Chapter 10: Tools to Compare and Evaluate Options

Key points of chapter

Another tools chapter. Decision Matrices are probably the most versatile. I even tell my classes I found one of my sons many years ago using this technique to decide which girl to ask to the senior prom. I refuse to divulge the criteria. Queuing takes up the most space, but as long as they get the concept of what queuing is, I really wouldn't expect anyone to do it manually. This chapter has lots of limited use stuff, such as EOQ, but note the diagram in the text which shows that even EOQ can be applied to a different way of thinking. Take the chance to practice these tools, since just reading or discussing this stuff won't work.

Answers to Study Questions

1. When the criteria being evaluated are of unequal importance or value to the decision.
2. The numbers in each cell have a realistic, not simply a relative or scalar value.
3. Of course. The text examples all have three, but any number is possible.
4. Only by accident. Generally, the answer is "no."
5. Probably like a skewed-to-the-right product life cycle.
6. Yes. It's almost imperative unless your demand is flat and predictable.

Answers to Exercises

Individual exercise - no common answer.

Possible answer: Top Box (Student: 100%); 2nd row: (Reading: 30%, Class: 25%, Study & homework exercises 45%); 3rd row breaks out class into lecture, exercises, tests; etc.

Cost of the instructor, overhead assigned to each class (registration cost, room space amortization, etc.), use of supplies (such as paper for handouts, markers, etc.), state subsidy, tuition and fees (in- and out-of-county) paid by students).

Other Materials

- An additional queuing example
- An additional decision tree example

Additional example of Queuing

(I considered this one too long to leave in the text – RHV)

Example 2: Taxi Service

This is a queuing analysis to determine the number of taxis needed to serve the demand in a small town. Here are the assumptions for this example: Average time serving (including going to pick up point) - 20 minutes. Average time between calls - 6 minutes. Cost of driver & auto operation - $25/hour. Average fare & tip - $16. Customer willingness to wait - after 10 minutes, 50% will take a bus.

In setting up the simulation, the analyst could assume a call every six minutes. That table would look like this for 1, 2, 3 or 4 cabs in service:

Time	Start	Stop	Wait - 1	Wait - 2	Wait - 3	Wait - 4
00-06	0	20	No	No	No	No
07-12	7	26	--	No	No	No
13-18	13	32	--	--	No	No
19-24	19	38	--	--	--	No
25-30	25	44	No	--	--	--
31-36	31	50	--	No	--	--
37-42	37	56	--	--	No	--
43-48	43	62	--	--	--	No
49-54	49	68	No	--	--	--
55-60	55	74	--	No	--	--

And the pattern would continue to repeat. If calls come exactly every 6 minutes and each service takes exactly 20 minutes, 4 cabs will be just right. No one ever has to wait.

But how about if calls come in randomly? To simulate this, roll a di (one half a pair of dice), and each time a "1" comes up, we say a call has come in. And, instead of each trip being 20 minutes, we use a random method to determine how long the trip will be. Roll 6 dice, add them up and subtract one. That would give an average of 20, but with results ranging from 5 to 35. Or maybe the manager or analyst could keep track for several nights or check historical dispatch records. However it is done, we want to test the assumption that four cabs is adequate. We know three is not, of course. A random number table could also be used to construct this (see the Appendix to the book).

Now some reality has been introduced to the model. The following table was constructed by actually tossing one and six dice. Instead of the smooth flow we had by using only averages, you now see random idle servers and random waits.

In order to keep the table from going on for several pages, all times during the two hour simulation in which no change happens were eliminated. Here's what the headings mean:

- Time is in minutes from zero. The first twenty minutes are needed to get the system up and running, so they are not shown. The two hour simulation runs from minute 21 through 140.
- The Yes/Time column indicates that a call was received for service in that minute, and the length of the required service is indicated in minutes.
- Cab 1 busy indicates (with an x) that the first cab is in service; "Cab 2" the second, and so on. The numbers under the cab columns indicate that a trip started and how long it will take to complete.
- Unshaded boxes indicate that the cab is not busy; lightly shaded that it is busy; darker shaded that it is busy and has another fare waiting.

