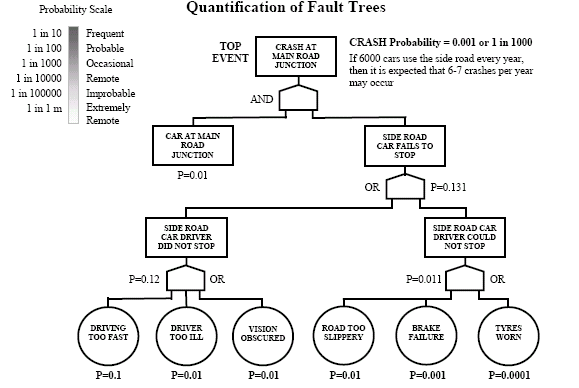
OIE 542 RISK MANAGEMENT & DECISION MAKING

Final Exam

All responses must be typed in Microsoft Excel, with each answer on a different tab. Responses must be submitted via Canvas. Please submit **only 1** Excel file---**do not submit multiple files**, as this makes grading and commenting cumbersome. Also, put your name in the title of your saved file: for example, "jsmith final exam;" NOT just "final exam."

This exam is **open-book** and take-home. You may use any reference materials you like except for other people or answers that were calculated by other people. Your answers should demonstrate a thorough understanding of the subject matter as well as the ability to apply it to real-world situations. You may NOT consult with *anyone*; this work must be yours and yours alone. Please include on Honor Code statement with your completed exam—a suitable statement is “I certify that I am familiar with and have followed WPI’s policy on Academic Integrity and that I have not cheated, fabricated, facilitated, or plagiarized for this assessment.” There are 4 questions worth a total of 100 points. Good luck.

1. **(30 Points). Fault Tree and Threshold Change Analysis**. In Templeton, MA, the (fictional) intersection of Royalston Road with Route 2 has presented a safety problem to the town; 6,000 cars use the Royalston Road-Route 2 intersection each year and there have been several accidents there over the past decade, some of which proved fatal. Each accident costs the town an average of $150,000 in road repairs, insurance claims, police details, ambulance and EMT costs, and lawsuits. The town of Templeton has contracted you to make some safety recommendations because of your expertise in this area. Your staff has already developed a Fault Tree for this situation, which is presented below. (You will recognize this fault tree as the same one discussed during the Module 8 lecture.) You may safely assume that the fault tree and all its data are correct and complete. *Please use a 10-year planning horizon for this exercise*.



a. Please identify the Minimum Cut Sets for this Fault Tree.

b. Please calculate the Fussell-Vesely Importance Factors for each of the lowest-level events. On which would you focus, and why? *You must show all work and calculations*.

c. Several remediation measures are under consideration; they are listed in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| Option | Cost | Risk Impacted | Impact\* |
| Build an Overpass | $10 million | Car at Main Road Junction | Reduces the probability of “Car at Main Road Junction” from 0.01 to 0 |
| Install a stoplight and grading | $150,000 | Car at Main Road Junction | Reduces the probability of “Car at Main Road Junction” from 0.01 to 0.003 |
| Install Speed Bumps | $25,000 | Driving too fast | Reduces probability of “Driving too fast” from 0.1 to 0.05 |
| Install Radar Speed Display | $10,000 | Driving too fast | Reduces probability of “Driving too fast” from 0.1 to 0.06 |
| Install additional Speed Limit signs | $2,000 | Driving too fast | Reduces probability of “Driving too fast” from 0.1 to 0.08 |

\*Note that the impacts of the various options for mitigating the same risk are not additive. That is, if you install both speed bumps and a Radar Speed Display, the impact of the Radar Speed Display is negligible. Similarly, if you install both an overpass and a stoplight the impact of the stoplight is negligible.

Please expand the table above by calculating, for each option, q (the Net Probability of an accident if that particular measure is implemented,) effectiveness E, and the Change Cost-Effectiveness Ratio C/E. You may ignore the impact of Risk Aversion in your analysis. *Hint: pL is greater than $1 million in this problem.*

d. With respect to the possible remediation measures, what are your recommendations to the Town of Templeton, and why? For the selected remediation measure(s), please calculate the implementation cost to the town, the revised accident probability once the selected remediation measure(s) have been implemented, the net savings to the town over 10 years, and the Simple Payback in years. *You must show all work and calculations*.

