Overview

Should my company implement a proposed waste reduction strategy?

Goals

In this case, you will break down and quantify a business problem, focusing on tasks like:

1. Identifying and thinking about trade-offs.
2. Calculating costs of several inputs (e.g., materials, labor, assets, property).
3. Thinking in common units of measurement (e.g., cost per square foot or cost per week).
4. Identifying the break-even point when investing in new technology.
5. Communicating your findings effectively by addressing the key performance indicators that matter.

Introduction

Business Context. You are an analyst at a wholesale distribution company that imports housewares in bulk and mails them out to individuals. Being environmentally conscious, your boss wants to reduce the amount of waste in your distribution process, specifically waste from packaging materials. However, your boss is looking for a way to reduce waste at *no extra cost*. The company imports products and often has excess cardboard material, so you suggest converting the excess cardboard into a more environmentally friendly packaging material using a cardboard perforator. Your boss thinks this could work but needs to know how much it will cost. You have been asked to account for all the inputs and changes in the business processes so that an informed decision can be made.

Business Problem. You will need to quantify all the current business inputs and calculate the financial cost or benefit of implementing this waste reduction strategy.

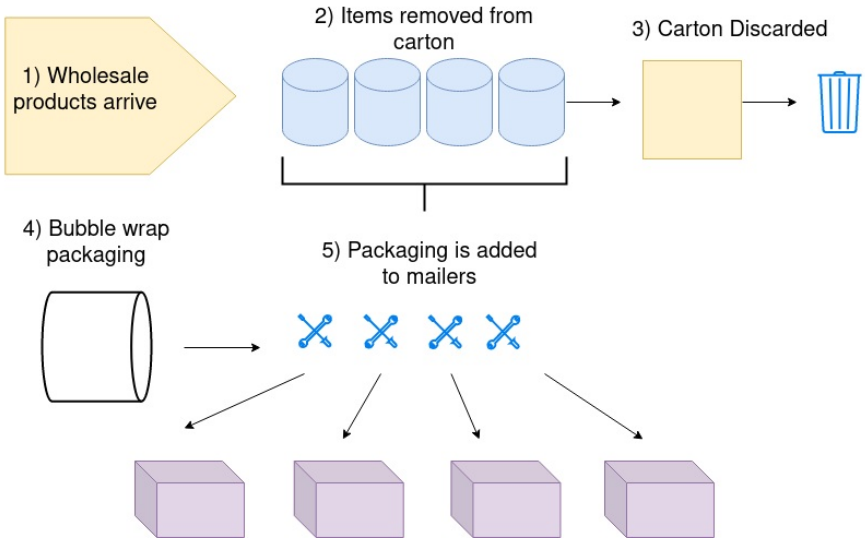
Analytical Context. All the information that you require will be provided as we go through this case. You will need to use the given information to come to an informed decision on how to proceed with the proposed initiative.

This is an example of cardboard perforation performed by a Formax Greenwave 410 tabletop perforator.

Mapping out the Process & Exercise 1

The most important thing when deciding what to change about a business process is to *thoroughly understand the current process*. You have been provided with the below step-by-step process information and the accompanying diagram:

1. As a wholesale distributor, your warehouse receives purchases of housewares in bulk and then mails these out individually to customers. The arrow shows the shipments coming into the warehouse.
2. Once the shipment arrives, the items are removed from the carton. Products arrive in a carton of 12 units. The cylinders represent the items that are removed from the carton.
3. The outer carton is discarded as waste, shown by the blue garbage can symbol.
4. To prepare the products for individual shipment, plastic bubble wrap is used, as shown by the roll icon. This is the step that your boss has asked you to try and improve on.
5. The products are wrapped and put into mailers by hand, so labor is shown by the tools icon. The purple cubes show the final product.