At least one taxi is idle from the start of the study at minute 21 through minute 45. After that point, there is NO idle time clear through minute 93, then it eases up again. At one point (minute 71) three customers are waiting at the same time.

Five customers over the two hours have waits of 9, 14, 18, 7 and 2 minutes. How much of a problem is this? The results of this model: In the 120 minutes 17 calls were received. 12 were served immediately and three more within ten minutes. One additional cab would have reduced all waits to within the ten minute limit (calculation not shown). That would have "saved" one of the two customers who would have taken a bus. The gain in this simulation of adding another cab would be $16 (one more customer) but the cost would be $50 (2 hours @ $25/hr), for a net loss of $34. If the decision is strictly financial, running four cabs is best.

If the company wants to have a ten minute guarantee, a fifth cab is needed, but that will reduce profits overall. A compromise could be what some of the restaurant chains have done with their ten minute lunch guarantees: If we're not there in ten minutes, your trip is free. That way, it would only cost them $32 instead of $34. Yes, the restaurants that make that offer probably did this sort of an analysis to determine how many cooks and servers to have on duty.

Minutes	Yes / Time	Cab 1 busy	Cab 2 busy	Cab 3 busy	Cab 4 busy
21	no	x	end	NO	NO
24	x-32	x	NO	NO	start 24-55
27	no	end	NO	NO	x
41	x-33	start 41-73	NO	NO	x
42	x-21	x	start 42-62	NO	x
46	x-31	x	x	start 46-76	x
47	x-17	x	x	x	x + wait
49	x-9	x	x + wait	x	x + wait
55	no	x	x + wait	x	end + wait
56	x-21	x + wait	end + wait	x	start 56-72
63	no	x + wait	start 63-71	x	x
65	x-13	x + wait	x + wait	x	x
71	x-19	x + wait	end + wait	x	x + wait
72	no	x + wait	start 72-92	x	end + wait
73	no	end + wait	x	x	start 73-85
74	no	start 74- 92	x	x	x
76	no	x	x	end	x
77	x-17	x	x	start 77-93	x
85	no	x	x	x	end
89	x-24	x	x	x	start 89-112
92	no	end	end	x	x
93	x-16	start 93-108	NO	end	x
96	x-10	x	start 96-105	NO	x
105	no	x	end	NO	x
108	no	end	NO	NO	x
112	x-25	NO	NO	start 112-136	end
123	x-28	NO	start 123-150	x	NO
133	x-15	start 133-147	x	x	NO
136	no	x	x	end	NO
139	x-23	x	x	NO	start 139-161

Additional example of a Decision Tree

(I considered this one too long to leave in the text – RHV)

This is a decision tree showing the choice options for creating an advertising catalog. You need to decide among:

- A full line catalog with everything we sell vs. a seasonal catalog vs. a sale items catalog.
- Full color glossy vs. 2 color on newsprint vs. simple copy on a high speed printer.

Frequency, costs, and expected results from each format are shown in the following table.

Example Decision Tree

Initial Question	Focus/ Size	Format $ cost per page Number /yr	Projected sales per month from each issue	Expense per issue	Annualized Income (Expected Value)
Which Catalog Strategy to Use?	Full Line (100 pages)	4 color glossy ($400/pg) 4 per year	$360,000	$40,000	$360,000 x 12 - $40,000 x 4 = $4,160,000
		2 color Newsprint ($150/pg) 6 per year	$210,000	$15,000	$210,000 x 12 - $15,000 x 6 = $2,430,000
		Low cost copies ($70/pg) 12 per year	$138,000	$7,000	$138,000 x 12 - $7,000 x 12 = $1,572,000
	Seasonal (40 pages)	4 color glossy ($400/pg) 4 per year	$120,000	$16,000	$120,000 x 12 - $16,000 x 4 = $1,376,000
		2 color Newsprint ($150/pg) 6 per year	$60,000	$6,000	$60,000 x 12 -$6,000 x 6 = $684,000
		Low cost copies ($70/pg) 12 per year	$36,000	$2,800	$36,000 x 12 - $2,800 x 12 = $398,4000
	Sale items (16 pages)	4 color glossy ($400/pg) 4 per year	$24,00	$6,400	$24,000 x 12 - $6,400 x 4 = $262,400
		2 color Newsprint ($150/pg) 6 per year	$12,000	$2,400	$12,000 x 12 - $2,400 x 6 = $129,600
		Low cost copies ($70/pg) 12 per year	$9,000	$1,120	$9,000 x 12 - $1,120 x 12 = $94,560

