysis. It made sense that students with weaker computer skills were less eager to learn about the Monte-Carlo simulation.

Chapter 1: Introduction

Background

Industry and academia both have a vested interest in decision analysis techniques. It is more productive for businesses if employees join the workforce with critical thinking skills. The purpose of this research is to create future leaders with skills applicable to both academia and industry and form teams that make sound and timely technical decisions in an organized way. According to Winterfeldt (2012), only two universities offer decision analysis classes to prepare future leaders in decision making. The University of Southern California and University of California San Diego are the only schools with nationally recognized engineering programs in Southern California that offer decision analysis classes. This dissertation discusses algebra level decision analysis techniques focusing on future leaders in industries, specifically in Southern California.

Decision theory is the analysis of an individual's behavior when faced with non-strategic uncertainty. This uncertainty is a result of what is known as *nature*, which is defined as a stochastic natural event such as a coin flip, seasonal crop loss, personal illness, etc. If other individuals are involved, their behavior is treated as a statistical distribution known to the decision maker. Decision theory depends on probability theory, which was developed in the 17th and 18th centuries by notables such as Blaise Pascal, Daniel Bernoulli, and Thomas Bayes.

Sun (2014) stated that there are subjective decisions made in the conceptual design phase that can have a major impact on the final performance of the design. Decision analysis techniques are used widely in the high-tech industry for technical decision making. Decision analysis technique is subjective, which explain how someone looks into situation. In addition, business and management leaders can make the right decisions at the appropriate time using available information. These leaders can help companies win new business and increase customer confidence. Barker (2012) stressed that decision analysis helps decision makers assess tough decisions by managing risk in a way that provides a convincing course of action.

Barker (2012) also noted when making decisions, human beings apply heuristic rules of thumb that they have learned or developed through experience. Judge Tobin noted “As an adjective, heuristic (pronounced hyu-RIS-tik and from the Greek ‘heuriskein’ meaning “to discover”) pertains to the process of gaining knowledge or some desired result by intelligent guesswork rather than by following some pre-established formula. (Heuristic can be contrasted with algorithm; J. Tobin, personal communication, January 22, 2013). The term seems to have two usages:

1. Describing an approach to learning by trying without necessarily having an organized hypothesis or way of proving that the results proved or disproved the hypothesis. That is, “seat-of-the-pants” or “trial-by-error” learning.
2. Pertaining to the use of the general knowledge gained by experience, sometimes expressed as “using a rule-of-thumb.” (However, heuristic knowledge can be applied to complex as well as simple everyday problems. Human chess players use a heuristic approach; J. Tobin, personal communication, January 22, 2013).

As a noun, a heuristic is a specific rule-of-thumb or argument derived from experience, which is the definition used here. Decision analysis techniques are an application of heuristic knowledge to a problem. However, decision heuristics can be misleading. When decisions are made frequently and the decision maker has significant experience, using decision heuristics can be a quick and effective method. However, for individuals with less experience or those dealing with unfamiliar situations, faulty decisions are made that can result in costly or ineffective outcomes. Decision analysis helps decision makers evaluate tough decisions by managing complexity in a way that provides a compelling and defensible course of action. It incorporates both objective data and subjective perspective into a decision model. Then the decision maker analyzes the model and chooses the preferred course of action.

This study investigates some of the most recognized decision analysis techniques applied by global leaders in the last decade. Several decision analysis tools exist, such as heuristic decisions, multi-attribute rating, decision trees, Monte-Carlo simulations, and influence diagrams (Barker, 2012). There are also basic decision analysis indicators such as defenders, prospectors, analyzers, reactors, and spontaneous (Miles & Snow, 1978). IBM is one of the one of the companies that use decision analysis techniques widely.

> Defenders seek moderate, steady growth by offering a limited range of products and services to a well-defined set of customers. Prospectors seek fast growth by searching for new market opportunities, encouraging risk taking and being the first to bring innovative new products to market. Analyzers are a blend of the defender and prospector strategies. Analyzers seek moderate, steady growth and limited opportunities for fast growth. Analyzers are rarely first to market with new products or services. Organizations try to simultaneously minimize risk and maximize profits by following or imitating the proven successes of prospectors. Unlike defenders, prospectors, or analyzers, reactors do not follow a consistent strategy. Rather than anticipating and preparing for external opportunities and threats, reactors tend to respond to changes in their external environment after the changes occur. (Williams, 2006, p. 44)

Other examples of the most recognized decision analysis techniques include those used by NASA’s Goddard Space Flight Center, which introduced a 5x5 risk analysis technique that is commonly used for decision analysis involving high tech industry with military and space contracts. “Widely accepted and state-of-the-art risk matrix templates are available from several reputable sources including, Defense Acquisition University (DAU)/Defense Systems Management College (DSMC), Software Engineering Institute (SEI), NASA Policy Guidance Document 7120.5B as well as others” (Malone & Moses, 2004, p.4).

> Furthermore, Bharath Bhushan Dantu (2011) postulated that complex system decision making is explained using system dynamics and Zachman Framework techniques. Zachman Framework is an Enterprise Architecture introduced in 1987 by John Zachman ad extended by Sowa in 1992. This framework helps in modifying an enterprise into a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management and as well as the development of the enterprise’s systems. (Dantu, 2011, p. 36)

This System Dynamics approach is inferior to Soft-System Methodology (SSM), first introduced by Checkland in 1981, which attempts to define a single right method of action. The SSM method is more effective because a “complex system has fuzzy problems that occur when objectives are unclear, multiple objectives exist, and where there may be several different perceptions of the problem” (Dantu, 2011, p. 7).

Hightower (2014) compared the most widely recognized decision analysis techniques such as group decision-making introduced between consensus and analytic hierarchy process techniques. In that study, he explained that “Interacting groups typically use some form of voting or consensus to make group decisions” (Green & Taber, 1980). “Voting can be by majority, minority, or unanimous polling” (Saaty & Shang, 2007). “Consensus is a process that builds through iteration to arrive at a decision that everyone can ‘live with’” (Arnold, 2008, p. 178).

Decision making techniques in support of a simulation training transfer selections study is also reviewed for this research. Research includes "the Equipment Quantifying Usage Impact Process (EQUIP), the disjunctive decision-making approach, the Multi-Attribute Utility Theory (MAUT), the lexicographic approach, the elimination by aspects decision-making method, hierarchical task analysis and Lens decision making models" (Bachman, 2012, p. 16).

"The more traditional rational-classical decision making can become very costly in time and effort, if multiple options must be explored and assessed in detail" (Flaming, 2007, p. 5). "They appear to apply the decision alternative that most immediately satisfies their highest priority criteria rather than conduct exhaustive searches for the most optimal decision option" (Zsambok & Klein, 1997, p.184). "The most skilled decision makers may develop their own heuristics or decision rules-of-thumb that guide them in reaching effective decisions" (Klein, 2002; McLucas, 2003, p. 207). As (Mohrman & Finegold, 2004) mentioned the visions on expert decision making can also help bond the knowledge gap that typically exists between formal company procedures and expert enactment.

Statement of Problem

Most of the decision analysis techniques are not taught at higher education institutions. Leaders, project managers, and procurement agents have strong technical knowledge, and it is crucial for them to apply their knowledge at the right time to make critical decisions. There are uncertainties, problems, and risks involved in business processes. Decisions must be made by responsible parties to address these problems in order to sustain and grow the company business. Leaders must set up the projects with proper requirements, including timelines and costs.

Organizations need employees with a structured decision analysis background to not make biased decisions. Scientists and engineers assist the program managers with technical rationales to define the conditions in the early stage of product development. Procurement agents and planners help project managers and leaders with timelines and background experience. Procurement agents, program managers, team leaders, scientists, and engineers make decisions as a group. The problem is further many of the important decision analysis techniques require advanced knowledge of statistical analysis. However, decision analysis techniques using algebra level math are more suitable to organizations.

Decision theory has two components: a cognitive decision maker and a random event. The decision maker performs analysis and calculations, and renders a cognitively-biased decision. The natural event is random, not cognitive, does not select a course of action in any biased way, and depends on probability. The two fundamental concepts of decision theory are arbitrary environmental conditions and a decision maker's actions. The theory states that the random event is not controlled by the decision maker, but controlled by nature; however, the decision maker controls the selection of available actions. The decision maker should have the proper training to make an unbiased decision.

Leaders must learn decision analysis techniques because risk, issue, and opportunity management are orderly, systematic, continuous practices of identifying, analyzing, handling, communicating, and tracking risks, problems, and opportunities. Timely application of these principles is critical for effective technical management in a dynamic (ever-changing) business environment. It is vital to provide a decision making plan to each team in the organization, with the standard tools and techniques for efficient decision-making.

For this study, decision analysis techniques are gathered to create a core competency for leaders. As Northouse (2013) mentioned, transformational leadership is an appropriate choice for coaching and teaching the decision-making techniques because it provides an innovative way of thinking about leadership. Northouse emphasized inspiration, innovation, and individual concern. Bass and Avolio (1990) stressed that transformational leadership is a good leadership style for training and development, and is often used in decision-making groups. In *Leadership: Theory and Practice,* Northouse (2013) identified four core elements of transformational leadership: idealized influence, inspirational motivation, intellectual stimulation, and individual consideration.

The other leadership theory which is focused in this study is Leader/Member exchange theory (LMX). Graen and Uhl-Bien (1995) found that LMX is tied to organizational performance, innovation, and job climate. Graen and Uhl-Bien (1995) validated the theory with these improved organizational outcomes.

The cognitive learning style is in line with the intellectual stimulation element of transformational leadership. Northouse (2013) stated, “It encourages followers to think things out on their own and engage in careful problem solving” (p. 179). An intelligent approach can be formulated using decision analysis techniques rather than unwisely following the footsteps of others. Examples of transformational leaders include Mohandas Gandhi, who raised hope in his followers; Ryan White, who become a government spokesperson and increased government support for AIDS; and Nelson Mandela, who was the first non-White president of South Africa and elevated the morale of his people. Bass and Avolio (1990) referenced and explained transformational leadership style in several cases. According to Northouse, Walt Disney was a transformational leader who helped change the status quo by appealing to followers’ values and their sense of higher purpose.

A focused, cohesive structure is a foundation for high-performing teams (Bolman & Deal, 2003) and is one of the pillars of transformational leadership. Hirsh and Kummerow (1998) introduced a different type of organization with one of the characteristics of a transformational leader. Transformational leaders are committed to increasing company morale. Another transformational leadership factor is designed to increase intellectual stimulation by fostering innovation with a focus on customer satisfaction.

According to Bass and Avolio (1990), effective leaders can possess traits of both transformational and transactional leadership; however, they use training evaluation results to determine which leadership style best fits the organization. Decision analysis techniques are applied to transformational or LMX leaders to enhance their leadership characteristics. Decision analysis is a well-established discipline. Early decision theory research was concerned with using probability and utilities to evaluate alternatives (Raiffa & Schlaifer, 1961). Scattered techniques are used across industries for making decisions rather than basic statistics and probability. It is important for companies to have set decision-making techniques to ensure homogeneity within the business. Knowledge of these techniques allows everyone to speak the same language and have a cohesive decision-making team. Newell and Simon (1963) stated that business and management learners must be exposed to these techniques because decision making is the essence of management. Decision analysis techniques provide a means of formulating problems, defining hypotheses, collecting scatter solutions, and finalizing results.

Statement of the Purpose

The purpose of this mixed-method research (both qualitative and quantitative) in combination with a quantitative correlational study is threefold: (a) to perform a literature search to determine the top decision analysis skills that managers should possess; (b) to examine business students' baseline levels of knowledge about the skills before receiving training; and (c) after receiving training on these tools, to determine students' likelihood of using the tools in the future. In addition, demographic variables will be gathered to examine which types of students have prior knowledge about the tools and identify demographics of individuals who would be more likely to use those tools in the future.

Significance of the Topic

Industries have interest in risk and opportunity (R&O) analysis and this study seeks to motivate business teams to learn decision analysis techniques as they apply to R&O analysis. It is critical for leaders to have a background in decision analysis techniques prior to joining the workforce. It is important to create a training course in the field of decision analysis for future managers, team leaders, marketing, and supply chain groups to raise their expertise in the industry toward technology development.

This study seeks to identify learners' transformational leadership and LMX knowledge within the context of decision analysis techniques. The consequences of engineering and business decisions (both good and bad) demonstrate the power to generate vast wealth or drive once-prosperous corporations into bankruptcy. Decision making is a critical skill that comes with risk and uncertainty factors. This research enables the learner to formulate, collect, analyze, frame, and interpret decision-making information for selecting the best alternative action.

This study will implement decision analysis techniques utilized by global leaders and create a decision analysis training package for future managers, team leaders, marketing and supply chain groups. The purpose is to increase expertise in this field and move businesses and industry forward in technology development through the use of effective decision analysis techniques. The objective is for leaders to gain a working knowledge of techniques for R&O analysis, while exposing them to technical decision making opportunities in order to grow their appreciation for these skills.

Key Definitions

- *Andragogy:* another term for adult learning.
- *Cognitive learning:* Shows what happens to learners and how training may have impacted their memories and performance. Knowles, Holton, and Swanson (2011) stated, "Three streams of closely related cognitive psychological research help explain how prior experience influences learning: schema theory, information processing, and memory research" (p. 189).
- *Decision theory:* Pertains to human decision making in a world of incomplete information and lack of human control over events.
- *Fishbone:* "A graphic mapping technique originated in Japanese quality practices, called Ishikawa Fishbone diagrams, where the underlying causes are identified and visually linked to their effects" (Fleming, 2007, p. 11).
- *Heuristic:* A rule of thumb, practical method that is not guaranteed.
- *Leader-Member exchange:* A form of leadership in which the leader forms special relationships with all of his or her subordinates. Each of these relationships is special and has its own unique characteristics.
- *IDSS:* IDSS is a decision making tool. The main new tool described is Induction of Decision trees with Second-order decision-tree induction and Support vector machines for multi category (Lee, 2008).
- *Intelligent stimulation:* "Encourages followers to think things out on their own and engage in careful problem solving" (Northouse, 2013, p. 179).
- *Risk:* Per the National Aeronautics and Space Administration (National Aeronautics and Space Administration [NASA], 1999) procedures and other industry standards define risk

as: "A future event with a definite probability of occurring and an anticipated negative consequence. Risk mitigation involves taking specific actions to reduce the probability that a risk will occur or [to reduce] the severity of the consequences" (NASA, 1999, p. 3).

- *Stochastic process:* probability process of random variables.
- *SODI:* Second-Order Decision-tree Induction, a well-established algorithm tool (Lee, 2008).
- *SVMM:* Support Vector Machines for Multi-category, a well-established algorithm tool (Lee, 2008).
- *Transformational leadership:* Introduced by James McGregor Burns (1978) in his book, *Leadership*. Defined as a method by which leaders and followers raise one another to higher levels of morality and motivation.

Key Assumptions

Key assumptions for this research are identified as follows:

- Learners in undergraduate programs are typically of adult age, but in a few cases learners might have started at the university at a younger age. Therefore, if they are under the age of 18, they will not be permitted to take the survey.
- Data collection will be focused on adult learners with algebra-level mathematical backgrounds or higher (decision analysis methods require some mathematical calculations).
- Learners are employed in high-tech industry so they can apply the knowledge to the current or future perspective positions.
- Some learners might already be familiar with some of the leadership styles since focus groups are higher education learners.

Limitations of the Study

Limitations of the study include:

- Only one group within the university under investigation will be surveyed.
- Managerial level of users of through literature study for top decision analysis techniques is not detectable.
- Not all decision analysis techniques are used in this study
- The entire workforce is not being surveyed.
- Based on the proprietary nature of some work, learners with military background or working for high-tech industries might not disclose the full scope of their prior experience for training in the field of decision making.

Summary

Decision analysis techniques have never been taught in College of Business and Public Management undergraduate programs. Decision analysis techniques would be taught during Leadership in Organizations class. Learners such as managers, marketing, and human resources face critical decision making situations. Algebra level decision analysis techniques focuses on leaders in industries, specifically in Southern California in this research. Several academic institutes and companies that have an interest in decision making techniques, and top leaders use a variety of decision analysis tools. Some transformational and LMX Leaders might not be familiar with the standard tools and techniques for efficient decision making.

Chapter 2: Review of Literature

Historical Background and Context of the Issue

This study demonstrates the need for a decision-making curriculum in undergraduate organizational leadership programs. Von Winterfeldt's (2012) study at the University of Southern California showed how much of the workforce would benefit from an advanced decision making education. This study is a replication study of an advanced decision analysis class by Dr. Detlof von Winterfeldt at the University of Southern California (USC). Dr. Winterfeldt teaches the decision analysis techniques with advanced statistical analysis to engineering management program at USC. This study shows how to apply similar techniques and additional techniques learned from industry with algebra level math to management students.

Theoretical Framework for the Study

Decision analysis theory. French mathematician Blaise Pascal first introduced probability and decision theory in 1964 (Chew, 2016). "The Pascal's Wager argument tacitly exploits some principles of practical rationality that have come to be enshrined in an explicit theory, sometimes called 'decision theory' or 'rational choice' theory" (Princeton University, 2016, p.1). Daniel Bernoulli introduced Utility theory 1738 via the St. Petersburg Paradox which is another game theory that was introduced to decision theory.

To offer a brief history of decision analysis, John von Neumann and Oskar Morgenstern introduced modern utility theory and the basic theory of games from 1944-1947. In the early 1950s, Harry Markowitz presented the beginning of portfolio theory (implies quadratic utility functions) and Maurice Allais (1953), known for paradoxical gambles and the end of maximum expected utility as a descriptive theory for decision analysis. In the early 1960s, William Sharpe explained the single index model as a computationally efficient model of portfolio analysis. In the 1970s, Stephen Ross introduced the multiple-index model as an economics-based model of portfolio theory, Daniel Kahneman and Amos Tversky explained Prospect Theory as a non-maximum expected utility and cumulative Prospect Theory as also a non-maximum expected utility theory (von Winterfeldt, 2008).

Learning theory. The theoretical development framework approach for this research is Analyze, Design, Develop, Implement, and Evaluate (ADDIE), which includes cognitive, behavioral, and constructive learning theories (Knowles et al., 2011). The main training and development approach focuses on creating a decision analysis framework for adult business backgrounds. ADDIE is the framework implemented with adult learning andragogy and cognitive learning, and is evaluated using Kirkpatrick's model. The Kirkpatrick model, created by Dr. Don Kirkpatrick in the 1950s, is designed to both maximize and demonstrate general adult training's value to the organization.

***Andragogy*.** This research follows andragogy theory since the future learners are all adults. Knowles et al. (2011) stated, "We see the strength of andragogy as a set of core adult learning principles that apply to all adult learning situations" (p. 233).

The andragogical instructor (teacher, facilitator, consultant, change agent) must prepare a set of procedures to involve the learners and other relevant parties in a process that includes the following elements:

- Learner preparation,
- Establishment of a climate conducive to learning,
- Creation of a mechanism for mutual planning,
- Diagnostics on the need for learning,
- Formulation of the program objectives (content),

- Design of a pattern of learning experiences,
- Implementation of these learning experiences with suitable techniques and materials, and
- Evaluation of the learning outcomes and re-evaluation of the learning needs.

A step-by-step procedure is followed to prepare learners to follow the decision analysis techniques. The profession of the learners is considered in order to explain decision analysis topics effectively to improve their job performance. These decision analysis topics are designed to create a climate conducive to learning in the organization. The example focuses on how these techniques are applied to make certain leadership decisions. Furthermore, the learners have different industry backgrounds and math expertise, and the techniques are developed using algebra-level statistical analysis. This research uses evaluation of the learning from Kirkpatrick's Four-Level Training Evaluation Model in order to measure reaction, learning, behavior, and results.

Miller (1964) wrote the following about adult learning:

> Attempts to bring the isolated concepts, insights, and research findings regarding adult learning together into an integrated framework began as early as 1949, with the publication of Harry Overstreet's The Mature Mind. Other related publications followed, including Informal Adult Education (Knowles, 1950), An Overview of Adult Education Research (Bruner, 1959), How Adults Learn (Kidd, 1973), J. R. Gibb's chapter titled "Learning Theory in Adult Education" in the Handbook of Adult Education in the United States in 1960, and Teaching and Learning in Adult Education. (Miller, 1964, p. 904)

Knowles et al. (2011) introduced andragogy as an informal general adult learning theory, focusing mainly on how adults develop and lead their own learning process. Andragogy states that adults need to know why they have to learn something. This theory is general in the sense that it lacks evidence for specific adult learning cases. However, the theory has been improved continuously throughout the years, since the background and experience of the adult learners and topics of interest varies. Knowles et al. recognized the idea of individual differences impacting learning, “A typology of individual differences that impact learning was presented” (Jonassen & Grabowski, 1993, p. 194) to evolve andragogy theory, but there are still flaws in the theory.

By 2011, andragogy theory had expanded to consist of six core principles:

(a) The learner’s need to know

(b) Self-concept of the learner

(c) Prior experience of the learner

(d) Readiness to learn

(e) Orientation to learning

(f) Motivation to learn. (Knowles et al, 2011)

This theory is relevant to learners because they are adults; however, this research needs more learner-focused training. Adult learning process mentioned above evolved in more than 50 years, but andragogy theory is too general; therefore this research is exploring cognitive learning, which is specific and suited for this study. This will be explained in more detail in the cognitive learning section; however, the focus is on both andragogy and cognitive learning theory.

Gagné (1972) identifies five different areas of the learning process, all of which have their own approach:

1. Motor skills, which are developed through practice.
2. Verbal information, the major requirement for learning being its presentation within an organized, meaningful context.

