

K2's Eight Awesome PivotTable Features

Are you looking to take your PivotTables to the next level? Many experts consider PivotTables to be Excel's most powerful feature. Yet, most who create and work with them barely scratch the surface of all that PivotTables can do. In this session, you'll learn eight powerful features you may have missed. From user-defined calculations to consolidating reports and adding KPIs, we'll show you how to get the most out of your PivotTables. These are just some examples of the great things you can do with PivotTables, and in this session, you will learn these and other techniques to make your PivotTables even more powerful.



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Introduction

Are you looking to take your PivotTables to the next level? Many experts consider PivotTables to be Excel's most powerful feature. Yet, most who create and work with them barely scratch the surface of all that PivotTables can do. In this session, you'll learn eight powerful features you may have missed. From user-defined calculations to consolidating reports and adding KPIs, we'll show you how to get the most out of your PivotTables. These are just some examples of the great things you can do with PivotTables, and in this session, you will learn these and other techniques to make your PivotTables even more powerful.

Learning Objectives

Upon completing this session, you should be able to:

1. Identify three types of user-defined calculations in PivotTables;
2. List the steps necessary to add Key Performance Indicators to PivotTables;
3. Name at least two benefits of using PivotTables for data consolidation needs;
4. Differentiate between Slicer and Timeline filters; and
5. Cite examples of potential benefits associated with linking data into PivotTable reports.

Creating Calculated Fields

A *calculated field* is one form of a user-defined calculation you can add to a PivotTable. The other option for creating a user-defined measure is a *calculated item* (discussed beginning on page 6.) You will employ a calculated field to use data from different *fields* in your user-defined calculation. On the other hand, you will use a calculated item when you want your formula to use data from *one or more specific items within a given field*.

This example will create a simple PivotTable from a single table in Sage 100, the customer master file, **AR_Customers**. First, we will connect to the external data source using Open Database Connectivity (ODBC), an open standard for connecting applications to a database. With the connection in place, Excel presents a list of tables. You can expand this list to display the fields contained in each table. First, expand the field list by clicking on the plus (+) sign to the left of the table name in the left-hand pane. Then, choose the fields to display in the report and click on the (>) button. This action will move them to the right-hand pane, as shown in **Figure 1**. Next, select the following fields: **CustomerNo**, **State**, **SalespersonNo**, **CurrentBalance**, **AgingCategory1**, **AgingCategory2**, **AgingCategory3**, and **Aging Category4**.

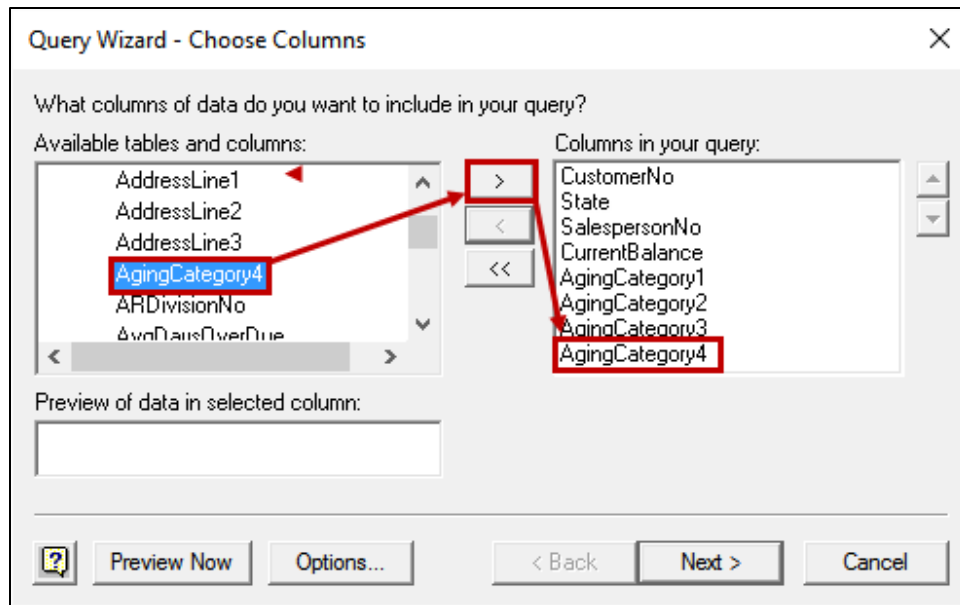


Figure 1 – Selecting the Fields for the Report

After selecting the required fields are selected, click **Next** several times. Select **Return Data to Microsoft Office Excel** and click **Finish** in the Query Wizard- Finish pane. In the **Import Data** dialog box, select the **PivotTable Report**. Then, specify the location for the report, and then click **OK**. Next, drag-and-drop the fields to the appropriate report quadrants in the **PivotTable Task Pane**, rename and format the column labels, choose a number format for the data, and complete the PivotTable just as with any other. The primary difference is that this PivotTable links dynamically to the underlying data in the database. If you need the same report next week or next month, all you need to do is retrieve the workbook, refresh the PivotTable, and print the updated version, a process that takes but seconds to complete. **Figure 2** illustrates creating the initial PivotTable.

	A	B	C	D	E	F	G
1	State	(All)					
2	SalespersonNo	(All)					
3							
4	Row Labels	Current	Over 30	Over 60	Over 90	Over 120	Sum of Balance
5	A To Z Carpet Supply	8,732.40	-	-	-	-	8,732.40
6	Allen's Appliance Repair	582.11	18.95	31.70	12.75	-	645.51
7	American Business Futures	4,474.96	1,257.40	-	-	-	5,732.36
8	American Concrete Service	12,657.82	1,085.98	-	-	-	13,743.80
9	Autocraft Accessories	12,940.31	-	6,406.53	4,607.18	-	23,954.02
10	Avnet Processing Corp	7,377.37	-	-	-	-	7,377.37
11	Bay Pyrotronics Corp.	10,529.66	3,057.64	3,057.64	-	-	16,644.94
12	Breslin Parts Supply	11,828.26	-	-	-	-	11,828.26
13	Capri Sailing Ships	56,169.33	-	-	-	-	56,169.33
14	Custom Craft Products	11,634.72	4,476.31	3,335.40	-	-	19,446.43
15	Greater Alarm Company	825.50	-	-	-	-	825.50
16	Hillsboro Service Center	402.86	1,000.00	1,500.00	-	-	2,902.86
17	Jellico Packing	5,055.91	-	-	-	-	5,055.91
18	Orange Door & Window Co.	263.37	-	-	-	-	263.37
19	R & S Supply Corp.	-	6,251.31	835.43	-	-	7,086.74
20	Shepard Motorworks	513,339.95	-	-	-	-	513,339.95
21	Grand Total	656,814.53	17,147.59	15,166.70	4,619.93	-	693,748.75

Figure 2 – Creating a PivotTable Connected to an External Data Source

Our initial PivotTable contains an accounts receivable aging report, but it does not have a column for the total outstanding balances owed by our customers. To create a column for the outstanding balances, we must create a calculated field to include the values from other fields in the formula.

To insert a calculated field, follow the procedure described below.

1. Position the cursor anywhere in the **Over 120** column.
2. In Excel, on the **PivotTable Tools, Analyze** contextual tab, click **Fields, Items, & Sets** followed by **Calculated Field**.
3. In the **Insert Calculated Field** dialog box, enter a name for the added field. Type in **Balance**.
4. Then, build the formula. Position the cursor in the **Formula** box, click and highlight **CurrentBalance** in the **Fields** box, and click **Insert Field**. Next, type in the plus sign (+) and then click and highlight **AgingCategory1** in the **Fields** box. Again, click on **Insert Field**. Repeat this process until all fields through **AgingCategory4** are summed in the **Formula** box. Click **OK** to complete the process, as shown in **Figure 3**.

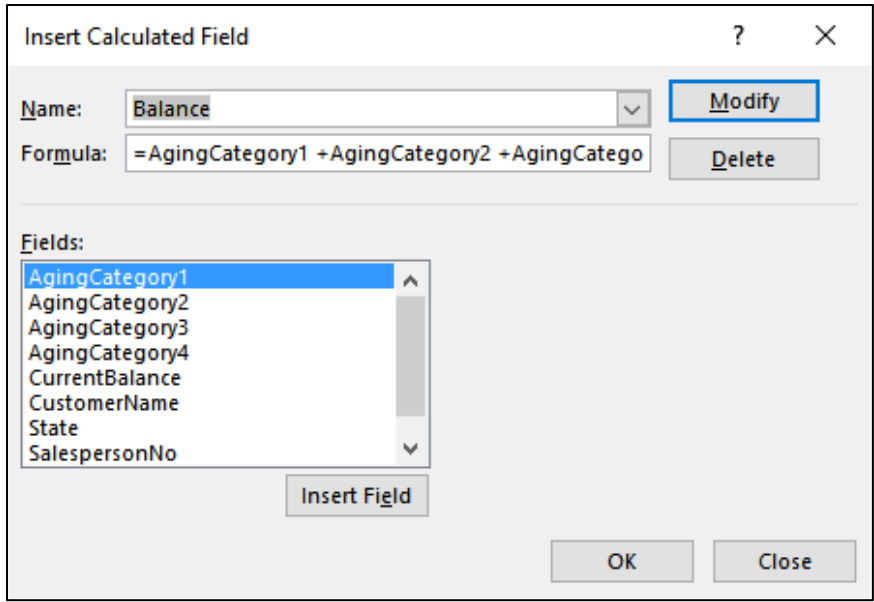


Figure 3 – Entering a Formula for a Calculated Field

5. Excel adds the new field in a separate column to the right of the **Over 120** column.

To complete the table, drag **SalespersonNo** to the **Rows** quadrant and drag the **CustomerName** field to the **Filters** quadrant. The reconfigured PivotTable helps users examine and understand their sales staff’s sales and collection performance. Similarly, we could have replaced **SalespersonNo** in the **Rows** quadrant with **State** to produce an accounts receivable aging of accounts by state, which could help users manage the risk of non-collection in specific locations. **Figure 4** displays the completed PivotTable.