Solution: Although it requires the greatest investment, the full line, 4 color, 4 per year strategy is predicted to have the greatest payback.

Bonus Tool: Decision Table Explanation and Examples

Decision Tables

A decision table is used where the process must produce some output or take some actions based on complex decisions. If the decisions are based on several different variables (input data elements), and if those variables can take on many different values, then the logic expressed by structured English or pre/post condition is likely to be so complex that the user won't understand it.

A decision table is created by listing all the relevant conditions (variables or inputs) and all the relevant actions on the left side of the table. In many applications, it is easy (and preferable) to express the variables as binary (true/false) variables, but decision tables can also be built from multivalued variables. Every possible combination of values of the variables is listed in a separate column. Each column is typically called a rule. A rule describes the action, or actions, that should be carried out for a specific combination of values of the variables. At least one action needs to be specified for each rule (for each vertical column in the decision table), or the behavior of the system for that situation will be unspecified.

The example decision table below can be used to determine which medication, if any, should be given to a patient with certain symptoms. The following information must be considered prior to the decision:

- Is the patient 21 or older?
- Is the patient male or female?
- Does the patient weigh at least 150 pounds?

With three options of two choices each, there are eight possible rules (or columns). You can review the chapter or appendix on statistics, but this is true because we have 2^3 (2x2x2) possibilities.

Rule #	1	2	3	4	5	6	7	8
Age > 21	Y	Y	Y	Y	N	N	N	N
Gender	M	M	F	F	M	M	F	F
Weight > 150	Y	N	Y	N	Y	N	Y	N
Medication 1	X				X			X
Medication 2		X			X			
Medication 3			X			X		X
No medication				X			X	X

To create a Decision Table, you must discuss each rule with the user to ensure that you have identified the correct action, or actions, for each combination of variables. It is quite common, when doing this, to find that the user has never thought about certain combinations of variables or that they have never occurred in his or her experience. The advantage of the decision table approach is that you can concentrate on one rule at a time. Another advantage is that the decision table approach does not imply any particular form of implementation. Decision tables are often referred to as a nonprocedural system modeling tool.

Steps to Create a Decision Table:

1. Identify all the conditions, or variables, in the specification. Identify all the values that each variable can take on.
2. Calculate the number of combinations of conditions. If all the conditions are binary, then there are 2N combinations of N variables.
3.Identify each possible action that is called for in the specification.
4. Create an "empty" decision table by listing all the conditions and actions along the left side and numbering the combinations of conditions along the top of the table.
5. List all the combinations of conditions, one for each vertical column in the table.
6. Examine each vertical column (known as a rule) and identify the appropriate action (s) to be taken.
7. Identify any omissions, contradictions, or ambiguities in the specification (rules in the decision table for which the specification does not indicate that actions should be taken).
8. Discuss the omissions, contradictions, and ambiguities with the user.
9. Combine rules where all possible values of one variable result in the same action (don't care value).

Example #1: Calculating Commissions

Write a decision table for the following narrative specification, and indicate any omissions, ambiguities, or contradictions that you find:

The Swell Store employs a number of salespeople to sell a variety of items. Most of these salespeople earn their income from a commission, paid on the items they sell, but a few are salary-plus-commission employees; that is, they receive a fixed salary, regardless of the quantity or type of items they sell, plus a commission on certain items. The Swell Store sells several different lines of merchandise, some of which are known as standard items (a can of tomato soup, for example) because they are widespread and do not require any creative sales techniques; in addition, there are bonus items that are highly profitable but difficult to sell (a gold-plated, diamond-studded Cadillac, perhaps). The standard and bonus items generally represent the low and high ends of the price spectrum, sandwiching a greater number of items in the middle of the spectrum.