1. **(30 points). Logistic Regression**. You are the head of Human Resources for a 2500-person high-tech Massachusetts company. The company has been plagued recently by a very high (>20%) turnover rate (meaning that 20% of current employees leave the company each year). This is wreaking havoc on the company’s stability and profitability, and you have been asked by the company’s CEO to make this high turnover stop by modifying hiring practices.

You decide to use logistic regression to try to predict which candidate new employees will stay with the company for at least 5 years. You suspect that the following 5 parameters are important:

* Candidate’s age
* Number of years candidate has been married
* Number of children (under age 18) candidate has
* Number of years the candidate attended college
* Average tenure in the candidate’s previous 3 jobs, in years

Your assistant has analyzed data from 50 of your past employees and has developed the following table (a Microsoft Excel file is included below):

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Past Employee | | Age at Hire | | No. of Years Married at Hire | | No. of Kids at Hire | | No. of Years of College | Ave Tenure in previous 3 jobs | | Stayed >5 years? | |
| Alex | | 27 | | 5 | | 3 | | 0 | 6 | | No | |
| Alice | | 55 | | 12 | | 3 | | 4 | 4 | | No | |
| Allison | | 26 | | 4 | | 1 | | 2 | 5 | | Yes | |
| Angie | | 41 | | 18 | | 1 | | 0 | 20 | | Yes | |
| Anton | | 44 | | 14 | | 2 | | 4 | 13 | | No | |
| Archie | | 34 | | 0 | | 0 | | 0 | 3 | | No | |
| Beaver | | 43 | | 0 | | 0 | | 0 | 2 | | No | |
| Billy-Bob | | 25 | | 16 | | 0 | | 4 | 4 | | Yes | |
| Bonnie | | 31 | | 0 | | 0 | | 4 | 10 | | No | |
| Candy | | 36 | | 24 | | 2 | | 8 | 15 | | Yes | |
| Carol | | 29 | | 5 | | 0 | | 0 | 8 | | No | |
| Christo | | 27 | | 2 | | 2 | | 4 | 6 | | No | |
| Cynthia | | 35 | | 40 | | 4 | | 2 | 4 | | Yes | |
| David | | 49 | | 10 | | 3 | | 4 | 8 | | Yes | |
| Eddie | | 23 | | 2 | | 3 | | 0 | 2 | | No | |
| Ellen | | 64 | | 11 | | 2 | | 0 | 33 | | Yes | |
| Fred | | 36 | | 0 | | 0 | | 4 | 15 | | Yes | |
| Herb | | 34 | | 40 | | 2 | | 0 | 13 | | Yes | |
| Jack | | 43 | | 0 | | 3 | | 5 | 22 | | Yes | |
| Jake | | 26 | | 1 | | 1 | | 4 | 5 | | No | |
| Jane | | 27 | | 53 | | 0 | | 2 | 6 | | Yes | |
| Joe | | 47 | | 10 | | 3 | | 0 | 16 | | Yes | |
| Joey | | 29 | | 26 | | 0 | | 4 | 8 | | Yes | |
| Kate | | 32 | | 0 | | 0 | | 4 | 11 | | No | |
| Katie | | 27 | | 8 | | 4 | | 4 | 6 | | No | |
| Kelly | | 25 | | 14 | | 0 | | 8 | 4 | | No | |
| Lew | | 36 | | 47 | | 6 | | 4 | 15 | | Yes | |
| Luigi | | 27 | | 22 | | 2 | | 0 | 6 | | Yes | |
| Mark | | 56 | | 30 | | 3 | | 4 | 5 | | Yes | |
| Marty | | 23 | | 0 | | 2 | | 8 | 2 | | No | |
| Matthew | | 53 | | 4 | | 0 | | 4 | 2 | | No | |
| Mikey | | 26 | | 4 | | 1 | | 4 | 5 | | Yes | |
| Nomar | | 63 | | 34 | | 2 | | 8 | 4 | | No | |
| Norbert | | 35 | | 12 | | 0 | | 4 | 4 | | No | |
| Norton | | 43 | | 12 | | 2 | | 0 | 22 | | Yes | |
| Occam | | 25 | | 20 | | 5 | | 0 | 4 | | Yes | |
| Patty | | 37 | | 2 | | 1 | | 5 | 16 | | Yes | |
| Peggy | | 23 | | 0 | | 0 | | 0 | 2 | | Yes | |
| Pete | | 30 | | 12 | | 1 | | 2 | 9 | | Yes | |
| Peter | | 28 | | 0 | | 2 | | 5 | 7 | | No | |
| Quince | | 39 | | 4 | | 0 | | 5 | 18 | | Yes | |
| Ramon | | 29 | | 20 | | 0 | | 5 | 8 | | No | |
| Riley | | 31 | | 16 | | 1 | | 0 | 10 | | Yes | |
| Rodolfo | | 35 | | 22 | | 1 | | 8 | 14 | | Yes | |
| Sara | | 54 | | 14 | | 0 | | 2 | 33 | | Yes | |
| Slatts | | 55 | | 0 | | 0 | | 4 | 34 | | Yes | |
| Thomas | | 24 | | 0 | | 0 | | 4 | 3 | | No | |
| Tom | | 24 | | 8 | | 1 | | 8 | 3 | | No | |
| Tommie | | 34 | | 0 | | 0 | | 4 | 3 | | No | |
| Willis | | 23 | | 35 | | 6 | | 4 | 2 | | Yes | |
|  | |  | |  | |  | |  | | |  | |  | |
|  | |  | |  | |  | |  | | |  | |  | |
|  | |  | |  | |  | |  | | |  | |  | |



