ENMA 724: Risk Analysis

Student Name: ______________________

Short test #3

Case 3.1

Consider the following case. Suppose a buyer needs to identify which of five car options is best across three evaluation criteria Car Color, Miles per Gallon (MPG), and Price. Furthermore, suppose the criterion MPG is twice as important as the criterion Car Color and Car Color is half as important as Price.

Suppose the buyer made the value assessments in Figure 3.20 for each criterion. Assume these criteria are mutually preferentially independent.

The three criteria are assumed to be mutually preferentially independent. It follows that the additive value function can be used to generate an overall score for the performance of each car across the three evaluation criteria. In this case, the additive value function is

$$V_Y(y) = w_1 V_{X_1}(x_1) + w_2 V_{X_2}(x_2) + w_3 V_{X_3}(x_3)$$

(Equation 1)

where V x X1 1 ( ), V x X2 2 ( ), and V x X3 3 ( ) are the value functions for Car Color, MPG, and Price, respectively; and, w i i for =1, 2, 3 are nonnegative weights (importance weights) whose values range between 0 and 1 and where $w_1 + w_2 + w_3 = 1$.

Since the criterion MPG was given to be twice as important as the criterion Car Color and Car Color was given to be half as important as Price, the weights in Equation 1 are determined as follows: let w1 denote the weight for Car Color, w2 denote the weight for MPG, and w3 denote the weight for Price. From this, $w_2 = 2w_1$ and $w_1 = w_3 / 2$.

Thus, $w_2 = 2\left(\frac{1}{2} w_3\right) = w_3$

Since w1 + w2 + w3 =1, it follows that

$$\frac{1}{2} w_3 + w_3 + w_3 = 1 \Rightarrow \frac{5}{2} w_3 = 1 \Rightarrow w_3 = \frac{2}{5} \Rightarrow w_2 = \frac{2}{5} \Rightarrow w_1 = \frac{1}{2} w_3 = \frac{1}{5}$$

From this, Equation 1 can be written as

$$V_Y(y) = \frac{1}{5} V_{X_1}(x_1) + \frac{2}{5} V_{X_2}(x_2) + \frac{2}{5} V_{X_3}(x_3)$$

(Equation 2)

Next, suppose the buyer collected data on the five car options according to their performance against each of the three criteria Car Color, MPG, and Price. In Table 1, the left half of the matrix shows the data on each car option across these criteria. The right half of the matrix shows the equivalent numerical scores from the value functions shown in Figure 1. The scores in the last column of Table 1 come from applying the value functions in Figure 1 to Equation 2. In Equation 2, the term $V_{X_1}(x_1)$ is given by the top function in Figure 1; the terms $V_{X_2}(x_2)$ and $V_{X_3}(x_3)$ are shown at the bottom of Figure 1. They are defined as

$$V_{X_2}(x_2) = \frac{1 - e^{-(x_2 - 10)/24.326}}{1 - e^{-(30-10)/24.326}}$$

$$V_{X_3}(x_3) = \frac{1 - e^{-(45 - x_3)/30.4076}}{1 - e^{-(45-20)/30.4076}}$$

For example, from Equation 2, Car 1 has the following overall value score.

$$V_Y(y) = \frac{1}{5}V_{X_1}(4) + \frac{2}{5}V_{X_2}(15) + \frac{2}{5}V_{X_3}(30)$$

$$V_Y(y) = \frac{1}{5}\frac{13}{15} + \frac{2}{5}(0.33) + \frac{2}{5}(0.69) = 0.58$$