Customers, also, are categorized. Some are known as regulars, because they do business so often that no creative selling is required. Most of the customers, however, do a small amount of business at the Swell Store, and are likely to walk in right off the street, buy something, and then disappear forever.

The management's commission policy is as follows: If a non-salaried employee sells an item that is neither standard nor bonus to someone other than a regular customer, he receives a 10 percent commission, unless the item costs more than $10,000, in which case the commission is 5 percent. For all salespeople, if a standard item is sold, or if any item is sold to a regular customer, no commission is given. If a salaried salesperson sells a bonus item, he receives a 5 percent commission, unless the item sells for more than $1,000, in which case he receives a flat $25 commission. If a non-salaried salesman sells a bonus item to someone other than a regular customer, he receives a 10% commission, unless the item sells for more than $1,000, in which case he receives a flat commission of $75.

Answer: The Commission Table for the Swell Store Sales Force is shown on the following page.

Rule#	1	2	3	4	5	6	7	8
Employee Type (S, N)*	N	N	-	-	S	S	N	N
Item Type (S, G, B)**	G	G	S	-	B	B	B	B
Customer (R, W)**	W	W	-	R	-	-	W	W
Cost > $1,000 (Y/N)	-	-	-	-	N	Y	N	Y
Cost > $10,000 (Y/N)	N	Y	-	-	-	-	-	-
Commission paid:								
10%	x						x	
5%		x			x			
None			x	x				
$25						x		
$75								x

*Employee type - Salaried, Non-salaried; *Item type - Standard, General, Bonus; *Customer - Regular, Walk-in

Ambiguities: Only two item types are described (Bonus and Standard), but a third category is referenced (General).

Omissions: Salaried employees selling General items are not included in rules.
Salaried employees selling Bonus items should only get commission on Walk-in customers, but this condition is not stated.

Example #2: Check acceptance policy

Create a decision table for a check acceptance policy. The conditions are:

- Check amount is less than $100
- Customer has a driver's license
- Customer has a check guarantee card
- Check is a two-party check
- Customer is a "preferred customer"

The check can be accepted if:

- Customer has a check guarantee card and a driver's license
- Check is less than $100 and the customer shows a driver's license or a check guarantee card
- Customer is a "preferred customer" and check amount is less than $100
- Customer is a "preferred customer" and check is a two-party check

Answer:

Rule #	1	2	3	4	5
Check amount < $100	-	Y	Y	Y	-
Customer has driver's license	Y	Y	-	-	-
Customer has a check guarantee card	Y	-	Y	-	-
Check is a two-party check	-	-	-	-	Y
Customer is a "preferred customer"	-	-	-	Y	Y
Check accepted	x	x	x	x	x

Example #3: Class selection

You are trying to decide what to take among several available classes for next quarter. Some of the classes are about interesting subjects. Others don't sound all that exciting, but some of them are required for your degree. Your also have (or have heard) some strong opinions about the teachers. You want to rank the classes as High, Medium, Low, or Forget-it to help you put together you schedule.

If the subject is interesting, is a requirement, and has a good teacher, it will definitely be rated high. As a matter of fact, even if it isn't required (an elective), you will still rate it high. On the other hand, if it is not interesting, doesn't meet a requirement, and has a bad teacher, forget it. If it is an interesting subject and is a required course, you will deal with a bad teacher if you have to and rate it medium. Also, if it is required with a good teacher, you will have to take it sometime, even if it is boring, so rate this as medium. You are not too excited about non-required courses taught by bad teachers, even if the subject is very interesting, or boring non-required courses, even if the teacher has a good reputation. Rate these combinations as low. If a boring, required course is being offered with a teacher you can't stand, you rate it low. You will have to take it sometime (otherwise, you would forget it), but you can always hope someone else will teach it in the future.

1. What is the maximum number of rules in this table?
2. Can any rules be eliminated or consolidated (if so, which)?
3. Complete a Class Ranking decision table for this problem.