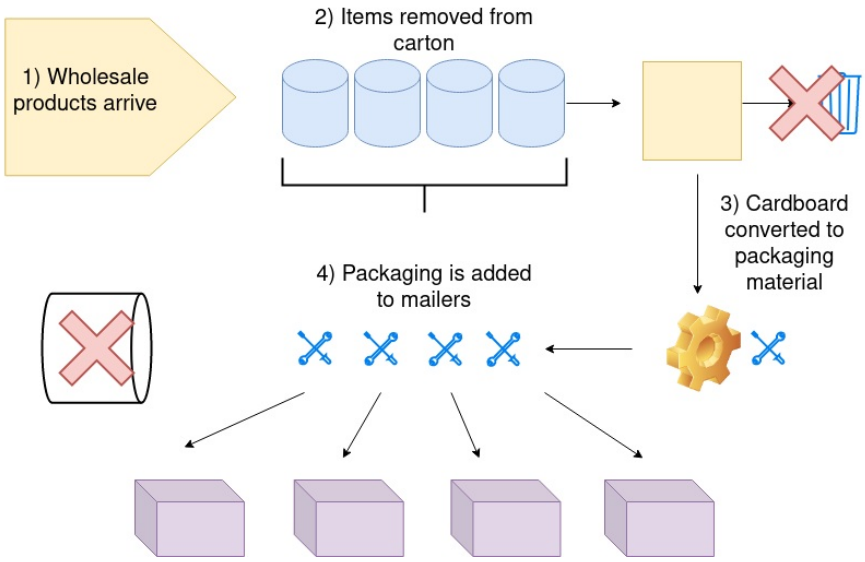


Exercise 1

Our goal is to measure the difference between this existing business process and one that includes a method of converting cardboard waste into packaging material.

Quantifying the current process

One possible solution would be to remove the existing bubble wrap packaging and replace it with a cardboard perforation machine. This new machine will require some additional labor to operate, and as we'll see below, there will be a few extra costs that you will need to think through:



Once we have understood the current process, we must *quantify the costs at each step*. Without this quantification, we cannot make a precise recommendation based on facts and will instead be "hand-waving" our way into a solution.

Our goal is to compare the benefits and costs of both processes. You go around the warehouse and collect the following figures and estimates:

1. **Machinery Costs**: You price out a machine that would be appropriate for the task of converting excess cardboard to packaging material. The cost is \$5,540. This machine can convert all 3,000 square feet of weekly cardboard waste within 2 hours. (Note: Assume there is no additional electricity or maintenance cost for the machine in this example.)

2. **Labor Costs**: Labor wages of a warehouse employee are \$18.50 an hour. Someone will need to operate the new machinery! All employees currently work a standard work week of 40 hours/week.

3. **Packaging Costs**: Plastic bubble wrap is purchased in 1' (feet) by 750' (feet) rolls at \$48 per roll. See here.

4. **Amount of Waste**: Every week, an estimated 3,000 square feet of cardboard is thrown away.

5. **Waste Removal Costs**: Recycling pickup costs are \$32 per week for an industrial waste disposal subscription. You estimate that more than 90 percent of the recycling comes from outer-carton disposal. Completely diverting this waste would drop the recycling pickup costs to a basic subscription plan of 19 dollars per bi-weekly pickup.

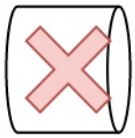
6. **Weekly Packaging Volume**: On average, your company ships out 1,500 packages a week. Each package uses 2 square feet of packaging.

7. **Warehouse Costs**: A new machine would take up an additional 25 square feet of space in the warehouse. Assume your company rents the space at a rate of \$2.23 per square foot per month.

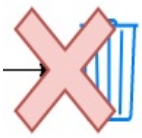
That's a lot of information! But we have moved from just having a flow chart visualization to also including quantitative values for each step in the process. To make this a bit clearer, we can return to each part of the flowchart and attribute each listed quantitative figure to the corresponding visual, as shown below:

New Machine: The machine is a one-time \\\$5,540 expense.
The warehouse costs of $2.23 per square foot will be added here as well.

Labor: Wherever labor is required, add in at \\\$18.50 an hour.



Packaging: This bubble wrap is what is being replaced; the current cost is $48 per roll.



Waste: This cost will be reduced from \\\$32 a week to $19 bi-weekly.

Trade-offs and Unit Conversions

Now that we have quantified each aspect of the current business process, we can compare the two processes to calculate the **trade-off** of switching from the current process to the new proposal. A trade-off can be thought of as the cost of switching between two mutually exclusive options (i.e., when only one of two options can be selected at a time).

Let's start with the first item in the list mentioned earlier - machinery costs. We can call the "before" process "Business-As-Usual (BAU)". This will be compared to the "after" state, which we'll refer to as "Additional Machine". The difference between the two can be shown in a "Trade-Off" column:

Business As Usual (BAU)	Additional Machine	Trade-Off
No change, current cost is $0	New machine, cost is $5,540	-$5,540

We have done the machinery costs here for you; however, we need to think about the *entire* business process. You might immediately notice that the new machine is a single, one-time purchase or a **fixed cost**. Other costs will have to be paid on a regular basis (e.g., every week, every month) or will depend on the quantity of something you are dealing with (e.g., per employee, per package), and are known as **variable costs**.

