## Poisson Distribution Using Excel

In this tutorial we will be solving Poisson Distribution problems using Excel.

In our problem, we want to suppose that we have a consulting business that receives an average of 30 phone calls per hour, and during a two-hour period, we want to determine:

- the probability that exactly 50 calls will be received in the next two hours
- the probability that fewer than or equal to 50 will be received in the next two hours
- the probability that 50-100 calls will be received in the next two hours

The first thing we need to do is set up a table for entering the number of calls per hour, the mean, the probability X equals 50, the probability X is less than or equal to 50 and the probability X is between 50 and 100.

Here is our table area in Microsoft Excel we set up for entries for calls per hour that, in this problem, will be 30 and our mean (which is 30 calls per hour times 2 hours), so we will put 60 in cell B4. We also put in cells for X, P(X), and  $P(X \le x)$ .

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	C7	• (=	fx										*
	A		В	С	D	E	F	G	Н		J	K	Â
1	Poisso	on Di	stribution										
2													
3			30	calls per h	nour								
4	λ		60	calls per 2	2 hours								
5													
6	Х		P(X)	P(X≤x)									
7													
8													
9													
10													
11													
12													
13													
14													
15													

Now we want to set-up the table area with formulas for the probability X equals 50 and then calculate the probability that X is less than or equal to 50. Once we have those, we can simply copy them to the lower cells to fill in for  $x = \text{or } x \le 60, 70, 80$ , and so on. First, we enter our X values as shown below.

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	А		В	С	D		E		F	G	Н	1	J	K	-
1	Poisson	i Dis	stribution												
2															
3			30	calls per l	nour										
4	λ		60	calls per 2	2 hours										
5															
6	Х		P(X)	P(X≤x)											
7		50													
8		60													
9		70													
10		80													
11		90													
12	1	.00													
13															
14															
15															

Now to calculate the probability that X or P(X) equals 50, we are going to use the POISSON.DIST function. To do so, select cell **B7** and click the function button ( $f_x$ ).

	B7 <b>▼</b> (*	f <sub>x</sub>			
	А	В	С	D	Е
1	Poisson Di	stribution	2.	Click the f	unction
2				button,	<b>f</b> <sub>x</sub> .
3		30	calls per h	our	
4	λ	60	calls per 2	hours	
5					
6	Х	P(X)	P(X≤x)		
7	50		←	1. Select	cell B7.
8	60				
9	70				
10	80				
11	90				
12	100				
13					
14					

An **Insert Function** window will display. Select **Statistical** from the dropdown menu next to "Or select a category:", and then scroll down under "Select a function" to locate and select POISSON.DIST, as shown here.

	B7 ▼ (* X •	/ f <sub>x</sub> =							
	А	В	С	D	E	F	G		
1	Poisson Di	stribution							
2									
3		30	calls per h	pour					
4	λ	60	calls per 2	Insert Function Search for a function:					
5				Type a brief description of w Go	hat you want to do and then di	ick <u>G</u> o			
6	Х	P(X)	P(X≤x)	P(X≤X)     Or select a category: Statistical       Select a function:       PERCENTILE.INC       PERCENTRAIK.EXC       PERCENTRAIK.INC       PERCENTRAIK.INC					
7	50	=							
8	60			POISSON.DIST PROB QUARTILE.EXC		-			
9	70			POISSON.DIST(x,mean,cu Returns the Poisson distributi	on.				
10	80				<b>v</b>	,			
11	90			Help on this function	ОК	Cancel			
12	100								
13									
14									

Now click **OK**. The **Function Arguments** window will appear as shown on the next page.

POIS	POISSON.DIST V F =POISSON.DIST()										
	А	В		С	D	E	F	G			
1	Poisson Di	stribution									
2											
3		30	call	s per h	our						
4	λ	60	call	Function Argum	hourc ents		8	x			
5				POISSON.DIST	x I	<b>FE</b>	mhar				
6	Х	P(X)	P(X		Mean	= nui	mber				
7	50	N.DIST()		Returns the Poiss	son distribution.	=	il di				
8	60				X is the	number of events.					
9	70			Formula result =							
10	80			Help on this func	tion		OK Can	cel			
11	90										
12	100										
13											

**NOTE:** The POISSON.DIST is used for Excel 2007 or 2010 and the PLAN POISSION is used in 2003 and earlier versions of Excel.

In the Function Arguments window, we will enter our values for X, Mean, and Cumulative as shown below. Our X value is 50 so enter **A7**, our mean is in cell B4 so enter **\$B\$4**, and for cumulative, we are going to say **false** because we only want the probability at 50.

Function Arguments			? ×			
POISSON.DIST						
x	A7 💽	=	50			
Mean	\$8\$4	=	60			
Cumulative	false 💽	=	FALSE			
= 0.023271198						
Returns the Poisson distributio	n.					
<u>(</u>	imulative is a logical value: for the cur Poisson probability mass fur	mula nctio	itive Poisson probability, use TRUE; for the n, use FALSE.			
Formula result = 0.0232711975						
Help on this function			OK Cancel			

Click **OK** and that gives us a probability of 0.02327119575 for the number of calls being exactly 50. If you see ######## in cell B7, just simply widen the B column to see the result.

