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Enhancing Equipment Investment Decisions Using Equivalent Annual Cost

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Abstract

For any piece of equipment or system required to operate a hospitality business, there are typically many available choices that would perform various required functions. But while any of those machines may do a particular job, they are likely to differ in ways that make selection complicated. For example, some commercial ice machines are air-cooled while others are water-cooled. Both make ice, of course, but the purchase decision involves contrasting considerations. Air-cooled machines are less expensive upfront, but they have higher annual operating costs. On the other hand, water-cooled machines are more expensive upfront, while presenting lower annual operating costs. Beyond that, the two types of ice machine may have different expected useful lives. In combination, these factors (as well as possible external considerations) make it complicated to determine the most cost-effective choice.

Keywords

hospitality, equipment, selection, investment, annual cost

Disciplines

Hospitality Administration and Management

Comments

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EXECUTIVE SUMMARY

Hospitality managers make numerous equipment-purchase decisions in the course of creating outstanding guest experiences. One important type of decision involves purchasing or replacing equipment or systems that are required to keep the firm in business. In most cases there are multiple equipment models that would do the job, each with different up-front costs, ongoing running costs, and expected useful lives. In addition to those considerations, this study includes the time value of money as part of a thorough methodology for identifying and choosing the best all-in value when considering equipment alternatives. The companion Cornell Hospitality Tool provides an easy-to-use spreadsheet-based application that can be used to quickly compare the economic value across alternatives.

ABOUT THE AUTHORS

Pamela Moulton, PhD, is an associate professor of finance and area coordinator for finance at the School of Hotel Administration, Cornell SC Johnson College of Business. Her teaching and research interests include financial markets and market microstructure, with a special interest in the role of investors. Her current research focuses on the impact of high-frequency trading on stock performance, the role of designated and voluntary market makers in stock liquidity, and detecting fraud in financial statements. Moulton's research has been published in several of the leading finance and accounting journals, including the *Journal of Finance*, the *Journal of Financial Economics*, the *Journal of Accounting and Economics*, and the *Journal of Financial and Quantitative Analysis*. Prior to her academic career, Moulton worked in fixed-income research for more than a dozen years at various Wall Street investment banks, including Deutsche Bank, where she was a managing director and global co-head of relative value research. From 2003 to 2006, she was a managing director and senior economist at the New York Stock Exchange, where she focused on equity market microstructure research.

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For any piece of equipment or system required to operate a hospitality business, there are typically many available choices that would perform various required functions. But while any of those machines may do a particular job, they are likely to differ in ways that make selection complicated. For example, some commercial ice machines are air-cooled while others are water-cooled. Both make ice, of course, but the purchase decision involves contrasting considerations. Air-cooled machines are less expensive upfront, but they have higher annual operating costs. On the other hand, water-cooled machines are more expensive upfront, while presenting lower annual operating costs. Beyond that, the two types of ice machine may have different expected useful lives. In combination, these factors (as well as possible external considerations) make it complicated to determine the most cost-effective choice.

Exhibit 1

Survey responses for recent equipment purchase

Item	# Responses
Cars/Vans/Bicycles	13
Dishwasher	9
Laundry equipment	8
Ice machine	7
F&B management system	7
Air conditioning	5
Printer	5
Floor cleaning machine	4
Ovens/Convection ovens	4
Mattresses	3
Power generator	3
Mobile food service equipment	3
Composter	2
Soft goods	2
Banquet items	2
Full kitchen	2
Heat pump	2
Unspecified	2
Total Responses	**83**

Background

The first step in pricing out equipment options is gathering the upfront cost for each equipment choice, including taxes, delivery, and installation fees, if any. Next, a manager would tally the annual operating costs, including the cost of items such as electricity, water, gas, and required routine maintenance. Finally, the useful life of the equipment is included in the purchase consideration, given the expense of replacing a machine.

Some alternatives are intrinsically easy to evaluate. For example, if Equipment A has a lower upfront cost, lower annual operating costs, and a longer expected useful life than Equipment B, Equipment A is clearly more attractive from a cost perspective. More commonly, each alternative has some advantages and some disadvantages, making for a complicated decision. As in the case of our hypothetical ice machine, one washing machine may have a higher upfront cost but lower operating costs (by requiring less water, for example) than a less-expensive model, and the two machines may also have different useful lives. In such a case, choosing the machine with the lowest upfront cost may not be the best course of action.

