SupplyChain Analytics Report:

The problem

The problem we will be working on in this case study is a make versus buy decision. We are hired as a supply chain analyst at a company called Ternate Industries - a company that sells replacement parts for industrial pizza ovens. our task is to calculate the full cost of the Make and Buy Options. We will be using data tables of quotes and internal manufacturing estimates. A quote or a quotation is a document that a seller provides to a buyer to offer goods or services at a stated price, under specified conditions.

Analytical Approach:

We will start by learning how to analyze costs for the buy option. In the buy option, we are considering purchasing the products from an external supplier.The quotes dataset consists of quotes from many suppliers for multiple parts at multiple production volumes. It is common to quote the same part to many suppliers to ensure the best option is selected. Each quote line consists of part number quoted, supplier minimum production volume for the price quoted, unit cost (per product), non-recurring expenses associated with the minimum production volume. Our task is to create analysis that helps the company determine make versus buy decisions for many products.

Quotes are the suppliers price commitments for certain products and certain volumes. They essentially say, "If you buy X volume of this part you will need to pay unit cost per unit and a one time cost equal to non-recurring expenses".

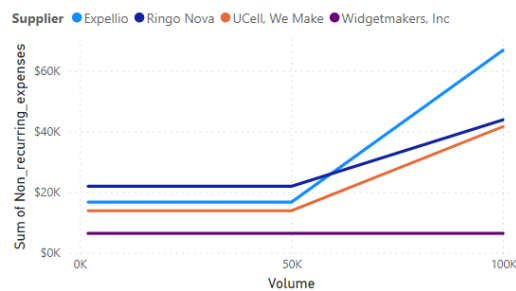| Supplier	Part_Number	Volume	Sum of Non_recurring_expenses	Unit_Cost
Expellio	P0380	1000	$13,627.81	$0.21
Expellio	P0380	2000	$13,627.81	$0.15
Expellio	P0380	5000	$13,627.81	$0.13
Expellio	P0380	50000	$13,627.81	$0.08
Expellio	P0380	100000	$54,511.25	$0.07
Expellio	P0604	1000	$13,333.42	$48.87
Expellio	P0604	2000	$13,333.42	$47.26
Expellio	P0604	20000	$26,666.84	$46.22
Expellio	P0604	50000	$63,333.42	$40.46
Expellio	P0604	100000	$73,333.42	$40.03
Expellio	P0622	1000	$9,568.46	$18.30
Expellio	P0622	5000	$6,144.37	$14.81

Count of Quote_ID by Part_Number
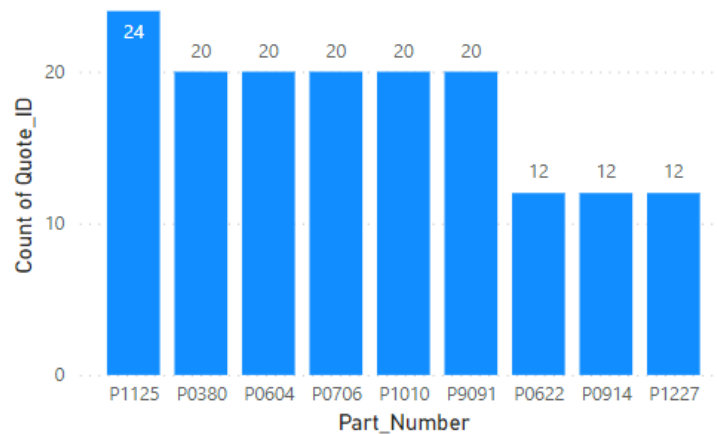
P1125 had the highest count of quotes at 24, followed by P0380 and P0604, which tied for second at 20.   The fact that P1125 accounted for 15.00% of the total count of quotes indicates that it is in high demand or usage compared to other parts in the dataset. This information could be valuable for inventory management purposes. Parts with high quote ID counts, such as P1125, might warrant closer attention in terms of stock levels and procurement strategies to ensure availability and meet customer demand effectively.

Exploring Suppliers:

Supplier selection is an important aspect of the buy option. Supplier selection is a multi-faceted decision and cost is one of the most important factors to consider. We want to visualize how both the unit cost and non-recurring expenses changes with change in volume.