	A	B	C	D	E	F	G
1	State	(All)					
2	CustomerName	(All)					
3							
4		Current	Over 30	Over 60	Over 90	Over 120	Balance
5	0100	\$ 16,303.22	\$ 1,257.40	\$ -	\$ -	\$ -	\$ 17,560.62
6	0200	\$ 521,120.18	\$ 7,251.31	\$ 2,335.43	\$ -	\$ -	\$ 530,706.92
7	0300	\$ 30,719.81	\$ 4,476.31	\$ 9,741.93	\$ 4,607.18	\$ -	\$ 49,545.23
8	0400	\$ 88,671.32	\$ 4,162.57	\$ 3,089.34	\$ 12.75	\$ -	\$ 95,935.98
9	Grand Total	\$ 656,814.53	\$ 17,147.59	\$ 15,166.70	\$ 4,619.93	\$ -	\$ 693,748.75

Figure 4 – Aging of Accounts Receivable by Salesperson

Remember, our PivotTable links dynamically to the underlying data in Sage 100. So, to use this report in the future, retrieve the workbook and click **Refresh** to produce an updated summary based on the transactions and postings as they exist in the underlying database at the time of refresh.

Creating Calculated Items

Let us now turn our attention to the task of creating a *calculated item*. Remember, we will use calculated items to incorporate the values associated with other items into our formulas. In our first example, we will create a calculated item to compute the gross margin from the PivotTable pictured data in **Figure 5**.

	A	B	C	D	M	N
1	Page1	(All)				
2						
3	Sum of Value	Column Labels				
4	Row Labels	1/1/2021	2/1/2021	3/1/2021	12/1/2021	Grand Total
5	Revenue	344,000	377,000	414,000	1,032,000	7,481,000
6	Cost of Sales	173,000	183,000	193,000	285,000	2,748,000
7	Distribution	35,000	45,000	55,000	148,000	1,095,000
8	Facilities	17,000	17,000	17,000	17,000	204,000
9	SG&A	35,000	45,000	55,000	148,000	1,095,000
10	Total Expense	87,000	107,000	127,000	313,000	2,394,000
11	Net Income	84,000	87,000	94,000	434,000	2,339,000
12	Grand Total	775,000	861,000	955,000	2,377,000	17,356,000

Figure 5 – Simple Consolidation PivotTable

To insert a calculated item, use the following procedure.

1. Select any one of the row items, such as *Revenue*, *Cost of Sales*, or *Distribution*.
2. In Excel, on the **PivotTable Tools, Analyze** tab of the Ribbon, click **Fields, Items, & Sets** followed by **Calculated Item**, as shown in **Figure 6**.

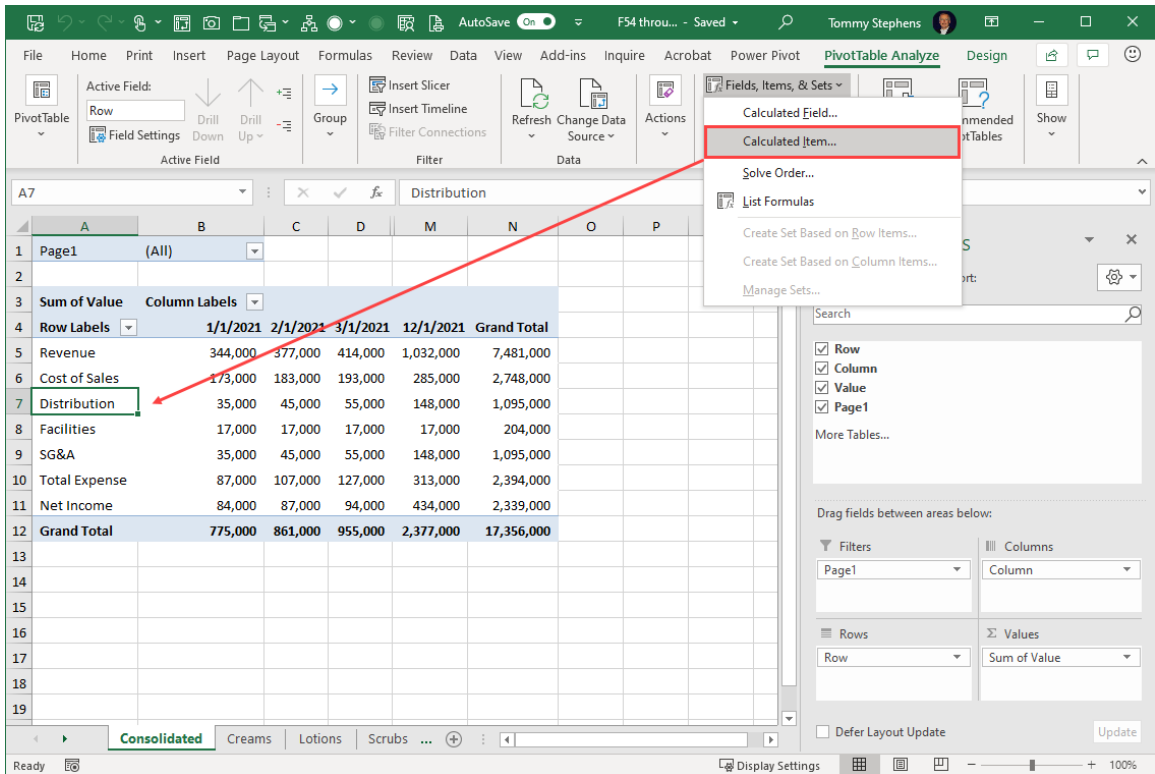


Figure 6 - Creating Formulas from the PivotTable Analyze Tab of the Ribbon

3. In the **Insert Calculated Item** dialog box, enter a name for the added item. Type in **Gross Margin**.
4. Now, build the formula. First, position your cursor in the **Formula** box, click and highlight **Revenue** in the **Items** box in the lower right-hand corner, and click **Insert Item**. Next, type in the minus sign (-) and click and highlight **Cost of Sales** in the **Items** box. Finally, click on **Insert Item** and then **OK** to complete the process, as shown in **Figure 7**.

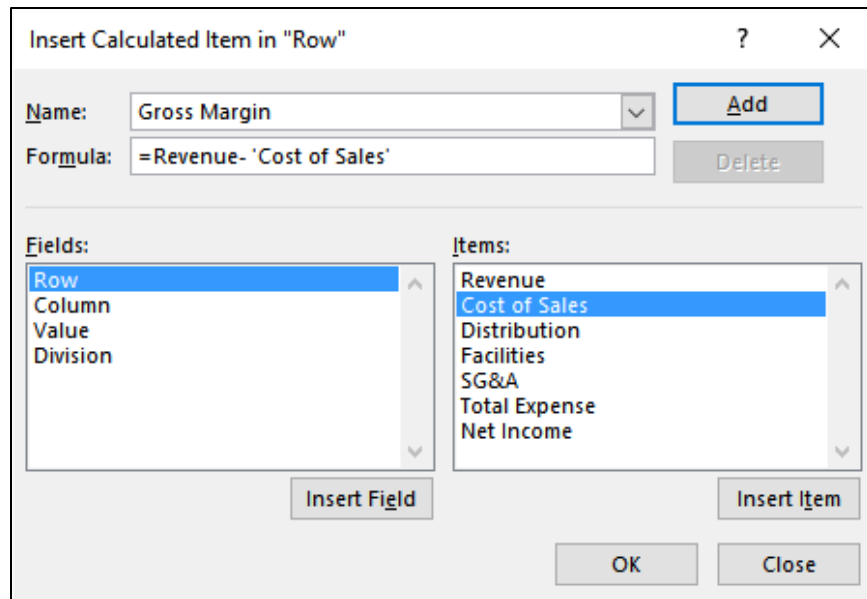


Figure 7 – Entering the Formula for a Calculated Item

- Excel will create an item at the bottom of the column. Use your mouse to drag the item to the correct position in the report.



Excel will display an error message if you attempt to group months into quarters in the PivotTable report because the built-in date and number groupings are not allowed across calculated items in PivotTables.

Return to the Insert Calculated Item dialog box to delete a calculated item. Then, use the drop-down list to select the appropriate item in the **Name** box and click **Delete**.

Calculated Items can contain relative references to their underlying data in a PivotTable. For instance, suppose one wanted to use the prior months' data in a PivotTable to estimate future results. More specifically, someone preparing a forecast believes that sales for the current month can be estimated by averaging sales for the prior two months and multiplying that result by 150%. You can use a Calculated Item to perform this calculation. To do so, click in the Months field of the PivotTable and then click **Formulas** from the **PivotTable Tools, Analyze** tab of the Ribbon to open the **Insert Calculated Item** dialog box. Enter the Calculated Item's name and the appropriate formula, as shown in **Figure 8**.

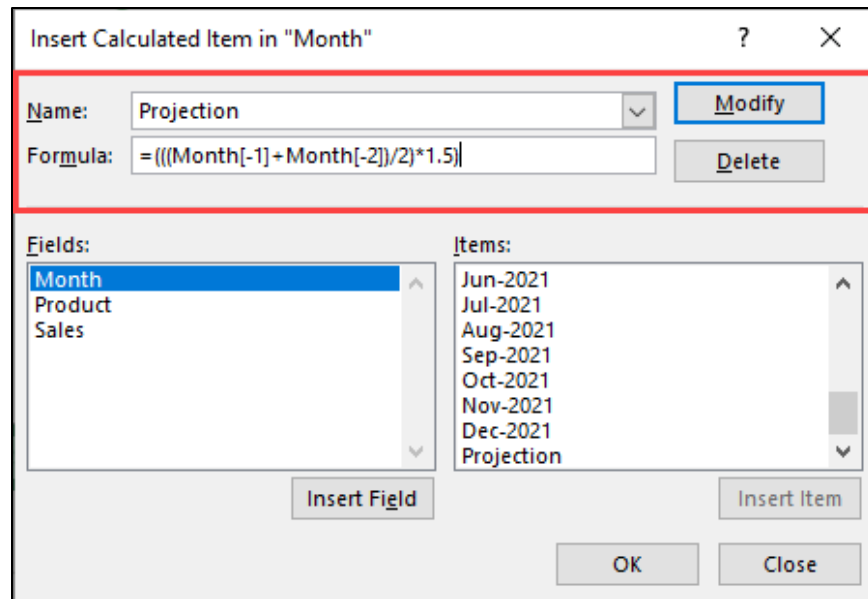


Figure 8 - Creating a Calculated Item

It is unnecessary to return to the Calculated Item dialog box to edit the Calculated Item. Instead, you can edit it directly in the Formula Bar or PivotTable after creating a Calculated Item. To do so, double-click in the PivotTable on the Calculated Item of interest, and it will open for editing, as shown in **Figure 9**.