3. Intellectual skills, the learning of which appears to require prior learning of prerequisite skills.
4. Cognitive strategies, the learning of which requires repeated occasions in which challenges to thinking are presented.
5. Attitudes, which are learned most effectively through the use of human models and "vicarious reinforcement." (pp. 3–41)

Bloom, Engelhart, Furst, Hill, and Krathwohl (1956) identified three domains of educational objectives: cognitive, affective, and psychomotor. Cognitive learning "deals with the recall or recognition of knowledge and the development of intellectual abilities and skills" (p. 7).

Decision making should be applicable to proposal, failure investigations, and future design considerations. The recollection and application of the skills will lead to intellectual stimulation. Learners will check their skills, as they would apply formal, structured, and statistically based decision analysis techniques in the case study (see Appendix A). Selected cognitive learning is in line with the transformational leadership style, since cognitive learning prepares learners with intellectual stimulation. Both cognitive learning and the transformational leadership style are concerned with the learner's intellectual stimulation.

The word *learning* is related to the individual in whom the transformation arises or is expected to happen. Learning advances skills, increases knowledge, and changes the behavior of the learner. According to Knowles et al. (2011) on learning theory:

> Just as there is no single theory that explains all of human learning, there is no single theory of adult learning. Instead, we have a number of frameworks, or models, each of which contributes something to our understanding of adults as learners. The best known of these efforts is andragogy. (p. 83)

The cognitive-based approach is selected for the adult learning model through a critical examination and comparison with constructivist and behaviorist learning.

Cognitive learning theory. Cognitive learning theory explores what happens to learners when training impacts their memory and performance. Cognitive learning is a better approach to learning decision making skills. Knowles et al. (2011) stated, "Three streams of closely related cognitive psychological research helps to explain how prior experience influences learning: schema theory, information processing, and memory research" (p. 189). The cognitive learning approach objective is to gain the learners' attention while informing them of the decision analysis topic and stimulating recall of prerequisite learning. Finally, the learners are presented with intellectually stimulating material as it relates to the following applications: learning techniques and applying techniques to improve learners' job performance, improvement of information retention, and finally, transferring the information to their present work. Making decisions with a more thorough analysis process enhances job performance. Information retention is improved using procedural knowledge and transferring information to present work.

The key aspects of cognitive learning rules apply to the decision analysis topic and eventually the learning procedures using the Kirkpatrick model. The first step ensures that the training package includes declarative and procedural knowledge. PowerPoint presentations, videos, and exercises with real work examples are a way to facilitate the decision theory topic. The workflow is created to structure the learning package. Leaders learn each type of declarative knowledge in a different way. There are different ways to communicate facts and concepts learned through on-the-job training and the theoretical principles. Facts, concepts, principles of decision making, and risk analysis techniques should be presented while trying to avoid overloading the learning package with theory and formulas. Instead, industry examples are used to explain and implement the principles. Examples such as decision making for buying a car, naming an unborn child, or picking a restaurant for dinner are fun applications to practice using decision analysis techniques. Learners apply techniques to simple interactive decision analysis topics initially and then gradually the complexity of the examples is increased for intellectual stimulation. To complete the training package and to maintain cohesiveness, all of the information is presented in the same structure. Different problems will be defined to show clear, moderate, or poorly structured problems. Initially the learner implemented the techniques on well-defined problems with one clear solution then moderate problems with several solutions, or vague problems with one or more variables missing are examined. The research has varied procedural knowledge based on the structured prior trainings. One cognitive learning tool is procedural knowledge that involves manipulating the relevant mental model. To move toward correct decision making, a cognitive learning approach may be use to manipulate the learner's relevant mental model. The learners follow a systematic format using techniques based on the project's facts.

To solve unfamiliar problems inductively first, this research forms an initial step to help the learner understand the problem. Unfamiliar problems are then presented to learners in order to check what they know about similar problems. Learners form a subset that is appropriate for the existing problem, and they recall a specific past procedure that can be followed in the subset of the unfamiliar problem. If the problem is unfamiliar, then a new solution will be needed, and a plan to get there will be created. If the problem is not well structured, a simple approach is to describe the characteristics of a desired solution. For example, the solution should come at a competitive price point, and should be determined on a specific schedule. The decision-making technique approach would help both types of decision makers, expert and novice, by recognizing these key differences and adapting the appropriate process without being pedantic. There would be an initial self-assessment once a problem requiring a decision is identified. The assessment should ask the decision maker to inventory his or her prior mental models and procedures for a given topic. Based on the results of the assessment, the decision analysis techniques shall be tailored.

Cognitive theory's final rule is that cognitive load is important in training and performance. The knowledge shall be presented to the learners in small amounts to give them time to process it and apply it to present projects. Cognitive load will be managed strategically so it is easier for learners to recall, process, and implement. There is no point in dumping all of the information during long days of training and expecting learners to implement the training effectively. One can liken this process to a computer's processor. If a large amount of data is loaded onto a computer, it might crash the computer or it may take a long time to process it. If the computer processes a little information at a time, the total processing time is shorter and the results are more desirable.

After learners gain decision analysis knowledge, the results and effectiveness of the learning would be explored and measured using Kirkpatrick's evaluation strategy. After completing the decision analysis learning techniques Kirkpatrick's Four-Level Training Evaluation Model is applicable to measure reaction, learning, behavior, and results. This evaluation model can be used with cognitive, behavioral, constructivist, and adult learning theory. The results can demonstrate how effective the training methods and techniques are in helping learners make well-analyzed decisions. As an example, complete risk and decision tree analyses are often deliverable items to customers during design reviews and become part of the design package for the specific project. Knowledge of risk analysis techniques gives learners the satisfaction of knowing they have a skill to use in the case of a crisis.

Learning decision analysis information and the associated skills improve projects. Leaders' behavior changes toward making critical decisions after learning these techniques. Project results may be compared before and after application of these techniques to evaluate their effectiveness. Performance surveys may be used to measure new or improved skills.

The learners' behavior and their effectiveness in the decision-making process will be evaluated by monitoring them. These decision analysis methods provide more definitive answers and help avoid design changes in the later stages of a project, which would be more costly to implement. Participant behaviors are checked to determine if they liked the techniques and used them, or they did not like them and used their old behavior and intuition instead.

Learning results may be collected by asking leaders about the likelihood of project's success based on utilization of these methods. It will take time to see the transformation of learners and their application of structured decisions using the techniques. Measurement of the before and after results, and repetition of the techniques whenever the opportunity arises, are ways to implement and evaluate the learning.

Constructivist theory. According to constructivist theory. Another instructional system design (ISD; Gagné, Wager, Golas, & Keller, 2005), learning experiences reflect real-world experiences, enabling learners to transfer what they learn to their jobs more efficiently and effectively. This learning theory has real-world applications that aim to create a framework that places value on polished products and job-related tools. This learning theory requires learners to define tasks and subtasks and provides an opportunity to collaborate and complete activities. Knowles et al. (2011) wrote:

Constructivists advocate a different approach to learning. Savery and Duffy (1996) suggest the following constructivist instructional principles:

- Anchor all learning activities to a larger task or problem.
- Support the learner in developing ownership for the overall problem or task.
- Design an authentic task.
- Design the task and the learning environment to reflect the complexity of the environment in which learners should be able to function at the end of the learning.
- Give the learner ownership of the process used to develop a situation.
- Encourage testing ideas against alternative views of alternative contexts.
- Provide opportunity for and support reflection on both the content learned and the learning process (p. 191).

This theory might not be a viable option because the leader needs to examine tasks and their deliverables from different perspectives to arrive at the best answer as part of decision analysis. This method is not well-suited for decision analysis since constructivist theory allows for competing solutions and often leads to a variety of diverging outcomes; in contrast, decision analysis benefits from converging perspectives. For example, a program manager picks a supplier based on scheduling, a procurement agent picks a supplier based on pricing, and a systems engineer picks the supplier based on device performance. These techniques merge different perspectives in order to converge on a single supplier. Knowles et al. (2011) wrote:

> Although it has always been a part of instructional systems design models, it has been neglected over the years. Traditional front-end environmental analysis emphasized the

> importance of analyzing elements in the external environment that might affect learning but largely ignored learner characteristics (p. 191).

Behaviorist theory. According to Knowles et al. (2011), behaviorists emphasize preferred behaviors, particularly in the areas of inspiration and transfer or maintenance of learning. The frequent use of these new behaviors encourages their preservation.

The behaviorist learning method focuses on *how* the individual is learning (objective-based) and not on *what* the individual is learning (topic-based). It also applies to developmental testing of training material prototypes and approaches learners with the goal of improving their present standard. The process is iterative and seeks to continuously revise the present standard. Subsequently, a new standard is developed. Behaviorist learning theory is not a good selection for the decision analysis training package since it focuses on real implementation of the decision-making techniques, and has no benefit from an iterative, revision-based process.

According to Knowles et al. (2011):

> Cognitive theorists stress the importance of a psychological climate of orderliness, clearly defined goals, careful explanation of expectations and opportunities, openness of the system to inspection and questioning, and honest and objective feedback. The cognitive theorists who emphasize learning by discovery also favor a climate that encourages experimentation (hypothesis testing) and is tolerant of mistakes provided something is learned from them. (p. 119)

Cognitive learning is not a revision-based process like behaviorist theory. The cognitive approach to training gives rise to more in-depth strategies and tactics, helping learners acquire cognitive skills. There are 11 rules of cognitive theory that change the way learners think about making decisions. The power of the mind is stronger to influence their behavior long-term. The 11 rules of cognitive theory are as follows:

1. *Job tasks include declarative and procedural knowledge.* Decision analysis technical experts in the industry have declarative knowledge that is passive since they mostly learned it through on-the job training. Some experts also have procedural knowledge based on requirements for their job. They have past work experience applying decision analysis to projects. Learners must apply the techniques rather than just learning about the theories. Technical experts whose jobs require implementation of the techniques already have the framework to transfer this knowledge to other learners, yet they may not be able to mentor others in industry. A decision analysis training package is a good opportunity to prepare learners for industry.
2. *Knowledge is learned in structures.* Mager (2008) asserted that experts' mental models are different from those of novices. Declarative and procedural knowledge may be combined to learn about decision analysis techniques. Learners can implement the new techniques by knowing the status of existing projects to link their previous knowledge.
3. *People learn each type of declarative knowledge in a different way.* Facts, concepts, or principles of these decision analysis techniques should be included in learning. Different ways to teach the facts and concepts—based on theory, principles, and on the job experience—is also offered in the training package. All of the facts, concepts, and principles included in the training package are designed to make sure learners know the techniques in theory and how to apply the principles to their work.

4. *Concepts and principles are best learned from a combination of examples and definitions.* Facts, concepts, and principles of decision and risk analysis techniques, in theory, can overwhelm the learner with theory and formulas. Real industry examples should also explain and implement the principles.
5. *Learners learn best when they learn the whole knowledge structure at once.* All of the key techniques of decision and risk analysis are gathered in one course so learners do not have to take portions of it in different sessions. If this topic is going to be taught in several courses, there is a chance that learners might forget the first portion by the time the next stage is taught, which would compromise the cohesiveness of the topic. Enforcing inclusion of the entire topic in one course forces trainers to develop a well-structured, step-by-step learning tool.
6. *Procedural knowledge is how to do.* The techniques are not the focus of the theory; rather, the objective is to show learners how to apply decision analysis techniques to real project as transformational or LMX leaders. After the training, learners should know how to use decision analysis techniques on projects on which they are working for their current leading role.
7. *Procedural knowledge varies according to its structure.* Technical experts face different problems that are clear, moderate, or hard-structured in industry. The practice learner should implement the techniques on well-defined problems that have one clear answer, instead of moderate problems with several solutions, or vague problems that have one or more missing variables.
8. *Procedural knowledge involves manipulating the relevant mental model.* "Manipulating your mental model is key step in problem solving because it helps you

predict the effects of various possible actions and select the action that will move you closer to the solution" (Kirkpatrick, 2008, p.11). To move toward application of the decision analysis techniques, the cognitive learning approach is used to manipulate the learner's relevant mental model regarding decision making that follows a systematic format. Learners use the techniques based on project facts, which guide decisions. Learners use a stage-by-stage procedural knowledge transfer method to open their minds about all aspects of the project prior to making any emotionally based decisions.

9. *People solve unfamiliar problems inductively.* The seven steps from the American Society for Training & Development (ASTD, 2008) handbook for solving unfamiliar problems use the inductive process. The first stage is the initial step to develop an understanding of the problem. Information known about similar problems will form a subset of the problem that is appropriate to the existing problem. Learners should recall specific past procedures to follow. If the problem is unfamiliar, then it is declared that a new solution is necessary, along with a plan to implement the solution. The solution is evaluated at the end of the plan. If the solution is achieved, then the problem is considered solved. If not, then the problem solver needs to challenge the assumptions and process what went into forming the initial understanding, which is broadened and reformulated. If the problem is not well structured, a simple first task is to describe the characteristics of a desired solution. For example, the solution should be based on a competitive price point, and it is arrived at on a specific schedule. Decision analysis techniques are used in the seven-step problem-solving process. For familiar problems, the techniques are well-defined and the decision

makers use simple techniques in an effort to apply known solutions to a present problem. Decisions are made by tailoring the past known solution to the existing unique, yet similar, problem. If the decision makers need to generate a new solution, then more complex decision processes are implemented.

10. *An expert problem solver knows different things than a novice does.* Experts have more insight and knowledge regarding decisions than novices do. This research explores how decision analysis techniques recognize the key differences between an expert learner and novice, and are adaptable and useful to each type of decision maker. Expert learners have more mental models on a wider range of decisions than novices, allowing them to move more quickly through the first stages of the decision process and work more systematically on a solution. Expert learners tend to apply memory background of previous experiences to current projects. Expert learners have more experience applying a procedure to their mental model, allowing them to solve problems and make decisions more efficiently. Expert learners are better at organizing the problem and also summarize and group decisions differently than novices. Expert learners tend to work forward from the initial state to the solution, whereas novices tend to work backwards, starting from the solution. There are also situational and individual differences that affect the mental processing of a decision maker and his or her ability to work through to a solution. For this study, two different sets of lecture notes shall be prepared for each team of freshman and expert learners based on their knowledge on leadership and the pre-determined decision analysis topic. The decision analysis approach is designed to help both types of decision makers, expert and novice alike, by recognizing key differences and

adapting these differences to the appropriate process. An initial self-assessment would be assigned once a problem requiring a decision is identified. Decision analysis assessment asks the decision maker to inventory his or her prior mental models and procedures related to a given topic. The techniques are tailored based on the results of the assessment.

11. *Cognitive load is important in training and in performance.* A small load of knowledge is presented to the learner during the training. The learner is given time to process the material and figure out how to apply it to present projects. The cognitive load is managed so it is easier for them to recall, process, and implement as needed. There is no point in providing all of the information in one training session and expect learners to implement the training effectively.

Transformational Leadership

Learners are motivated to learn about transformational leadership because it is designed to increase morale and improve job performance. Transformational leadership is the best choice for coaching and teaching (Bass & Avolio, 1990). Research on this topic explains that the transformational leadership style is a good fit for learning purposes because, unlike contingency theory and situational leadership, it provides a more general way of thinking about leadership. Transformational leadership enhances the job performance of the professional learner and incorporates decision analysis techniques. Bass and Avolio (1990) stressed that transformational leadership is a good leadership style for training and development. Northouse (2013) emphasized inspiration, innovation, and individual concern in relation to transformational leadership. In *Leadership: Theory and Practice,* Northouse identified four elements of transformational leadership: idealize influenced, inspirational motivation, intellectual stimulation, and individual consideration.

The cognitive learning style was chosen was chosen for this research because it is in line with the intelligent simulation element of transformational leadership; “It encourages followers to think things out on their own and engage in careful problem solving” (Northouse, 2013, p. 179). Learners use an intelligent approach with the techniques when it comes to making decisions rather than unwisely following others’ footsteps. Northouse’s example of a plant manager who promoted workers’ distinct works to solve problems is different from the theory shared with the learners. The research uses techniques in failure analysis cases and selects the correct process based on decision-making techniques. This would slow the production process; however it would have a more efficient result in the long run by preventing failure in the system.

This study focuses on two leadership styles: transformational leadership and LMX theory. The Myers-Briggs Type Indicator (MBTI) assessment (Hirsh & Kummerow, 1998) and the Fundamental Interpersonal Relations Orientation Assessment (Schultz, 2002) are tools for evaluating leadership strengths. The MBTI assessment (Hirsh & Kummerow, 1998) is a tool that can identify leadership qualities to determine if the person acts as an active role model that inspires, motivates, and encourages followers. CPP.Inc (2016) provides personality assessment tools such as MBTI that can help leaders know their strengths and weaknesses to determine their personal leadership style. MBTI personal leadership style may show a natural leader’s characteristics to see if he/she takes charge quickly, adapts, and applies past experiences to solve problems to get to the core of the situation immediately, and then decides and implements the solution immediately.

Northouse (2013) described the transformational leader as dominant and self-confident, with a desire to influence others. This research explores how leaders become strong role models, show competencies, articulate goals, communicate expectations, and express confidence through transformational leadership training. A transformational leader contributes to the organization and prefers a learning style, with the order of preferences such as problem-solving approach, preferred work environment, and potential pitfalls. Traditional leaders who respect the systemic hierarchy motivate learners to learn techniques by implementing the results of job performance change. This results in raising the learners' confidence, broadening goals, and increasing job performance, which is the effect of charismatic and transformational leadership that Northouse expected. From this leadership style, learners develop a highly adaptive communication style, which shows they can communicate better with followers who are aligned with the principles of transformational leadership.

The Fundamental Interpersonal Relations Orientation Assessment (FIRO; Schultz, 2002) is another assessment tool that indicates if a transformational leader pays attentions to the needs of others and is a measure of how the leader can take control either directly or indirectly as a dominant charismatic quality. FIRO also is going be introduced to learners to use in future to find their leadership style and strength. This assessment also indicates that as a transformational leader, one can communicate with learners clearly in order to motivate them.

The Smithfield technique (Schein, 2010) is implemented to let leaders take care of the team and ensure there is collaboration. The Smithfield techniques also is going to be explained to the learner. The key characteristics of the Smithfield technique are to create and conceptualize. In this technique, the teams are responsible for operation and course outcome. Learners gain a sense of responsibility and ownership to see the plan as a child that needs protection. This is a self-assigned section of learning. The training facilitators are in charge of managing the training, as Smithfield recommended. The training is created in an environment for successful teamwork by providing stability and predictability, focusing on efficiency and productivity. A focused, cohesive structure is the foundation for high-performing teams (Bolman & Deal, 2003). As a leader, learners should prefer to structure team projects to have stability and predictability. The leader communicates the goal with the team often and focuses on efficiency and productivity by showing the result of applying the techniques on the project to motivate learners. Learners should have a sense of ownership of their project, and feel satisfied with well-structured results.

If leaders want to train employees during working hours, it would cost a high tech company around $200 an hour per employee. Hiring employees with existing knowledge of decision and risk analysis techniques would save them around $600 per employee. An alternative solution is to create a learning package to train potential employees prior to joining the workforce or while they are working in industry after work hours as an extra-curricular activity.

Teamwork and customer collaboration are often cited in customer satisfaction feedback surveys. One of the distinctive characteristics of a transformational leader is a commitment to increasing company morale. Another transformational leadership factor is to increase intellectual stimulation by fostering innovation with a focus on customer satisfaction. Transformational leadership encourages innovation and further review as a patent or trademark. The transformational leader works on organizational structure by rethinking the interdependent relationships of organizational structure, strategy, and the business environment with a focus on implementation.

According to Bass and Avolio (1990), while effective leaders can possess traits of both transformational and transactional leadership, evaluating these leaders will point to one style over the other. Kirkpatrick (2008) asserted that the leader cares more about what the learners acquire and how motivated the learners are to apply the new decision-making techniques to present and future work. The learners are asked if the learning inspires them, which mainly indicates the individual concern leaders shows for learners. An indication of success occurs when learners pick an existing project to apply the decision analysis techniques, and their manager and technical expert guides and evaluates them. These projects would produce changes across the company and employees can see immediate gain from implementing them.

Leader/Member Exchange (LMX) Theory

"Leadership-member exchange (LMX) theory is an ideology based on dyadic relationship between leader and follower. Relationship is measured by the amount of mutual trust, loyalty, support, respect and obligation" (Management Study Guide [MSG], 2016, p. 81).

Northouse (2013) described this theory as the leader forming an individualized working relationship with his or her subordinates to form a dyadic relationship. This dyad means the followers are separately connected to the leader vertically and each role has unique characteristics. LMX theory is another approach that looks at the leadership process, focusing on the interactions between leaders and followers. This theory will also be taught to the organizational leadership undergraduate learners. The interaction can be described as a dyadic relationship. This research explores the vertical dyad linkage (VDL) theory, in which the leader's relationship with a follower is viewed as a vertical, two-way interaction, formed with characteristics of the individual follower. There are generally two types of relationships within work groups: the in-group and the out-group. The in-group is based on expanded and negotiated roles and responsibilities, and the out-group is based on formally defined roles. The in-group typically looks at the organization as a whole and takes on more responsibilities beyond their job description. The out-group simply does what they are told and goes home.

The next stage of LMX theory looks at how the quality of these relationships affects organizational effectiveness. For example, high-quality leader-member exchanges tend to result in lower employee turnover and an increase in performance evaluations, number of promotions and employee morale. These exchanges are shown to be positive for the organization. The quality of the LMX is directly related to positive organizational change.

Leadership training involves creating effective, high-quality relationships with all team members, not just a few people who are part of the in-group. Making everyone feel as though they are members of the in-group leads to building networks of relationships throughout the organization. This process has an overall positive influence on the goals of the organization. This study teaches learners the time-phased nature of leadership-making. As time in passes the relationship, leadership-making can develop via three sequential phases: the stranger phase, the acquaintance phase, and the mature partnership phase. The quality of the relationship grows stronger with the progression of these phases. This way of thinking shows that work organization partnerships are transformational and help both leaders and followers get past their own self-interests for the good of the team to accomplish organizational goals (Graen & Uhl-Bien, 1995).