Supplier	Part_Number	Volume	Sum of Non_recurring_expenses	Unit_Cost
Expellio	P9091	2000	$16,706.78	$16.25
Ringo Nova	P9091	2000	$21,931.38	$18.68
UCell, We Make	P9091	2000	$13,876.15	$14.93
Widgetmakers, Inc	P9091	2000	$6,414.83	$18.78
Expellio	P9091	5000	$16,706.78	$15.16
Ringo Nova	P9091	5000	$21,931.38	$17.76
UCell, We Make	P9091	5000	$13,876.15	$14.22
Widgetmakers, Inc	P9091	5000	$6,414.83	$18.41
Expellio	P9091	20000	$16,706.78	$13.29
Ringo Nova	P9091	20000	$21,931.38	$17.35
UCell, We Make	P9091	20000	$13,876.15	$13.86
Widgetmakers, Inc	P9091	20000	$6,414.83	$16.66
Expellio	P9091	50000	$16,706.78	$13.29
Total			**$3,94,449.68**	
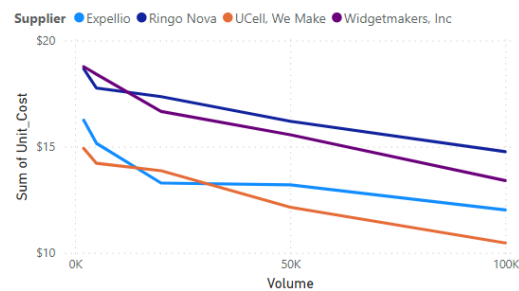
For Part number P9091,
Expellio had the highest total Sum of Non_recurring_expenses at $1,33,654.23, followed by Ringo Nova, UCell, We Make, and Widgetmakers, Inc. 100000 in Supplier Expellio made up 16.94% of Sum of Non_recurring_expenses. Expellio had the highest average Sum of Non-recurring expenses at 26,730.85, followed by Ringo Nova, UCell, We Make, and Widgetmakers, Inc. For same part number selected, Ringo Nova had the highest total Sum of Unit Cost at $84.75, followed by Widgetmakers, Inc, Expellio, and UCell, We Make. 2000 in Supplier Widgetmakers, Inc made up 6.19% of Sum of Unit Cost. Ringo Nova had the highest average Sum of Unit Cost at 16.95, followed by Widgetmakers, Inc, Expellio, and UCell, We Make.

Key findings:

1. **Non-Recurring Expenses Analysis**:

   - Expellio is the primary contributor to non-recurring expenses for Part number P9091, with a total sum of $133,654.23. This suggests that Expellio might be involved in significant one-time expenses related to the production or procurement of this part.

   - Ringo Nova, UCell, We Make, and Widgetmakers, Inc. also contribute to non-recurring expenses but to a lesser extent compared to Expellio.

   - Expellio's expenses represent a substantial portion (16.94%) of the total non-recurring expenses, indicating a significant financial commitment to the production or procurement process.

   - Expellio also has the highest average non-recurring expenses per transaction, further highlighting its significant contribution to expenses for Part number P9091.

2. **Unit Cost Analysis**:

- Ringo Nova has the highest total sum of unit costs for Part number P9091, indicating that Ringo Nova's components or services contribute significantly to the overall cost of producing or procuring this part.

- Widgetmakers, Inc., Expellio, and UCell, We Make also contribute to the unit costs, but to a lesser extent compared to Ringo Nova.

- Widgetmakers, Inc. accounts for a notable portion (6.19%) of the total unit costs, suggesting its importance in the production or procurement process.

- Ringo Nova also has the highest average unit cost per transaction, indicating that its components or services are relatively expensive compared to other suppliers.

Overall, the analysis suggests that Expellio and Ringo Nova play crucial roles in both the non-recurring expenses and unit costs associated with Part number P9091. Also the general trend is quoted cost decreases with volumes.