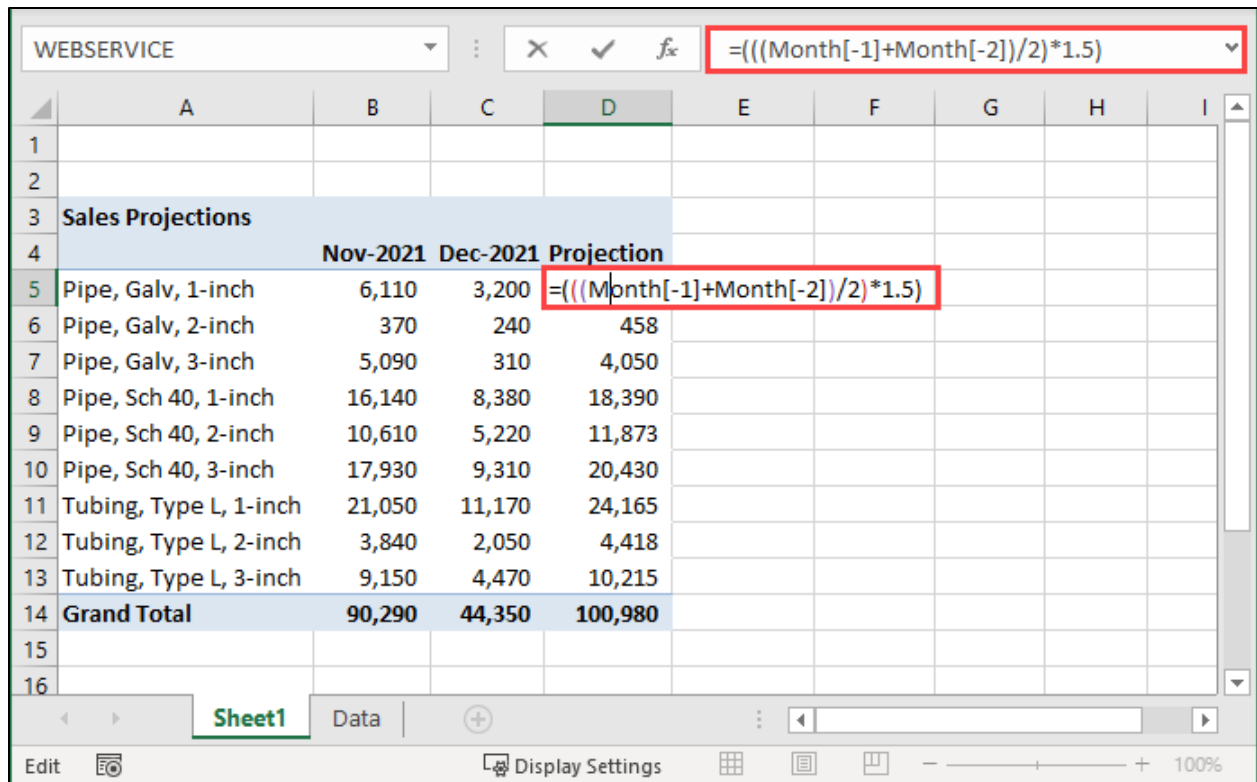


Figure 9 - Editing a Calculated Item in a PivotTable

Adding Slicer and Timeline Filters

Slicers are a relatively new form of filtering. A Slicer is essentially a visual filter, allowing even inexperienced end-users to filter a PivotTable to meet specific needs. In addition, you can add multiple Slicers to the same PivotTable, extending their functionality and usefulness.

To add a Slicer to a PivotTable, choose **Insert Slicer** from the **PivotTable Tools, Analyze** tab to open the Insert Slicer dialog box shown in **Figure 10**.

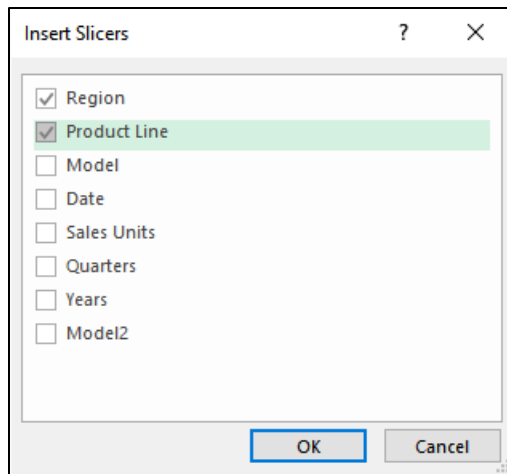


Figure 10 - Adding Slicers to a PivotTable

Click in the boxes next to the fields you want to add a Slicer, and then click **OK**. Then, drag the Slicer to its desired location on the PivotTable report. Note that in the example presented in **Figure 11**, two Slicers are present – one for the **Region** and one for the **Product Line**. Based on the filters applied by these Slicers, the PivotTable has been filtered to show only results for the *Northeast* and *West* **Regions** and only for the *Drives* and *Keyboards* **Product Lines**.

		Sales Analysis Report				
		2019	2020	2021	Grand Total	
Region						
Southeast						
Midwest						
West						
Northeast						
Product Line						
Drives						
Keyboards						
Monitors						
Processors						
		Drives	14,616,125	17,635,173	22,728,560	54,979,858
		5400-150-25	638,313	720,322	951,913	2,310,548
		5400-150-35	2,296,537	2,858,063	3,623,007	8,777,607
		5400-250-25	1,101,924	1,294,283	1,567,245	3,963,452
		5400-250-35	185,383	233,481	306,000	724,864
		5400-350-25	1,629,422	1,957,137	2,375,982	5,962,541
		5400-350-35	331,889	372,563	489,463	1,193,915
		7200-150-25	477,634	573,991	749,793	1,801,418
		7200-150-35	1,170,750	1,321,082	1,763,520	4,255,352
		7200-250-25	637,721	789,914	989,685	2,417,320
		7200-250-35	1,407,181	1,677,903	2,294,918	5,380,002
		7200-350-25	590,583	690,394	1,003,701	2,284,678
		7200-350-35	2,003,619	2,549,724	3,312,454	7,865,797
		SS250-25	225,731	283,279	368,965	877,975
		SS250-35	606,505	779,863	966,901	2,353,269
		SS350-25	1,312,933	1,533,174	1,965,013	4,811,120
		Keyboards	1,137,631	1,438,932	2,107,637	4,684,200
		E104	253,826	318,013	453,330	1,025,169
		EB104	639,241	832,827	1,223,221	2,695,289
		S104	162,401	190,151	283,461	636,013
		SB104	82,163	97,941	147,625	327,729
Grand Total		15,753,756	19,074,105	24,836,197	59,664,058	

Figure 11 - Slicers Added to a PivotTable Report

Note that you can customize the physical appearance of a Slicer by clicking on the Slicer, followed by selecting the **Slicer Tools, Options** contextual tab on the Ribbon. You can access color, size, and alignment options from that contextual tab. Additionally, by choosing **Report Connections** on the **Slicer Tools, Options** contextual tab, you can link one Slicer to control multiple PivotTables.

Timeline Filters

Like Slicers, **Timeline** filters are visual filters. Therefore, you can use Timelines only with fields that contain dates. Timelines allow you to quickly filter your PivotTables and PivotCharts by *Day*, *Month*, *Quarter*, or *Year*. With Timelines, you apply filters by clicking and dragging on the Timeline's edges.

To add a Timeline filter, select **Timeline** from the **PivotTable Analyze** tab of the Ribbon. Then, select the date fields you want to filter using a Timeline. At that point, the process is complete, and you can use the newly-created Timeline to assist in analyzing your data.



What are the relative merits of using Slicers and Timelines to filter your PivotTables?

Filtering Multiple PivotTables Simultaneously

An interesting aspect of Slicers and Timelines is connecting them to multiple PivotTables constructed from the same data source. When you link numerous PivotTables to the same Slicer or Timeline filter, you can filter each connected PivotTables from the Slicer or Timeline. The advantages of this technique are 1) each connected PivotTable filters to the same criteria, and 2) you spend less time filtering your PivotTables.

To link multiple PivotTables to a Slicer or Timeline, add the Slicer or the Timeline to one of the PivotTables. Once added, right-click on the Slicer or Timeline and choose **Report Connections**. Then, check the box next to each of the additional PivotTables you would like to link to that filter. Next, click **OK** to complete the process. Upon doing so, you will control multiple PivotTables from the same Slicer or Timeline.

Using Power Query to Link Data into PivotTables

Microsoft added **Power Query** to the 2010 release of Excel as an add-in. Subsequently, Microsoft incorporated Power Query fully into Excel, beginning with the 2016 release of the application. Power Query provides exceptional functionality in two areas: 1) the option to link data from external data sources into Excel and 2) the ability to create and apply transformations to data and have those transformations automatically apply each time you refresh a query. Our focus in this session will be using Power Query to link external data into our PivotTables.

Power Query provides Excel users with the ability to link data into Excel from virtually any common external data source, including those named below.

- Other Excel workbooks
- Text files
- Access databases
- SQL Server databases
- Webpages
- PDF documents
- ODBC-compliant databases, including those used by most accounting applications

Importantly, when using Power Query, you will establish persistent, refreshable links between your data source(s) and Excel. Therefore, you can refresh your queries quickly, thereby eliminating dated export/import processes and allowing your PivotTables to report on real-time or near real-time data.

Linking Data from an Accounting Application

Suppose you needed to create a PivotTable report that uses data from your accounting application. Further, suppose you want the summary to contain a refreshable link to avoid the need to manually export/import the data from the accounting application every time you need to update the report. This scenario represents a great example of using Power Query to create a refreshable, persistent link between the source data and the PivotTable.

This example will use Power Query to link data from a QuickBooks data file, using an ODBC driver supplied by [CData](#). To begin, assuming you have acquired and installed the appropriate driver, open the QuickBooks data file from which you would like to query data. Then, in Excel, perform the following steps.

1. On the **Data** tab of the Ribbon, click **Get Data, From Other Sources, From ODBC**.
2. In the **Data Source Name** box, choose **CData QuickBooks Source** and click **OK**.
3. In the **Navigator**, expand the **CData** entry and then expand the **QuickBooks** entry.
4. Choose the table(s) you wish to link into Excel. In this example, choose **Bills**.
5. Click the drop-down arrow next to **Load** (near the bottom of the window) and choose **Load To**, followed by **PivotTable Report**.
6. Click **OK** to complete the process of creating the query.

At this juncture, you can create your PivotTable by dragging and dropping the fields into their desired locations on the report. For example, the PivotTable shown in **Figure 12** illustrates how a completed PivotTable might appear using data linked through Power Query.