Given that managers face many such decisions, our purpose in this paper is to introduce a calculation known as equivalent annual cost (EAC), which is a comprehensive way for managers to evaluate alternative equipment choices, taking into account all of the costs involved in purchasing, running, and maintaining equipment, as well as the equipment's useful life. We discuss a survey of managers' common evaluation techniques, review some of those approaches, and then explain how equivalent annual cost can be used to overcome their limitations. Finally, we present a Cornell Hospitality Tool that enables hospitality managers to apply the equivalent annual cost methodology to evaluate their own equipment choices.

Survey of Equipment Purchases

We sent a survey to 819 hotel general managers, of whom 83 responded (see appendix for survey). First, we asked respondents to describe their recent equipment purchases, as reported in Exhibit 1. In 25 of these decisions, survey respondents indicated that there was a clear choice that was better on all dimensions (cheaper to buy, higher quality, cheaper to run, and better expected life). In those cases, no further analysis was required because the best choice was obvious. In the other 58 examples given by respondents, each of the options had some advantages, so the choice was not obvious. For example, several respondents described situations in which one option cost more upfront but also had a longer expected life and lower expected maintenance costs.

Respondents described a variety of ways that they approached these decisions when there was no simple superior choice, as shown in Exhibit 2. For instance, a comparison of the sixth and seventh responses in Exhibit 2 illustrates that expected life can be viewed differently depending on the type of equipment being considered. Some respondents saw longer expected life as an advantage, since the equipment would not need to be replaced as frequently. In contrast, for some purchases, managers viewed a shorter average life as more beneficial (all else equal), specifically when improved technologies are expected to become available over time. We will return to this point later.

Importantly, half of the examples reported by managers involved quality differences between the options. For some choices (especially those that are guest-facing), quality may be the most important factor. For other decisions, financial considerations will be more important. Even when quality differences are paramount, financial analysis is useful because it allows managers to assess the all-in cost of getting higher quality.

In the second part of the survey, we probed respondents' financial analysis methods more deeply by presenting a simplified situation where there is no quality difference between the choices. In our hypothetical example, Equipment A has a lower initial cost, lower annual running cost, and shorter expected life than Equipment B (which has a higher initial cost, higher annual running cost, and longer expected life). More than three-quarters of the respondents made their decision by comparing the simple cost per year (calculated by dividing the initial cost by the number of years the equipment is expected to last, and adding that number to the annual running cost) for the two equipment choices. The remaining respondents described either using an approach similar to equivalent annual cost (nine respondents) or basing their decision on initial cost alone (four respondents), while two of them did not explain their approach. In the following sections we explore the differences between using the initial cost, simple cost per year, and equivalent annual cost to make recurring investment decisions.

Initial Cost and Simple Cost per Year

As we have discussed above, the most basic approach is to choose the option with the lowest initial cost. While this approach is simple, it may not lead to the wisest choice if the machine with the lowest

Exhibit 2

Purchase decision approaches

Explanation given	# Respondents
Lower up-front cost	15
Higher quality	12
Higher quality and lower operating cost	6
Lower running cost and longer expected life	5
Lower ongoing maintenance/best service availability	4
Best quality and longest life	4
Best quality and shortest life	4
Combination of quality and higher implied return	3
No explanation provided	5

Exhibit 3

Simple cost-per-year calculation

Equipment #1

Name	Machine 1
Initial cost	700
Annual running cost	4,128
Expected life (years)	5

Calculations: Equipment #1

Year	1	2	3	4	5
Annual running cost	4,128	4,128	4,128	4,128	4,128
Initial cost/#years	140	140	140	140	140
Simple cost per year	4,268	4,268	4,268	4,268	4,268

Equipment #2

Name	Machine 2
Initial cost	2,548
Annual running cost	3,562
Expected life (years)	4

Calculations: Equipment #2

Year	1	2	3	4
Annual running cost	3,562	3,562	3,562	3,562
Initial cost/#years	637	637	637	637
Simple cost per year	4,199	4,199	4,199	4,199

price involves higher operating costs or will need to be replaced more frequently. For example, Exhibit 3 presents two machines which differ significantly in their cost features. The first machine has a much lower initial cost, $700 versus $2,548 for the second machine. Under the initial cost criterion, the first machine would appear to be the best choice, but that judgment ignores the fact that the first machine will cost more to run on an ongoing basis. The initial cost method is usually employed only when the purchasing budget is tight, as several survey respondents pointed out.