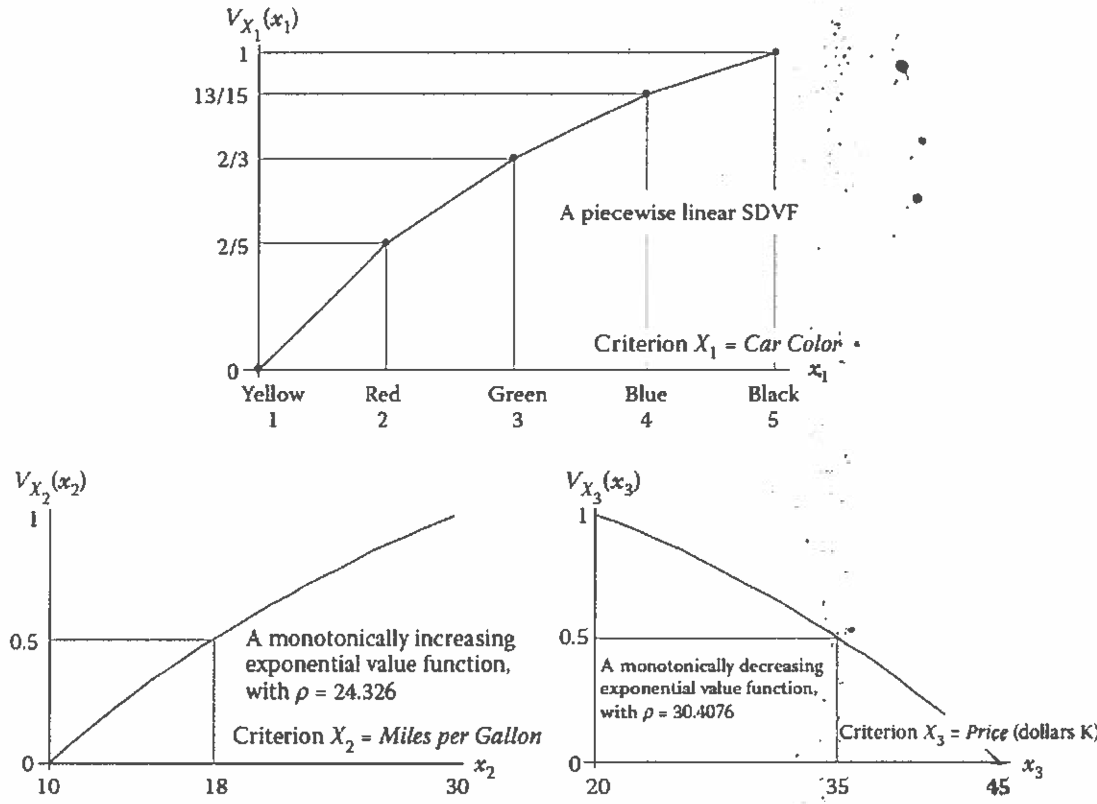
The overall value scores of the remaining car options are similarly computed. From this, Car 5 is the "best" choice followed by Car 2, Car 1, Car 3, and Car 4.

Table 1

A Performance Matrix of the Buyer's Car Options

	Criterion Level (Score)				Equivalent Value Scores			Overall
	Color	MPG	Price		Color	MPG	Price	Value Score
Car 1	4	15	30	Car 1	0.87	0.33	0.69	0.58
Car 2	1	22	25	Car 2	0.00	0.69	0.86	0.62
Car 3	5	18	38	Car 3	1.00	0.50	0.37	0.55
Car 4	3	12	42	Car 4	0.67	0.14	0.17	0.26
Car 5	2	28	21	Car 5	0.40	0.93	0.97	0.84

Figure 1



1. Generate right-half of Table 1 using MS Excel

2. Generate a revised Table based on this new set of raw data:

	Color	MPG	Price
Car 1	1	23	35
Car 2	3	25	40
Car 3	2	30	38
Car 4	5	20	39
Car 5	1	33	45

3. Give 3 NEW examples each of nominal scale, ordinal scale, cardinal interval scale, and cardinal ratio scale (include in the Excel file submission).

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Short test 4

Consider Haime's 11 criteria for risk ranking and how they were used to rank failure of sub-system X (see table). Apply Borda Algorithm discussed in Module 5 to rank the failures of these various sub-systems.

Table VII. Scoring of Subtopics for OOTW Using the Criteria Hierarchy

Criteria	1.1 Telephone	1.2 Cellular	2. Cable	3.1 CIS	4. Satellite	5. International
Undetectability	Low	Low	Med	High	Low	High
Uncontrollability	Med	Med	High	High	Med	High
Multiple Paths to Failure	High	Med	High	High	Med	High
Irreversibility	Med	High	Med	High	High	Low
Duration of Effects	High	High	High	High	High	High
Cascading Effects	Med	Med	Low	Low	High	High
Operating Environment	High	High	High	High	Med	High
Wear and Tear	Med	High	Low	High	Med	High
Hardware/Software/Human/Organizational	High	High	Med	High	High	High
Complexity and Emergent Behaviors	Med	High	Low	High	High	High
Design Immaturity	Med	High	Med	High	High	Med

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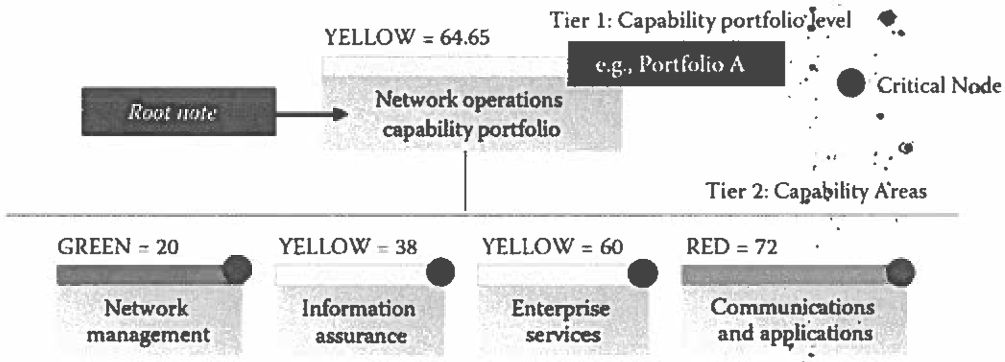
Short test 5