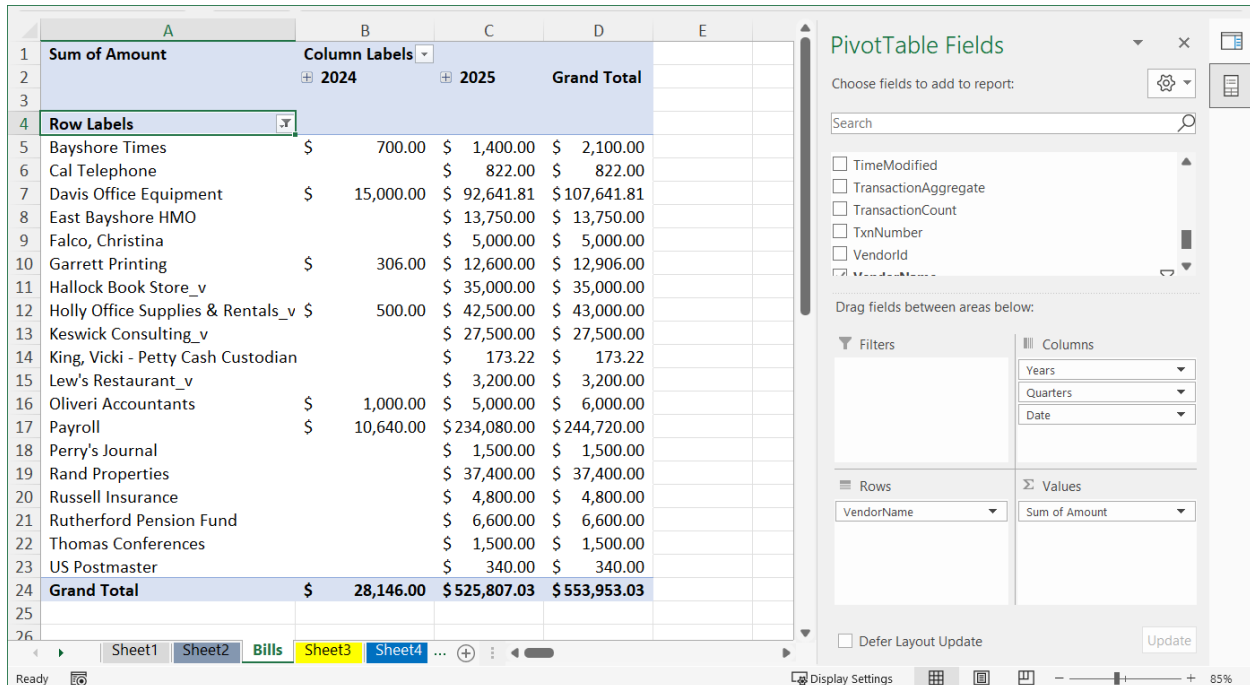


Figure 12 - Sample PivotTable Created from Data Linked Using Power Query

Consolidating Data Using PivotTables

You can use **Consolidation PivotTables** to report data that is already summarized. For example, suppose you need to combine divisional or departmental income statements, product line, or channel profitability reports. You can use Consolidation PivotTables to produce the merged summary quickly, without entering formulas. However, to use this technique, the layout of the individual worksheets you wish to consolidate must be similar, although they need not be identical.

Preparing to Consolidate

An icon for Consolidation PivotTables is not available natively from the Ribbon. To access this functionality, you must add the PivotTable and PivotChart Wizard icon to the Quick Access Toolbar (QAT) or Ribbon.

We will combine product line income statements into a single report with all PivotTable reporting flexibility in the following example. **Figure 13** illustrates a sample of the data, which has identical tables for the three product lines.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	DNM Distribution Company												
2	Comparative Budgeted Monthly Income Statements												
3													
4	Creams												
5		Jan-2021	Feb-2021	Mar-2021	Apr-2021	May-2021	Jun-2021	Jul-2021	Aug-2021	Sep-2021	Oct-2021	Nov-2021	Dec-2021
6	Revenue	100,000	115,000	132,000	152,000	175,000	201,000	231,000	266,000	306,000	352,000	405,000	466,000
7	Cost of Sales	50,000	53,000	56,000	59,000	62,000	65,000	68,000	71,000	74,000	77,000	80,000	83,000
8	Gross Margin	50,000	62,000	76,000	93,000	113,000	136,000	163,000	195,000	232,000	275,000	325,000	383,000
9	Distribution	10,000	13,000	16,000	19,000	22,000	25,000	28,000	31,000	34,000	37,000	40,000	43,000
10	SG&A	10,000	13,000	16,000	19,000	22,000	25,000	28,000	31,000	34,000	37,000	40,000	43,000
11	Facilities	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
12	Total Expense	25,000	31,000	37,000	43,000	49,000	55,000	61,000	67,000	73,000	79,000	85,000	91,000
13	Net Income	25,000	31,000	39,000	50,000	64,000	81,000	102,000	128,000	159,000	196,000	240,000	292,000

Figure 13 - Data to be Summarized Using a Consolidation PivotTable

Simple Consolidating PivotTables

In the first dialog box of the PivotTable Wizard, choose **Multiple consolidation ranges**. Click **Next**. Then, select how you wish to create the Page fields. To ensure maximum reporting flexibility, choose **I will create the page fields** and then click **Next**. The dialog box for the next step in the wizard appears, as shown in **Figure 14**. Next, define each data range in the single page field, one for each of the three product lines – *Creams*, *Lotions*, and *Scrubs*.

In our example, each range to consolidate is on a separate worksheet in a single workbook. However, there is no requirement that all the data reside in the same workbook. You can consolidate data that resides in multiple workbooks. To summarize ranges from other workbooks, open the other workbooks and point to the data ranges during the PivotTable creation process. Alternatively, type in the range addresses using the following format.

[workbook name] sheet name! range

Include the brackets around the workbook name and the exclamation point between the sheet name and the range specification. Using tables or defined names to define the data ranges in the individual workbooks will make the task easier and less prone to error.

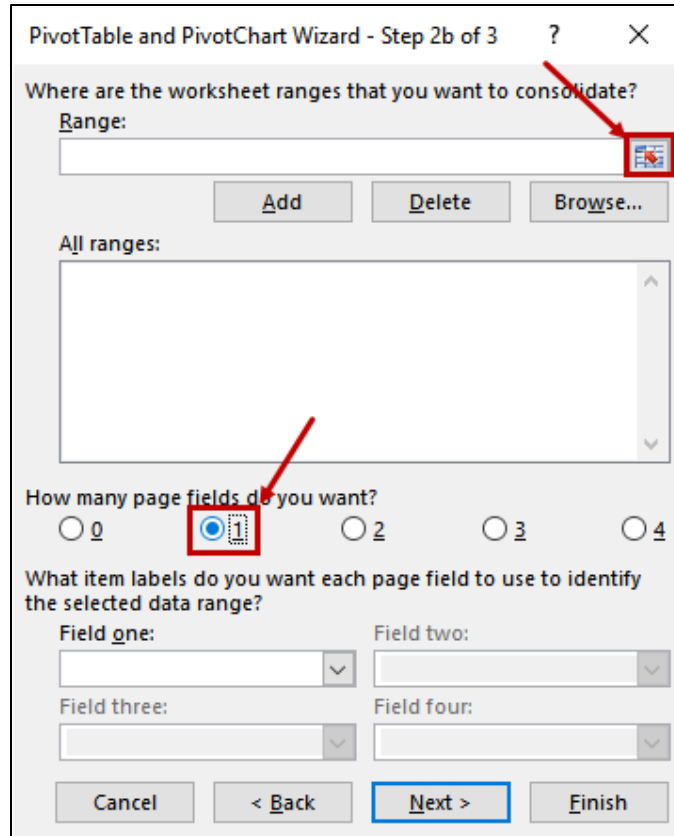


Figure 14 - Using the Collapse Dialog Button When Highlighting Ranges

Next, click on the **Collapse Dialog** button, shown in Figure 14, at the range box's right end to hide the dialog box temporarily. Using the mouse, highlight a range to include in the report, and click the **Collapse Dialog** button to redisplay the dialog box. Click **Add** to add the content to the consolidation. In the **Field one** box, enter the item name. Each of the ranges added in the dialog box will have an item name – in this example, *Creams*, *Lotions*, and *Scrubs*. The completed dialog appears in **Figure 15**.

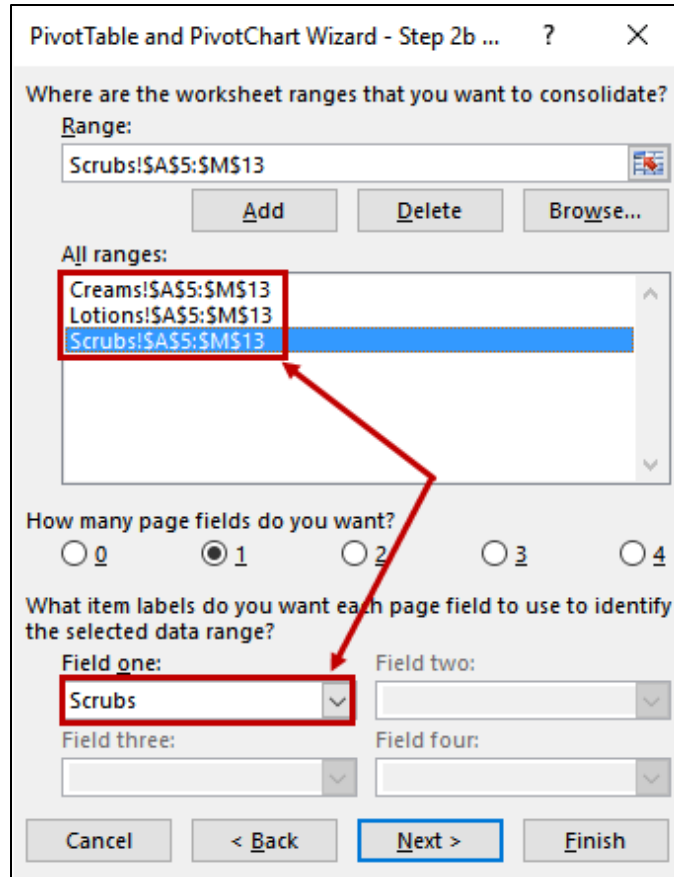


Figure 15 - Naming Each Field when Adding the Field Range

Click **Next**. Choose to create the PivotTable on a new worksheet and then click **Finish**. After grouping Months into Quarters and making some minor formatting changes, the initial PivotTable should resemble the one shown in **Figure 16**.