A more common approach is to divide the initial cost by the number of years in the machine's useful life, then add that amount to the annual operating cost to compute a rough cost per year. This is the method that was described by the preponderance of survey respondents. In the example in Exhibit 3, the first machine has a lower initial cost and a longer life but costs more to operate, while the second machine has a higher initial cost and shorter life but costs less to operate. To calculate the simple cost per year, we add the initial cost divided by the number of years the machine is expected to last (initial cost divided by number of years) to the annual operating cost. Exhibit 3 shows that the simple cost per year is $4,268 for the first machine versus $4,199 for the second machine, suggesting that the second machine is a better value, in contrast to the initial-cost-based conclusion.

The main disadvantage of applying the simple-cost-per-year approach is that it ignores the time value of money—that is, it implicitly assumes that a dollar spent today is the same as a dollar spent in the future. Most managers intuitively understand that a dollar spent today is not the same as a dollar spent five years from now, and that money that is not spent in the present can be invested to earn a return over time. However, including the time value of money complicates the decision. In terms of simple cost per year, Machine 2 in Exhibit 3 appears cheaper, but it also involves spending much more money up front despite its lower annual operating costs. To take the time value of money into account, we offer the calculation of equivalent annual cost.

Equivalent Annual Cost

By incorporating time value of money together with all of the one-time and ongoing costs involved in purchasing and operating equipment, equivalent annual cost provides managers with a more comprehensive and reliable way of making recurring equipment investment decisions. Beyond the normal equipment cost information, the additional input required to calculate EAC is a discount rate. The discount rate can be thought of as the firm's cost of capital, or the return on investment required by the firm's ownership. For a publicly traded firm the discount rate should reflect the firm's weighted average cost of capital; in a private firm, the discount rate should reflect the return expected by the firm's owner. Effectively, the discount rate represents opportunity cost, or the return that could be earned on other projects of roughly similar level of risk, if the money were not invested in this equipment purchase.[1]

In Exhibit 4 we examine the same two machine options as in Exhibit 3, but now with the addition of an assumed discount rate of 12 percent. Using those figures we can calculate each machine's EAC. The steps to calculate each machine's EAC are as follows:[2]

(1) List the initial cost (including taxes, delivery, and installation) at time zero.

(2) List the annual running cost of the equipment (including electricity, water, and annual maintenance) for the useful life of the equipment, and sum the cash flows by year.

(3) Calculate the present value of each annual cash flow by discounting the cash flow at the given discount rate for the appropriate number of years, using the formula:

$$\text{Present value} = \frac{\text{Future value}}{(1 + \text{Discount rate})^t}$$

where t is the number of years until the cash flow occurs and future value is the cash flow in year t.

(4) Sum all of the present value cash flows.

(5) Solve for the level annual (annuity) payment such that the present value of all the annual payments over the life of the equipment is equal to the sum of the present value of cash flows. This can be done using a table of annuity factors, a financial calculator, or built-in spreadsheet functions (which we use in the accompanying tool).

Exhibit 4 shows that the EAC for the first machine is smaller than the EAC for the second machine (by $79: $4,322 EAC for the first versus $4,401 EAC for the

[1] For projects that must be done to stay in business, such as purchasing or replacing equipment without which the business cannot continue, some organizations use a lower discount rate than their usual cost of capital.

[2] These calculations are pre-programmed in the accompanying CHR Tool; they are outlined here merely to provide clarity and transparency.

Exhibit 4

Equivalent annual cost (EAC) calculations

Equipment #1

Name	Machine 1
Initial cost	700
Annual running cost	4,128
Expected life (years)	5
Discount rate	12%

Calculations: Equipment #1

Year	0	1	2	3	4	5
Initial cost	700					
Annual running cost		4,128	4,128	4,128	4,128	4,128
Total cash flow	700	4,128	4,128	4,128	4,128	4,128
Present value cash flow	700	3,686	3,291	2,938	2,623	2,342
Sum of PV cash flows	15,581					
Equivalent Annual Cost (EAC)	4,322					

Equipment #2

Name	Machine 2
Initial cost	2,548
Annual running cost	3,562
Expected life (years)	4
Discount rate	12%

Calculations: Equipment #2

Year	0	1	2	3	4
Initial cost	2,548				
Annual running cost		3,562	3,562	3,562	3,562
Total cash flow	2,548	3,562	3,562	3,562	3,562
Present value cash flow	2,548	3,180	2,840	2,535	2,264
Sum of PV cash flows	13,367				
Equivalent Annual Cost (EAC)	4,401				

second). So, with these relative costs, the first machine is actually more attractive. Note that the EAC, which takes into account the time value of money, leads to the opposite choice compared to the simple annual cost calculation in this example, using the same cost data.