LMX theory works by recognizing the main concepts of the dyadic relationship and the in- and out-groups. Leaders can work with the in-group to get more work done and reach organizational goals more effectively. While out-group members operate within the prescribed goals and agreed upon roles, the leaders may continue development by offering the out-group members chances to take on additional roles and responsibilities (Graen & Uhl-Bien, 1995).

LMX is the first theory to accurately describe what is already known; that there are in-groups and out-groups in work organizations. LMX theory also shows the importance of the dyadic relationship between the leader and follower, and that communication has to be effective for the leader to be effective. LMX theory and the concept of leader-making offer guidelines for leaders to try and coach followers into the in-group by continuing to present opportunities for increased visibility and growth within the organization (Graen & Uhl-Bien, 1995).

In their summary of the research on LMX theory, Graen and Uhl-Bien (1995) found that it is tied to organizational performance, innovation and job climate. The theory is validated with these improved organizational outcomes, known as the 5Ws of LMX theory.

The 5Ws of LMX. This is a decision analysis tool used to explain LMX theory to learners.

Who. The leader and subordinates are the key players.

What. The Management Study Guide (MSG, 2016) explained that leaders differentiate between the in-group and out-group members based on apparent resemblances with respect to personal traits, such as gender, age, or personality.

- Role Taking:
  - New membership
  - Assessment of talents and abilities
  - Demonstration of competencies
- Role Making:
  - Informal cooperation on work-related factors
  - Critical stage of decision making by leader with respect to the new member
  - Members similar to the leader are likely to succeed

    - Any mistakes or betrayal are likely to lead to out-group membership

- Routinization:
    - Relationships between leaders and subordinates are established
    - In-group members work hard to maintain status
    - Difficult to break into in-group from out-group (Mind Tools, 2016).

How (extra). Working with an in-group allows a leader to accomplish more work in an effective manner as opposed to working independently. The in-group members are willing to do more than required to advance their group’s goals (Graen & Uhl-Bien, 1995).

Working out-group members act quite differently from in-group members. Rather than trying to do extra work they will merely do roles that are assigned to them. Leaders treat them fairly according to the formal contract but they are not given special attention (Graen & Uhl-Bien, 1995).

Why. MSG (2016) describes the strengths of LMX theory as follows:

- Focuses on and discusses specific relationships between the leader and each subordinate.
- Draws attention to the importance of communication in leadership.
- Theory is effective and practical in approach.
- Robust explanatory theory.
- Points to what people could do to strengthen or weaken the leadership dynamics.

This research describes the implications of the studies assessing LMX theory that have found the leaders in-groups support and may even expand their ratings on poor performance.

Favoritism from leaders toward in-group members leads to:

- Better performance at work

- Positive attitudes
- Job satisfaction
- Mentoring and high career goals

MSG (2016) elaborates that due to these factors, in-group members are associated with:

- Low attrition rates
- Increased salaries
- Higher promotion rates

Why not (extra). MSG (2016) criticizes the LMX theory as follows:

- Fails to explain specifics of how high-quality relationships are created.
- Based on the foundation of fairness and justice since some subordinates receive special attention from leaders.
- Assumes that all subordinates are equally worthy of trust, prestigious projects, and advancement; in reality, not everyone is honest, hard-working, and worthy of esteem.
- Real world scenarios prove that talented people will get more interesting opportunities and attention than less-talented ones.

Where. Applications of the LMX Theory are as follows (Mind Tools, 2016):

- Self-awareness as a leader can help to identify your out-group.
    - Analyze why members belong to the out-group.
    - Did they do something in particular to lose trust?
    - Bad behavior?
    - Are they truly incompetent or have low motivation?
- Re-establish the Relationship
    - High quality relationships build higher morale and productivity.

  - Out-group members may question sudden interest from leader.
  - Reconnect with each member on a one-on-one basis. It helps to identify the "unspoken" benefits they expect from their leader.
  - Find out what truly motivates individual team members.
  - Continuously touch base with team members. (Mind Tools, 2016)

Mind Tools (2016) also shared how to provide training and development opportunities through LMX theory:

- Develop a mentoring or coaching relationship with your out-group.
- Offer out-group members with low risk opportunities to test and grow their skills and gradually increase the challenge of their work.
- Utilizing task allocation strategies may be effective in assigning the right tasks to the right personnel.
- Regularly assess their potential occasionally in order to present subordinates with the right development opportunities.

When. When explains when to apply the techniques. A case study from an aerospace company (LMX Theory) is presented to the learners in a training plan. Decision analysis techniques among the in-group are as follows:

- Picking a supplier per their parameters:
  - Reliability of electronic devices
  - Delivery schedule
  - Cost

An example of decision analysis may be performed to choose between two suppliers of a component. The team leaders, technical supports, and supply chain are part of in-group LMX team, who can use decision analysis to reduce ambiguity. They all take different roles to demonstrate their core competencies. Leaders are required to assign different roles during a critical stage of decision making. Selecting the suitable electronic component's supplier reduces the risk of schedule or cost overruns to the program while maintaining high reliability and performance. Decision analysis uses models, tools, and techniques to understand the structure of the problem that the leader faces based on the analysis result.

ADDIE Training Approach and Development

This research explores ADDIE as framework (Sink, 2008). ADDIE is an Instructional Systems Design (ISD) model. A similar customized ISD flowchart may also be used to create the decision analysis techniques. The flowchart presented in Figure 1 is introduced as an example for decision analysis. In the flowchart, the start and stop/end of the process are defined with oval shapes. Decision points are diamond shapes with the words *yes* and *no,* and other stages are rectangular. This allows the learners to see a real example of a decision process regarding the design of a search engine.

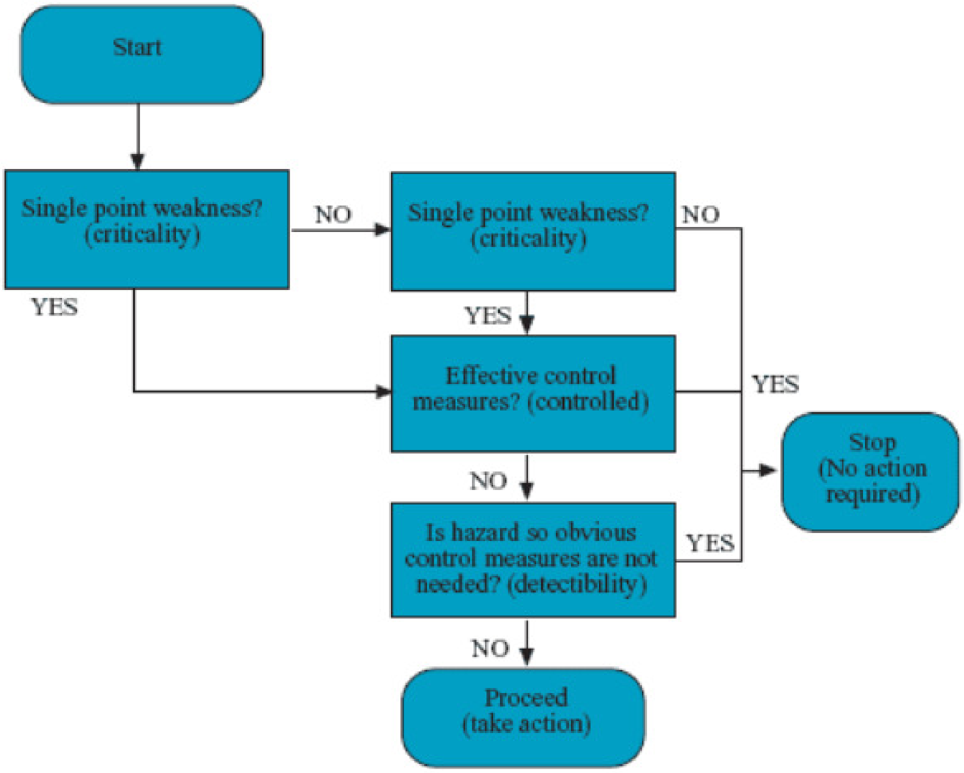

Figure 1. Flowchart decision analysis example. From "Figure 3-2: Mistake-proofing the Design of Health Care Processes," by the Agency for Healthcare Research and Quality, 2007 (http://archive.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/mistakeproof/mistakefig3-2.html). Copyright 2007 by the author. Reprinted with permission.

Analysis phase. The leader uses his or her skill and knowledge to identify the environment to create a systematic approach to decision analysis techniques. The problem is that teams are not familiar with the risk analysis techniques. The leaders should gather the learners' list project parameters and evaluate their desire to learn these techniques by taking a survey at the beginning of the meeting. The existing learning techniques known by the learner, similar to the decision analysis techniques, should be gathered in order to avoid duplication. The delivery option should be communicated at the beginning of the training. Educational consideration of techniques is the levels of statistical analysis that learners are familiar with to teach risk analysis are different. It should be considered that learners are adults and they come into this project with different mathematical backgrounds. For example, some learners have completed algebra-level math whereas others have completed calculus and/or differential equations. The decision analysis techniques should be suitable for all levels of mathematical backgrounds. During the analysis stage, the learning techniques identify the deadlines and considers the budget and time allocated to this project. A timeline schedule may be used for this decision analysis effort.

Design phase. In this stage of ADDIE, the leader gathers all of the subject topics and methods to plan the lessons, content, exercises, and projects using a systematic approach and process for technical decision making. The new approach is designed through teaching transformational leadership, LMX theory, and decision analysis technique training. The leaders strategically plan the curriculum of the training package. They should gather all of the documents from the past projects that have used different risk analysis and decision analysis techniques. They should create PowerPoint presentations for lectures, videos, and exercises with real work examples that can benefit learners directly, such as the consequence table (Appendix B), weighting the variables, 5x5 Matrix for Risk Analyses, and Decision Tree using the two-supplier selection project. Design of Experiment (DOE) is a licensed software that is available as a student version. It is a statistical analysis software tool that is available that can be used for decision analysis purposes. During the decision analysis learning, the DOE software may be used as a tool in the decision making project.

The learners should have access to resources, notes, tools, examples, charts, and videos during the entire study. The Microsoft Excel programs and graphs also enable learners to plug in numbers easily to obtain results. A prototype example of a Microsoft Excel file should be created in the training package for the learners.

Development phase. Once a curriculum is outlined, a learning package may be created along with the software, programs, surveys, and PowerPoint presentation to facilitate the learners. The training is designed to target the techniques that are beneficial for all of the learners. The content of the lecture not only targets the origin of the techniques, but also focuses on how this technique is going to help the learners. A review system should be developed that gives experts a chance to review presentations and provide feedback. There should be planned feedback meetings among experts and learners to make the meeting productive. Once all of the material and procedures are created, the experts should put them in order to create a logical teaching flow.

Implementation phase. All of the material and training package should be created, reviewed, and approved by the experts as well as the learner prior to the start of the training. The materials are made available to the learners before the start of the training to give them the chance to review and get interested in taking the training. Learners have the chance to review the materials and come up with a project to discuss during the meeting time. The method of delivery should be face-to-face in class after professional learners' work hours so they do not have any other distractions. Also, the learners should implement the techniques in at least one project during the training. The learners will be evaluated by presenting their decision analysis projects to the facilitator.

Evaluation phase. All of the learners will be evaluated by survey. The learners who will take the class will be evaluated on the training content and logistics. The ADDIE process has a formative evaluation during this stage. During the training, learners and facilitators might come up with the ideas and methods that they would find beneficial to add to the content. The new topics will be presented to learners so they can decide when, where, and how to add the new topic. Learners will take a survey to make the final decision to add the new material to the content.

Strategic Planning

According to McCune (1989), adult learning requires a self-renewing process, which is how organizations are able to change. Decision analysis techniques can be utilized as a business approach to produce a successful performance and renew the process. The learning contents toward running the business with a focus on strengthening the competitive position, satisfying customers, and achieving performance objectives for the professional adult learners will be planned strategically. The range of the decision analysis techniques are planned strategically the next move toward the leadership preparation of learners. Another example of the 5 Ws technique, as used here, is presented as follows:

1. What? Learners can benefit from well-known and recognized decision and risk analysis techniques such as decision tree, consequence table, 5W, fish bone, 5x5 risk analysis, and decision theory.
2. Why? These decision and risk analysis techniques are well-known and in use for technical decision making industry wide by leaders and followers. They help people make the right decisions at the right time using all of the present information and discourage implementing the same solutions, or simply doing business as usual. They can help the organizations win new business and perspectives, and increased customer confidence may be used to highlight the organization's core competencies and create innovative, streamlined solutions.
3. Who benefits from this learning? Leaders, followers, technical leads-engineers-scientists, managers, procurement agents, and the marketing team.

4. Where are these decision and risk analysis techniques used? In proposal packages, in technical presentations (internal and external), in marketing materials, employees real-time and monthly update, and when assessing new ideas.
5. When are these decision and risk analysis techniques used? During idea selection and implementation, during project proposal to make technical decisions, during project execution, whenever technical issues arise, during failure analysis, and to determine corrective and preventive actions to regain customer confidence.

Selecting the right electronic component supplier is a way to explain reducing the risk of schedule or cost overruns to a program while maintaining high reliability and performance. Decision analysis should be used to model, tools, and methods to understand structure of problems based on analysis results. Decision analyses can be performed to choose between two suppliers of complex system device components. The consequence table and sensitivity analysis will be performed on weighted costs, and the decision tree analysis is based on the consequence table, which should be used in supplier selection.

In this example the program decision makers—such as technical leads, program managers, end users, engineers, and procurement agents—select the supplier that grades the highest. The purchase order should be placed for the application based on decision analysis techniques. These analysis tools may be used more broadly to assist in selecting among suppliers for electronic devices to reduce the risk of schedule or cost overruns while maintaining high reliability.

Reconnecting with strategies. Decision analysis techniques in organizational leadership undergraduate program improve leadership style, as Northouse (2013) emphasized inspiration, innovation, and individual concern. If leaders apply decision analysis techniques, they can create distinctive and profitable products. Decision analysis activities in the example show how business value chains are distinctively effective; customers, distribution channels and purchase points may be most profitable. Decision analysis techniques may be use to select between suppliers of complicated system components since decision making is usually very biased and subcontractors are usually selected based on what the companies have been doing for years. Some failure can happen in some of the devices that subcontractors make, and customers may lose confidence in the reliability of the system. Fixing or replacing the device that is already installed in system will create a delay in the delivery date. It is important to reduce the risk of schedule or cost overruns to a program while maintaining high reliability and electrical performance. Techniques and tools should be included during this analysis such as the consequence table, risk analysis, and the decision tree.

Real industry examples can illustrate these analysis tools more broadly across companies to assist in selecting among suppliers for electronic devices. This analysis reduces the risk of schedule or cost overruns to a program while maintaining high reliability through leadership's streamlined approach.

Decision analysis techniques may create additional skills for transformational and LMX leaders. Transformational and LMX leadership skills along with a decision analysis method, serve as tools to achieve core competency for the leaders. The development of structured decision making as a core competency gives these learners an advantage over other leaders. Transformational leadership motivates the followers, and increase their morale and performance.

The technical expert should guide and evaluate the learners and measure success by learners' application of the decision analysis techniques to an existing project. The research should evaluate the learning by evaluating data collection and analyzing the survey. In the 1950s.

Dr. Don Kirkpatrick created an evaluation model that will be used to design a form that will quantify the learners' reactions in this research.

There are several cases to which decision analysis may be applicable. For example, consider a device that fails during system integration testing. Several different aerospace programs under development use this device. It is critical for program management to decide how to proceed in a timely and efficient manner. The following questions may arise:

- What are the device reliability requirements in the previously manufactured systems?
- What is the cause of the failure?

This is the time to implement decision analysis techniques. Management must realize it is critical for teams to be familiar with these methods in time-sensitive cases, like in this example, and several employees may need to get involved to expedite the decision process.

It is critical for businesses to have employees who consider all of the variables and make quick and accurate decisions during contract proposals. The leadership puts together proposals that incorporate the best technology, with a reasonable price and schedule, in a timely manner. If decision makers cannot get on the same page with the best solution, they can potentially lose the proposal and fail to bring the new project to the company. As Kotter (2007) noted, without motivation, people would not help and the effort would not go anywhere. To motivate followers, the leaders bring examples of past projects that effectively implemented decision analysis and show how necessary it is to perform the analysis. Kotter demonstrated that 75% of companies' management think a business-as-usual approach is totally unacceptable and they must change the organization once in a while to be competitive in industry.

The inclusion of training regarding transformational leadership and LMX theory should be presented along with decision analysis techniques; however, these techniques are a complement to all leadership styles. The long-term vision is to create a universal language of decision analysis methods to be used by management at all levels of development.

A guiding coalition may be formed with a clear vision of the learning techniques to be implemented with a defined plan. The guiding coalition team understands the benefits of decision analysis techniques to enhance leadership capabilities.

A step-by-step process will be created to make it easier to achieve the long-term goals with a series of short-term, smaller wins. This motivates the guiding coalition to be on board with the changes. The “iron triangle” (us history, 2016, p 127) is formed so that each of the three points represent the necessary steps, using decision analysis techniques in conjunction with transformational and LMX leadership skills.

The iron triangle, or triple constraint, consists of the traditional steps of scope, schedule, and resources. The scope is a technical approach to make the schedule as a second milestone, which is the first milestone in the decision analysis. The third milestone is weighing the resources and their availabilities.

The critical objective of the project is to make sure decision analysis learning techniques keep up with the technology s-curve (Figure 2). Andy Grove (1996), Intel’s cofounder, described a strategic inflection point as an event that changes the way management think and act. This point is the strategic inflection point of decision analysis techniques used by business management.

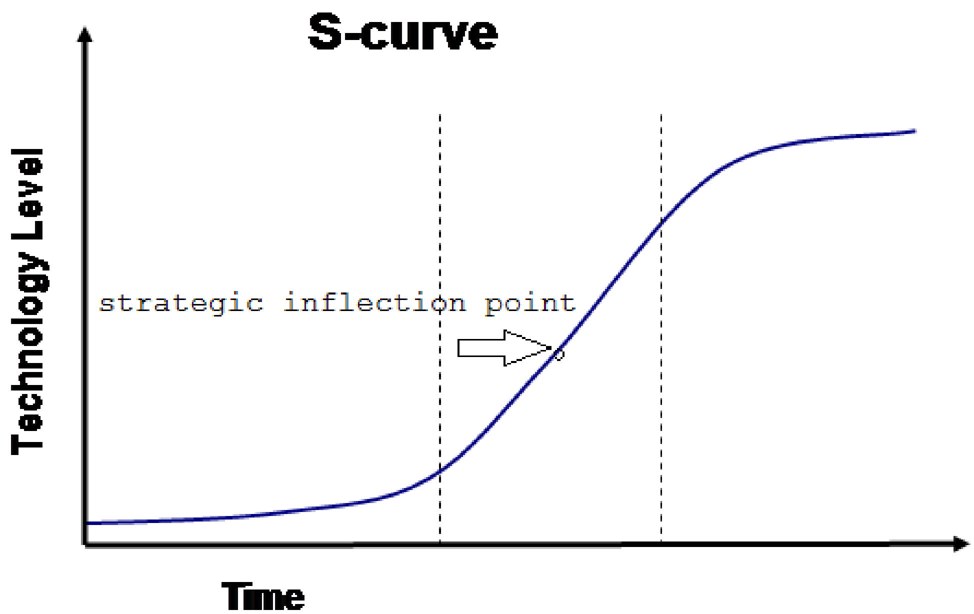

Figure 2. S-curve. Adapted from "Exploring the Limits of the Technology S-curve," by C. M Christensen, 1992, *Production and Operations Management*, *1*(4), 335. Copyright 1992 by the author.

To make sure structured analysis techniques are going to be an ongoing project that remain in use, the availability of these techniques shall be researched. In the current situation, learners from a non-engineering background, who only have algebra-level mathematics, would not get a chance to learn these methods through the adult education system. This is not a temporary tool that gets supported and used for a period of the time. The idea should be central to the management program and eventually become a core competency for leaders since there is no school that offers training in this area to adult learners. The managers and leaders making critical decisions systematically are valuable to companies. Customers can only count on the companies to give them a world-class product if their management uses logical decision analysis to deliver quality products.

Last Decade Top Decision Analysis Skills Needed for Today's Leaders and Managers

The decision analysis skills mentioned herein are hard, technical, pathetically challenging, and computer intensive skills as opposed to soft, people skills that are based on emotional intelligence. Several scholarly papers and dissertations are reviewed to investigate the top decision analysis techniques.

In "Primed for Decision Analysis," Barker (2012) described several decision analysis tools such as heuristic decisions, multi-attribute rating methods, decision trees, Monte-Carlo simulations, and influence diagrams. The author explains how engineers are well-suited to understand and properly implement these tools, based on their mathematical and analytical background: "engineers are uniquely qualified to be able to understand decision analysis and apply it correctly to real-world complex decision problems. Why? Because engineering-based knowledge of statistics and analytical methods provides an excellent foundation for decision analysis" (Barker, 2012, p. 333).

The following list presents decision analysis tools that offer skills to leaders:

1. Heuristic decisions to help balances and interactions between choices for decision making: These are intuitive, *rule of thumb* decisions based on experience. They do not take trade-offs or consequences into account. This uses multi-attribute rating methods. Using this method, a list of attributes for the decision is made and the possible choices are rated as to how they satisfy each attribute. This method helps realize tradeoffs and relationships between choices and outcomes, leading to better decisions.
2. Decision trees are a good visual tool to break the problem into pieces: This method takes uncertainties and probabilities into account. They break the larger decision down into smaller problems and make the pieces of the decision visible to the stakeholders.