	A	B	C	D	E	F
1	Page1	(All) <input type="button" value="v"/>				
2						
3	Sum of Value	Column Labels <input type="button" value="v"/>				
4	Row Labels <input type="button" value="v"/>	Qtr1	Qtr2	Qtr3	Qtr4	Grand Total
5	Cost of Sales	549,000	641,000	733,000	825,000	2,748,000
6	Distribution	135,000	227,000	319,000	414,000	1,095,000
7	Facilities	51,000	51,000	51,000	51,000	204,000
8	Gross Margin	586,000	870,000	1,309,000	1,968,000	4,733,000
9	Net Income	265,000	365,000	620,000	1,089,000	2,339,000
10	Revenue	1,135,000	1,511,000	2,042,000	2,793,000	7,481,000
11	SG&A	135,000	227,000	319,000	414,000	1,095,000
12	Total Expense	321,000	505,000	689,000	879,000	2,394,000
13	Grand Total	3,177,000	4,397,000	6,082,000	8,433,000	22,089,000

Figure 16 - Initial Consolidation PivotTable Created from Product Data

The only task remaining is to complete the PivotTable for presentation. Hide the field headings, center the column headings, rename the Filter to **Product Line**, and give the values field a descriptive name, such as **Budgeted Income Statement**. The completed PivotTable should resemble the one shown in **Figure 17**. Keep in mind that all the drag-and-drop PivotTable functionality is available in the consolidated report.

	A	B	C	D	E	F
1	Product Line	(All) <input type="button" value="v"/>				
2						
3	Budgeted Income Statement					
4		Qtr1	Qtr2	Qtr3	Qtr4	Grand Total
5	Revenue	1,135,000	1,511,000	2,042,000	2,793,000	7,481,000
6	Cost of Sales	549,000	641,000	733,000	825,000	2,748,000
7	Gross Margin	586,000	870,000	1,309,000	1,968,000	4,733,000
8	Distribution	135,000	227,000	319,000	414,000	1,095,000
9	Facilities	51,000	51,000	51,000	51,000	204,000
10	SG&A	135,000	227,000	319,000	414,000	1,095,000
11	Total Expense	321,000	505,000	689,000	879,000	2,394,000
12	Net Income	265,000	365,000	620,000	1,089,000	2,339,000

Figure 17 - Completed PivotTable

Creating PivotTables from Data Models

A data model is a collection of two or more tables that you *relate* or link together based on the presence of one or more common fields. Once you create a data model, Excel interprets it as a single source of data, and you can use the data model as the source data for a PivotTable.

Conceptually, a data model might appear similar to the image in **Figure 18**. In this illustration, three tables link together to create a data model, and you can use the data model as the source data for a PivotTable.

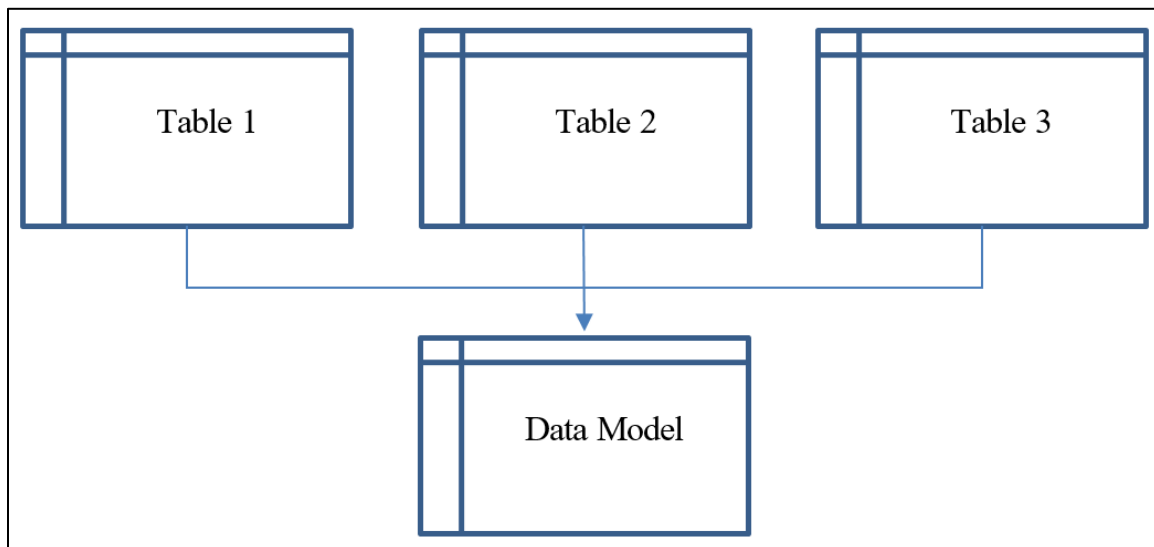


Figure 18 - Schematic of an Excel Data Model

Creating Simple Data Models from Excel Tables

Creating data models in Excel can be easy; in fact, you can do so with a single click of the mouse. However, before attempting to relate multiple Excel tables, you should first verify that each table has a field common to the other table(s) in the data model. For example, suppose you are attempting to relate two tables containing inventory data; in this case, you would probably look for a part number or SKU code common to each table. Likewise, if you desire to relate multiple employee-related tables, you would probably do so based on a common field of employee identification numbers or a similar field.

Our first example of relating tables together to create a data model will be in the context of creating a PivotTable. In this example, we have an Excel workbook that contains two tables – *Transactions* and *Product*. We would like to build a PivotTable that uses data from both tables, but we do not want to use an XLOOKUP or VLOOKUP approach to consolidate the data from the two tables. Fortunately, we can use data models to solve the problem.

Begin by clicking on either of the tables. Then, click **Summarize with PivotTable** from the **Table Tools Design** tab of the Ribbon to open the **Create PivotTable** dialog box pictured in **Figure 19**. In this dialog box, check the box next to **Add this data to the Data Model**. Note that checking this box adds *all* tables in the workbook – not just the currently-selected table – to the workbook's data model.

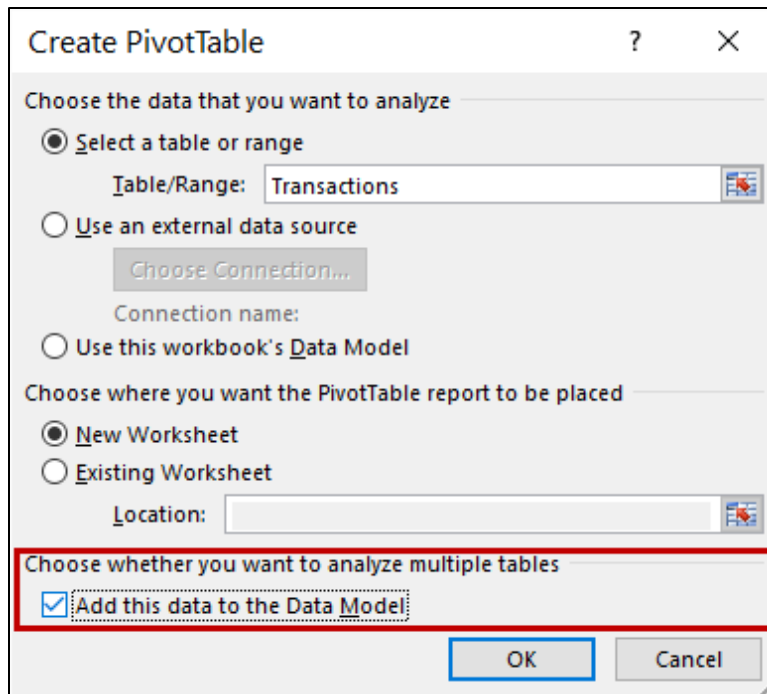


Figure 19 - Adding Tables to a Workbook's Data Model

Click **OK** to complete the process, and Excel opens a new workbook with the **PivotTable Field List** available, as shown in **Figure 20**. As indicated in the figure, click **All** to see all of the tables available for use in the PivotTable. Further, notice the faint line that separates the *Product* table from the *Transactions* table. This line indicates that the two tables are not yet related. You should never build a PivotTable (or any other analytical tool) from unrelated tables in the data model! If you do, Excel will display a warning message indicating that you should relate your tables. Further, if you build a PivotTable from unrelated tables, you will probably notice that the calculations in your PivotTable do not seem to make sense. In short, always ensure that proper relationships exist before continuing with your PivotTable.

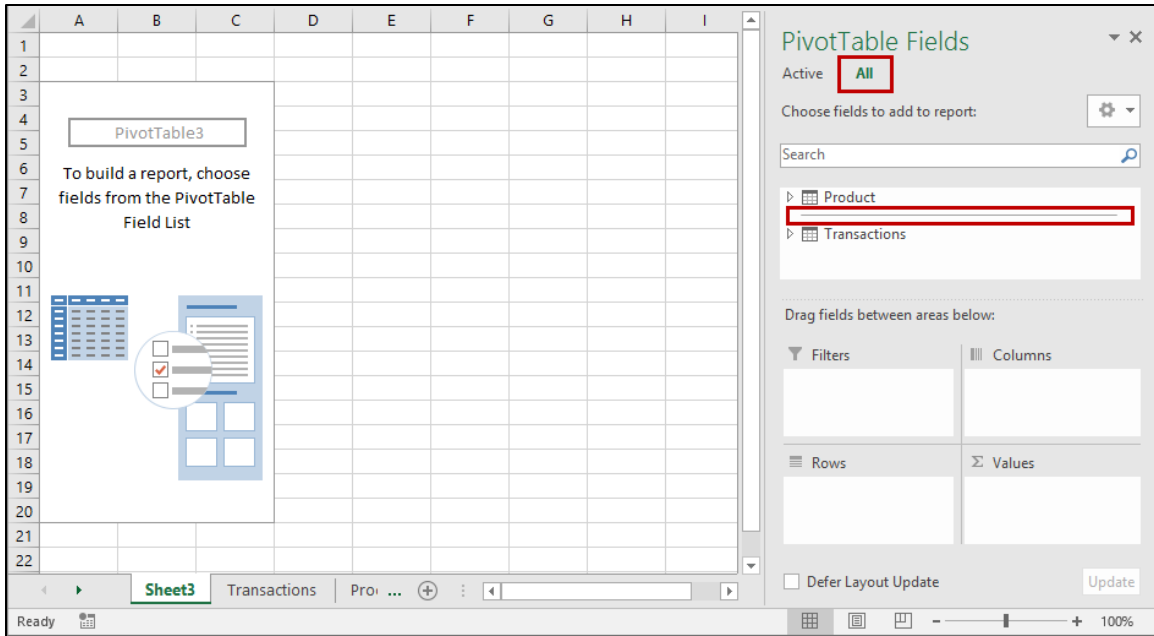


Figure 20 - Unrelated Tables in PivotTable Field List

You can establish relationships between the tables in the data model using multiple approaches. First, suppose Excel provides you with an **Auto-Detect** option similar to that pictured in **Figure 23**. In that case, you can click on the **Auto-Detect** button, and Excel will attempt to identify and relate the tables together automatically. There is a high probability that this process will be successful in relatively simple data models. However, if it does not, you will need to establish the relationships manually. To do so, click the **Create** button pictured in Figure 21, or click **Relationships** from the **PivotTable Tools Analyze** tab of the Ribbon. Both approaches will open the **Manage Relationships** dialog box illustrated in **Figure 22**. You can also access the Manage Relationships dialog box by clicking the **Relationships** button on the **Data** tab of the Ribbon.