	B7 <b>▼</b> (*	f <sub>≭</sub> =POISSON.DIST(A7,\$B\$4,FA	LSE)	
	А	В	С	D
1	Poisson Di	stribution		
2				
3		30	calls per h	our
4	λ	60	calls per 2	hours
5				
6	Х	P(X)	P(X≤x)	
7	50	0.0232711975		
8	60			
9	70			
10	80			
11	90			
12	100			

To determine the number of causes less than or equal to 50, we will once again use the POISSON.DIST function.

	C7 • (*	fx			
	А	В	С	D	Е
1	Poisson Di	stribution		2. Click the	e function
2				butto	n, <i>f</i> <sub>×</sub> .
3		30	calls per h	our	
4	λ	60	calls per 2	hours	
5					
6	Х	P(X)	P(X≤x)		
7	50	0.0232711975			
8	60				
9	70			1 Selec	t cell C7
10	80			11 00100	
11	90				
12	100				
13					
14					

To do so, select cell **C7** and click the function button  $(f_x)$ .

Like before, an **Insert Function** window will display. Select **Statistical** from the dropdown menu next to "Or select a category:", and then scroll down under "Select a function" to locate and select POISSON.DIST. Once again, the **Function Arguments** window will appear.

In the Function Arguments window, we will enter our values for X, Mean, and Cumulative as shown below. Our X value is 50 so enter **A7**, our mean is in cell B4 so enter **\$B\$4**, and for cumulative we are going to say **true** because we want the entire distribution up to 50.

Function Arguments	increase as		? <mark>x</mark>				
POISSON.DIST							
x	A7 💽	=	50				
Mean	\$8\$4	=	60				
Cumulative	true	=	TRUE				
= 0.107677879							
Returns the Poisson distributio	n.						
<b>Cumulative</b> is a logical value: for the cumulative Poisson probability, use TRUE; for the Poisson probability mass function, use FALSE.							
Formula result = 0.107677879							
Help on this function			OK Cancel				

Click **OK** and that gives us a probability of 0.107678.

	C7 • <i>f</i> * =POISSON.DIST(A7,\$B\$4,TRUE)									
	А	В	С	D						
1	Poisson Di	stribution								
2										
3		30	calls per hour							
4	λ	60	calls per 2 hours							
5										
6	Х	P(X)	P(X≤x)							
7	50	0.0232711975	0.107678	$\leftarrow$						
8	60									
9	70									
10	80									
11	90									
12	100									
13										
14										

Finally, to find the probabilities that X will be less than or equal to 60, 70, 80, etc., simply copy and paste the cells from **B7/C7** to **B8/C8** through **B12/C12**.

	D9 • ( <i>f</i> x										
	А	В	С	D							
1	Poisson Di	stribution									
2											
3		30	calls per h	our							
4	λ	60	calls per 2	hours							
5											
6	Х	P(X)	P(X≤x)								
7	50	0.0232711975	0.107678								
8	60	0.0514317450	0.534262								
9	70	0.0216029757	0.909813								
10	80	0.0021862680	0.994368								
11	90	0.0000636807	0.999883								
12	100	0.000006130	0.999999								

We want to know the probability that X lies between 50 and 100. To do so, we need to add a cell for this on our spreadsheet as shown below.

	B14 • (*	<i>f</i> <sub>x</sub> P(50≤x≤100)				
	А	В	С	D		
1	Poisson Di	stribution				
2						
3		30	calls per h	our		
4	λ	60	calls per 2	2 hours		
5						
6	Х	P(X)	P(X≤x)			
7	50	0.0232711975	0.107678			
8	60	0.0514317450	0.534262			
9	70	0.0216029757	0.909813			
10	80	0.0021862680	0.994368			
11	90	0.0000636807	0.999883			
12	100	0.000006130	0.999999			
13						
14		P(50≤x≤100)	$\leftarrow$			
15						

We are going to have to use two formulas and subtract one from the other: take the probability that X $\leq$ 100 from C12 and subtract the probability that X $\leq$ 50 from C7. So in our spreadsheet, we will type =+C12-C7 in cell **C14**, hit the **Enter** key or click the checkmark icon, and we get a probability of .892321.

C15 • 6 fx				
	А	В	С	D
1	Poisson Di	stribution		
2				
3		30	calls per hour	
4	λ	60	calls per 2 hours	
5				
6	Х	P(X)	P(X≤x)	
7	50	0.0232711975	0.107678	
8	60	0.0514317450	0.534262	
9	70	0.0216029757	0.909813	
10	80	0.0021862680	0.994368	
11	90	0.0000636807	0.999883	
12	100	0.000006130	0.999999	
13				
14		P(50≤x≤100)	0.892321	
15				

<u>Click here</u> to download the completed spreadsheet so you can compare it to yours.

In summary, we setup the tables for entering calls per hour, the mean, the probability X equals 50, the probability X is less than or equal to 50, and the probability X is between 50 and 100. The next thing we did was setup the table with formulas for the probability X equals 50, the probability X is less than or equal to 50, and the probability X is between 50 and 100. After we entered the formulas, we can view the results in the table.

This concludes the tutorial on solving Poisson Distribution problems using Excel.