a) Use the Logistic Regression function in Palisade DecisionTools and StatTools Suite to develop an equation that indicates the probability that a candidate will leave before 5 years (as a function of the independent parameters) and submit that equation (with all terms clearly identified). NOTE: To receive full credit, you *must* include the output page from the Logistic Regression analysis of the Palisade StatTools package. You must also show and explain the step-by-step details you used in arriving at the equation. Finally, you must develop the *best model possible* from the existing data.

b) Using the equation developed in a) above, predict the probabilities that each of the following candidates will leave before 5 years:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Candidate | Age | No. of Years Married | No. of Kids | No. of Years of College | Ave Tenure in previous 3 jobs |
| Sue Ellen | 33 | 0 | 2 | 0 | 3 |
| Bobby | 49 | 33 | 3 | 4 | 6 |
| J. R. | 33 | 7 | 4 | 0 | 5 |

1. **(15 points). SMART**. Andrea is house hunting with her husband, Bill. They are both 28 years old, have no children, and have a combined income of $110,000 per year. After looking at over 50 houses, they have narrowed their choices down to 4 located in the towns of Maynard, Stow, Hudson, and Bolton. The parameters that are important to them are commute, price, school system, and availability of good local Chinese food. After much soul-searching and discussion, they are able to construct the following table rating each option on each attribute (for Schools and Chinese Food, the ratings are on a subjective 0-10 scale; 10 is best and 0 is worst):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Maynard** | **Stow** | **Hudson** | **Bolton** |
| Commute (miles): | 6 | 12 | 18 | 25 |
| Price: | $325,000 | $425,000 | $350,000 | $525,000 |
| Schools: | 5 | 7 | 4 | 7 |
| Chinese Food: | 6 | 8 | 8 | 6 |

Andrea and Bill feel that $250,000 would be a terrific price for a home while $550,000 would be terrible; they also feel that a 50-mile commute would stink but a 5-mile commute would be wonderful. Use the SMART technique to determine which house Andrea and Bill should buy, given the following relative weights: Commute: 15, Price: 20, Schools: 10, Chinese Food: 25. *You must show all work and calculations*.

1. **(25 points). Monte Carlo Simulation**. Six months before its annual convention, the American Medical Association must determine how many rooms to reserve. At this time the AMA can reserve rooms at the swanky Acme Hotel at a cost of $200 per room. The AMA must pay the $200 room cost even if the room is not occupied. The AMA believes the number of doctors attending the convention will be normally distributed with a mean of 4500 and a standard deviation of 1500. If the number of people attending the convention exceeds the number of rooms reserved, extra rooms must be reserved at a cost of $275 per room. **Part A:** Use @RISK simulation to determine the number of rooms that should be reserved to minimize the expected cost to the AMA. **Part B:** Then, for your solution calculate the probability that the AMA will need to obtain at least 200 extra rooms in addition to those reserved. (Important: For both parts, you are responsible for showing how you got your results, including all @Risk settings and formulas.)