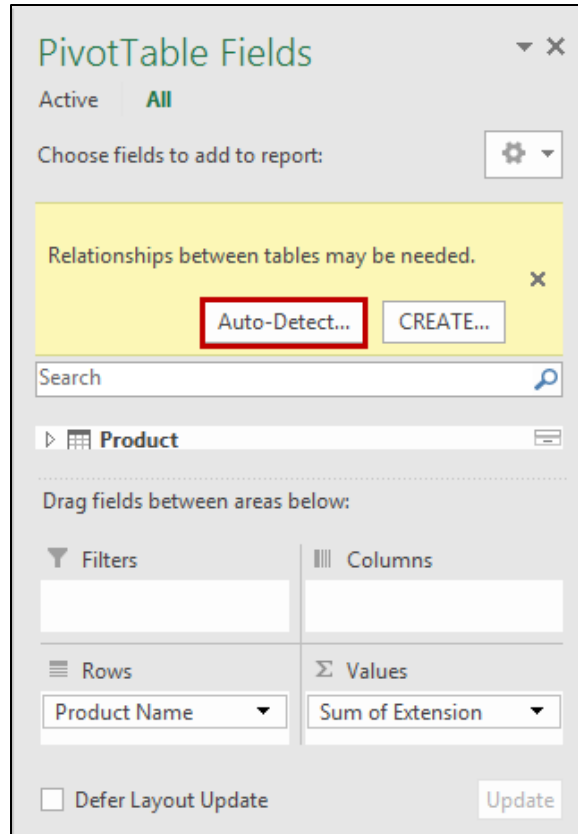


Figure 21 - Using Excel's Auto-detect Feature to Establish Relationships in Data Models



Figure 22 - Excel's Manage Relationships Dialog Box

In the Manage Relationships dialog box, click the **New** button to open the **Create Relationship** dialog box shown in **Figure 23**. Choose the tables you wish to relate on the left side of this dialog box. Next, choose the field common to both tables on the right side of the dialog box. Click **OK** to

complete the process of relating these two tables. Repeat this process for as many tables as you need to link in the data model.

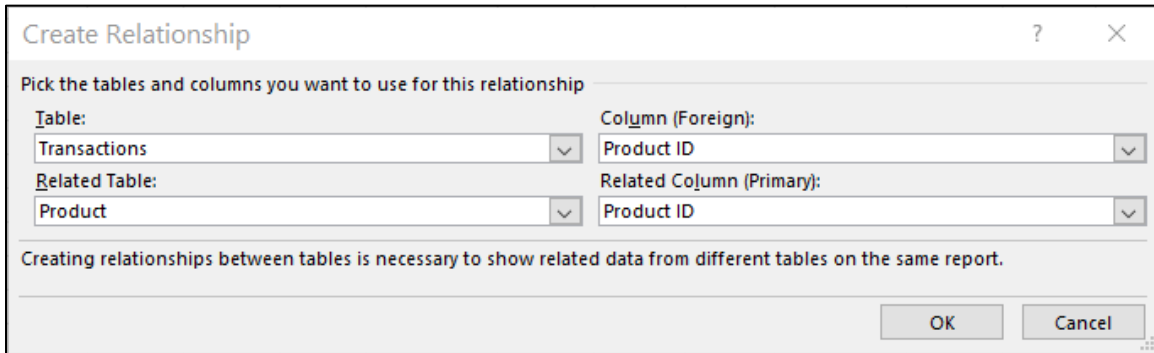


Figure 23 - Manually Establishing Relationships between Tables in a Data Model

After successfully establishing the relationship, the Manage Relationships dialog box will change to reflect the relationship and its current status, as shown in **Figure 24**.

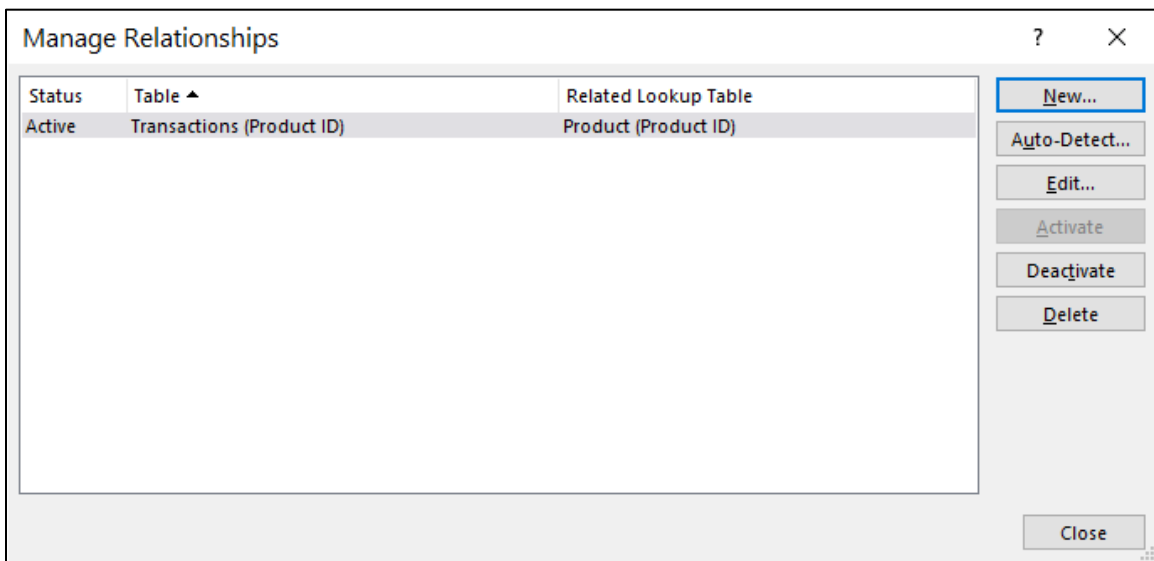


Figure 24 - Displaying All Relationships in the Manage Relationship Dialog Box

With the relationship between the two tables in place, we can construct a PivotTable that utilizes data from both tables in the data model. **Figure 25** presents an excerpt of that PivotTable.

	A	B	C	D	E	F
3	Summary of Sales by Product/Year					
4		2016	2017	2018	Grand Total	
5	Active Outdoors Crochet Glove	516.20	3,563.44	775.03	4,854.67	
6	Active Outdoors Lycra Glove	674.85	4,922.01	1,560.09	7,156.95	
7	Descent	77,759.06	1,312,790.24	495,070.87	1,885,620.17	
8	Endorphin	12,192.99	204,626.02	60,020.01	276,839.02	
9	Guardian "U" Lock	35.00	763.90	105.00	903.90	
10	Guardian ATB Lock	39.42	782.93	306.60	1,128.95	
11	Guardian Chain Lock	27.00	250.68	39.38	317.06	
12	Guardian Mini Lock	325.23	825.63	434.73	1,585.59	
13	Guardian XL "U" Lock	19.90	1,104.46	179.10	1,303.46	
14	InFlux Crochet Glove	54.00	1,732.13	693.23	2,479.36	
15	InFlux Lycra Glove	369.69	1,948.37	593.67	2,911.73	
16	Micro Nicros	4,307.31	24,568.02	8,436.25	37,311.58	
17	Mini Nicros	5,524.28	27,128.10	6,426.19	39,078.57	
18	Mozzie	57,154.08	452,709.11	122,659.45	632,522.64	
19	Nicros	13,556.88	147,789.54	42,435.27	203,781.69	
20	Rapel	18,450.26	161,853.64	52,759.56	233,063.46	

Figure 25 - Sample PivotTable Created from a Data Model

Adding Calculations Using Power Pivot

Power Pivot is the tool you can use to perform more significant modifications to your data models. For example, one such change could be adding user-defined calculations in the data model. You can add two forms of user-defined calculations to your data models – *calculated columns (a/k/a calculated fields)* and *measures*. Both calculations use **Data Analysis Expressions (DAX)** instead of the traditional Excel function library. Some of the approximately 300 DAX functions available today resemble standard Excel functions, but most are substantially different. You can learn more about the DAX function library at <https://docs.microsoft.com/en-us/dax/>.

Creating Simple Calculated Columns with DAX

Calculated columns are columns that you add to an existing data model. Then, instead of pasting or importing values in the column, you create a DAX formula that defines the column's values. Once you create a calculated column, you can use the column's values the same way you would use data from any other column.

To illustrate the power of calculated columns built using DAX expressions, consider the data shown in **Figure 26**. The extraction pictures ten records from a population of 34,169 records of time and billing data for a consulting firm. The firm operates on a fiscal year starting on July 1 and ending on June 30. PivotTables – including those built from data models – have the inherent capability to group date data automatically only on calendar years/quarters/months; fiscal year groupings can be created but involve manual workarounds.