3. Monte-Carlo simulations to find best value: This is used when a decision tree with multiple uncertainties becomes too large and complex. It uses computer software programs to arrive at best values for probabilistic outcomes.
4. Influence diagrams to display decision making to stakeholders: These are visual, graphical diagrams of the problem, incorporating the decision choices, the chance or probabilistic events, and the values of the outcomes. This process helps stakeholders and decision makers see the interaction of choices with the decision values.
5. Top-down induction of decision trees algorithm decision making for data mining and knowledge discovery: In a 2008 Ph.D. dissertation, *A New Approach of Top-Down Induction of Decision Trees for Knowledge Discovery,* Jun-Youl Lee (2008) described advanced computer techniques for data mining and knowledge discovery. The results of the data mining techniques can be used in decision trees for decision analysis. The main new tool described is induction of decision trees with SODI and SVMM (called IDSS), where SODI and SVMM are other, and well established algorithm tools. SODI is second-order decision-tree induction, and SVMM refers to support vector machines for multi-category. The new IDSS tool uses more complex decision descriptions to effectively reduce the size of decision trees, using attributes (SODI) and numerical (SVMM) problems.
6. Group decision making (Consensus vs. Analytic Hierarchy Process): In the 2008 paper titled, "A Comparative Study of Participant Satisfaction with Group Decision-Making between Consensus and Analytic Hierarchy Process Techniques," Arnold described group decision-making using voting by majority, minority, or unanimous polling, and the Analytic Hierarchy Process for decision-making with interacting groups. In "A

Comparative Study of Participant Satisfaction with Group Decision-Making between Consensus and Analytic Hierarchy Process Techniques," Abdullah and Islam (2011) described decision-making with interacting groups using a process for generation and discussion of ideas similar to brainstorming, followed by a process to reach consensus. "Consensus is a process that builds through iteration to arrive at a decision that everyone can "live with" (Arnold, 2008, p. 178).

7. Complex system decision making using Zachman Framework techniques: Systems are growing more complicated as technology advances. Leaders need systematic decision-making framework to deal with these sophisticated systems. In the paper, "Improvement of Complex System Decision Making Using System Dynamics & Zachman Framework Techniques" (2011), Bharath Bhushan Dantu (2011) described a soft-system methodology (SSM) that integrates technology and human factors to solve complex problems.

> Zachman Framework is an Enterprise Architecture introduced in 1987 by John Zachman ad extended by Sowa in 1992. This framework helps in modifying an enterprise into a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management and as well as the development of the enterprise's systems. The units of the framework can also be understood as organization scheme for all kinds of systems and have therefore become widely recognized during the last years. Since this Framework is independent from tools or methodologies, any methodology can be mapped against it to understand about the system. (Jonas, Goldsteen, & Goldsteen, 2007, p. 176)

> The Zachman Framework is a powerful answer by providing a global view of the multiple aspects of enterprise architecture, it offers a navigation tool that acts both as starter and a compass for enterprise modelers. It provides a context in which Business and IT architects can build a flexible, consistent information system, according to the strategy of their enterprise. (Zachman, 1999, p. 21)

8. *Decision analysis for Strategic Planning Techniques.* D. Edwards (2011) authored a paper titled "Analyzing Decision-Making Styles and Strategic Planning Techniques for Information Technology in Non-profit Organizations." According to Edwards:

> Miles and Snow (1978) described decision-making process indicators used to identify the organizational leadership style. Basic decision-making process indicators are defined as: Defenders, prospectors, analyzers, reactors, and spontaneous.… The determination is made to base the research upon the decision-making processes identified by Scott and Bruce (1995) and the strategic approaches identified by Frese, van Gelderen, and Ombach (2000). (pp. 44, 47)

Snow and Phillips (2008) indicated that managers need to be good decision makers in order for their organizations to function at the highest level.

9. *Analytical Hierarchy Process mission-sensitive factors use by NASA:* In his paper "Decision-Making using the Analytical Hierarchy Process (AHP) and SAS/IML," Alexander (2012) described the AHP as a tool to aid decision makers in selection of the best solution from many options with complex selection criteria. The process creates a matrixed set of criteria or attributes and uses rankings to assign weight to the inputs. The overall goal is to be at the top of the hierarchy. The quantitative rankings put the criteria

on a normalized scale, and the best solution is highlighted with the best score or attribute ratio, e.g. benefit-to-cost ratio. The benefit-to-cost ratio scatter plot is another related technique where the attributes of benefit and normalized cost are calculated and plotted on three axes: normalized-cost, benefit, and benefit-to-cost ratio. The best solution is again immediately evident as the one with the lowest normalized cost and the greatest benefit to cost ratio. AHP is a leading decision-making process and has been used, for example, by NASA to determine several mission-sensitive factors for the human MARS exploration project.

10. *Fishbone diagram decision analysis tool for visual cause and effect.* In her doctoral dissertation, "Leadership of Risk Decision Making in a Complex, Technology Organization: The Deliberative Decision Making Model," Flaming (2007) described the use of fishbone diagrams, risk tools and the deliberative decision making model for complex risk analysis and technical decision making and management in a fast-paced communications satellite manufacturing environment. Fishbone diagrams, or techniques, are a way of structuring a discussion to visualize cause and effect to get to the root cause of a problem or anomaly. It can be a dynamic, technical team effort used to get the details *out on the table* where effective decisions can be made. The diagrams and resulting discussions can be useful for making informed risk analysis and decisions and can drive the direction of future effort. In a fishbone diagram, the problem or anomaly is written as the head of the fish and the related or perceived major categories or causes of the problem are listed as stemming off from the head problem, like fish bones. Subcategories and details of each cause are listed off the bones during a brainstorming exercise.

11. *Leadership of risk decision making in a complex organization.* A risk tool is an online database tracking tool that captures the results of risk management, reduction and burndown. This records the identification of risks, mitigation strategies and efforts, probability analysis, and resolutions. The database is a constant reference for program managers, engineers, and decision makers during the technical life cycle of the organization. The deliberative decision making model comes from the observation that engineering decisions follow from a series of deliberations or discussions (for the purpose of making a decision; Pava 1984). The model has three contributing factors, or nodes: proactive integrated product team (IPT) leadership including six leadership decision activities (LDAs); supporting organizational systems, work processes and tools; and a coherent decision culture (shared beliefs, values and standards). The LDAs consist of understanding the risk, structuring the decision process, compiling and analyzing the data, managing bias, managing debates, and reaching decision closure. The successful IPT leader is constantly balancing and managing these three nodes to reach consensus and making effective decisions to drive the technology and products through the life cycle.

Summary

This research evaluates change by education organizational leadership undergraduate learners about transformational and LMX leadership along with decision analysis techniques. The research designed a plan that quantifies reactions using a survey and obtains response rates from the instructor-led program during training. This research explores acceptable standards to measure ratings using a survey. Trainers make decisions based on ratings against standards. The constructivist theory was deemed an inappropriate learning theory for decision analysis techniques because it requires a specific framework that does not give the learners ownership over the decision-making process. The behaviorist learning method focuses on objectives and is not topic-based so it is not well-suited for decision analysis techniques either.

Chapter 3: Research Methods

This chapter contains an outline of the research methodology used in this study. Included in this chapter are the research plan, the method chosen for selecting the topic, the group of contributors, and the method selected for collecting the data.

This study includes consultation with the graduate organizational leadership students at Pepperdine University taught by Dr. June Schmieder and facilitated with the researcher to develop the decision analysis course topics. The professor agreed that the decision analysis techniques training course as designed would enhance the learners' leadership skills. The goal of this course is to create a learning package using decision analysis techniques to meet the leader's objective. This research applies some industry examples using the decision analysis techniques.

The training package is titled *Decision Analysis for Leaders.* The training course is designed to provide learners with an introduction to the different tools and techniques used in statistical decision analysis. Below is the list of criteria to evaluate the effectiveness of decision analysis methods for leaders. The subjects for this study are adult learners in the organizational leadership graduate program at Pepperdine University. Next section explain the details the cross-reference research questions and surveys.

Research Study Questions

This study uses a mixed-method research (both qualitative and quantitative) approach. The specific quantitative research questions (McMillan &Schumacher, 2010) are included in the research question section. Per Stringfield and Yakimowski-Srebnick (2005), a quantitative method design is a good fit in a pragmatic effort to capture the widest range of effects of accountability efforts. Cross references the research questions and the ways in which they will be measured via survey is shown below.

Research Questions and Measurements:

1. For each of the decision tools, what was the level of knowledge that the students had prior to attending the lectures? (Measurement with teaching a class and survey students)
2. Is the student's level of knowledge for each of the decision tools related to his/her demographics (gender, age, years of college, computer sophistication, level of math knowledge, etc.)? (Measurement with teaching a class and survey)
3. For each of the decision tools, how likely are the students to use the tool in their future professional work? (Measurement with teaching a class and survey)
    a. Is the student's likelihood of using each of the decision tools in the future related to his/her demographics (gender, age, years of college, computer sophistication, level of math knowledge, etc.)? (Measurement with teaching a class and survey)

According to the research literature from 2006-2016, the top decision analysis skills that managers should have today were identified. (Literature review for quantitative part)

The research questions explored in this study include the following:

1. For each of the decision tools, what was the level of knowledge that the students had prior to attending the lectures? (measurement with teaching a class and survey students)
2. Is the student's level of knowledge for each of the decision tools related to his/her demographics (gender, age, years of college, computer sophistication, level of math knowledge, etc.)? (measurement with teaching a class and survey)
3. For each of the decision tools, how likely are the students to use the tool in their future professional work? (measurement with teaching a class and survey)

a. Is the student's likelihood of using each of the decision tools in the future related to his/her demographics (gender, age, years of college, computer sophistication, level of math knowledge, etc.)? (measurement with teaching a class and survey)

Purpose of the Study

The purpose of this mixed-methods (both qualitative and quantitative), correlational study is threefold: (a) determine based on the literature the top decisional analysis skills that managers should have; (b) examine business students' baseline levels of prior knowledge about the skills before receiving training; and (c) after receiving training on these tools, determine students' likelihood of using the tools in the future. In addition, demographic variables will be gathered to identify which students have more prior knowledge about the tools and determine who is more likely to use these tools in the future.

Research Survey Design

Data will be collected through surveys taken by the learners in the decision analysis class (See Appendices E and F). This correlational research design measures the "degree of association (or relationship) between two or more variables or sets of scores" (Creswell, 2005, p. 325).

Data Gathering Instruments and Analysis

The quantitative part of this research accentuates statistical, mathematical, or numerical analysis of data and will be collected through surveys from learners in a decision analysis class. This research focuses on gathering numerical data through a correlational study intended to generate consent. The quantitative methodology is applied to collect the data on a 5-point Likert scale. Comprehensive use of ranking and mean rating is conducted throughout the two-round correlational study. The research will solicit opinions from learners in an iterative process of answering survey questions before and after each topic of transformational leadership, LMX theory, and decision analysis techniques applied to these leadership styles is taught.

Appendix G is the short course syllabus. The example that will to be used to introduce decision analysis techniques during the short course is outlined as follows:

- Engineering models are received from both suppliers and there are electrical performance and reliability concerns, including scheduling, and cost effects.
- After a critical design review, Supplier 1 is rated for electrical performance and reliability satisfaction.
- The promised delivery date for Supplier 1 is far before Supplier 2; however, they delivered 4 months later than the promised date.
- The satisfaction delivery date is rated for both suppliers. Supplier 2 had some electrical or reliability issues in the past, so their satisfaction rate is lower; however, we expected these concerns may be cleared for new engineering model's designs.
- These parameters and the results are evaluated to form a risk analysis and decision tree based on the consequence table (Appendix C) and data collected from the critical design review and engineering models.

As W. Edwards, Miles, and von Winterfeldt (2007) stated, in general, natural scales are preferred over constructed scales because the latter requires qualitative judgments. The qualitative portion of the investigation is used to define the why and how of decision making, not merely what, where, and when. The ranking weight used in the example for this analysis is on a scale of 1 to 5. The rated weight for Management is 75%, Task Performance 75%, and Technical performance 100% (seventh column of Appendix C). The consequence table is refined and weighted parameter areas are Management, Performance, and Technical. Weight attributes are defined as worst and best (range 1–5), then rated and normalized as shown in Appendix C. A survey was conducted among selected technical experts, procurement agents, program managers, and other stakeholders to define the weighted attributes.

In this example of a consequence table, analysis of three vendors is evaluated based on:

- Resource and Risk Management
- Issues Response
- Progress Reporting
- Schedule Performance (Risk analysis and Decision tree)
- Technical Performance (Risk analysis and Decision tree)
- Quality Performance (Risk analysis and Decision tree)
- Post-Delivery Support
- Cost (Risk analysis and Decision tree)
- Previous particular device build experience with Yacht Company
- In-House assembly-test capability
- Engineering Depth
- Engineering Capability
- Design Tools on building their engineering models.

In this stage, one supplier is eliminated based on the low rating. An effective tool for capturing and analyzing risk factors is also introduced through this study as a 5X5 matrix for risk analysis. Goddard Space Flight Center, NASA, the International Standards Organization, and the United States Department of Defense have published articles using the 5x5 matrix for risk analyses, which are also used for the supplier selection project. The 5x5 matrix for risk analysis allows the user to graphically see the risks of each decision and compare the relative consequences and likelihood of occurrence.

The consequence of these factors is the same for both suppliers, but the likelihood of occurrence is based on each supplier's past performance and on-site assessments. Supplier 1 has a serious issue with reliability, which could impact cost and schedule. The likelihood of occurrence is high; this is a very bad combination and would probably rule out the selection of this supplier if the issue cannot be mitigated. If this one factor can be mitigated somehow with Supplier 1, they would have a significant advantage over Supplier 2, who had two selection aspects close to the red area and one already in the red.

Decision analysis techniques explain that these types of matrices are not limited to issues like supplier selection but are commonly used for managing large projects. The number of columns and rows used in a matrix for risk analysis can vary depending on how much granularity is required in the decision process. As Goddard Space Flight Center, NASA, the International Standards Organization, and the United States Department of Defense have published articles using the 5x5 matrix for risk analysis, this tool is deemed most effective for making higher-level decisions and the 5X5 configuration is usually adequate. The risks that show up in the red area receive immediate attention and the items in yellow are watched closely and assessed for risk mitigation actions. If the factors in red for supplier selection could not be resolved through further discussions with the supplier or mitigated somehow internally, then these would play a very strong role in down selection.

Risk mitigation. According to Johanns (n.d.), a former United States Senator from Nebraska, there is a tremendous amount of support for this study's approach to base decisions on risk analysis and thoughtful scientific process. Risk analysis is used in this lecture as an example that results in many of the components by Supplier 1 being redesigned, which reduces the technical risk associated with the evaluated parameters. However, it affects the cost and schedule. Some of the more risky devices needed to be designed out and removed from the application. The changes are driven by electrical performance. Risk analysis is used to reduce technical and reliability risk, cost, and schedule.

This example of risk analysis is explained to the learners. This study also uses it in the process of data collection and analysis for the selected research project.

Elements of decision tree. W. Edwards et al. (2007) explained the standard statistical paradigm, involving a decision whose payoff depended on an uncertain population parameter. This is presented on a four-move decision tree.

The first move on the decision tree is choosing between Supplier 1 and Supplier 2. The consequences of success and failure are common between the suppliers. The uncertain events are late delivery, reliability failure, electrical failure, and cost. These are also commonalities between suppliers. In this case, Supplier 2 graded the highest and Supplier 1 will remain a second source supplier for small quantities. Some of the models are in higher quantities and if they can obtain budget approval, they will use Supplier 1 as a second source for a single part quantity.

This section presented a specific example of supplier selection to show how the decision analysis techniques are used to make critical decisions. The next section explores how to use an evaluation model to gauge the effectiveness of the decision analysis techniques course in the new leadership process. Another effective tool for quantifying and analyzing risk factors is called a decision tree. A decision tree can be used to show how to compare several critical factors, for example. After introducing the decision analysis techniques to adult learners, another survey is taken for data collection in this correlational study.

Reliability and Validity

Data gathering instruments refer to the arrangement used to collect data, such as questionnaires, which in this case are the surveys taken by learners. It also identifies information sources and information collected during an evaluation. Cooper and Schindler (2008) identified threats to internal validity as “history, maturation, testing, instrumentation, selection, statistical regression, and experimental mortality” (p. 264).

Validity of data is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform. It is rare, if nearly impossible, that an instrument be 100% valid, so validity is generally measured in degrees. As a process, validation involves collecting and analyzing data to assess the accuracy of an instrument. There are numerous statistical tests and measures to assess the validity of quantitative instruments, which generally involve pilot testing.

Reliability is directly related to the validity of the measurement. There are several important principles. First, a test could be considered reliable, but not valid.

A reliable instrument produces consistent results regardless of the setting, yet reliability does not ensure accuracy or validity. Reliability supplemented with validity regarding an instrument worthy of use in conducting doctoral research.

Protection of Human Subjects in Research

The policy of Pepperdine University is that all research involving human participants/subjects must be conducted in accordance with accepted ethical, federal, and professional standards for research. In addition, all such research must be approved by one of the university’s Initial Review Boards (IRBs; Pepperdine University Institutional Review Board, 2009). For this research study, this study sought exemption from Federal Regulation 45CFR

46.101b. An application for the exemption claim will be filed with the IRB at Pepperdine University seeking exempt status for the following reasons:

1. The surveys taken are confidential. Using pseudonyms in surveys removes the concern about any confidences shared in the group. The data are recorded so human subjects are not identified by name and all responses are kept confidential.
2. Disclosure of the responses would not place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
3. This research would not involve protected groups, such as individuals with developmental disabilities, minors, and prisoners, as subjects.
4. This research would not present more than minimal risk to the participants.
5. This research clearly identifies the purpose of the study and does not anticipate any deviation from the purpose of the study.
6. Participants are reminded throughout the study that the survey is not a test and that there are no right or wrong answers. Participants are also to be reminded that opting out of the survey would not affect their class grade.

This study is empirical and so the research had to go through IRB, as Pepperdine also requires all learners, faculty and staff to receive IRB determination regarding whether their study meets the federal definition of research. The researcher completed Collaborative Institutional Training Initiative (CITI, 2016) training as required by Pepperdine. The researcher's training certificate is attached herein (Appendix H). The researcher registered AFFILIATED with Pepperdine University and also took the Education/Social Science course.

The researcher reviewed the Belmont Report during the training. The Belmont Report is a statement of basic ethical principles and guidelines to assist in resolving the ethical problems that surround the conduct of research with human subjects. “The Belmont Report” (Office for Human Research Protections, 1979):

> Defines and delineates between “Practice” and “Research,” describes the concept of “Respect for Person” and provides formulations for the ethical distribution of research benefits and risks (Principle of Justice). The Belmont report does not describe the necessity to effectively manage conflicts of interest. (p. 1)

Subparts have been added to the basic provisions of the federal regulations as pregnant women, fetuses, neonates, and prisoners are subparts of the United States Department of Health and Human Services regulations. This provides additional protections and considers vulnerable populations; therefore, the research checked on the original survey the age, pregnancy, and criminal status of study participants to exclude them from taking survey.

A letter stating that the researcher is competent and certified to give this training is provided to IRB (Appendix I) stating that she allowed the researcher conduct this research.

Data Collection and Analysis

“The correlation design best determines the existence of the degree of a relationship among multiple variables” (Melnyk & Overholt, 2005, p. 75).

This study’s correlational method data is collected by handing out two surveys to each learner at the start of the lecture (Appendix J), and at the end in order to receive feedback of individual contributions and knowledge. Three times survey is appropriate in this case since data collection will measure the before and after learning for two lectures. This process will give the learners the opportunity to revise views in a form of some degree of anonymity for the individual responses. “This current quantitative correlational study follows statistical designs used to measure the strength of the relationship of the criterion variable to the predictor variables” (Holbrook, 2010, p. 73).

Wasonga (2005) used correlational analysis and a pre and post-test to determine the “effect of multicultural knowledgebase on attitudes and feelings of preparedness” (p. 67). Schmidt (2007) also used correlational analysis and found that students had a strong relationship between background knowledge and test scores.

This research investigates the advantages and disadvantages of using correlational research method for this project. The advantages are anonymity and confidentiality of responses, limited timed required for respondents to complete surveys, cost effective and flexible-fast, versatile, and avoids direct confrontation of experts (no peer pressure). The main disadvantage of the correlational method is that subsets of data might be too small to reflect the results of the broader set. The process of selecting data sources is explained in detail in the following sections. Originally, the research strategically planned the process. Decision analysis methods such as 5W were used to plan this research. Reconnecting with strategies is necessary for the research to stay focused on the topic and outcome. The risk analysis explains to learners as a section of decision analysis techniques; however, it is a reminder in this study to use it in process of data collection and analysis for the selected research project more as form of risk mitigation.

Elements of the decision tree are another part of decision analysis techniques. The researcher will present this to the learners using the supplier selection example. This study also uses the decision tree to select the research method and the process for data collection.

Summary

The mixed methods correlational research methodology was explained in this chapter. The research for this study includes consultation with an organizational leadership undergraduate program professor to develop the decision analysis course topics. Research study questions were also reiterated in this section along with the research survey results. The data gathering instrument (surveys) and statistical analysis methods were presented. The quantitative methodology is applied to collect the data on a 5-point Likert scale. This is the correlational study creating iterative approach using consent. The correlation method data is collected by handing out two surveys to each learner at the start of the lecture, and at the end in order to receive feedback of individual contributions and knowledge. The example of a supplier selection project using decision analysis techniques was presented. The 5X5 risk analysis tool was introduced to capture and analyze the supplier selection data. Risk mitigation method, decision tree, strategic planning, and reconnecting with strategies are explained in this project as key decision analysis techniques. After facilitating the adult learners' LMX and transformational leadership style with the supplier selection decision analysis case study, the second and round of the survey will be issued. This chapter also discussed the reliability and validity of the data collected. This is human subject research; therefore, the researcher completed the certification of Protection of Human Participants in Research as required by IRB. This study sought exemption from Federal Regulation 45CFR 46.101b, on the grounds that the surveys are confidential and do not use protected groups and the disclosure of the responses would not place the subjects at risk.