With the exception of the cost of new machinery, each one of these costs needs to be converted to a common unit of measurement so we can see how this investment might pay off over time. Costs could be calculated on a daily, weekly, monthly, or even yearly basis. Once we have them in a common unit of measurement, it becomes easy to do math involving the individual costs to arrive at a final assessment of the total cost of the process.

Since many of the above costs are given in *weekly* units, going forward, we will convert everything to weekly units.

Exercise 2

Suppose that labor costs for a warehouse employee are \$18.50 an hour (someone will need to operate the new machinery!).

Hint: You can assume that all employees are working 40 hours a week, as the key is to analyze the *change* in the number of hours between the two processes, not the number of hours itself. It will take 2 hours per week to operate the machinery. Do not include overtime pay in your calculations.

▼ **Click here for the answer.**
As noted in the exposition of machine costs, an estimated 2 hours a week will be needed to process the excess cartons into packaging material. This is what an analysis of the labor cost trade-off might look like:

BAU	Additional Machine	Trade-Off
\$18.50 x 40 hours	\$18.50 x 42 hours	-$37 / week

Additionally, we can think about labor as “regular labor” (the standard 40-hour work week) plus “machine-related labor” (the additional 2-hour estimate), such that only labor attributed to the use of an additional machine is accounted for:

BAU	Additional Machine	Trade-Off
0 (no machine labor)	\$18.50 x 2 hours	-$37 / week

In both these answers, only the *difference* between the two options is what needs to be measured: -$37 a week.

Note: One thing to consider if implementing this in the real world is how the employment contract is set up. If someone is contracted to only work 40 hours per week, do these 2 additional hours a week count as “overtime pay”? Will a part-time employee need to be hired for only 2 hours of work a week? Since this could change between states or regions, it adds an extra layer of complexity that must be accounted for.

Exercise 3

Suppose we know that plastic bubble wrap is purchased in 1’ (feet) by 750’ (feet) rolls and costs $48 per roll.

From the information given, we know that each roll of 1’ by 750’ costs $48.

▼ **Click here for the first part of the answer.**

We know that each roll of 1’ by 750’ bubble wrap costs $48. That means we have 750 squares of bubble wrap that are 1’ x 1’ or 750 square feet. But we need to convert this into a **cost per week**. To answer this question, we need to check the weekly volume of packages, which was given as: “On average, your company ships out 1,500 packages a week. Each package uses 2 square feet of packaging.”

▼ **Click here for the second part of the answer.**
So we take 1,500 packages and multiply this by 2 square feet of packaging - that's 3,000 square feet of packaging a week. Each roll is 750 square feet, so to obtain that amount of packaging, we need 3,000 $\div$ 750 = 4 rolls. We know that each roll costs 48 dollars, so the total weekly cost is 48 dollars $\times$ 4 = 192 dollars.

BAU	Additional Machine	Trade-Off
1,500 packages $\times$ 2 feet of packaging = 3,000 feet		
3,000 feet $\div$ 750 foot rolls is 4 rolls	$0 on packaging	+$192 / week
4 rolls at 48 dollars per roll = 192 dollars		

Note: We use “+” here to show the amount of money saved; however, this is NOT income! The trade-off is not the same thing as income or cash flow.

Exercise 4

Suppose we know that recycling pickup costs are 32 dollars per week for an industrial waste disposal subscription. You estimate that more than 90% of the recycling comes from outer-carton disposal. Fully diverting this waste would lower the recycling pickup costs to a basic subscription plan at 19 dollars for bi-weekly pickup.“

▼ **Click here for the answer.**
The current recycling costs are already given in weekly rates, but we need to calculate the new prices in weekly units instead of bi-weekly units. Since \$19 would be spent every two weeks, this would simply be \$19 divided by 2, or $9.50 per week:

BAU	Additional Machine	Trade-Off
\$32 per week	19 ÷ 2 or \$9.50 per week	+\$22.50

Note: Similar to Exercise 3, the “+” denotes a positive trade-off, *not* \$22.50 of income.

Exercise 5

Suppose we know that a new machine would take up an additional 25 square feet of space in the warehouse. Assume your company rents space at a rate of \$2.23 per square foot per month.