	Trans Date	Region	Account Category	Service Line	Sector	Hours	Net Revenue	Add Column
34162	5/26/2021	South A...	Regional	HR Manageme...	Transpor...	160.67	24960.12	
34163	5/27/2021	South A...	Regional	IT Consulting	Transpor...	2.79	4645.97	
34164	6/2/2021	South A...	Regional	HR Manageme...	Transpor...	173.36	70883.16	
34165	6/10/2021	South A...	Strategic Account	IT Consulting	Transpor...	28.35	4199.76	
34166	6/11/2021	South A...	Regional	IT Consulting	Transpor...	37.56	9594.96	
34167	6/14/2021	South A...	Regional	IT Consulting	Transpor...	5.49	1329.28	
34168	6/24/2021	South A...	Regional	IT Consulting	Transpor...	98.54	10235.11	
34169	6/27/2021	South A...	Regional	IT Consulting	Transpor...	5.38	2748.79	

Figure 26 - Extraction of Time and Billing Data to be Used in Creating Calculated Columns with DAX

In this example, a relatively easy-to-implement workaround will be to use three DAX functions – **MONTH**, **YEAR**, and **IF** – to create calculated columns in the data model to identify the appropriate fiscal quarter and fiscal year for the time and billing records. Note that these three functions operate as DAX functions almost exactly as they do in a traditional Excel environment.¹

Begin by double-clicking at the top of a blank column in the data model and enter *Month* as the column header. Repeat that process two times, adding *Fiscal Quarter* and *Fiscal Year*. Then, enter the following formula on the first row of the Month column.

=Month([Trans Date])

This formula identifies the month number (1 through 12) based on the data in the current row of the *Trans Date* column in the data model. Notice that it uses a **MONTH** DAX function that operates identically to the MONTH function in traditional Excel spreadsheets.

Next, enter the following formula in the first row of the *Fiscal Quarter* column.

=IF([Month]<4,3,IF([Month]<7,4,IF([Month]<10,1,2)))

This formula checks to see if the month is January, February, or March (month numbers 1 through 3) and, if so, it assigns the value of 3 to that row of the *Quarters* column, indicating that the month falls into the third fiscal quarter. If the month is April, May, or June (month numbers 4 through 6), the formula assigns 4 to that row of the *Quarters* column, indicating that the month falls into the fourth fiscal quarter. If the month is July, August, or September (month numbers 7 through 9), the formula assigns a value of 1 to that row of the *Quarters* column, indicating that the month falls into the first fiscal quarter. Finally, if the month is October, November, or December (month numbers 10 through 12), the formula assigns a value of 2 to that row of the

¹ Those well versed in Power Pivot may already realize that Date Tables (also known as Calendar Tables) represent a viable option to the use of DAX-based formulas to identify fiscal reporting periods in data models.

Quarters column. Of course, this assignment indicates that the month falls into the second fiscal quarter.

Finally, enter the following formula into the *Fiscal Year* column.

=IF([Month]<7,Year([Trans Date]),Year([Trans Date])+1)

This formula identifies the appropriate fiscal year for the transaction. It does so by checking to see if the month is January through June and, if it is, assigns the transaction to the year found in the *Trans Date* field. Otherwise, if Excel identified the month as July through December, Excel deems the transaction to occur in the following fiscal year. **Figure 27** displays the modified data model, with three newly added calculated columns based on **MONTH**, **YEAR**, and **IF**, three DAX functions.

	Trans Date	Region	Account Category	Service Line	Sector	Hours	Net Revenue	Month	Fiscal Quarter	Fiscal Year
1	7/1/2019	Asia	Global Account	IT Consulting	CleanTech	13.4	2228.7	7	1	2020
2	7/1/2019	Asia	Regional	HR Manageme...	Defense...	103.87	7643.16	7	1	2020
3	7/1/2019	Asia	Global Account	HR Manageme...	Defense...	3.64	1017.11	7	1	2020
4	7/1/2019	Asia	Strategic Account	Training	Defense...	15.6	4100.06	7	1	2020
5	7/1/2019	Asia	Global Account	IT Consulting	Defense...	4.44	973.24	7	1	2020
6	7/1/2019	Asia	Regional	IT Consulting	Life Scie...	10.61	2329.37	7	1	2020
7	7/1/2019	Asia	Strategic Account	HR Manageme...	Life Scie...	16.68	2710.77	7	1	2020
8	7/1/2019	Asia	Regional	IT Consulting	Life Scie...	23.69	4426.17	7	1	2020
9	7/1/2019	Asia	Global Account	HR Manageme...	Oil & Gas	380.77	74851.97	7	1	2020

Figure 27 – Creating Calculated Columns in the Data Model with DAX Expressions

The only remaining action is to complete the PivotTable with the calculated columns in place. From Power Pivot’s **Home** tab, click **PivotTable**. Then, in the PivotTable field list, drag *Region* and *Service Line* to the *Rows* quadrant, *Fiscal Year* and *Fiscal Quarter* to the *Columns* quadrant, and *Net Revenue* to the *Values* quadrant. The completed report, with formatting added, might resemble that pictured in **Figure 28**.

	B	C	D	E	F	G	H
3	Summary of Revenue by Region by Service Line						
4		2020				2021	Grand Total
5		Q1	Q2	Q3	Q4		
6	Asia						
7	Advisory Services	1,658,032.94	1,576,453.77	1,301,879.93	1,892,261.05	12,360,427.55	18,789,055.24
8	HR Management	4,520,169.49	5,137,624.93	3,906,747.95	3,284,249.64	25,869,617.77	42,718,409.78
9	IT Consulting	4,121,422.18	4,625,545.13	4,924,517.10	5,449,134.85	25,900,438.80	45,021,058.06
10	Training	675,998.37	727,372.56	653,771.06	411,210.91	4,524,464.40	6,992,817.30
11	Europe						
12	Advisory Services					32,556,283.45	32,556,283.45
13	HR Management					83,009,493.19	83,009,493.19
14	IT Consulting					62,567,734.62	62,567,734.62
15	Training					11,730,023.94	11,730,023.94
16	North America						
17	Advisory Services	12,306,107.21	11,758,282.30	9,985,846.06	14,550,079.51	93,790,984.33	142,391,299.41
18	HR Management	43,044,885.85	44,382,045.00	37,769,699.45	31,831,110.70	238,928,484.35	395,956,225.35
19	IT Consulting	30,640,819.14	34,164,260.01	36,674,269.90	42,187,684.74	198,726,768.70	342,393,802.49
20	Training	5,327,027.03	4,860,874.83	4,669,726.12	2,949,590.75	34,129,956.82	51,937,175.55
21	South America						
22	Advisory Services	6,529,300.05	5,802,681.90	3,151,025.60	7,354,537.67	31,050,687.45	53,888,232.67
23	HR Management	24,838,193.69	24,784,377.11	19,747,035.21	15,501,797.02	80,532,819.96	165,404,222.99
24	IT Consulting	13,908,957.85	16,457,588.23	15,400,544.65	22,633,945.64	60,822,949.84	129,223,986.21
25	Training	2,601,007.04	2,835,299.61	2,698,274.45	1,440,770.40	11,443,707.04	21,019,058.54
26	Grand Total	150,171,920.84	157,112,405.38	140,883,337.48	149,486,372.88	1,007,944,842.21	1,605,598,878.79

Figure 28 - PivotTable Using Calculated Columns for Fiscal Period Groupings

Creating Measures in a PivotTable Using DAX

Consider the need for advanced data analysis capabilities in a PivotTable built from data models. For instance, the PivotTable pictured in **Figure 29** presents data by region, year, and service line; however, it paints an incomplete picture relative to revenue because it does not show the number of revenue-producing sectors in each region. In other words, a simple comparison of revenue between regions does not provide the depth of analysis necessary if the South American region does not operate in all the industry sectors that the North American region does.

	A	B	C	D
1	Total Revenue			
2		Asia	North America	South America
3	2020			
4	Advisory Services	6,428,627.69	48,600,315.08	22,837,545.22
5	HR Management	16,848,792.01	157,027,741.00	84,871,403.03
6	IT Consulting	19,120,619.26	143,667,033.79	68,401,036.37
7	Training	2,468,352.90	17,807,218.73	9,575,351.50
8	2021			
9	Advisory Services	12,360,427.55	93,790,984.33	31,050,687.45
10	HR Management	25,869,617.77	238,928,484.35	80,532,819.96
11	IT Consulting	25,900,438.80	198,726,768.70	60,822,949.84
12	Training	4,524,464.40	34,129,956.82	11,443,707.04
13	Grand Total	113,521,340.38	932,678,502.80	369,535,500.41

Figure 29 – Sample PivotTable Analyzing Revenue by Region, Year, and Service Line

You can add a measure to the PivotTable built from the data model to paint a complete picture. *Measures* are formulas explicitly created for use in PivotTables (or PivotCharts) that use data from data models. You can create measures based on standard DAX aggregation functions, such as **COUNT** or **SUM**, or you can create a formula using DAX expressions. You always use measures in the *Values* area of a PivotTable. If you need calculated results to be placed elsewhere in a PivotTable – such as a row or column – you should use a calculated column instead of a measure.

When you define a formula for a measure, nothing happens until you add the measure to the PivotTable. Upon adding the measure, the formula evaluates for each cell in the PivotTable's Values area. Because Excel creates a result for each combination of row and column headers, a measure's result can and likely will be different in each cell. Excel saves the definition of the measure you create with its source table. It appears in the PivotTable Fields list and is available to all workbook users.

Returning to the example presented in Figure 29, you can use a DAX function – **DISTINCTCOUNT** – only available using DAX to create a deeper analysis of the data. **DISTINCTCOUNT** identifies the number of distinct values that a PivotTable summarizes at each unique intersection of a column and a row. To add this calculation to the PivotTable shown in Figure 29, begin by clicking the arrow under **Measures** on the **Power Pivot** Ribbon and then choose **New Measure** to open the **Measure** dialog box pictured in **Figure 30**. In the dialog box, add the formula, using the

DISTINCTCOUNT function and referring to the table and the column header in the table on which you want to base the calculation.