The advantages and disadvantages of using a correlational research method for this project were explored. The advantages of anonymity and confidentiality of responses is contrasted by the fact that the subset data size may be too small to statistically sample the larger set.

Decision analysis techniques along with leadership theory will be presented to Pepperdine University's College of Education graduate Course class EDOL 765.25: Strategic Leadership and Management of Global Change. The researcher will teach the class on the mentioned topics and the class and the professor will be there to introduce the speaker to students.

Chapter 4: Presentation of Findings

This chapter presents the results of the correlation study, including learning of decision analysis techniques evaluated by 15 leadership students, along with the data collected in each of the two phases of the study. There is discussion regarding the recruitment of participants and initial responses to the study.

Research Methodology

The purpose of this mixed-method research (both qualitative and quantitative), in combination with a quantitative correlational study, was threefold: (a) to perform a literature search to determine the top decision analysis skills that managers should possess; (b) to examine business students' baseline levels of knowledge about the skills before receiving training; and (c) after receiving training on these tools, to determine students' interest in using the tools in the future. In addition, demographic variables were gathered to determine which types of students have prior knowledge about the tools and identify demographics of individuals who would be more interested in using those tools in the future. Survey data from 15 students were used.

For the 15 students, there were more males (60.0%) than females (40.0%). Ages ranged from 29 to 63 years old (M = 42.60, SD = 9.33). Sixty percent of the students described themselves as having "a lot" of skill with computers, with two others (13.3%) considering themselves to be "expert." All 15 were in the process of earning a graduate degree. All but three (80.0%) had taken at least trigonometry in school (Table 1).

Table 1

Frequency Counts for Demographic Variables (N = 15)

Variable	Demographic	*n*	%
Gender			
	Female	6	40.0
	Male	9	60.0
Age [a]			
	29 to 39 years	6	40.0
	40 to 49 years	6	40.0
	50 to 63 years	3	20.0
Computer Skill Level			
	Some	4	26.7
	A lot	9	60.0
	Expert	2	13.3
Education After High School			
	Earning graduate degree	15	100.0
Highest Math Completed [b]			
	Basic algebra	3	20.0
	Trigonometry	7	46.7
	Calculus	4	26.7
	Differential equations	1	6.6

[a] Age: $M = 42.60$, $SD = 9.33$.
[b] Highest Math: *Median* = "Trigonometry"

Recruitment of Participants

The investigator obtained subjects' signatures on the study's consent form. The researcher solicited volunteers in the EDOL 765 Strategic Leadership and Management of Global Change class. An initial letter was sent to the professor to teach the class at the beginning of January of 2017 and she agreed to discuss this with the students taking the class. Students showed an interest in learning decision analysis techniques and all 15 students volunteered to take the training and the survey before and after the training.

Answering the Research Questions

Research Question 1 was, "For each of the decision tools, what was the level of knowledge that the students had prior to attending the lectures?" Table 2 displays the relevant variables. When queried in Item 6 about "How much did you learn about decision analysis techniques applying it to leadership?" the median rating was "some." When queried in Item 8 about their level of knowledge about "Heuristic decisions (balances and interactions between choices for decision making)," the median rating was "a little."

Table 2

Frequency Counts for Level of Knowledge Prior to Attending the Lectures (N = 15)

Variable	Category	*n*	%
6. How much did you learn about decision analysis techniques applying it to leadership? [a]			
	None	1	6.7
	A little	6	40.0
	Some	3	20.0
	A lot	3	20.0
	Expert	2	13.3
8. Heuristic decisions (balances and interactions between choices as for decision making) [b]			
	None	5	33.3
	A little	3	20.0
	Some	5	33.3
	A lot	1	6.7
	Expert	1	6.7

[a] Level of Knowledge: *Mdn* = "Some"
[b] Level of Knowledge: *Mdn* = "A little"

Research Question 2 was, "Is the student's level of knowledge for each of the decision tools related to his/her demographics (gender, age, computer sophistication, and level of math knowledge)?" Cohen (1988) suggested some guidelines for interpreting the strength of linear correlations. He suggested that a weak correlation typically had an absolute value of $r = .10$ ($r^2 = 1\%$ of the variance explained), a moderate correlation typically had an absolute value of $r = .30$ ($r^2 = 9\%$ of the variance explained) and a strong correlation typically had an absolute value of $r = .50$ ($r^2 = 25\%$ of the variance explained). Therefore, due to the small sample size ($N = 15$) and for the sake of parsimony, this chapter will primarily highlight those correlations that were of at least moderate strength to minimize the potential of numerous Type I errors stemming from interpreting and drawing conclusions based on potentially spurious correlations.

Table 3 displays the Spearman correlations between the two pretest knowledge items and the four demographic variables (gender, age, computer skill level, and the highest level of math completed). Although none of the eight correlations were significant at the $p < .10$ level, three were not significant but still of moderate strength using the Cohen (1988) criteria. Specifically, Item 6, "How much did you learn about decision analysis techniques applying it to leadership?" tended to have a positive relationship with the respondents' computer skill level ($r_s = .30$, $p = .28$). In addition, the knowledge rating for Item 8, "Heuristic decisions (balances and interactions between choices for decision making)" tended to be higher for males ($r_s = .33$, $p = .23$) and tended to be higher for those with more computer skill ($r_s = .36$, $p = .19$).

Table 3

Spearman Correlations Between Pretest Knowledge Level and Demographics (N = 15)

Knowledge	Gender [a]	Age	Computer Skill Level	Highest Math Completed
6. How much did you learn about decision analysis techniques applying it to leadership?	.18	.03	.30	.04
8. Heuristic decisions (balances and interactions between choices for decision making)	.33	-.03	.36	-.06

* $p < .10$.
[a] Gender: 1 = *Female* 2 = *Male*.

Table 4 displays the Spearman correlations between the two posttest knowledge items and four demographic variables (gender, age, computer skill level, and the highest level of math completed). Although none of the eight correlations were significant at the $p < .10$ level, one was not significant but still of moderate strength using the Cohen (1988) criteria. Specifically, the knowledge rating for Item 8, “Heuristic decisions (balances and interactions between choices for decision making)” tended to be higher for those with more computer skill (r_s = .38, p = .17).

Table 4

Spearman Correlations Between Posttest Knowledge Level and Demographics (N = 15)

Knowledge	Gender [a]	Age	Computer Skill Level	Highest Math Completed
6. How much did you learn about decision analysis techniques applying it to leadership?	.18	.01	.25	.03
8. Heuristic decisions (balances and interactions between choices for decision making)	-.10	.23	.38	-.10

* $p < .10$.
[a] Gender: 1 = *Female* 2 = *Male*.

Table 5 displays the Spearman correlations between the two gain in knowledge scores (posttest minus pretest) and the four demographic variables (gender, age, computer skill level, and the highest level of math completed). Although none of the eight relevant correlations were significant at the $p < .10$ level, one was not significant but still of moderate strength using the Cohen (1988) criteria. Specifically, the gain in knowledge for Item 8, “Heuristic decisions (balances and interactions between choices for decision making)” tended to be higher for females (r_s = -.43, p = .11).

Table 5

Spearman Correlations Between Knowledge Level Gains and Demographics (N = 15)

Knowledge	Gender [a]	Age	Computer Skill Level	Highest Math Completed
6. How much did you learn about decision analysis techniques applying it to leadership?	.03	-.05	-.10	-.04
8. Heuristic decisions (balances and interactions between choices for decision making)	-.43	.17	-.03	-.04

* $p < .10$.
[a] Gender: 1 = *Female* 2 = *Male*.
Note. Gain score = posttest minus pretest.

Research Question 3 was, “For each of the decision tools, how interested are the students to use the tool in their future professional work?” Table 6 displays the pretest interest ratings for selected decision tools. There ratings were based on a 5-point metric: 1 = *Not at all* to 5 = *Very Interested*. The highest level of pretest interest was for Item 7, “How interested are you to learn about decision analysis techniques applying it to leadership? (*M* = 3.60).” The lowest level of pretest interest was for Item 10, “Monte-Carlo simulations (find best value; *M* = 2.20).”

Table 6

Descriptive Statistics for Pretest Interest for Selected Decision Tools Sorted by the Highest Mean (N = 15)

Decision Tool	*M*	*SD*
7. How interested are you to learn about decision analysis techniques applying it to leadership?	3.60	1.35
9. Decision trees (visual tool to break the problem to pieces)	3.20	1.08
15. Decision analysis for Strategic Planning Techniques	2.93	1.39
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	2.87	1.36
18. Risk analysis decision making (complex organization)	2.73	1.28
17. Fishbone diagram decision analysis tool (visual cause and effect)	2.67	1.29
11.Influence diagrams (display decision making)	2.53	1.41
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	2.47	1.30
16. Analytical Hierarchy Process (mission-sensitive factors)	2.33	1.35
14. Zachman Framework techniques (Complex system decision making)	2.27	1.44
10. Monte-Carlo simulations (find best value)	2.20	1.42

Note. Ratings based on a 5-point metric: 1 = *Not at all* to 5 = *Very Interested.*

Table 7 displays the posttest interest ratings for selected decision tools. There ratings were based on a 5-point metric: 1 = *Not at all* to 5 = *Very Interested*. The highest level of posttest interest was for Item 7, “How interested are you to learn about decision analysis techniques applying it to leadership? (*M* = 3.93).” The lowest level of posttest interest was for Item 10, “Monte-Carlo simulations (find best value; *M* = 3.27).”

Table 7

Descriptive Statistics for Posttest Interest for Selected Decision Tools Sorted by the Highest Mean (N = 15)

Decision Tool	*M*	*SD*
7. How interested are you to learn about decision analysis techniques applying it to leadership?	3.93	1.22
9. Decision trees (visual tool to break the problem to pieces)	3.87	1.06
17. Fishbone diagram decision analysis tool (visual cause and effect)	3.80	0.94
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	3.73	1.10
15. Decision analysis for Strategic Planning Techniques	3.67	1.11
18. Risk analysis decision making (complex organization)	3.60	1.06
14. Zachman Framework techniques (Complex system decision making)	3.47	1.25
16. Analytical Hierarchy Process (mission-sensitive factors)	3.40	0.99
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	3.40	1.24
11.Influence diagrams (display decision making)	3.40	1.18
10. Monte-Carlo simulations (find best value)	3.27	1.28

Note. Ratings based on a 5-point metric: 1 = *Not at all* to 5 = *Very Interested.*

Table 8 displays the gain in interest scores (posttest minus pretest) for selected decision tools. The highest gain in interest was for Item 14, "Zachman Framework techniques (Complex system decision making; *M* = 1.20)." The lowest gain in interest was for Item 7, "How interested are you to learn about decision analysis techniques applying it to leadership? (*M* = 0.33)."

Table 8

Descriptive Statistics for Interest Gains for Selected Decision Tools Sorted by the Highest Mean (N = 15)

Decision Tool	*M*	*SD*
14. Zachman Framework techniques (Complex system decision making)	1.20	1.32
17. Fishbone diagram decision analysis tool (visual cause and effect)	1.13	0.92
10. Monte-Carlo simulations (find best value)	1.07	1.22
16. Analytical Hierarchy Process (mission-sensitive factors)	1.07	1.22
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	0.93	1.03
11.Influence diagrams (display decision making)	0.87	1.06
18. Risk analysis decision making (complex organization)	0.87	0.99

(continued)

Decision Tool	*M*	*SD*
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	0.87	1.06
15. Decision analysis for Strategic Planning Techniques	0.73	0.96
9. Decision trees (visual tool to break the problem to pieces)	0.67	0.98
7. How interested are you to learn about decision analysis techniques applying it to leadership?	0.33	1.29

Note. Ratings based on a 5-point metric: 1 = *Not at all* to 5 = *Very Interested*. Gain score = posttest minus pretest.

Research Question 4 was, “Is the student’s interest in using each of the decision tools in the future related to his/her demographics (gender, age, computer sophistication, level of math knowledge)?” Table 9 displays the results of the Spearman rank-ordered correlations for the 11 pretest interest items with the four demographic variables. For the resulting 44 correlations, four were significant at the $p < .10$ level with another four being not significant but still of moderate strength using the Cohen (1988) criteria. Men had more pretest interest in Item 7, “How interested are you to learn about decision analysis techniques applying it to leadership?” ($r_s = .50$, $p = .06$)” and in Item 13, “Group decision making (Consensus vs. Analytic Hierarchy Process)” ($r_s = .45$, $p = .10$). Older respondents had more pretest interest in Item 17, “Fishbone diagram decision analysis tool (visual cause and effect)” ($r_s = .47$, $p = .08$). Those with less math training had more pretest interest in Item 15, “Decision analysis for Strategic Planning Techniques” ($r_s = -.44$, $p = .10$).

Four additional correlations in Table 9 were not significant at the $p < .10$ level, but were still of moderate strength using the Cohen (1988) criteria. Specifically, men tended to have more pretest interest in Item 15, “Decision analysis for Strategic Planning Techniques” ($r_s = .35$, $p = .20$). Those with more computer skill tended to have more pretest interest in Item 14, “Zachman Framework techniques (Complex system decision making)” ($r_s = .30$, $p = .28$). In addition, those with less math training tended to have more pretest interest in Item 11, “Influence diagrams (display decision making; r_s = -.41 p = .13)" and in Item 17, "Fishbone diagram decision analysis tool (visual cause and effect; r_s = -.35, p = .20).

Table 9

Spearman Correlations Between Pretest Interest Ratings and Demographics (N = 15)

Interest Rating	Gender [a]	Age	Computer Skill Level	Highest Math Completed
7. How interested are you to learn about decision analysis techniques applying it to leadership?	.50 *	.26	.00	-.07
9. Decision trees (visual tool to break the problem to pieces)	.10	.21	.17	-.29
10. Monte-Carlo simulations (find best value)	.03	.24	.25	-.12
11.Influence diagrams (display decision making)	.23	.26	.14	-.41
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	.24	.21	.11	-.26
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	.45 *	.12	.29	-.27
14. Zachman Framework techniques (Complex system decision making)	.05	.24	.30	-.05
15. Decision analysis for Strategic Planning Techniques	.35	.09	.22	-.44 *
16. Analytical Hierarchy Process (mission-sensitive factors)	.16	.23	.08	-.28
17. Fishbone diagram decision analysis tool (visual cause and effect)	.11	.47 *	.06	-.35
18. Risk analysis decision making (complex organization)	.26	.18	.27	-.24

* $p < .10$.
[a] Gender: 1 = *Female* 2 = *Male*.

Table 10 displays the results of the Spearman rank-ordered correlations for the 11 posttest interest items with the four demographic variables. For the resulting 44 correlations, three were significant at the $p < .10$ level, with another nine not being significant but still of moderate strength using the Cohen (1988) criteria. Those with more computer skill had more posttest interest in Item 13, "Group decision making (Consensus vs. Analytic Hierarchy Process)" ($r_s = .49$, $p = .06$)." Those with less training in math had more posttest interest in Item 12, "Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)" $r_s = -.57$, $p = .03$) and in Item 15, "Decision analysis for Strategic Planning Techniques" ($r_s = -.48$, $p = .07$).

Table 10

Spearman Correlations Between Posttest Interest Ratings and Demographics (N = 15)

Interest Rating	Gender [a]	Age	Computer Skill Level		Highest Math Completed	
7. How interested are you to learn about decision analysis techniques applying it to leadership?	.20	.17	.21		-.21	
9. Decision trees (visual tool to break the problem to pieces)	.09	-.17	.34		-.21	
10. Monte-Carlo simulations (find best value)	-.03	.17	.29		-.34	
11. Influence diagrams (display decision making)	.05	.21	.35		-.27	
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	.28	-.01	.06		-.57	**
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	.08	.12	.49	*	-.14	
14. Zachman Framework techniques (Complex system decision making)	-.10	.19	.33		-.36	
15. Decision analysis for Strategic Planning Techniques	.02	.11	.25		-.48	*
16. Analytical Hierarchy Process (mission-sensitive factors)	-.25	.40	.22		-.16	
17. Fishbone diagram decision analysis tool (visual cause and effect)	-.05	.39	.25		-.14	
18. Risk analysis decision making (complex organization)	-.05	.36	.34		-.08	

* $p < .10$. ** $p < .05$.

[a] Gender: 1 = *Female* 2 = *Male*.

Nine additional correlations were not significant at the $p < .10$ level but were still of moderate strength using the Cohen (1988) criteria. Specifically, older respondents tended to have more posttest interest in Item 16, “Analytical Hierarchy Process (mission-sensitive factors)” ($r_s = .40$, $p = .14$), Item 17, “Fishbone diagram decision analysis tool (visual cause and effect)” ($r_s = .39$, $p = .15$), and Item 18, “Risk analysis decision making (complex organization)” ($r_s = .36$, $p = .19$). Those with more computer skill tended to have more posttest interest in Item 9, “Decision trees (visual tool to break the problem to pieces; $r_s = .34$ $p = .21$), Item 11, “Influence diagrams (display decision making)” ($r_s = .35$, $p = .20$), Item 14, “Zachman Framework techniques (Complex system decision making)” ($r_s = .33$ $p = .23$), and Item 18, “Risk analysis decision making (complex organization)” ($r_s = .34$ $p = .21$).” Those with less math training tended to have more posttest interest in Item 10, “Monte-Carlo simulations (find best value)” ($r_s = -.34$ $p = .22$), and Item 14, “Zachman Framework techniques (Complex system decision making)” ($r_s = -.36$ $p = .19$; Table 10).

Table 11 displays the results of the Spearman rank-ordered correlations for the 11 interest gain scores (posttest minus pretest) with the four demographic variables. For the resulting 44 correlations, two were significant at the $p < .10$ level, with another seven correlations not being significant but still of moderate strength using the Cohen (1988) criteria. Specifically, females gained more interest for Item 15, “Decision analysis for Strategic Planning Techniques” ($r_s = -.47$, $p = .08$). Those with less training in math gained more interest in Item 12, “Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)” ($r_s = -.46$, $p = .09$).

Table 11

Spearman Correlations Between Interest Rating Gains and Demographics (N = 15)

Interest Rating	Gender [a]	Age	Computer Skill Level	Highest Math Completed
7. How interested are you to learn about decision analysis techniques applying it to leadership?	-.03	-.27	.06	-.28
9. Decision trees (visual tool to break the problem to pieces)	-.13	-.35	.13	.08
10. Monte-Carlo simulations (find best value)	-.12	-.35	.02	-.06
11.Influence diagrams (display decision making)	-.20	-.21	.19	.24
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)	.10	-.42	-.14	-.46 *
13. Group decision making (Consensus vs. Analytic Hierarchy Process)	-.41	-.17	.07	.14
14. Zachman Framework techniques (Complex system decision making)	-.20	-.32	-.07	-.25
15. Decision analysis for Strategic Planning Techniques	-.47 *	-.10	-.11	-.02
16. Analytical Hierarchy Process (mission-sensitive factors)	-.25	-.14	.07	.11
17. Fishbone diagram decision analysis tool (visual cause and effect)	-.15	-.26	.03	.30
18. Risk analysis decision making (complex organization)	-.35	.08	-.02	.23

* $p < .10$.
[a] Gender: 1 = *Female* 2 = *Male*.

Seven additional correlations in Table 11 were not significant at the $p < .10$ level but were still of moderate strength using the Cohen (1988) criteria. Female respondents tended to gain more interest for Item 13, "Group decision making (Consensus vs. Analytic Hierarchy Process)" ($r_s = -.41$, $p = .13$) and for Item 18, "Risk analysis decision making (complex organization)" ($r_s = -.35$, $p = .20$). Younger respondents tended to have more gains in interest for four items: (a) Item 9, "Decision trees (visual tool to break the problem to pieces)" ($r_s = -.35$,

p = .20); (b) Item 10, "Monte-Carlo simulations (find best value)" (r_s = -.35, p = .20); (c) Item 12, "Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)" (r_s = -.42, p = .12); and (d) Item 14, "Zachman Framework techniques (Complex system decision making)" (r_s = -.32, p = .24). Also, those with more training in math tended to have greater gains in interest for Item 17, "Fishbone diagram decision analysis tool (visual cause and effect)" (r_s = .30, p = .28).

Additional Findings

Table 12 displays the results of the Wilcoxon matched pairs tests comparing pretest ratings with equivalent posttest ratings for 13 survey items. Twelve of the 13 survey items had significant gains from pretest to posttest. The three largest gains were for Item 10, "Monte-Carlo simulations (find best value)" (p = .007), Item 14, "Zachman Framework techniques (Complex system decision making)" (p = .007), and Item 17, "Fishbone diagram decision analysis tool (visual cause and effect)" (p = .003).