1. Show and explain why critical average and max average rules both generate a risk measure of 64.65 for the node labeled Network Operations Capability portfolio. Refer to Figure 1 below-

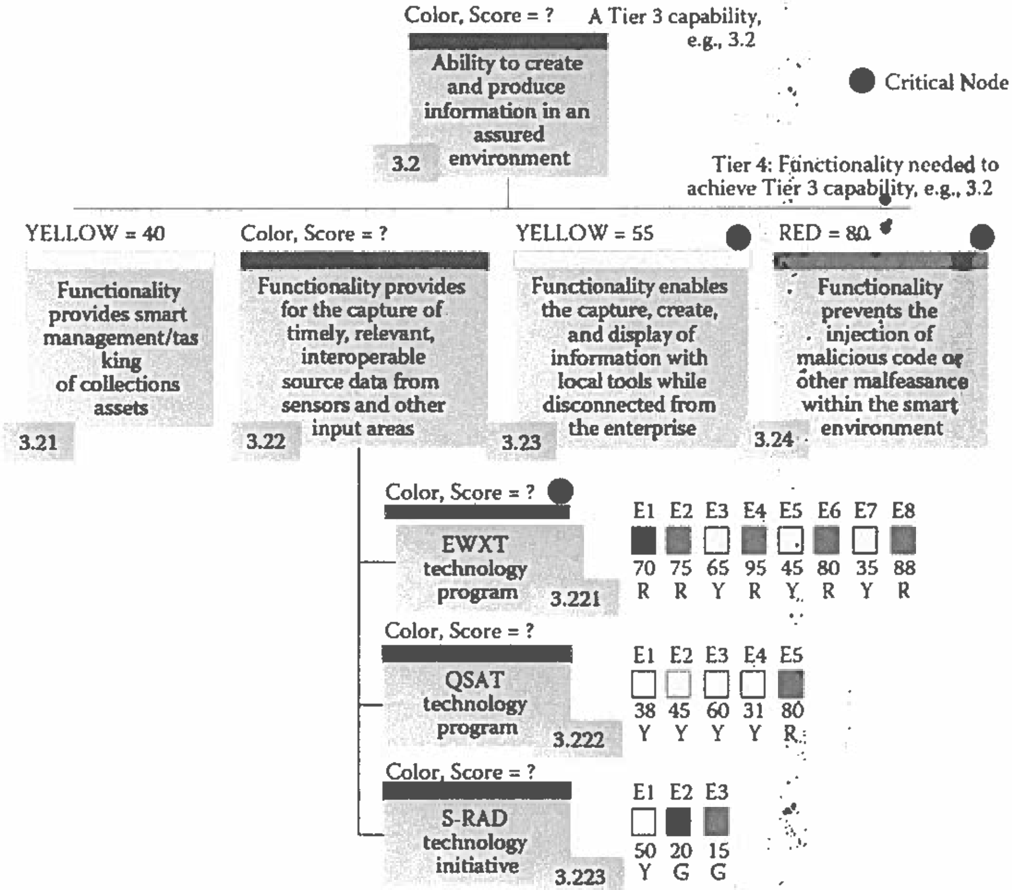
Figure 1.



Suppose all Tier 2 capability areas are critically important nodes to the portfolio

2. Suppose the Figure 2 presents a portion of a capability portfolio defined as part of engineering an enterprise system. Given the information shown, apply the risk analysis algebra in Module 6 to derive a risk measure for Capability 3.2. What risks are driving this measure?

Figure 2.


Color, Score = ?
A Tier 3 capability, e.g., 3.2
Ability to create and produce information in an assured environment
3.2
Critical Node
Tier 4: Functionality needed to achieve Tier 3 capability, e.g., 3.2
YELLOW = 40
Functionality provides smart management/tasking of collections assets
3.21
Color, Score = ?
Functionality provides for the capture of timely, relevant, interoperable source data from sensors and other input areas
3.22
YELLOW = 55
Functionality enables the capture, create, and display of information with local tools while disconnected from the enterprise
3.23
RED = 80
Functionality prevents the injection of malicious code or other malfeasance within the smart environment
3.24
Color, Score = ?
EWXT technology program
3.221
E1 E2 E3 E4 E5 E6 E7 E8
70 75 65 95 45 80 35 88
R R Y R Y R Y R
Color, Score = ?
QSAT technology program
3.222
E1 E2 E3 E4 E5
38 45 60 31 80
Y Y Y Y R
Color, Score = ?
S-RAD technology initiative
3.223
E1 E2 E3
50 20 15
Y G G