Cost metrics:

Next we will be calculating the extended cost and full cost. Unit cost refers to the cost of purchasing an additional unit and includes the manufacturer's raw material cost, production costs, and profit. Extended cost represents the cost paid for the products only and does not include one-time expenses. Extended cost is the number of units purchased multiplied by the unit cost. Even when buying products from a supplier, there are often one-time costs that must be paid to enable production. Suppliers often pass these costs on to the purchasing company. Common examples of non-recurring expenses include tooling or fixtures specific to the product being manufactured, engineering expenses to set up production, or even a minimum charge to occupy manufacturing equipment. As production volumes increase, it is common for non-recurring expenses to increase. This happens because higher volumes require either more manufacturing equipment or more labor for setup and management. This is a one-time or infrequent expense that a business incurs and is not expected to pay again in the future. Non-recurring expenses can include: Purchasing equipment. Renovating a business location. One-time, limited-run advertising campaigns.

Full cost represents the total amount a company must pay to buy a certain quantity of products. Full cost is the sum of the extended cost and the non-recurring expenses. When making a supply chain decision, focusing on the full cost is imperative because it is the total amount the company will pay to acquire the products. Full cost often includes overhead rates. The overhead rate is a cost allocated to the production of a product or service. Overhead costs are expenses that are not directly tied to production such as the cost of the corporate office.

So our next task is to calculate the full cost. It is the total cost the company pays to buy a certain volume of components. It includes any one-time costs as well as the cost per part that the supplier charges. For calculating the Full cost, we need Extended cost. Extended cost is the unit cost/quoted cost per item multiplied by the volume or number of units sold. Now Full Cost is derived from the sum of Extended Cost and Non-Recurring Cost.
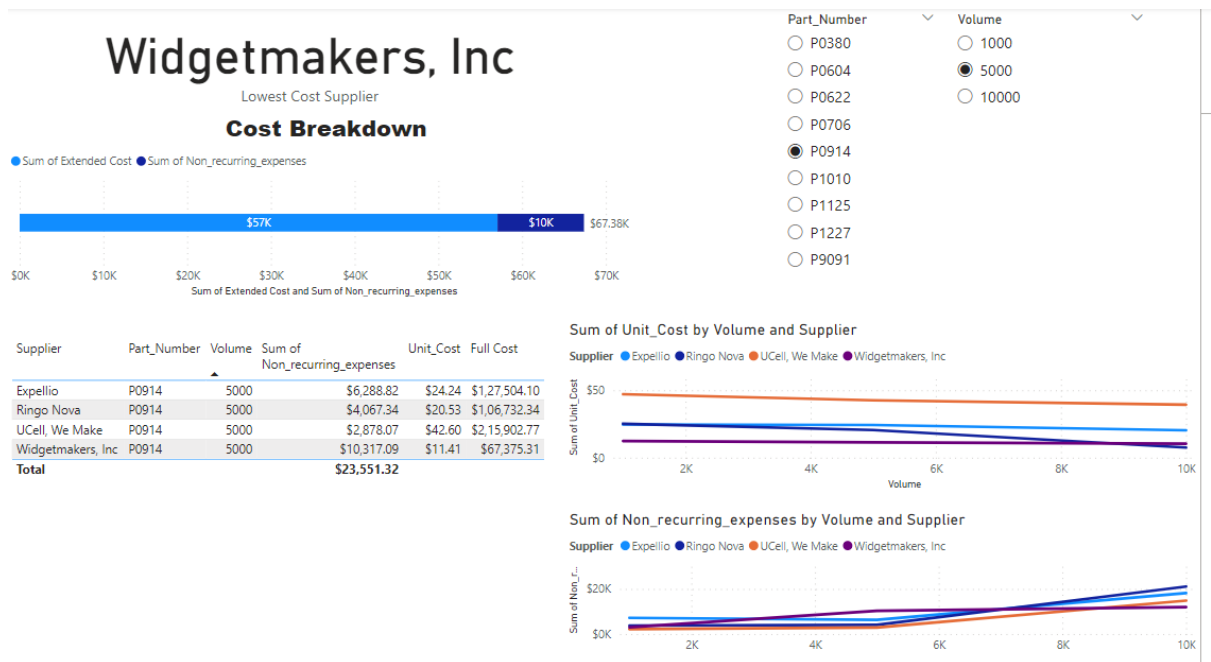
Supplier	Part_Number	Volume	Sum of Non_recurring_expenses	Unit_Cost	Full Cost
Expellio	P0622	1000	$9,568.46	$18.30	$27,866.60
Ringo Nova	P0622	1000	$2,201.44	$22.40	$24,605.44
UCell, We Make	P0622	1000	$6,402.49	$12.94	$19,343.77
Widgetmakers, Inc	P0622	1000	$3,563.29	$42.94	$46,500.53
Expellio	P0622	5000	$6,144.37	$14.81	$80,192.36
Ringo Nova	P0622	5000	$4,538.77	$19.96	$1,04,332.84
UCell, We Make	P0622	5000	$5,619.90	$12.48	$68,041.26
Widgetmakers, Inc	P0622	5000	$6,976.06	$37.99	$1,96,908.29
Expellio	P0622	10000	$7,956.79	$14.69	$1,54,862.87
Ringo Nova	P0622	10000	$1,280.15	$17.70	$1,78,275.40
UCell, We Make	P0622	10000	$9,869.59	$11.61	$1,25,992.29
Widgetmakers, Inc	P0622	10000	$4,988.97	$33.18	$3,36,818.08