Table 12

Wilcoxon Matched Pairs Tests Comparing Pretest and Posttest Scores (N = 15)

Rating	Time	*M*	*SD*	*z*	*p*
6. How much did you learn about decision analysis techniques applying it to leadership?				1.99	.05
	Pretest	2.93	1.22		
	Posttest	3.47	1.06		
7. How interested are you to learn about decision analysis techniques applying it to leadership?				0.81	.42
	Pretest	3.60	1.35		
	Posttest	3.93	1.22		
8. Heuristic decisions (balances and interactions between choices for decision making)				2.67	.008
	Pretest	2.33	1.23		
	Posttest	3.20	1.01		

(continued)

Rating	Time	*M*	*SD*	*z*	*p*
9. Decision trees (visual tool to break the problem to pieces)				2.23	.03
	Pretest	3.20	1.08		
	Posttest	3.87	1.06		
10. Monte-Carlo simulations (find best value)				2.72	.007
	Pretest	2.20	1.42		
	Posttest	3.27	1.28		
11.Influence diagrams (display decision making)				2.51	.01
	Pretest	2.53	1.41		
	Posttest	3.40	1.18		
12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)				2.66	.008
	Pretest	2.47	1.30		
	Posttest	3.40	1.24		
13. Group decision making (Consensus vs. Analytic Hierarchy Process)				2.59	.01
	Pretest	2.87	1.36		
	Posttest	3.73	1.10		
14. Zachman Framework techniques (Complex system decision making)				2.69	.007
	Pretest	2.27	1.44		
	Posttest	3.47	1.25		
15. Decision analysis for Strategic Planning Techniques				2.41	.02
	Pretest	2.93	1.39		
	Posttest	3.67	1.11		
16. Analytical Hierarchy Process (mission-sensitive factors)				2.66	.008
	Pretest	2.33	1.35		
	Posttest	3.40	0.99		
17. Fishbone diagram decision analysis tool (visual cause and effect)				3.00	.003
	Pretest	2.67	1.29		
	Posttest	3.80	0.94		
18. Risk analysis decision making (complex organization)				2.57	.01
	Pretest	2.73	1.28		
	Posttest	3.60	1.06		

Limitations

The researcher’s plan was originally to check the knowledge and interest of the learners prior and post training; however, the decision was made to emphasize their knowledge of heuristic decision making and check the interest of learners on the rest of nine other tools based on the way survey was created.

Summary

In summary, this study used survey data from 15 students to facilitate the top decision analysis skills that managers should possess; examine business students' baseline levels of knowledge about the skills before receiving training; and after receiving training on these tools, determine students' interest of using the tools in the future. The key findings for this chapter were that adult learners in organization leadership doctorate program were more interested to learn about the influence diagram, Zachman framework, and decision tree. In the final chapter, these findings will be compared to the literature, conclusions and implications will be drawn, and a series of recommendations will be suggested.

Chapter 5: Discussion, Conclusions, and Recommendations

Overview

The purpose of this study was to conduct a correlation study teaching top 10 decision analysis techniques and analyzing them and determining which technique were the most critical for leaders to learn. As a result of this study, the list of decision analysis techniques was narrowed down to 10 and placed into main themes or clusters. This chapter includes a discussion of the results, a comparison to earlier studies, the researcher's observations, and recommendations for future research.

Discussion of Demographics

For the 15 students, there were more males (60.0%) than females (40.0%). Ages ranged from 29 to 63 years old (M = 42.60, SD = 9.33). Sixty percent of the students described themselves as having "a lot" of skill with computers, with two others (13.3%) considering themselves to be "expert." All 15 were in the process of earning a graduate degree in statistical analysis. All but three (80.0%) had taken at least trigonometry in school (see Table 1).

Discussion on Reaching Consensus

The initial survey was passed through the class among 15 organizational leadership students. Both the first and second surveys contained 18 items. Through both surveys, every item reached consensus. In an effort to find interest in learning decision analysis techniques the researcher used a median score of 4.50 or higher to identify the techniques that would appear on the survey. The researcher assumed there would be less consensus than there actually was. The researcher used a 5-point Likert-type scale in order to avoid rater fatigue, which might have resulted in fewer participants taking the first survey.

Discussion of the Results

The researcher lectured the learner decision makers such as current or future leaders, managers, engineers-scientist-technical leads, procurement agents, and marketing on decision-making technique topics. The name of the training course that was created was Concise Course: Decision Analysis for Leaders Emphasizing on leadership. A concrete example of supplier selection analysis is presented to evaluate the effectiveness of these techniques. Selecting among suppliers requires risk reduction decisions to minimize scheduling or cost overruns to a program while maintaining high reliability and stakeholder satisfaction. Techniques and tools used during this analysis are the Consequence Table (Appendix C), Risk Analysis, Influence Diagram, and Decision Tree. The researcher explained decision theory to the adult learners, stating that decision making is a world of incomplete information and imperfect human control over events.

There were 15 learners in the class: six female and nine male learners. A great majority of the participants are working—with families and/or children. Data were collected through taking iterative surveys from these learners.

Figure 3 presents a simple decision analysis flowchart to show what kinds of problems exist prior to creating an electronic device that researcher explained to students. The flowchart is an example process flow of how to make a high performance device using decision analysis techniques presented to learners.

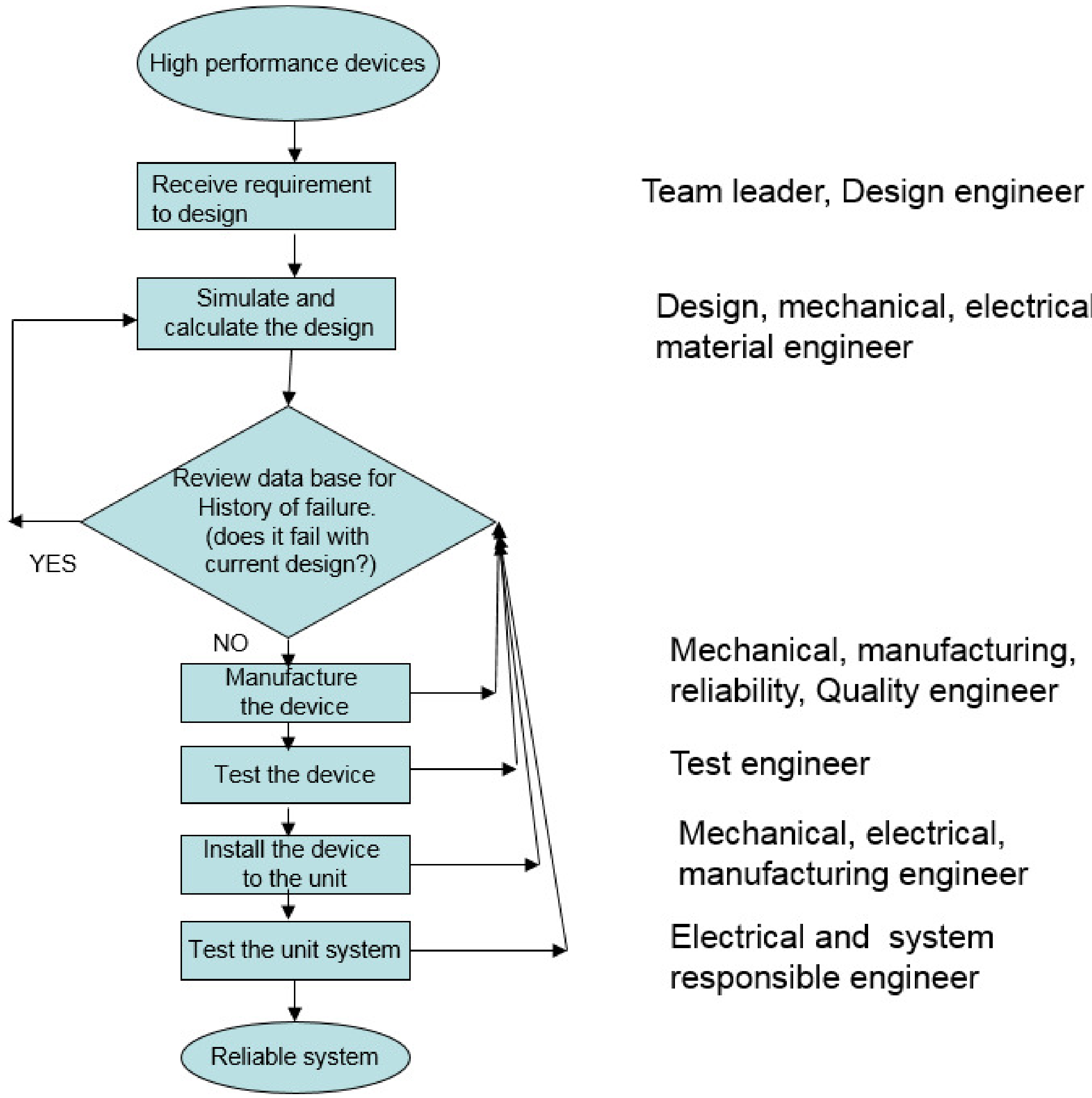

Figure 3. Flowchart example model.

Another ISD model (Figure 4) was presented to learners; this model involves creation of a knowledge capture database. This model allowed the learners to see a real example of a decision process regarding the design of a search engine.

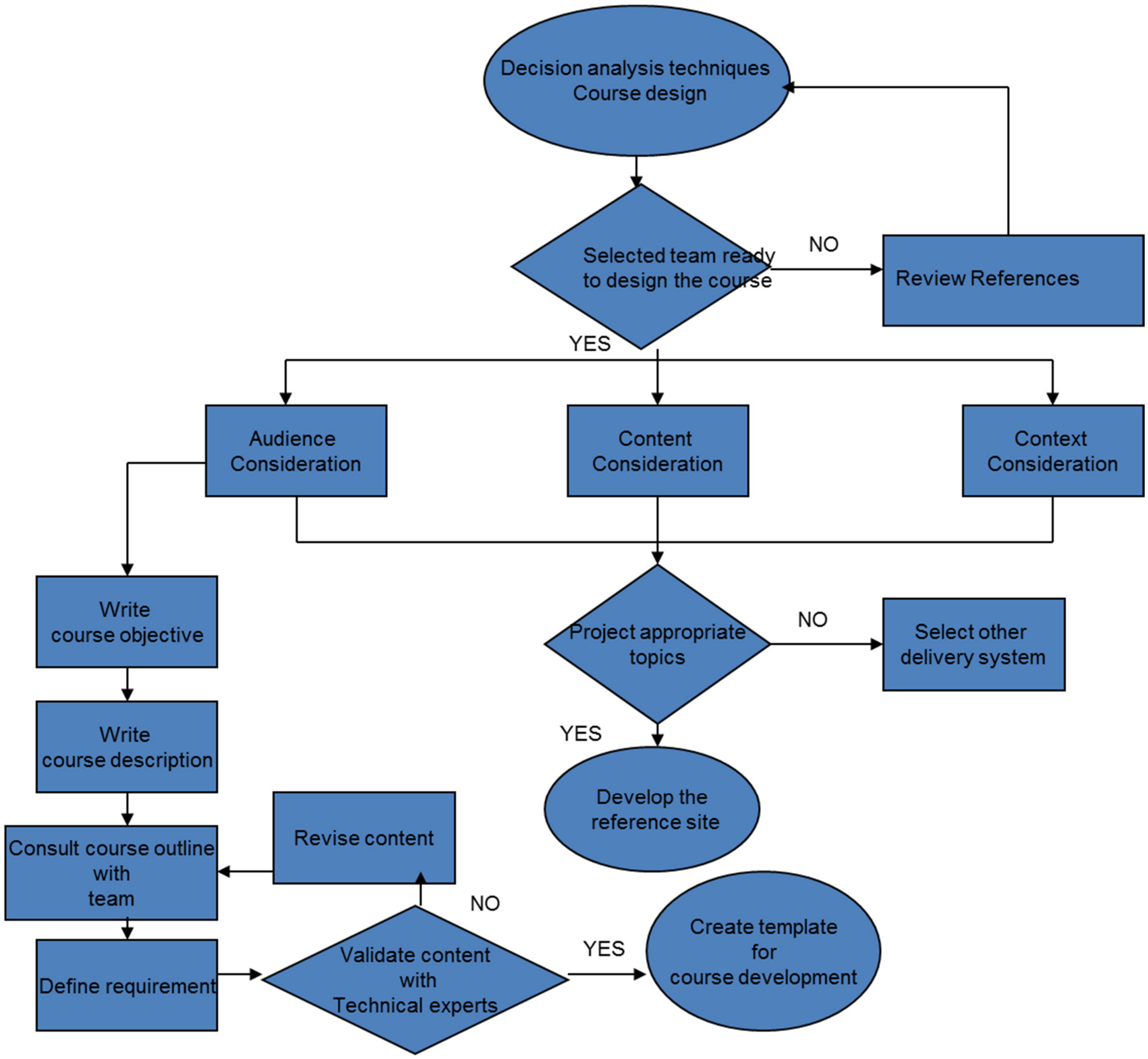

Figure 4. Flowchart example decision analysis model.

The goal of this research was to show how decision-making techniques are useful for adult learners who are in the process of developing their leadership styles. Leaners should grasp the benefits of this learning method when applied to leadership. Figure 5 shows Supplier 1 compared with Supplier 2 relative to four critical factors: reliability failures, electrical failures, late delivery, and cost as example of decision analysis techniques. In 5x5 analysis chart green means lowest risk, yellow means medium and red is high risk.

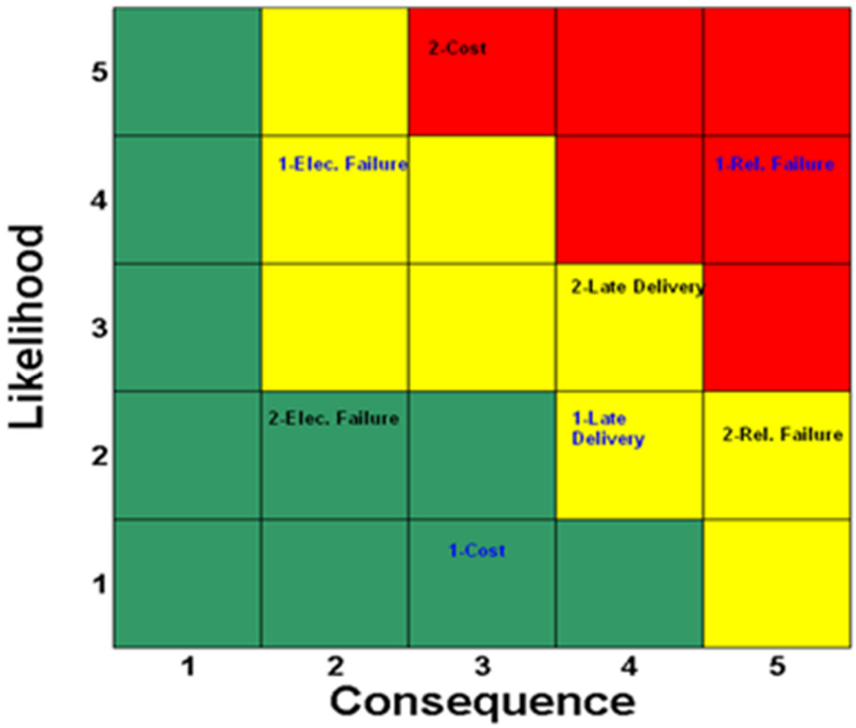

Figure 5. Proposed example of risk analysis 5x5.

For example, a decision tree can be used to show how two potential suppliers can be compared in terms of several critical factors. Figure 6 includes the decision tree analysis as example proposed by this study, which was taught during the learning plan.

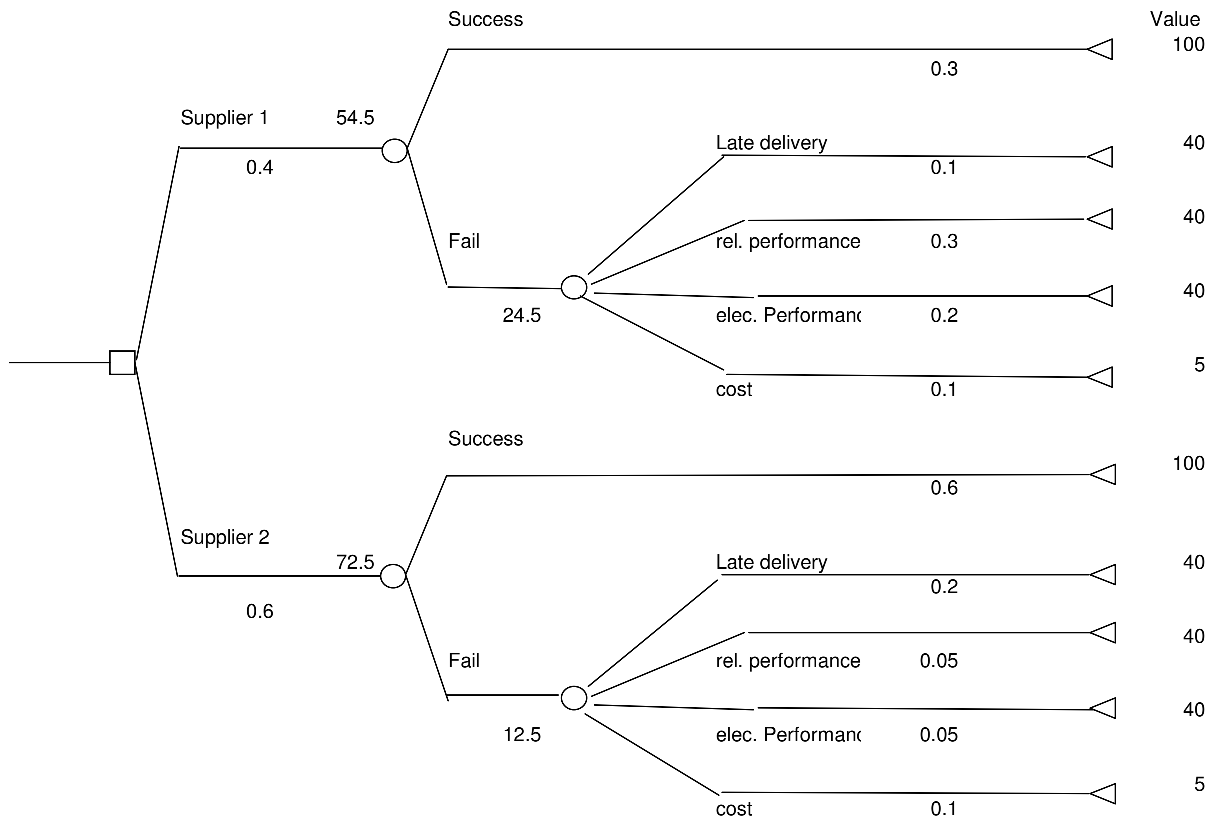

Figure 6. Proposed example of a decision tree.

Pearson completed the statistical measure for the coefficient of correlation in 1895 as an "illustration of the nature of his statistical biology" (MacKenzie, 1979, p. 140). Pearson's product-moment correlation coefficient (*r*) was used to analyze hypotheses 1, 2, 3, 4,and 5 in order to examine the data regarding a relationship between student differential pre and posttest scores and the use of the learning activities delivered by the instructional technology (MacKenzie, 1979). Correlation statistical analysis was used by researcher to analyze the result of survey by learners.

The fishbone diagram, heuristic decisions, Monte Carlo, and Zachman framework were also taught to learners. The Zachman framework diagram is a six by six visual table the columns have no order and columns are interchangeable, but cannot be reduced or created. In this framework each column has a simple generic unique information. The basic model of each column must be unique, which is the relationship object is interdependent but the representation objective is unique. Rows describe the view of a specific business group in the organization. Changing the name of rows may change the fundamental logical structure of the framework. This very generic framework was presented to students during training; students expressed a great deal of interest in this framework. It is a fundamentally structural model of the enterprise and not a flow representation. Learners showed more interest in this model after taking the training since they realized the applications of and need for this framework that as systems get more complicated and technology advances.

The researcher explained how to use Monte Carlo simulations to find the best value, also sharing a Microsoft Excel version of it with students. The researcher created also a step-by-step Monte-Carlo training in YouTube and shared the link with students so they could practice it in the future. The Monte Carlo simulation is used when a decision tree with multiple uncertainties becomes too large and complex. Monte-Carlo uses computer software programs to arrive at best values for probabilistic outcomes. Researcher showed students how to do Monte-Carlo simulation in excel. Learners showed more interest in the technique after receiving training on it.

One of the decision analysis tools that tended to have a positive relationship with learners' interest was the fishbone diagram. Fish bone decision analysis tool is for visual cause and effect diagrams, or techniques, which is a way of structuring a discussion to visualize cause and effect to get to the root cause of a problem or anomaly. The researcher explained to students that fish bone diagram can be a dynamic, technical team effort used to get the details *out on the table*, where effective decisions can be made. The diagrams and resulting discussions can be useful for making informed risk analysis and decisions and driving the direction of future effort. In a fishbone diagram, the problem or anomaly is written as the head of the fish and the related or perceived major categories or causes of the problem are listed as stemming off from the head problem, like fish bones. Subcategories and details of each cause are listed off of the bones during a brainstorming exercise. Decision analysis techniques applying the fishbone technique to leadership tended to have a positive relationship with the respondents' computer skill level. The knowledge heuristic decisions (balances and interactions between choices for decision making) tended to be higher interest for males and tended to be higher interest for those with more computer skill. For the two gains in knowledge scores (posttest minus pretest) and the four demographic variables (gender, age, computer skill level, and the highest level of math completed) the gain in knowledge for heuristic decisions (balances and interactions between choices for decision making)" tended to be higher for females.

Delivers Results

Due to the small sample size ($N = 15$) and for the sake of parsimony, the results will primarily highlight those correlations that were at least of moderate strength to minimize the potential for numerous false positive results stemming from interpreting and drawing conclusions based on potentially spurious correlations. Males gave a higher rate for heuristic decisions than females, which specified a positive statistical correlation among men as they had more interest to learn it to compare with women with negative statistical correlation. Older learners liked the fishbone diagram more than relatively younger students.

In general, younger students gained more knowledge than older students. In general, all gained knowledge from the decision analysis techniques. Pretest men had more interested in learning about decision analysis techniques than women. Table 4 of the statistical analysis showed that after lecture surveys knowledge people with more computer skill have knowledge on heuristic decision with some significant. Table 5 compared the pre and post learning survey, showing that women gained more knowledge on decision analysis technique. Women gained more knowledge from learning heuristic decision making analysis. Table 6 specified prior to learning that the participants were least interested in the Zachman and Monte Carlo simulations. Table 8 specifies the highest gain in learning or biggest change, which occurred for the Zachman and fishbone diagram. Table 9 displayed the significance that if the learner's age was higher, then they had more interest on fishbone diagram. Pre and post lecture compared in Table 11 showed gain of interest per age, computer skill, and highest math level. Table 12 specified non parametric version of NOVA Wilcoxon Matched, which specified lower the P and it is more significant.