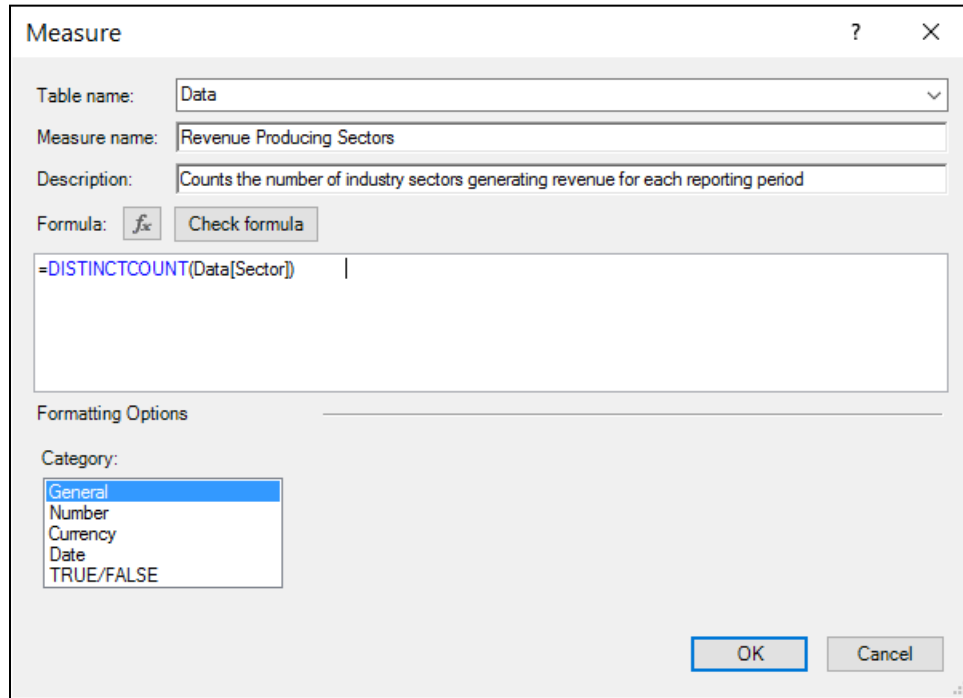


Figure 30 – Adding a Measure in Power Pivot’s Measure Dialog Box

Once you create the formula and click **OK**, Excel adds the measure to the PivotTable. After you add it, you can use it in any other calculation in the PivotTable. **Figure 31** illustrates the updated PivotTable, complete with the newly appended measures that offer greater insight into the revenues than was available previously.

	A	B	C	D	E	F	G
	Asia		North America		South America		
	Total Revenue	Revenue Producing Sectors	Total Revenue	Revenue Producing Sectors	Total Revenue	Revenue Producing Sectors	
2020	44,866,391.86	22	367,102,308.60	24	185,685,336.12	21	
Advisory Services	6,428,627.69	15	48,600,315.08	17	22,837,545.22	14	
HR Management	16,848,792.01	20	157,027,741.00	22	84,871,403.03	19	
IT Consulting	19,120,619.26	22	143,667,033.79	24	68,401,036.37	21	
Training	2,468,352.90	18	17,807,218.73	20	9,575,351.50	17	
2021	68,654,948.52	22	565,576,194.20	24	183,850,164.29	22	
Advisory Services	12,360,427.55	16	93,790,984.33	18	31,050,687.45	16	
HR Management	25,869,617.77	21	238,928,484.35	23	80,532,819.96	21	
IT Consulting	25,900,438.80	22	198,726,768.70	24	60,822,949.84	22	
Training	4,524,464.40	18	34,129,956.82	20	11,443,707.04	18	
Grand Total	113,521,340.38	22	932,678,502.80	24	369,535,500.41	22	

Figure 31 – PivotTable with Calculated Field Added by Power Pivot

Creating Key Performance Indicators in Power Pivot

Power Pivot provides the ability to develop **Key Performance Indicators (KPIs)** and measure results against the KPIs you establish. KPIs are visual measures of performance that help users quickly evaluate their progress toward meeting specified goals. For example, an organization’s

sales department could use a KPI to measure monthly sales against sales quotas. Similarly, the accounting department might compare monthly advertising expenses against budgeted amounts, or a human resources department might measure quarterly employee turnover to a target value. Business professionals frequently use KPIs grouped onto a business scorecard to quickly and accurately summarize business activities and identify trends.

Using KPIs can be very useful when you need to show clearly how actual results measure against expectations because KPIs are simply visual representations of performance. According to Microsoft, a “KPI gauges the performance of the value, defined by a Base measure, against a Target value, also defined by a measure or by an absolute value.”

When building KPIs in Power Pivot, understanding three terminology elements is essential.

1. **Base Value.** A base value is a measure that resolves to a numeric value. The base value, for example, could represent sales or net profit for a period, or it could represent year-to-date revenue through a specified date during the year.
2. **Target Value.** A target value can be a specific numeric target, or you can define it as a measure that resolves to a numeric value. For example, the sales target for the entire organization could be budgeted sales, a constant value. Alternatively, sales targets for each salesperson could be calculated in a measure as last year’s sales revenue plus a percentage increase.
3. **Status Thresholds.** Status thresholds are ranges between the high- and low-end points. Status thresholds display graphically (red light, yellow light, and green light, for example) to help users determine the base value’s progression toward a goal.

To create a KPI using Power Pivot, establish measures to serve as the **Base Value** and **Target Value**. In this case, construct measures to summarize sales and targeted sales for the year using the following DAX formulas.

TotalSales:=SUM(Transactions[SalesAmount])

TotalSalesTarget:=SUM(SalesTargets[2020SalesTarget])

After creating the measures, return to the **Power Pivot** tab of the Ribbon. Click **KPI, New KPI** to open the **Key Performance Indicator (KPI)** dialog box displayed in **Figure 32**. Select the TotalSales measure as the KPI base field in the Key Performance Indicator dialog box. Additionally, set the **TotalSalesTarget** measure as the **Target value**. Finally, adjust the upper and lower **Status thresholds** to **95%** and **90%**, respectively. Click **OK** to complete the process.

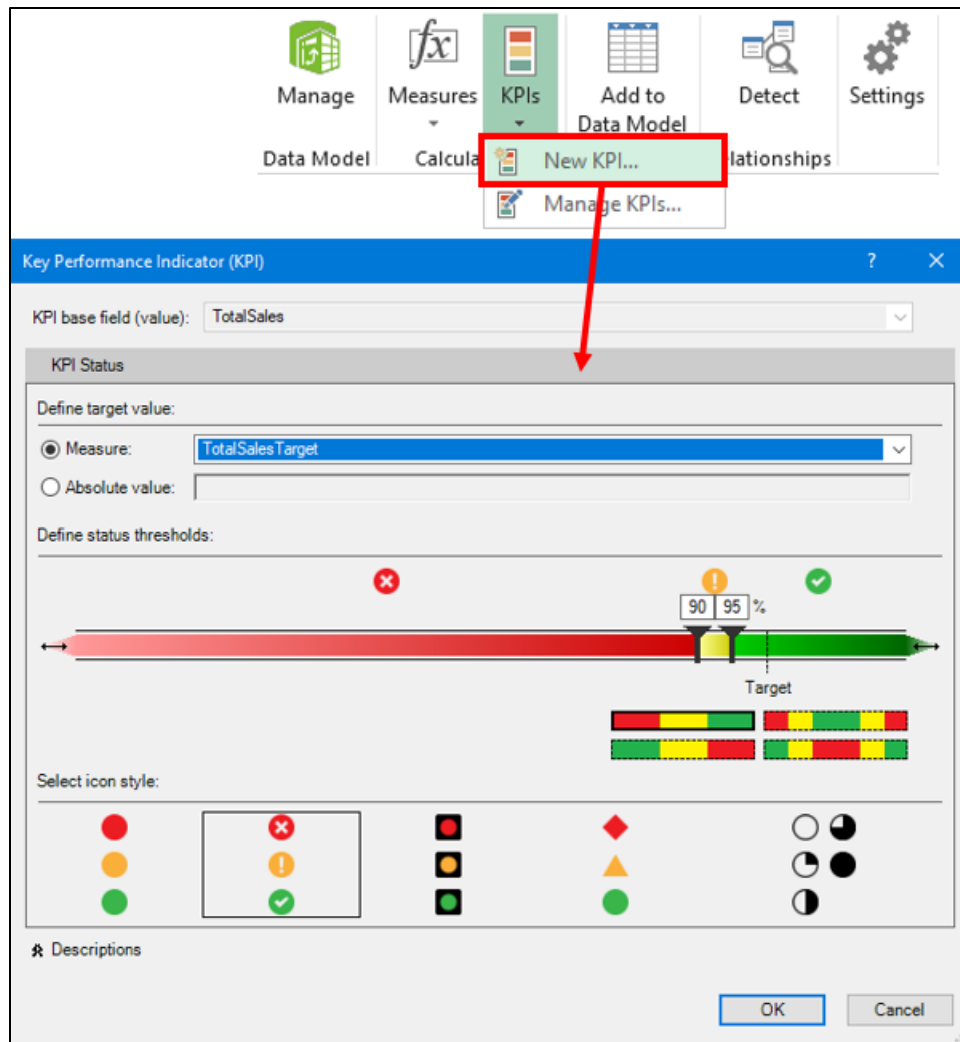


Figure 32 – Defining a New KPI in Power Pivot

As shown in **Figure 33**, each component of the KPI shows up as a new field that you can add to the PivotTable. Note the traffic signal symbol to differentiate a KPI from other fields in the Field List. Simply add the KPI to the PivotTable to complete the report.

Row Labels	Total Sales	Target	KPI
Abbas	\$14,611.05	16,000.00	!
Alberts	\$118,055.92	112,000.00	✓
Ansman-Wolfe	\$650,082.84	618,000.00	✓
Blythe	\$1,537,712.18	1,730,000.00	✗
Campbell	\$674,625.35	721,000.00	!
Carson	\$1,373,131.81	1,304,000.00	✓
Ito	\$1,076,280.83	1,022,000.00	✓
Jiang	\$245,166.79	233,000.00	✓
Mensa-Annan	\$837,494.84	796,000.00	✓
Mitchell	\$1,885,941.92	2,100,000.00	✗
Pak	\$1,157,128.34	1,099,000.00	✓
Reiter	\$1,089,192.44	1,165,000.00	!
Saraiva	\$1,906,118.50	1,811,000.00	✓
Tsoflias	\$397,590.82	378,000.00	✓
Valdez	\$800,033.89	905,000.00	✗
Vargas	\$364,258.19	346,000.00	✓
Varkey Chudukatil	\$1,368,690.20	1,300,000.00	✓
Grand Total	\$15,496,115.89	15,656,000.00	✓

PivotTable Fields

Active | All

Choose fields to add to report: [Settings]

Search [Search]

TotalSales

- f_x Value (Total Sales)
- Goal
- Status

Drag fields between areas below:

Filters	Columns
	Σ Values
Rows	Σ Values
LastName	Total Sales
	Target
	KPI

Defer Layout Update Update

Figure 33 - PivotTable with KPI Added

Summary

Many consider PivotTables to be Excel’s most powerful feature, but few take advantage of some of the more powerful options available in PivotTables. In this session, you have learned about eight awesome features in PivotTables that can help you summarize and present data – including vast quantities of data – with little time and effort expended. Take advantage of these features, and you’re sure to see your PivotTable productivity increase immensely!