▼ **Click here for the answer.**
Now, we need to convert costs from monthly rates to weekly rates. This is commonly done by multiplying the monthly rate by 12 to convert it to a yearly rate (since there are 12 months per year), then dividing that by 52 to convert it to a weekly rate (since there are 52 weeks per year):

BAU	Additional Machine	Trade-Off
\$0	\$2.23 $\times$ 25 $\times$ 12 $\div$ 52, or \$12.87 per week	-\$12.87

To summarize, the 2.23 gets multiplied by 25 feet to give the cost of the additional space in a month of 55.75. This then gets multiplied by 12 to give a yearly cost of 669 dollars. Lastly, this is divided by 52 to give \$12.87 of additional weekly costs.

Putting it all together

Now that we have converted all of our data to weekly units, we can see what the trade-off is like over time. Let's combine all of this information to come up with a total weekly trade-off.

We only have a few items to consider here, but in a larger project, you might be looking at hundreds of trade-off measures and would need to use an Excel spreadsheet or similar tool to keep track of everything:

Item	Weekly Trade-off
Labor	-\$37.00
Packaging	\$192.00
Waste Removal	\$22.50
Warehouse Space	-\$12.87
Total	$164.63

In summary, we would expect to save approximately $164.63 per week with the new packaging process. Using this information, we can do some calculations to see when this project might pay off.

Computing a break-even

The major additional expense with this project is the purchase of the cardboard perforation machine, coming in at \$5,540. This expense will be offset by the savings that we gain when we move from business as usual to the new method of packaging and shipping products.

To think about this more concretely, if we were to purchase the new machine and switch the packaging process for just one week before stopping, it would cost us 5,540 minus one week's worth of cost savings of 164.63. This would result in a 5,375.37 loss if we were to stop using the new process after just one week. However, every additional week we use the machine saves us another 164.63. If we kept saving 164.63 per week, week after week, we would eventually reach a point where our total savings cover the initial cost of the machine. This is known as the **break-even point** in time when the project finishes paying for itself.

Exercise 6

▼ **Click here for the answer.**
If we simply divide the $5,540 cost of the machine by the weekly savings amount of 164.63, we get 33.65 which is the number of weeks that we would effectively be spreading this 5,540 cost over. Rounding this, we could say that the project would break even between weeks 33 and 34.

To see how the cost savings would add up week by week, we can create a simple table. Even after accounting for the purchase of the cardboard converter, the additional labor, and the added rental costs, the project would result in over $3,000 of savings for the company in the first year!

Weekly Savings	Balance	Week	Weekly Savings	Balance	Week	Weekly Savings	Bala
$164.63	-$5,375.37	1	$164.63	-$2,576.66	18	$164.63	$222.
$164.63	-$5,210.74	2	$164.63	-$2,412.03	19	$164.63	$386.
$164.63	-$5,046.11	3	$164.63	-$2,247.40	20	$164.63	$551.
$164.63	-$4,881.48	4	$164.63	-$2,082.77	21	$164.63	$715.
$164.63	-$4,716.85	5	$164.63	-$1,918.14	22	$164.63	$880.
$164.63	-$4,552.22	6	$164.63	-$1,753.51	23	$164.63	$1,04
$164.63	-$4,387.59	7	$164.63	-$1,588.88	24	$164.63	$1,20
$164.63	-$4,222.96	8	$164.63	-$1,424.25	25	$164.63	$1,37
$164.63	-$4,058.33	9	$164.63	-$1,259.62	26	$164.63	$1,53
$164.63	-$3,893.70	10	$164.63	-$1,094.99	27	$164.63	$1,70
$164.63	-$3,729.07	11	$164.63	-$930.36	28	$164.63	$1,86
$164.63	-$3,564.44	12	$164.63	-$765.73	29	$164.63	$2,03
$164.63	-$3,399.81	13	$164.63	-$601.10	30	$164.63	$2,19
$164.63	-$3,235.18	14	$164.63	-$436.47	31	$164.63	$2,36

$164.63	-$3,070.55	15	$164.63	-$271.84	32	$164.63	$2,52
$164.63	-$2,905.92	16	$164.63	-$107.21	33	$164.63	$2,69
$164.63	-$2,741.29	17	$164.63	$57.42	34	$164.63	$2,85
——	——	–	——	——	–	$164.63	$3,02

Communicating Findings: Exercises 7&8

Communicating our findings

Exercise 7

▼ Click here for the answer.
Some good points to emphasize are listed below:

1. Outline the *goals* and how they were met. Your boss gave you specific and measurable goals: “Reduce the amount of waste in your distribution process…at *no extra cost*”. The proposed process checks off both of these boxes, so you can easily communicate this by stating that the two objectives can be met. If there is any room to elaborate in your presentation, you could talk about specific, measurable changes within this process; e.g., 3,000 square feet of single-use plastic packaging material will be removed from the packaging process every week. You could talk about how this adds up over the course of a year to drive the point home (156,000 square feet a year!)