The sample size was small; therefore, Spearman rank-order correlations were appropriate for the statistical analysis since no broad analysis could be done on the limited size sample test. For example, subtracting the results of prior survey rating and post lecture survey rating of same students specified that women gained more knowledge from learning strategic planning, group decision making, and risk analysis. Students with higher-level math background learned more about decision tree techniques than those with lower-level math background. Younger students learned more about the decision tree, Monte Carlo, and Zachman frameworks. The three largest gains in general were related to the Monte Carlo, Zachman, and fishbone diagrams.

Comparison to Earlier Studies

According to von Winterfeldt (2012), only two universities offer decision analysis classes for business leaders: the University of Southern California (USC) and University of California San Diego. These two schools offer nationally recognized engineering programs that include decision analysis classes. University of California Irvine recently started to offer this class to business management students as well. All three classes require a minimum of calculus as a prerequisite; however, the short course offered by the researcher requires only an algebra math level with more graphical presentations.

Dr. von Winterfeldt (2012) currently teaches the decision analysis techniques with advanced statistical analysis to the engineering management program at USC. This study shows how management students may apply similar techniques and additional industry-learned skills with algebra level math.

French mathematician Blaise Pascal first introduced probability and decision theory in 1964 (Chew, 2016). Daniel Bernoulli introduced Utility theory 1738 via the St. Petersburg Paradox: another game theory (probability of occurrence of game in theory) that was introduced to decision theory. In the 1970s, Stephen Ross introduced the multiple-index model as an economics-based model of portfolio theory, Daniel Kahneman and Amos Tversky explained Prospect Theory as a non-maximum expected utility and cumulative Prospect Theory as also a non-maximum expected utility theory (von Winterfeldt, 2008).

Analyze, Design, Develop, Implement, and Evaluate (ADDIE), is the theoretical development framework approach for this research. ADDIE includes cognitive, behavioral, and constructive learning theories (Knowles et al., 2011). This study is different from the other frameworks studied in regard to decision analysis techniques. This research followed andragogy theory since the future learners are all adults. Knowles et al. (2011) stated, “We see the strength of andragogy as a set of core adult learning principles that apply to all adult learning situations” (p. 233).

Cognitive learning theory explores what happens to learners when training impacts their memory and performance. Earlier study of the cognitive learning approach objective was to gain the learners’ attention while informing them of the decision analysis topic and stimulating recall of prerequisite learning. In this research the learners are presented with intellectually stimulating material related to the following applications: learning techniques and applying techniques to improve learners' job performance, improvement of information retention, and finally, transferring the information to their present work. Making decisions with a more thorough analysis process may enhance job performance. Information retention is improved using procedural knowledge and transferring information to one's present work.

The key aspects of cognitive learning rules apply to the decision analysis topic and eventually the learning procedures using the (Kirkpatrick, 2008) model. The first step ensures that the training package includes declarative and procedural knowledge. The researcher presented PowerPoint presentations, videos, and exercises with real work examples as a way to facilitate the decision theory topic. Industry examples were used to explain and implement the principles. Learners first apply techniques to simple interactive decision analysis topics, and then gradually the complexity of the examples increases to achieve intellectual stimulation. To complete the training package and maintain cohesiveness, all of the information is presented in the same structure. The research varied procedural knowledge based on the structured prior trainings. To move toward correct decision making, a cognitive learning approach may be use to manipulate the learner's relevant mental model. The learners follow a systematic format using techniques based on the project's facts.

Researcher's Observations

The researcher's plan was originally to check the knowledge and interest of the learners prior and post training; however, the decision was made to emphasize their knowledge of heuristic decision making and check the interest of learners on the rest of nine other tools. The Zachman and fishbone diagrams showed the highest interest gain since they had the biggest change. Prior to the training, men had more interest in learning decision analysis techniques, especially strategic planning, and applying it to their leadership style. During the proposal time, the goal was the teach LMX and transformational leadership along with decision analysis techniques; however, the learners were in their senior year of a leadership doctorate program and they did not need leadership training along with decision analysis technique training. Older learners had more interest in learning the fishbone and influence diagrams prior to the training. Students with intermediate math were more interested in learning about strategic planning techniques before training. The trainees with more computer skills were interested in learning the Zachman framework technique, which was surprising to the researcher since this tool does not require extensive computer skills.

After the training, the researcher observed that learners with higher computer skills showed more interest in learning about group decision-making (consensus versus analytic hierarchy process). It came as a surprise to the researcher that students with intermediate math skills were more interested in top-down induction of decision trees, algorithm decision making (data mining and knowledge discovery), and strategic planning techniques.

Spearman correlations with a moderate strength showed that older respondents tended to be more interested in the analytical hierarchy process, fishbone diagram, and risk analysis tool. After the training, students with stronger computer skills showed greater curiosity about learning more about the decision tree analysis, Zachman framework, and risk analysis. It made sense that students with weaker computer skills were less eager to learn about the Monte-Carlo simulation.

Recommendations for Future Research

Future research may focus on online course programs such as the Distance Education Network (DEN) may be offered for engineering and organizational leadership undergraduate programs. DEN uses an electronic blackboard system that streams the lecture live so that learners can be in any remote location with Internet access, such as an office or home (e-learner). E-learners may either participate live (originally when the organization shapes) or watch recorded lectures any time after the class period (an option after the organization is established). If e-learners are participating live, there is a *live chat* feature in DEN that provides teacher assistance, allowing the remote learners to raise their e-hand and ask a question, just as if they are present in the class. This is helpful as one of the strategies for successful active learning mentioned by Silberman (2008) is to urge participants to ask questions and blend in technology wisely. An example course website can be designed in Sakai, which is an open source learning management system (LMS), instead of Blackboard as the official learning management system. E-learning of this class can be implemented.

Researchers also can do collaborative work with SMART Company that offers a Smart interactive board for learners. SMART Company product offerings started with the interactive whiteboard, which has significantly advanced to include interactive flat panels, interactive tables, interactive pen displays, learner response systems, wireless slates, audio enhancement systems, document cameras, conferencing software, a full line of interactive learning software and more. Beyond products, this company provides the support, integration and services needed to ensure customers can use solutions to their completely (SMART Technologies, 2013).

Smartboards are very useful devices for teaching in higher education, as they promote interaction and use the latest technology. Technology solutions enhance learning by smoothing the transition of knowledge. Knowledge transfer is eased by repetition and real-world examples that could be animated and highlighted using Smartboard technologies. SMART also offers tablets, which would provide an efficient, convenient solution to remote learners who could, for example, upload lessons from a central location before journeying to a more remote location. Then, when he/she is ready for additional lessons or content, the learner could perform an upload again from the central location (SMART Technologies, 2013).

In order to finance a decision analysis project one can promote and fund the project through the use of Kickstarter (www.kickstarter.com). Kickstarter (2013) is an online platform used to fund creative projects. Kickstarter is a way for innovative individuals to tell their story to the public by posting their idea and a personal video on the Kickstarter website for free. All of the financial support goes directly to the project; the donors are not rewarded with financial kickbacks, but rather with other rewards to thank their support. The Kickstarter portal is 100% driven by those who have the same beliefs and passion to create new projects. Therefore, the creators retain ownership of their project and are in no way indebted to their supporters.

Kickstarter (2013) was founded in 2009, over four million people have spent over $600 million to support approximately 42,000 creative projects, and currently there are thousands of projects looking to raise funds on Kickstarter. There are no limitations to the amount of funds a creator can request, and several multi-million dollar projects have been funded successfully over the years. The only limitations are the 60-day timeframe allowed to raise the funds, the project must have a clear and definitive end, and it must fall into one of the following categories: art, comics, dance, design, fashion, film, food, games, music, photography, publishing, technology, and theater.

To lecture this course in future few changes can be done in the length of the class per interest and expertise of learner. If the learners are expert the course should be more condense, shorter but with more advance examples and if the learners are beginners in this topic the length of the course should be longer to explain the content over longer time for ease of understanding the topic and comprehend it better.

Conclusion

Decision analysis techniques should be offered more broadly among the College of Business Management and leadership program for undergraduate and graduate level with Algebra level of math. Learners such as managers, marketing, and human resources face critical decision making situations in industry and companies like Apple and Microsoft would wildly benefit from these typical decision techniques. Several academic institutes and companies that have an interest in decision making techniques, and top leaders and managers can use variety of decision analysis tools.

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APPENDIX: A

Decision Analysis Techniques in the Case Study

Supplier selection case study

- 5W
- Fishbone
- Consequence table
- 5x5 risk analysis
- Risk mitigation
- Decision tree

APPENDIX: B

Consequence Table

		Rated weight	supplier 1	supplier 2			
Team leader		30				1.0125	0.9225
	resource	20	3	4		0.6	0.8
	risk	25	3.5	2.5		0.875	0.625
	issues responses	25	4	3		1	0.75
	progress reporting	30	3	3		0.9	0.9
performance		30				0.96	1.005
	schedule	30	2	4		0.6	1.2
	technical	30	4	2.5		1.2	0.75
	quality	20	3.5	3		0.7	0.6
	post delivery support	10	4	4		0.4	0.4
	cost	10	3	4		0.3	0.4
technical		40				1.2	0.9075
	previous experince	10	4	2		0.4	0.2
	in house design	10	4	3		0.4	0.3
	spec compliance	25	4	3		1	0.75
	depth(number of engineers)	25	4	3.5		1	0.875
	capability (competence)	20	4	3.5		0.8	0.7
	design tools	10	4	2		0.4	0.2
		100				*3.1725*	2.835

APPENDIX: C

Short Course Syllabus

Short course: Decision analysis for adult learners
Applying to transformational and leader-member exchange leadership styles

FACULTY INFORMATION
Instructor: Dr. June Schmieder
Facilitator: Farah Toosi

COURSE INFORMATION
Meeting times and place: EDOL 765, Strategic Leadership and Management of Global Change

Recommended Preparation: None

Prerequisite or Co-requisite
Algebra level mathematics

Course Description:
This study is will recognize learners' transformational leadership and leader-member exchange skills within the context of decision analysis techniques. Decision making is a critical skill that comes with risk and uncertainty factors. This research enable the learner to formulate, collect, analyze, frame, and interpret decision-making information for selecting the best alternative action. This study will recognized decision analysis techniques utilized by global leaders and create a decision analysis training package for future managers, team leaders, marketing and supply chain groups.

Suggested Readings:
Class handouts.

Required Materials/Supplies:
Scientific calculator

Methods of Evaluations
Students can get extra credit if they apply a decision analysis techniques on a project.

Topics Covered
- Leader/Member exchange theory
- Transformational leadership
- Decision analysis techniques applies to mentioned leadership styles
  - Supplier selection case study
    - 5W
    - Fishbone
    - Consequence table
    - 5x5 risk analysis
    - Risk mitigation
    - Decision tree

1. **EVALUATION AND GRADING POLICY**

Grading Components:
This class is CR/NC and only class participation required for original class.

APPENDIX: D

Collaborative Institutional Training Initiative (CITI) Training

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Farah Toosi (ID: 5237731)
- **Email:** [redacted]
- **Institution Affiliation:** Pepperdine University (ID: 1729)
- **Institution Unit:** Graduate school of education and psychology
- **Phone:** [redacted]

- **Curriculum Group:** Graduate & Professional Schools HSR
- **Course Learner Group:** Graduate & Professional Schools - Psychology Division Human Subjects Training
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 18041920
- **Completion Date:** 17-Apr-2016
- **Expiration Date:** 17-Apr-2019
- **Minimum Passing:** 80
- **Reported Score*:** 84

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	16-Apr-2016	3/3 (100%)
History and Ethical Principles - SBE (ID: 490)	16-Apr-2016	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	17-Apr-2016	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	17-Apr-2016	4/5 (80%)
Assessing Risk - SBE (ID: 503)	17-Apr-2016	4/5 (80%)
Informed Consent - SBE (ID: 504)	17-Apr-2016	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	17-Apr-2016	5/5 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	17-Apr-2016	4/5 (80%)
Cultural Competence in Research (ID: 15166)	17-Apr-2016	3/5 (60%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: https://www.citiprogram.org/verify/index.cfm?verify=2efbbe1d-4257-46cd-b303-779e169a1990

CITI Program
Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

APPENDIX: E

Letter Stating that the Researcher Is Competent and Certified to Give this Training, Provided to the IRB

Subject:	Re: Please review
From:	[redacted]
To:	
Cc:	
Date:	Wednesday, January 25, 2017 9:57 AM

I give permission for Farah Toosi to conduct her study in my EDOL 765.25 class tomorrow January 26, 2017. I am fully aware of all the details of the study and feel it will be of benefit to my class.

Dr. June Schmieder

June Schmieder-Ramirez,Ph.D.
Chair, Department of Leadership Studies
june.schmieder@pepperdine.edu
gsep.pepperdine.edu

PEPPERDINE GRADUATE SCHOOL OF EDUCATION & PSYCHOLOGY

PEPPERDINE

eProtocol

Home » Approved Protocols » Details

Protocol ID: 16-10-430

Principal Investigator: Toosi Farah

Details

Form Type	Submitted Date	Meeting Date	Status	Approval Date	Expiration Date	Comments	View Attachments
NEW	11/16/2016	11/29/2016	APPROVED	02/24/2017	N/A	Comments	View Attachments

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eProtocol

eProtocol » Investigator » Home » Approved Protocols

IRB

Protocol ID	Form Name	Principal Investigator	Title	Approval Date	Last Approval Date	Expiration Date	Review Decision	Form Type
16-10-430	IRB Form	Toosi Farah	DECISION ANALYSIS TECHNIQUES FOR ADULT LEARNERS – APPLICA...	02/24/2017	02/24/2017	N/A	Designated Review	NEW

APPENDIX: F

S-Curve

Sent: Saturday, July 23, 2016 2:43 PM
To: Production & Operations Management Society
Subject: permission to use Figure

Production and operations management,

I am completing a doctoral dissertation at Pepperdine University entitled "leadership organization." I would like your permission to reprint in my dissertation excerpts from the following:

PRODUCTION AND OPERATIONS MANAGEMENT
Vol. I. No. 4. Fall 1992
Prinrod in U.S.A.
exploring the limits of technology S-curve, retrieved from:
http://web.mit.edu/mamd/www/tech_strat/courseMaterial/topics/topic3/readings/Exploring_the_Limits_of_the_Technology_S-Curve/Exploring_the_Limits_of_the_Technology_S-Curve.pdf/Exploring_the_Limits_of_the_Technology_S-Curve.pdf

The excerpts to be reproduced are: S-Curve Figure.

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If these arrangements meet with your approval, please sign this letter where indicated below and return it to me in the enclosed return envelope. Thank you very much.

Sincerely,

Farah Toosi

From: Kalyan Singhal <[redacted]
Date: July 23, 2016 at 5:20:10 PM PDT
[redacted]
Subject: Re: permission to use Figure

Yes, you have our permission.

Kalyan Singhal,

Editor, POM

From: Production & Operations Management Society <[redacted]
Sent: Saturday, July 23, 2016 3:03 PM
To: farah toosi
Cc: Kumar, Subodha; Kalyan Singhal
Subject: Re: permission to use Figure

Subodha: Pl reply.

Sushil

Sushil Gupta, Ph.D.
Professor, Department of Decision Sciences
Knight Ridder Center Research Fellow
Executive Director, Production and Operations Management Society
College of Business Administration
Florida International University
RB 250, 11200 SW 8th Street
Miami, Florida 33199, U.S.A.
e-mail: [redacted]

APPENDIX: G

Permission to Reprint Flowchart Decision Analysis Example “Healthcare Failure Modes and Effects Analysis Decision Flowchart

Agency for Healthcare Research and Quality
Office of Communications and Knowledge Transfer
5600 Fishers Lane, 7th Floor
Rockville, MD 20857

Dear Sir or Madam,

I am completing a doctoral dissertation at Pepperdine University entitled “leadership organization.” I would like your permission to reprint in my dissertation excerpts from the following:

http://archive.ahrq.gov/professionals/quality-patient-safety/patient-

safetyresources/resources/mistakeproof/mistakefig3-2.html

The excerpts to be reproduced are: **Flowchart decision analysis example “Healthcare failure modes and effects analysis decision flowchart “**

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If these arrangements meet with your approval, please sign this letter where indicated below and return it to me in the enclosed return envelope. Thank you very much.

Sincerely,

Farah Toosi

DEPARTMENT OF HEALTH & HUMAN SERVICES

Agency for Healthcare
Research and Quality

540 Gaither Road
Rockville MD 20850
www.ahrq.gov

August 30, 2016

Farah Toosi

Irvine, CA 92614

Dear Farah:

This letter confirms that you have permission from the U.S. Agency for Healthcare Research and Quality (AHRQ) to reproduce for your dissertation the chart, "Figure 3.2. Healthcare failure modes and effects analysis decision flowchart," from *Mistake-Proofing the Design of Health Care Processes.*

We ask that proper credit be given to the source. The suggested source citation is:

> Grout J. Mistake-proofing the design of health care processes. (Prepared under an IPA with Berry College). AHRQ Publication No. 07-0020. Rockville, MD: Agency for Healthcare Research and Quality; May 2007.
> http://archive.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/mistakeproof/mistakeproofing.pdf

Please note that your letter to AHRQ did not include a document to sign, or a return envelope, so I will include the pertinent information here. This permission includes use of the chart in current and revised versions and editions of your dissertation, in both print and electronic formats, including non-exclusive world rights in all languages, and in the (prospective) publishing of your dissertation by ProQuest® Dissertation Publishing.

Please contact me if there are any additional issues that need to be addressed with regard to publishing your dissertation. However, it will be easier if you send me the request by email so I can contact you right away if there are any issues. My contact information is below my signature.

Sincerely,

Karen Carp

Karen Carp
Acting Manager of Copyright of Permissions
AHRQ
5600 Fishers Lane, 07N90D
Rockville, MD 20857

APPENDIX: H

Survey

1. Gender

Prefer not to declare Female male

2. What is your age? ____________ Years old.

3. What is your computer skill?

None A little Some A lot expert

4. How many years of education do you have after high school?

2 years college freshman or second year 3rd or senior year college graduate earning graduate degree master or doctorate degree

5. What level of math have you completed?

Basic math Basic algebra trigonometry calculus differential equations

6. How much do you know about decision analysis techniques applying it to leadership?

None A little Some A lot expert Could teach course

7. How interested are you to learn about decision analysis techniques applying it to leadership?

Not at all A little somewhat interested Very

For following decision tools, how much prior knowledge did you have before you took this course?

None A little Some A lot Expert Could teach course

8. Heuristic decisions (balances and interactions between choices for decision making)

None A little Some A lot expert Could teach course

9. Decision trees (visual tool to break the problem to pieces)

Not at all A little somewhat interested Very

10. Monte-Carlo simulations (find best value)

Not at all A little somewhat interested Very

11. Influence diagrams (display decision making)

Not at all A little somewhat interested Very

12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)

Not at all A little somewhat interested Very

13. Group decision making (Consensus vs. Analytic Hierarchy Process)

Not at all A little somewhat interested Very

14. Zachman Framework techniques (Complex system decision making)

Not at all A little somewhat interested Very

15. Decision analysis for Strategic Planning Techniques

Not at all A little somewhat interested Very

16. Analytical Hierarchy Process (mission-sensitive factors)

Not at all A little somewhat interested Very

17. Fishbone diagram decision analysis tool (visual cause and effect)

Not at all A little somewhat interested Very

18. Risk analysis decision making (complex organization)

Not at all A little somewhat interested Very

APPENDIX: I

Second Survey

1. Gender

Prefer not to declare   Female   male

2. What is your age? ____________ Years old.

3. What is your computer skill?

None   A little   Some   A lot   expert

4. How many years of education do you have after high school?

2 years college   freshman or second year   3rd or senior year   college graduate

earning graduate degree   master or doctorate degree

5. What level of math have you completed?

Basic math   Basic algebra   trigonometry   calculus   differential equations

6. How much did you learn about decision analysis techniques applying it to leadership?

None   A little   Some   A lot   expert   Could teach course

7. How interested are you to learn about decision analysis techniques applying it to leadership?

Not at all   A little   somewhat   interested   Very

For following decision tools, how interested are you going to use them in your future professional work?