The full cost is specific to the combination of part number, supplier and volume quoted so we added all those columns in the visualization.

Visualising lowest cost supplier:

Our task is to design a report page that shows

- The supplier name with lowest full cost for a part number and quote volume combination.
- The full cost breakdown by extended cost and full cost.
- Visibility to all of the other supplier quotes and full cost for the part number.

Widgetmakers, Inc
Lowest Cost Supplier

Cost Breakdown

● Sum of Extended Cost ● Sum of Non_recurring_expenses

Supplier	Part_Number	Volume	Sum of Non_recurring_expenses	Unit_Cost	Full Cost
Expellio	P0914	5000	$6,288.82	$24.24	$1,27,504.10
Ringo Nova	P0914	5000	$4,067.34	$20.53	$1,06,732.34
UCell, We Make	P0914	5000	$2,878.07	$42.60	$2,15,902.77
Widgetmakers, Inc	P0914	5000	$10,317.09	$11.41	$67,375.31
Total			**$23,551.32**		

For part number P0914 and volume =5000 units , Lowest full cost will be $67,375.31 and the lowest cost supplier will be Widgetmakers, Inc.

Scenario Analysis-volume changes:

Previously, we calculated full cost for the buy options at the small number of quoted production volumes. These data points could be used to drive supply chain decisions, but what if our production estimates don't match the quoted volumes? In reality, it is unlikely to order exactly the number of products that were quoted. Projects start with assumptions that often change as the team learns more. That is why it is important to have a tool that guides decisions over a wider range of volumes. Determining production volumes for a new product is full of uncertainty so our tool needs to help us analyses our volumes more dynamically. The primary source of uncertainty for production volumes is demand. This is especially true for new products. If a product has never been on the market before, how can we know how many customers will want to buy it? Even if a company is launching a next generation of an old product, there is still uncertainty based on product-market fit, outside economic conditions, and price.

Quotes are typically set up in a way that allows for us to develop a scenario analysis tool to analyse volumes that were not expressly included in the quotes. Recall that the volume column is the minimum production volume associated with the unit cost and the non-recurring expense. That means the full cost formula holds between quoted production volumes. We can utilize Power BI's Parameter function to set up a Scenario Volume Analysis. As a reminder, a Power BI parameter is a value that the user can control using a