2. Specify the *required changes in business processes*. Since you are recommending a change to the status quo that will take effort, you should present this in a succinct and streamlined manner. The proposed changes to the current business process are not very large in this case, but in other projects, you may need to implement changes with long timelines and complex logistics. You could communicate this as a list of four simple steps:

    1. Purchase the machinery and have it delivered and set up in one day.
    2. Allocate the 25 additional square feet of rental space and communicate this with the landlord in an email.
    3. Meet with employees and allocate someone 2 hours of cardboard processing labor every week.
    4. Call the waste collection company to change the current waste pickup subscription to the bi-weekly option.

3. Provide a *summary of the trade-offs*. Depending on your audience, some people may only be interested in the numbers. Show that the new process will save \$164.63 in costs per week. Not all of the trade-offs are financial though, and some of your colleagues will be more interested in the volume of waste reduction (e.g., the 156,000 square feet of plastic packaging per year mentioned above). However, don’t overwhelm your colleagues with too many numbers.

4. Show the *break-even point*. Acknowledge the upfront costs, especially if they are larger costs, but also when the costs will be recovered - in this case, after 33 - 34 weeks. Discuss how the savings add up over longer time periods, like a year or even 3 - 5 years.

Adjusting the calculation with new information

Your presentation was well received! Your boss is looking forward to implementing this new solution. However, some of your colleagues raised a few interesting points after listening to your presentation.

1. They mention that the machine will eventually break down and that we can only assume this machine is good for three years before it will need to be replaced.
2. Some concerns about health and safety were brought up, and your colleagues think that any employees operating the machine will need to take a short class on working with machinery. They estimate these costs to be \$500 a year.
3. Your local government will soon implement a tax on all industrial waste. Your waste removal costs are going to almost double!

Exercise 8

Note: You don't need to perform any calculations, but instead, use the terminology we have learned to think about how you would approach these challenges quantitatively.

▼ Click here for the answer.

1. Since the machine results in over 3,000 dollars in savings in the first year alone, even if it breaks after three years, it could be replaced from the savings alone (as you would save over 20,000 dollars vs. a cost of 5,540 dollars since after the first year you save 8560.76 per year because there are no new startup costs). Additionally, you could *amortize* the cost of the machine over three years as it *depreciates*. This means taking the initial cost and dividing it over the expected life of the machine (in this case, three years). Ideally, your company would then set aside money each week from the 164.63 per week in savings to fund the purchase of a new machine after three years.

2. Similar to the unit conversion exercises earlier, the additional 500 dollars in yearly safety expenses can be broken down into weekly costs and added to the **trade-off** and **break-even** analyses. This 500 dollars is probably relatively trivial for most businesses, but if the company faced higher recurring yearly costs, you might need to think more about how the business would manage this cash flow. For this exercise, it is sufficient to account for this as a weekly cost.

3. If the cost of waste removal doubles, then your savings from reducing this cost will also double. Try to plug in the new numbers of 64 dollars weekly vs. 38 dollars bi-weekly, which results in 45 dollars in weekly savings instead of the old 22.50.

Conclusion & Takeaways

We have quantified both the existing and proposed business processes and used these figures to calculate the benefits and costs of implementing a waste reduction strategy over time. The trade-offs between the two business processes were used in a break-even analysis. It was determined that the project would not only reduce waste but would pay for itself in less than a year. Lastly, we thought about how to communicate these findings and adjust them in light of new information.

In this case, you learned a framework for taking a qualitative business problem, breaking it down, quantifying each component, putting together the numbers from each, and finally concluding. This framework can be applied to many problems that you will encounter in practical settings.

Here are some tips to keep in mind as you apply this framework in the future:

1. Before making business recommendations, it's important to quantify all of the different options. Options can be compared with a trade-off analysis, which calculates the cost differences between mutually exclusive choices.
2. Recurring costs can be represented in common units (in this case, we converted everything to weekly costs) to better compare trade-offs over time.
3. Input costs are either fixed or variable and calculated accordingly. These inputs can be used in other calculations, such as break-even analysis.
4. Communicating findings should be done strategically, so it's important to identify which quantitative inputs can be used to convey your findings most effectively.

Attribution

Formax Greenwave 410 Tabletop Cardboard Perforator, available from Office Depot as of 5/13/2022: https://www.officedepot.com/a/products/7427318/Formax-Greenwave-410-Tabletop-Cardboard-Perforator/