Non-financial Considerations

Equipment quality. For many investment decisions simply choosing the option with the lowest EAC is sufficient. But in some cases, there is also a material quality difference (or other external considerations) between the two alternative machines. For example, perhaps the machine with the higher EAC is quieter. In this case, the difference between the two machines' EACs can be used as a measure of how much the firm would be implicitly paying for a quieter machine. Is it worth an extra $79 per year to have a quieter machine? Is it worth more or less than that per year? EAC gives managers a way to quantify such cost/benefit trade-offs. In other cases there may be a revenue angle. For example, will a fry machine that has a higher EAC than another produce fries that can be sold for a higher price per serving or increase the number of orders of fries sold? If so, will that additional revenue offset the difference in EACs between the two fryers? The EAC analysis allows managers to quantify these differences and make more informed equipment purchase decisions.

Equipment life. One final consideration arises when the equipment options have the same or similar EACs but different useful lives. In this situation, managers generally benefit from choosing the equipment with a shorter replacement cycle (that is, shorter economic life). The shorter replacement cycle allows them to take advantage of improvements in technology sooner, which may mean a lower replacement price or higher functionality than anticipated. This point was also raised in our survey responses. ■

EQUIVALENT ANNUAL COST TOOL

The Equivalent Annual Cost tool provides a quick and easy way to calculate and compare the EACs for alternative equipment purchases. The tool is available as an Excel file that you can download at no charge from the Center for Hospitality Research website (chr.cornell.edu). To use the tool:

1. Open the workbook and go to the spreadsheet labeled "EAC Tool."*
2. Enter the required information for each piece of equipment in the cells with red text (cells C5-C10 and C26-C31).
   a. Name is optional.
   b. Initial cost is the total upfront cost of the equipment, including taxes, shipping, delivery, and installation, if any.
   c. Annual running cost includes, for example, electricity, water, and annual maintenance costs.
   d. Expected life is in years; spreadsheet will accommodate up to 35 years automatically and can be extended manually beyond that if necessary.
   e. Salvage value is the amount that the equipment can be sold for at the end of its useful life (for example, if it can be sold in the market as used equipment or as scrap metal). If none, input zero or leave blank.
   f. Discount rate is set to be the same for both pieces of equipment by default (requiring input only for Equipment 1), but the discount rates can be changed separately.
3. The Calculations fill in automatically after inputs are entered, and the EAC for each piece of equipment appears in bold below the calculations.

**Note*: The formulas in the spreadsheet are protected by default, so that a user does not accidentally overwrite them. To unprotect the spreadsheet, go to the Excel menu at the top called Review, select Unprotect Sheet, and enter the password EAC.

Appendix

Hospitality Investment Survey

We are conducting a survey of how hospitality firms make investment decisions for equipment that will have to be replaced when it wears out. Some common examples include ice machines, laundry equipment, refrigerators, and shuttle vans—items that will be needed for as long as the hospitality firm is in business.

What can make these decisions complex is that the available choices often have different initial costs (price, delivery, and installation), different expected useful lives, or different annual running costs (for example, electricity, gas, or water usage). They may also have different quality output (for example, an ice machine that is quieter or makes different ice shapes).

Part 1:
Describe a recent equipment investment decision

Please think about the last investment decision you or colleagues have made involving a piece of equipment that you would expect to replace when it wears out, and keep that in mind to answer the following three questions:

Q1: What type of equipment was it?

Q2: Was one of the options clearly superior to the other(s) on every dimension? For example, was one cheaper to buy, higher quality, cheaper to run, and expected to last longer?

Yes
No

Q3: If one option was not clearly superior to the other on all dimensions, how was the decision made? For example, did you or your colleagues choose the one with the lower initial cost, or the higher quality, or the cheaper annual operating costs, or the longer life, or some combination of these considerations? If you used a back-of-the-envelope formula to assess these different aspects jointly, please describe it.

Part 2:
How would you approach a complex decision?

Consider the following information about two pieces of equipment, both of which would do the job equally well, and then answer the following two questions.

	Equipment A	Equipment B
Initial cost	$1000	$2000
Annual running cost	$100	$120
Expected life	2 years	5 years

Q4: Which piece of equipment would you choose to buy?

A
B
Indifferent between A & B

Q5: How did you decide between the two choices, A and B? If you used an intuitive framework or a formula to aid in your decision-making, please describe it. Also, please describe any other information or assumptions you used to evaluate this choice.

Thank you for taking the time to participate in this survey; your participation is very helpful to us! Please email us at pmoulton@cornell.edu if you would like us to send you the results of the survey and our related research.

Thank you,
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