slicer. So we will be creating a Full Cost measure based on the Scenario Volume parameter. For each part number- scenario volume combination, there may be many potential rows of unit cost and non-recurring expenses. We want the full cost measure to return the lowest full cost from the eligible supplier, part and volume combinations.
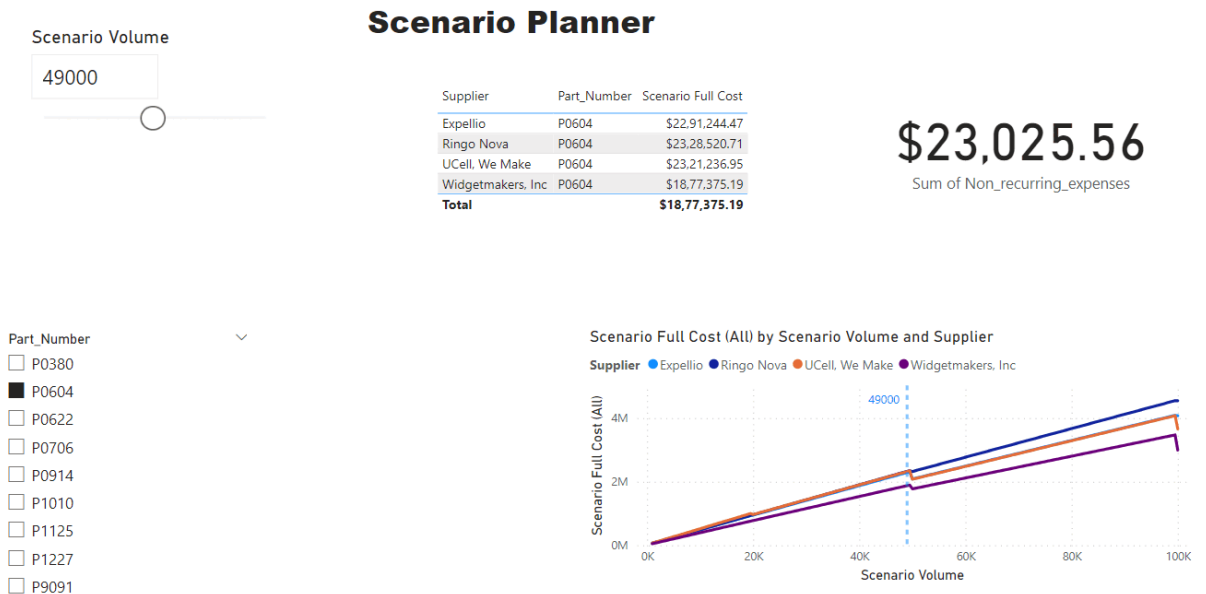
Adding a volume parameter:

We already calculated the full cost at the minimum volumes included in the quotes. We want to think about what happens if the company decides to order a volume that is different from the few points quoted. For this we will use a parameter to create a scenario planning tool that calculates the full cost for a wider range of production volumes. After creating a dynamic full cost measure that updates with volume, the finance team is also interested in the breakdown between nonrecurring expenses for cash flow reasons. So we want to show these breakdown of costs also in our scenario planner tool.
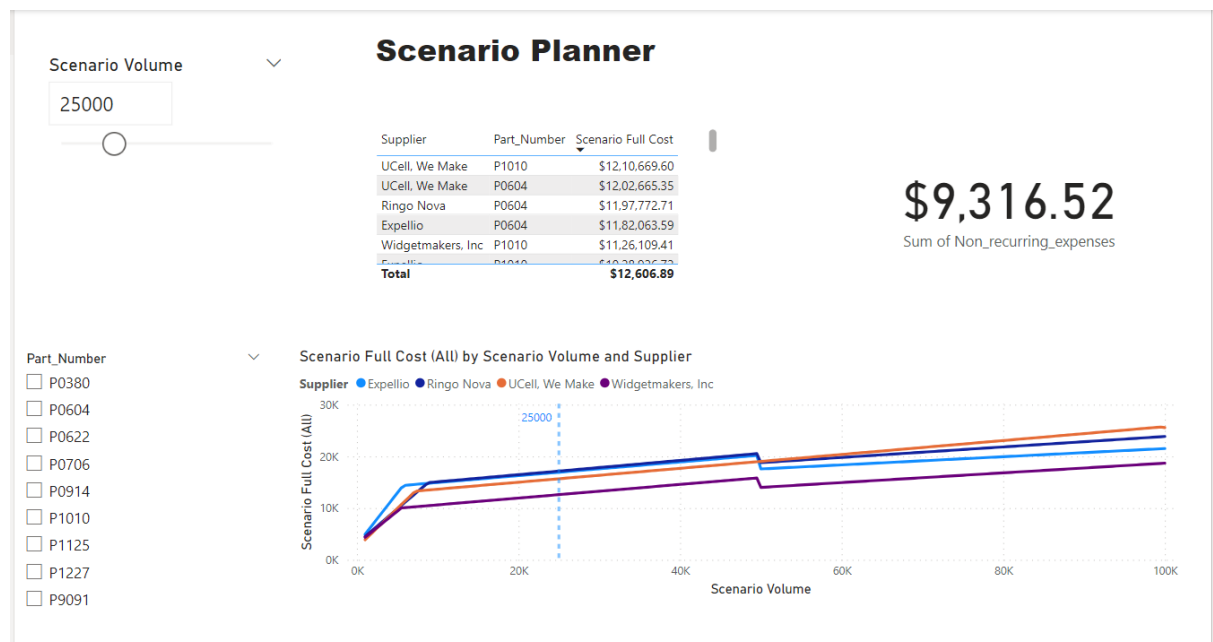
Recommending an order volume:

Marketing projects the demand for P0604 to be 48,000 units. Based on the visualisation what volume should be recommended for ordering?
The better solution is to order 50,000 or slightly more because once u cross the 50,000 unit threshold, the full cost is actually less expensive.

Scenario Planner

Scenario Volume

49000

Supplier	Part_Number	Scenario Full Cost
Expellio	P0604	$22,91,244.47
Ringo Nova	P0604	$23,28,520.71
UCell, We Make	P0604	$23,21,236.95
Widgetmakers, Inc	P0604	$18,77,375.19
Total		**$18,77,375.19**

$23,025.56
Sum of Non_recurring_expenses

Part_Number
- ☐ P0380
- ☑ P0604
- ☐ P0622
- ☐ P0706
- ☐ P0914
- ☐ P1010
- ☐ P1125
- ☐ P1227
- ☐ P9091

Scenario Full Cost (All) by Scenario Volume and Supplier

Supplier ● Expellio ● Ringo Nova ● UCell, We Make ● Widgetmakers, Inc

We can enhance this scenario planner tool by adding row level security such that they only want to see the results relevant to their projects. Create specific roles for each projects and add filters via Dax accordingly.

Assessing the make option:

Now we will be ready to incorporate the make side of the decision. Just like with the buy option, it is important to calculate the full cost of production when considering the make option. In the Buy option, our data were quotes from suppliers. In the Make option, we will use internal estimates. Internal estimates are similar to quotes because they have the expected unit cost and enough information to calculate upfront investments. Unlike quotes from external suppliers, internal estimates are not binding offers. If the cost of production changes, your company still has to absorb those costs. Internal estimates are forecasts or approximations made by a company's own team based on various factors such as labor, materials, overhead, and other costs.

Unlike formal contracts or quotes from external suppliers, internal estimates do not carry legal weight. They are not contractual commitments between the company and its internal departments or stakeholders. External supplier quotes, on the other hand, are often considered more binding as they represent formal offers from external entities. These quotes typically outline specific terms, conditions, and costs associated with the supply of goods or services. the non-binding nature of internal estimates means that companies must be prepared to adapt to changes in production costs. This flexibility allows for better responsiveness to market dynamics and project

modifications, but it also places the onus on the company to manage and absorb any cost fluctuations that may arise during the course of a project.

Internal Estimates include unit costs - which are comprised of raw materials, energy costs, and labour costs. These are costs that increase for every additional unit we produce.

Internal Estimates also include data about the equipment used to manufacture the parts. Depending on our existing machine capacity and production demand, we may or may not need to invest in new manufacturing equipment. The internal estimates include the equipment model number, the manufacturing capacity of each machine, the existing available capacity, and the cost of an additional piece of equipment. Note that the capacity for each machine is different for each part. If production demand exceeds existing capacity, we need to include the cost of new equipment in the full cost for the Make option.

For the Make versus Buy decision, we should only consider the incremental costs of our decision. Incremental costs are new costs introduced by our make-or-buy decision, not sunk costs that exist before the decision. If we already have a piece of manufacturing equipment, its cost should not be considered incremental to the Make versus Buy decision. While our incremental costs in this course focus on equipment investments, incremental costs can also include other costs such as facilities and hiring new salaried employees. If the current staff and facilities can handle the new production requirements, there is no need to include their cost in the full incremental cost for the make decision.

The full cost for the make option is similar to the buy option. The full cost is the extended cost plus any incremental investment cost. In this course, we can calculate our required investment cost by looking at our existing capacity versus the expected production volume. If the expected production volume exceeds the current capacity, we must include the incremental investment cost in our full cost calculation.

Required Unit capacity:

Our task is to calculate the full costs for the parts based on internal cost quotes. When considering internal manufacturing, we must consider capacity and capital investments in manufacturing equipment. We need to calculate the manufacturing machine investment required to meet the volumes. The first step is to identify the difference between the existing capacity and the production volumes.

We have created a measure called Additional unit capacity required. This measure calculates the additional unit capacity required for manufacturing based on certain estimates and scenarios. It starts by considering internal

manufacturing resource estimates. Then, it compares the maximum of the scenario volume (the expected production volume in a given scenario) minus the existing capacity of internal manufacturing resources. If this calculation yields a positive value, indicating that the scenario volume exceeds existing capacity, it reflects the difference as the additional unit capacity required. However, if the scenario volume is within or below the existing capacity, it returns zero, signifying that no additional capacity is needed in that case. Overall, the measure helps in assessing how much extra capacity is necessary to meet projected production demands.

Scenario Volume					
75000					

Part_Name	Part_Number	Machine_Model	Existing_Capacity	Unit_Capacity	Additional Unit Capacity Required
Grotop	P0604	3D Printer79	476	1072	74524
Degunkifier	P1227	3D Printer79	850	500	74150
Dewgodur	P1125	3D Printer79	1472	304	73528
Porlity	P0706	3D Printer79	1854	1141	73146
Furronaw	P9091	Lathe23	29760	13224	45240
Bewpittros	P1010	Lathe23	39273	8002	35727
Stepner	P0380	Lathe23	51007	20963	23993
Chattlecrat	P0914	Lathe23	240000	1000	0
Inperfusionator	P0622	Lathe23	240000	1000	0

Here for example the difference between the existing capacity and required capacity for P1010 if the volume parameter is set to 75000 units is 35727.

Full cost with capital investment:

We have created a measure already to calculate the excess production demand. Now using that measure we will calculate capital investment cost, which will allow us to calculate the full cost of the Make option.

The "Capital Investment Required (Make)" measure calculates the amount of capital investment needed for manufacturing operations. It begins by considering the estimate of internal manufacturing resources. It determines the additional unit capacity required based on the previously calculated measure "Additional Unit Capacity Required." This additional capacity is divided by the minimum unit capacity of the internal manufacturing resources to ascertain how many additional units of those resources are needed. The result is then rounded up to the nearest whole number. This quantity is then multiplied by the fixed cost associated with each machine within the internal manufacturing resources. This final product represents the capital investment required for expanding manufacturing capacity.

The "Make Scenario Full Cost" measure computes the total cost associated with a manufacturing scenario. It starts by considering the estimate of internal manufacturing resources. Then, it adds the capital investment required, as

calculated in the previous measure, to the product of the cost per unit (also part of the internal manufacturing resources) and the scenario volume, indicating the number of units to be produced in the given scenario. This final sum represents the comprehensive cost of manufacturing in the specified scenario, accounting for both initial capital investment and ongoing production costs.

Make vs Buy option:
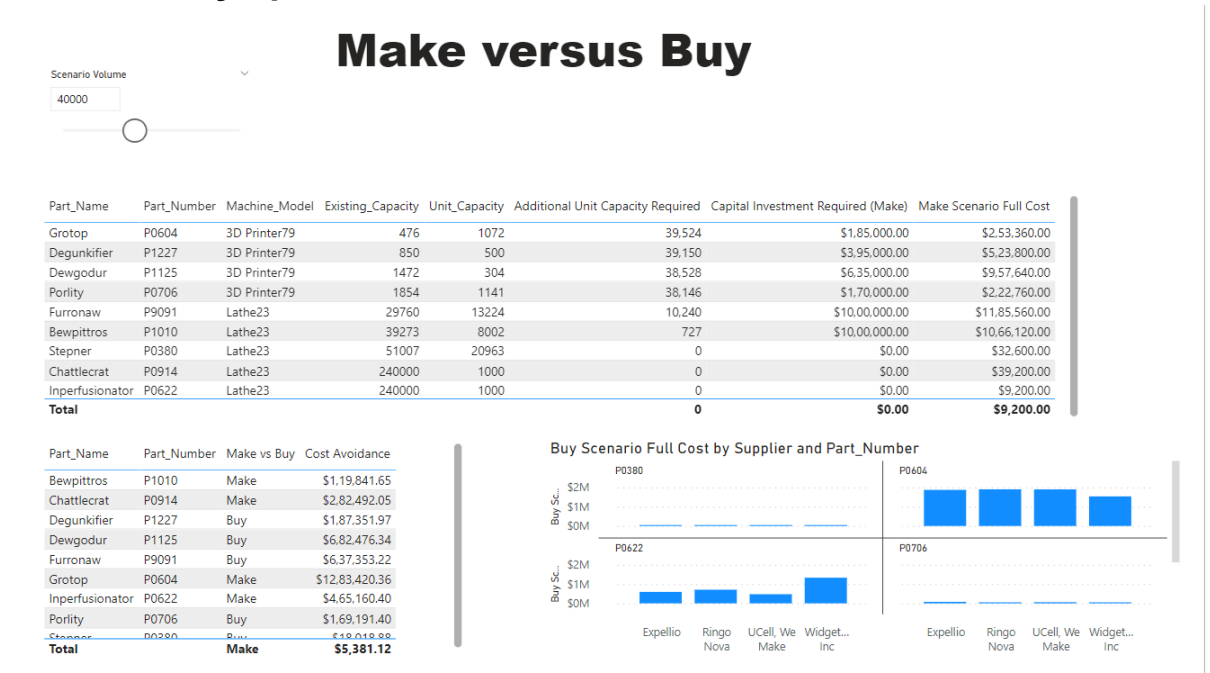
Suppose the go to market strategy for the part named "Bewpittros" has been finalized. We are tasked with identifying the lowest full cost option. What is the cost avoidance of our recommendation at 40,000 units?
The solution is $119,841.65

Set the volume to 21,000 units. Based on a full cost alone, do you recommend a make or buy option for P1227? If make which machine model. If buy which supplier.

Make versus Buy

Scenario Volume

`21000`

Part_Name	Part_Number	Machine_Model	Existing_Capacity	Unit_Capacity	Additional Unit Capacity Required	Capital Investment Required (Make)	Make Scenario Full Cost
Grotop	P0604	3D Printer79	476	1072	20,524	$1,00,000.00	$1,35,889.00
Degunkifier	P1227	3D Printer79	850	500	20,150	$2,05,000.00	$2,72,620.00
Dewgodur	P1125	3D Printer79	1472	304	19,528	$3,25,000.00	$4,94,386.00
Porlity	P0706	3D Printer79	1854	1141	19,146	$85,000.00	$1,12,699.00
Furronaw	P9091	Lathe23	29760	13224	0	$0.00	$97,419.00
Bewpittros	P1010	Lathe23	39273	8002	0	$0.00	$34,713.00
Stepner	P0380	Lathe23	51007	20963	0	$0.00	$17,115.00
Chattlecrat	P0914	Lathe23	240000	1000	0	$0.00	$20,580.00
Inperfusionator	P0622	Lathe23	240000	1000	0	$0.00	$4,830.00
Total					**0**	**$0.00**	**$4,830.00**

Part_Name	Part_Number	Make vs Buy	Cost Avoidance
Bewpittros	P1010	Make	$5,92,653.59
Chattlecrat	P0914	Make	$1,58,328.12
Degunkifier	P1227	Buy	$69,776.93
Dewgodur	P1125	Buy	$3,46,171.40
Furronaw	P9091	Make	$1,98,325.28
Grotop	P0604	Make	$6,81,857.83
Inperfusionator	P0622	Make	$2,48,897.26
Porlity	P0706	Buy	$83,108.51
Stepner	P0380	Buy	$5,934.57
Total		**Make**	**$7,250.43**

Buy Scenario Full Cost by Supplier and Part_Number

From the visuals, we can infer that the best option for P1227 at 21,000 units is but option with supplier as Expello.