None   A little   Some   A lot   Expert   Could teach course

8. Heuristic decisions (balances and interactions between choices for decision making)

None   A little   Some   A lot   expert   Could teach course

9. Decision trees (visual tool to break the problem to pieces)

Not at all   A little   somewhat   interested   Very

10. Monte-Carlo simulations (find best value)

Not at all   A little   somewhat   interested   Very

11. Influence diagrams (display decision making)

Not at all   A little   somewhat   interested   Very

12. Top-down induction of decision trees algorithm decision making (data mining and knowledge discovery)

Not at all A little somewhat interested Very

13. Group decision making (Consensus vs. Analytic Hierarchy Process)

Not at all A little somewhat interested Very

14. Zachman Framework techniques (Complex system decision making)

Not at all A little somewhat interested Very

15. Decision analysis for Strategic Planning Techniques

Not at all A little somewhat interested Very

16. Analytical Hierarchy Process (mission-sensitive factors)

Not at all A little somewhat interested Very

17. Fishbone diagram decision analysis tool (visual cause and effect)

Not at all A little somewhat interested Very

18. Risk analysis decision making (complex organization)

Not at all A little somewhat interested Very

APPENDIX: J

Summary of the Lecture

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- **Decision theory**
  1. **Five W: What? Why? Who? Where? When?**
  2. **Risk Analysis: 5x5**
  3. **Leadership of risk decision making in a complex organization**
  4. **Decision tree**
  5. **Fish bone**
  6. **ISD**
     1. **course design: ISD course design**
     2. **Influence diagrams: Case study**
  7. **Consequence table**
  8. **Heuristic decisions**
  9. **Monte-Carlo simulations**
  10. **Group decision making (Consensus vs. Analytic Hierarchy Process)**
  11. **Zachman Framework techniques:**
- **Survey**

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Decision theory

- Humans are engaged in purposeful belief formation (science)
- purposeful, as opposed to automatic, decision making(decision theory and game theory)
- Modern science begins with Galileo in the late 1500's and early 1600's.
- Modern decision theory begins with Pascal in the mid-1600's.
- Here is a very brief history of decision theory:
  - Blaise Pascal - Probability theory, decision theory, and MEV 1654 Pascal and Fermat state modern probability theory ,1658 Pascal states the first decision theory problem (Pascal's wager)
  - Daniel Bernoulli - Utility theory and MEU ,1738 Introduces the MEU theory via the St. Petersburg Paradox

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Decision theory

- Decision theory pertains to human decision making in a world of incomplete information and incomplete human control over events.
- Decision theory suggests two players: a cognitive human and a randomizing nature.
- The human, called the decision maker, performs analyses, makes calculations, and cognitively decides upon a course of action in an effort to optimize his or her own welfare.
- The metaphorical nature is non-cognitive, does not perform analyses or make
- calculations, and does not choose courses of action in any self-interested way.
- Rather, nature blithely selects courses of action purely in a probabilistic way.
- The two fundamental concepts of decision theory are states of nature and acts.
- States of nature are under the control of nature and beyond the control of the decision maker, and are probabilistically selected by nature.
- Acts are under the control of the decision maker and any one of the available acts can be selected by the decision maker.
- Further, decision theory presumes that the problem is presented to the decision maker, i.e., that the problem itself, like the states of nature, is beyond the control of the decision maker.

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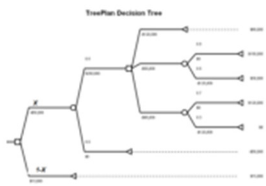
1. Five W: What

- Learners can benefit from well-known and recognized Decision and Risk Analysis Techniques such as decision tree, consequence table, 5W, fish bone, and 5x5 risk analysis
- Decision theory

Likelihood probability	Consequence Impact				
	1 insignificant	2 minor	3 moderate	4 major	5 catastrophic
A [illegible]	Medium	High	High	Extreme	Extreme
B likely	Medium	Medium	High	High	Extreme
C moderate	Low	Medium	High	High	High
D unlikely	Low	Low	Medium	Medium	High
E rare	Low	Low	Medium	Medium	High



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Why?

These Decision and Risk Analysis Techniques:

- Well-known, and in use industry wide used by leaders and followers for technical decision making
- Can help to make the right decisions at the right time, using all of the present information, and discourage the same solutions, or simply doing "business as usual"
- Can help the organizations win new business and perspectives and increase customer confidence
- May be used to highlight the organization's core competencies and to create innovative, streamlined solutions

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Where?

These Decision and Risk Analysis Techniques are used :

- in proposal package
- in technical presentations (internal and external)
- in marketing materials
- Employees real-time and monthly update
- Assessing new ideas

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When?

These Decision and Risk Analysis Techniques are used:

- During idea selections and implementations
- During project proposal to make technical decisions
- During project execution, whenever technical issues arise
- During failure analysis, to determine corrective and preventive actions to re-gain customer confidence

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2. Risk Analysis

- There is a tremendous amount of support for the approach we have taken, which again is to base our decisions on risk analysis and thoughtful scientific process.

Mike Johanns (former United States Senator from Nebraska, serving from 2009 to 2015)
http://www.brainyquote.com/quotes/quotes/m/mikejohann238288.html

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Risk Analysis

- Assumed all the cash flows occur with certainty.
- In reality future cash flows from the project are uncertain.
- Uncertainty: level of cash flows and their timing.
  - Numerous factors contribute to the uncertainties in the estimates of the amount and timing of component cash flows.
- Delivery or construction delays, unexpected bottlenecks in new projects, inflationary or recessionary pressures, labor negotiations and problems in R&D are only a few examples of changes that can and do occur to alter the amounts and timing of disbursements and receipts.
- The economic risk inherent in projects will be represented by a probability distribution apply to 5x5 governing the set of potential outcomes.

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- International Standards Organization (ISO) are the published articles using 5x5 risk matrix analysis which was also used for supplier selection project.

  Goddard Space Flight Center NASA, and United States Department of Defense
  - Allows the user to graphically see the risks of each decision and compare the relative consequences and likelihood of occurrence.
  - Not limited to issues like supplier selection but are commonly used for managing large projects.
  - The number of columns and rows used in a risk matrix can vary depending on how much granularity is required in the decision process.
  - Most effective for making higher level decisions. The risks that show up in the red area should get immediate attention and the items in yellow should be watched closely and assessed for risk mitigation actions.
  - If the factors in red for supplier selection can not be resolved through further discussions with the supplier or mitigated somehow internally
    - Would play a very strong role in down-selecting who would be chosen.

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Risk mitigation

- The risk analysis resulted in many of the components by Supplier 1 being redesigned, which reduced the technical risk associated with evaluated parameters. However, it is going to affect cost and schedule.
- Some of the more risky devices were designed out, and removed from the application.
- The unit connected to this device had sufficient return loss therefore the device which helped to correct this parameter was removed.
- The changes were driven by electrical performance.
- This risk analysis was used to reduce technical and reliability risk, cost, and schedule.

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Leadership of risk decision making in a complex organization:

- An online database tracking tool
- Captures the results of risk management, reduction and burndown. This records the identification of risks, mitigation strategies and efforts, probability analysis and resolutions.
- The database is a constant reference for program managers, engineers and decision makers during the technical life-cycle of the organization.
- The Deliberative Decision Making Model comes from the observation that engineering decisions follow from a series of deliberations, or discussions (for the purpose of making a decision) (Pava 1984).
- The model has three contributing factors, or nodes
  - proactive integrated product team (IPT) leadership including 6 leadership decision activities (LDAs)
  - supporting organizational systems, work processes and tools
  - a coherent decision culture (shared beliefs, values and standards).
- The LDAs consist of understanding the risk, structure the decision process, compile-analyze the data, manage bias, manage debates, and reach decision closure. The successful IPT leader is constantly balancing and managing these three nodes to reach consensus, and making effective decisions to drive the technology and products through the life-cycle.

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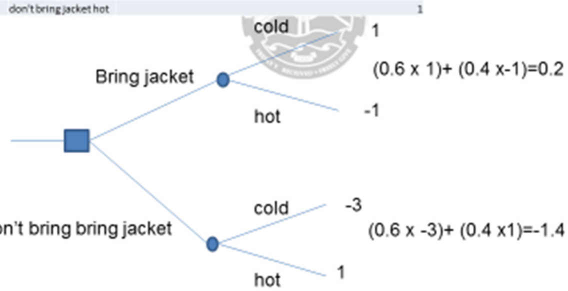
3. Decision tree
Simple example should I bring Jacket
Elements: decision, uncertainty and pay off

uncertainty	cold or not	Per weather channel 60 % below avg day and 40% above avg day
pay off	bring jacket and cold	1
	bring jacket and hot	-1
	don't bring jacket cold	-3
	don't bring jacket hot	1



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Decision tree

Decision trees is a good visual tool to break the problem to pieces: Take uncertainties and probabilities into account. They break the larger decision down into smaller problems and make the pieces of the decision visible to the stakeholders.

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Elements of decision tree

- "The standard statistical paradigm, involving a decision whose payoff depended on a uncertain population parameter, was presented on four-move decision tree."

(Edwards, Miles, & von Winterfeldt, 2007)

- First move on decision tree was the decisions were choosing between suppliers. Uncertain events were late delivery, reliability failure, electrical failure and cost from either first or second supplier. Consequences were the same if we pick either supplier.

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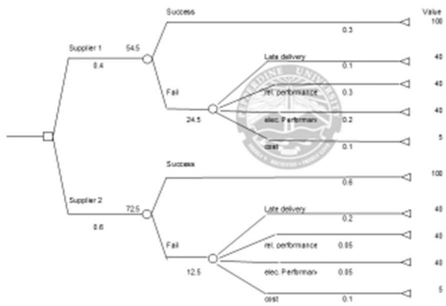
Decision tree



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Decision tree

Top-down induction of decision trees algorithm decision making for data mining and knowledge discovery:

- In a 2008 Ph.D. thesis, "A new approach of top-down induction of decision trees for knowledge discovery" Jun-Youl Lee (2008) describes advanced computer techniques for data mining and knowledge discovery.
- The results of the data mining techniques can be used in decision trees for decision analysis. The main new tool described is induction of decision trees with SODI and SVMM (called IDSS), where SODI and SVMM are other, and well established algorithm tools.
- SODI is second-order decision-tree induction, and SVMM is support vector machines for multi-category (Lee, 2008).
- The new IDSS tool uses more complex decision descriptions to effectively reduce the size of decision trees, using attributes (SODI) and numerical (SVMM) problems.

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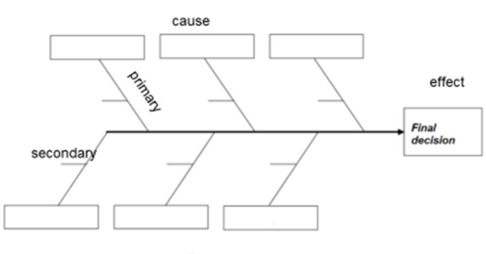
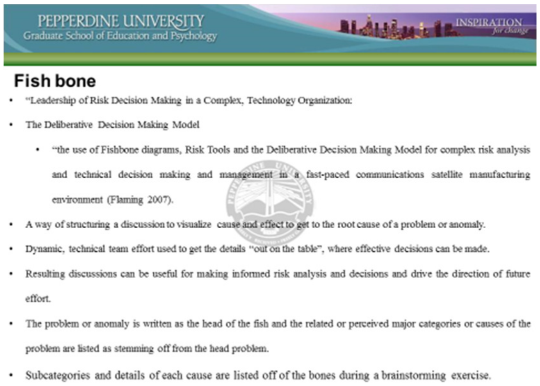
4. Fish bone

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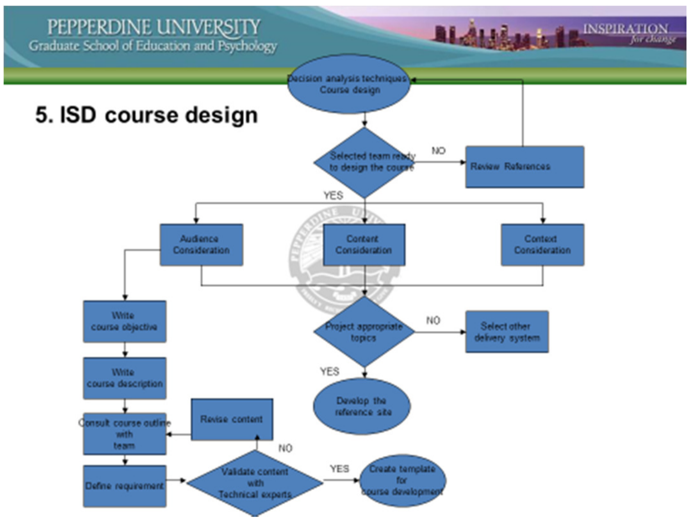
for change
Fish bone
"Leadership of Risk Decision Making in a Complex, Technology Organization:
The Deliberative Decision Making Model
"the use of Fishbone diagrams, Risk Tools and the Deliberative Decision Making Model for complex risk analysis and technical decision making and management in a fast-paced communications satellite manufacturing environment (Flaming 2007).
A way of structuring a discussion to visualize cause and effect to get to the root cause of a problem or anomaly.
Dynamic, technical team effort used to get the details "out on the table", where effective decisions can be made.
Resulting discussions can be useful for making informed risk analysis and decisions and drive the direction of future effort.
The problem or anomaly is written as the head of the fish and the related or perceived major categories or causes of the problem are listed as stemming off from the head problem.
Subcategories and details of each cause are listed off of the bones during a brainstorming exercise.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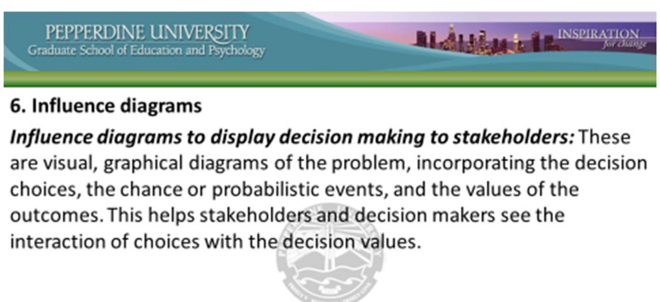
for change
5. ISD course design
Decision analysis techniques Course design
Selected team ready to design the course
NO
Review References
YES
Audience Consideration
Content Consideration
Context Consideration
Write course objective
Write course description
Consult course outline with team
Define requirement
Revise content
NO
Validate content with Technical experts
YES
Create template for course development
Project appropriate topics
NO
Select other delivery system
YES
Develop the reference site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INSPIRATION
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6. Influence diagrams
Influence diagrams to display decision making to stakeholders: These are visual, graphical diagrams of the problem, incorporating the decision choices, the chance or probabilistic events, and the values of the outcomes. This helps stakeholders and decision makers see the interaction of choices with the decision values.

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Case study from an aerospace company:

- Decision analysis among in group
  - Supplier selection
    - Reliability of electronic devices
    - Delivery schedule
    - cost
- Decision analysis have been performed to select between two supplier's of Radio frequency component
  - Team leader, technical support, and supply chain part of in group LMX routinized using Decision analysis to reduce ambiguity
  - Taking role to demonstration of competencies
  - Taking role on critical stage of decision making by leader
- Qualitative method investigation was used to define the why and how of decision making not just what, where, when.

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7. Consequence table

- Analysis of two vendors were evaluated:
  - Resource and Risk Management
  - Issues Response
  - Progress Reporting
  - Schedule Performance (Risk analysis and Decision tree)
  - Technical Performance (Risk analysis and Decision tree)
  - Quality Performance (Risk analysis and Decision tree)
  - Post Delivery Support, Cost (Risk analysis and Decision tree)
  - Previous particular device build experience with Aerospace
  - In-House assembly/test capability
  - Engineering Depth, Engineering Capability
  - Design Tools on building their EMs.

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Consequence table

		Rated weight	supplier 1	supplier 2			
Team leader		30				1.0125	0.9225
	resource	20	3	4		0.6	0.8
	risk	25	3.5	2.5		0.875	0.625
	issues responses	25	4	3		1	0.75
	progress reporting	30	3	3		0.9	0.9
performance		30				0.96	1.005
	schedule	30	2	4		0.6	1.2
	technical	30	4	2.5		1.2	0.75
	quality	20	3.5	3		0.7	0.6
	post delivery support	10	4	4		0.4	0.4
	cost	10	3	4		0.3	0.4
technical		40				1.2	0.9075
	previous experince	10	4	2		0.4	0.2
	in house design	10	4	3		0.4	0.3
	spec compliance	25	4	3		1	0.75
	depth(number of engineers)	25	4	3.5		1	0.875
	capability (competence)	20	4	3.5		0.8	0.7
	design tools	10	4	2		0.4	0.2
		100				*3.1725*	2.835

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8. Heuristic decisions

Heuristic decisions to help balances and interactions between choices for decision making:

These are intuitive, "rule of thumb" decisions based on experience. They are no compensatory, meaning they do not take trade-offs or consequences into account.

Multi-attribute rating methods: Using this method, a list of attributes for the decision are made and the possible choices are rated as to how they satisfy each attribute. This method helps realize tradeoffs and relationships between choices and outcomes, leading to better decisions.

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9. Monte-Carlo simulations

Monte-Carlo simulations to find best value: This is used when a decision tree with multiple uncertainties becomes too large and complex. Uses computer software programs to arrive at best values for probabilistic outcomes.

https://www.youtube.com/watch?v=qJ6UPx75kVE&feature=em-share_video_user

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10. Group decision making (Consensus vs. Analytic Hierarchy Process):

- ***Group decision making (Consensus vs. Analytic Hierarchy Process):***
- 2008, "A Comparative Study of Participant Satisfaction with Group Decision-Making between Consensus and Analytic Hierarchy Process Techniques", Arnold described group decision-making using voting by majority, minority, or unanimous polling, and the Analytic Hierarchy Process for decision-making with interacting groups. (Arnold, 2008).
- In the paper "A Comparative Study of Participant Satisfaction with Group Decision-Making between Consensus and Analytic Hierarchy Process Techniques", Abdullah & Islam…describe decision-making with interacting groups using a process for generation and discussion of ideas similar to brainstorming, followed by a process to reach consensus (Abdullah & Islam, 2011).
- "Consensus is a process that builds through iteration to arrive at a decision that everyone can "live with" (Arnold, 2008, p. 178).Page 29

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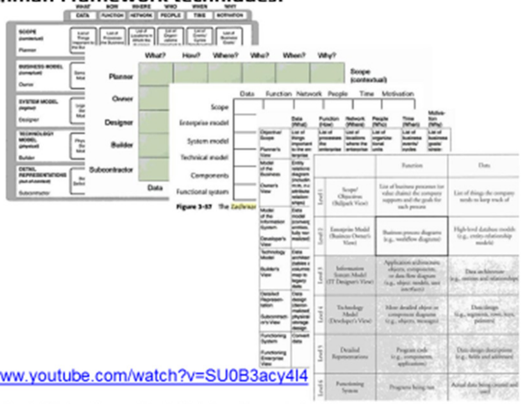
11. Zachman Framework techniques:



https://www.youtube.com/watch?v=SU0B3acy4I4

https://en.wikipedia.org/wiki/Zachman_Framework#/media/File:Zachman_Frameworks_Collage.jpg

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11. Zachman Framework techniques:

	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*
Objective/Scope (*Contextual*) → *Role: Planner*	List of Things important in the Business	List of Core Business Processes	List of Business Locations	List of important Organizations	List of Events	List of Business Goals/Strategies
Enterprise Model (*Conceptual*) → *Role: Owner*	Conceptual Data/ Object Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
System Model (*Logical*) → *Role: Designer*	Logical Data Model	System Architecture Model	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
Technology Model (*Physical*) → *Role: Builder*	Physical Data/ Class Model	Technology Design Model	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
Detailed Representations (*Out of Context*) → *Role: Programmer*	Data Definitions	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
Functioning Enterprise → *Role: User*	Usable Data	Working Function	Usable Network	Functioning Organization	Implemented Schedule	Working Strategy

https://en.wikipedia.org/wiki/Zachman_Framework#/media/File:Zachman_Frameworks_Collage.jpg

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11. Complex system decision making using Zachman Framework techniques:

Systems are getting more complicated as technology advance.

"Improvement of complex system decision making using system dynamics & Zachman Framework techniques", Bharath Bhushan Dantu, 2011

Soft-system methodology (SSM), that integrates technology and human factors to solve complex problems.

- "Zachman Framework is an Enterprise Architecture introduced in 1987 by John Zachman ad extended by Sowa in 1992.
- helps in modifying an enterprise into a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management and as well as the development of the enterprise's systems.
- The units of the framework can also be understood as organization scheme for all kinds of systems and have therefore become widely recognized during the last years. This Framework is independent from tools or methodologies, any methodology can be mapped against it to understand about the system" (Jones, Goldsteen, R and K (2007).
- "Is a powerful answer by providing a global view of the multiple aspects of enterprise architecture, it offers a navigation tool that acts both as starter and a compass for enterprise modelers. It provides a context in which Business and IT architects can build a flexible, consistent information system, according to the strategy of their enterprise" (Zachman, 1999).

12. Decision analysis for Strategic Planning Techniques:

- In the paper of "Analyzing Decision-Making Styles and Strategic Planning Techniques for Information Technology in Non-profit Organizations" (Edwards, 2011). "Miles and Snow (1978)
- Described decision-making process indicators used to identify the organizational leadership style. Basic decision-making process indicators are defined as:
  - Defenders, prospectors, analyzers, reactors, and spontaneous. (Edwards, 2011, P. 44) "The determination is made to base the research upon the decision-making processes identified by Scott and Bruce (1995) and the strategic approaches identified by Frese, van Gelderen, and Ombach (2000)" (Edward, P.47).
- Snow & Phillips (2008) indicate that managers need to be good decision makers in order for their organizations to function at the highest level.

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13. Analytical Hierarchy Process mission-sensitive factors use by NASA:

- "Decision-Making using the Analytical Hierarchy Process (AHP) and SAS/IML" Alexander describes the Analytical Hierarchy Process as a tool to aid decision makers in selection of the best solution from many options with complex selection criteria (Alexander 2012).
- The process creates a matrixed set of criteria, or attributes and uses ranking to assign weight to the inputs. (similar to consequence table)
- The overall goal is at the top of the hierarchy.
- The quantitative rankings put the criteria on a normalized scale, and the best solution is highlighted with the bet score or attribute ratio, e.g. benefit to cost ratio.
- The benefit-cost ratio scatter plot is another, related technique where the attributes of benefit and normalized cost are calculated, and plotted, on three-axes; normalized-cost, benefit and benefit to cost ratio.
- The best solution is again immediately evident as the one with the lowest normalized cost and the greatest benefit to cost ratio.
- AHP is a leading decision-making process and has been used, for example, by NASA to determine several mission-sensitive factors for the human MARS exploration project.

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Here is a quick link on Transformational:

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APPENDIX: K

IRB Approval

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TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: February 24, 2017

Protocol Investigator Name: Toosi Farah

Protocol #: 16-10-430

Project Title: DECISION ANALYSIS TECHNIQUES FOR ADULT LEARNERS – APPLICATION TO TRANSFORMATIONAL AND LEADER-MEMBER EXCHANGE LEADERSHIP STYLES

School: Graduate School of Education and Psychology

Dear Toosi Farah:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair