One Page Graphical Presentation of Multiple Project Performance

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ABSTRACT

An executive level manager of an organization performing multiple projects needs a reliable and simple tool to look at the "big picture". The goal of this paper is to present a technique which allows for a one page graphical presentation of multiple project performance, based on projects scope, cost and schedule performance.

1. THE NEED

As project management becomes more and more popular, there is an increasing number of companies and organizations, which perform many projects simultaneously. Multiple project performance allows a company to utilize existing business opportunities, but it also poses greater challenges and risks. It requires much higher level of discipline and synchronization of resources allocation. A major problem with a single project if it is overseen and not addressed timely may cause a "domino" effect of negative consequences for many other projects performed concurrently with the failing one.

It is important for an executive level manager of a company performing multiple projects to see the "big picture". The "big picture" is about seeing the overall project performance in a single number, or comparing single performance numbers of groups of projects clustered by project attributes such as project type, project location, project manager, contractor, client, etc.

2. MULTIPLE ROJECT PERFORMANCE MEASURES

Multiple project performance measures used in our approach are based on *the earned value analysis*, which integrates scope, cost and schedule performance. These measures give the most adequate picture of the projects health [1].

1. *Cost performance index* is a ratio of earned value and actual cost of completed works:

CPI = EV/AC Equation (1)

Where EV – earned value, formerly known as "budgeted cost of work performed" (BCWP); AC – actual cost, formerly known as "actual cost of work performed" (ACWP). A project that is exactly on cost will have CPI = 1. Accordingly, CPI < 1 means that a project is overspending.

2. *Schedule performance index* is a ratio of earned value and planned value of works scheduled to be completed by this time:

SPI = EV/PV Equation (2)

Where EV – earned value; PV - planned value, formerly known as "budgeted cost of the work scheduled" (BCWS). A project that is exactly on schedule will have SPI = 1. Accordingly, SPI < 1 means that a project is behind a schedule.

3. *% complete* is a ratio of earned value and project budget:

% complete = EV/PB Equation (3)

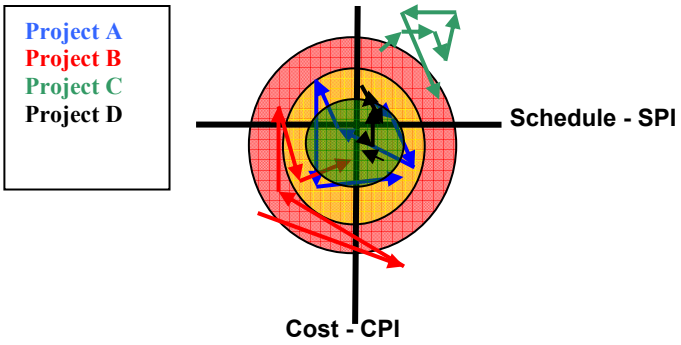
Where EV – earned value; PB – project budget

3. ONE PAGE GRAPHICAL PRESENTATION OF MULTIPLE PROJECT PERFORMANCE

It would be great if MS Project or any other project management software could automatically generate some kind of multiple project performance presentation. However, they cannot do it so far. This could be a recommendation to software developers to add this feature to future versions of their programs.

To address the problem, Hemsath & Ra [2] suggested a method to create one page graphical presentation of multiple project performance based on cost and schedule performance indices (Figure 1). This paper presents a further development of the method, which made it possible to include into one page presentation information about project % complete, size and type of a project.

Figure 1. Example of Multiple Project Tracking



This method can be easily implemented in Excel spreadsheets. We will illustrate it on a hypothetical example of "XYZ Inc.". Suppose that "XYZ Inc." is currently implementing 20 projects of three types (construction, engineering, and IT) in four locations (Anchorage, Fairbanks, Juneau, and Valdez) for four different clients (A, B, C, and D). Ten different project managers are carrying out the projects. The company summarized the data on multiple project performance in Figure 2.

Figure 2. "XYZ Inc." Multiple Project Performance Data

	A	B	C	D	E	F	G	H	I
1	"XYZ Inc." Multiple Project Performance Data								
2									
3	Project #	Project Type	Client	Location	Project Manager	Budget ($K)	% Complete	CPI	SPI
4	P-008	CONST	A	Fairbanks	Brown	3,000	30	0.92	0.98
5	P-017	CONST	B	Anchorage	Short	5,000	65	0.85	0.8
6	P-018	CONST	A	Fairbanks	Brown	7,000	12	0.92	0.6
7	P-002	ENG	C	Anchorage	Black	300	100	0.9	0.8
8	P-003	ENG	A	Anchorage	Black	1,500	78	1.06	0.97
9	P-004	ENG	B	Anchorage	Black	700	95	0.98	1.1
10	P-006	ENG	B	Anchorage	Clark	400	20	0.95	0.98
11	P-007	ENG	A	Fairbanks	White	2,300	87	0.99	1.1
12	P-010	ENG	D	Juneau	Smith	900	36	0.9	0.8
13	P-014	ENG	B	Juneau	Smith	2,900	92	1.03	1.01
14	P-015	ENG	B	Anchorage	Clark	950	35	1.1	0.95
15	P-016	ENG	B	Anchorage	Clark	500	42	1.05	0.98
16	P-001	IT	B	Anchorage	Green	500	73	0.35	0.3
17	P-005	IT	C	Juneau	Starr	100	91	0.85	0.9
18	P-009	IT	D	Valdez	Dowl	350	31	0.7	0.55
19	P-011	IT	D	Valdez	Dowl	1,200	85	0.5	0.4
20	P-012	IT	A	Anchorage	Green	1,500	85	0.65	0.6
21	P-013	IT	C	Anchorage	Green	700	94	0.9	0.8
22	P-019	IT	A	Fairbanks	Grey	1,200	97	0.55	0.6
23	P-020	IT	A	Fairbanks	Grey	2,100	95	0.3	0.35

Of course, data for individual projects can be plotted on a CPI – SPI graph. And it may work well for 20 projects. However, for a company performing several hundred projects simultaneously, this would result in an overcrowded graph, which would be of little help in seeing the "big picture". An ability to see the "big picture" of multiple project performance means an ability to cluster data and perform an aggregated analysis.

The method described here allows such clustering, because it works with average values. For our example we will cluster projects by project type.

Because different projects have different budgets and are at different stages of implementation, usage of an average CPI and SPI for each project type would create a misleading picture. The correct approach is to use a weighted average CPI and SPI with project budget and project % complete serving as weights.

$$\text{Weighted average CPI} = \frac{\sum_{i=1}^{n} a_i * b_i * c_i}{\sum_{i=1}^{n} a_i * b_i} \qquad \text{Equation (4)}$$

Where a_i - % complete of project i; b_i - budget of project; and c_i - CPI of project i. Weighted average SPI is found in a similar way.

$$\text{Weighted average CPI} = \frac{\sum_{i=1}^{n} a_i * b_i * s_i}{\sum_{i=1}^{n} a_i * b_i} \qquad \text{Equation (5)}$$

Where a_i - % complete of project i; b_i - budget of project i; and s_i - SPI of project i.

Figure 3. Pivot Table of Projects clustered by Project Type

	A	B	C	D	E	F
1	Pivot Table of Projects Clustered by Project Type					
2						
3	Project Type	Project #	Budget ($K)	% Complete	CPI	SPI
4	CONST		15000	107	2.69	2.38
5		P-008	3000	30	0.92	0.98
6		P-017	5000	65	0.85	0.8
7		P-018	7000	12	0.92	0.6
8						
9	ENG		10450	585	8.96	8.69
10		P-002	300	100	0.9	0.8
11		P-003	1500	78	1.06	0.97
12		P-004	700	95	0.98	1.1
13		P-006	400	20	0.95	0.98
14		P-007	2300	87	0.99	1.1
15		P-010	900	36	0.9	0.8
16		P-014	2900	92	1.03	1.01
17		P-015	950	35	1.1	0.95
18		P-016	500	42	1.05	0.98
19						
20	IT		7650	651	4.8	4.5
21		P-001	500	73	0.35	0.3
22		P-005	100	91	0.85	0.9
23		P-009	350	31	0.7	0.55
24		P-011	1200	85	0.5	0.4
25		P-012	1500	85	0.65	0.6
26		P-013	700	94	0.9	0.8
27		P-019	1200	97	0.55	0.6
28		P-020	2100	95	0.3	0.35
29						
30	Grand Total		33100	1343	16.45	15.57

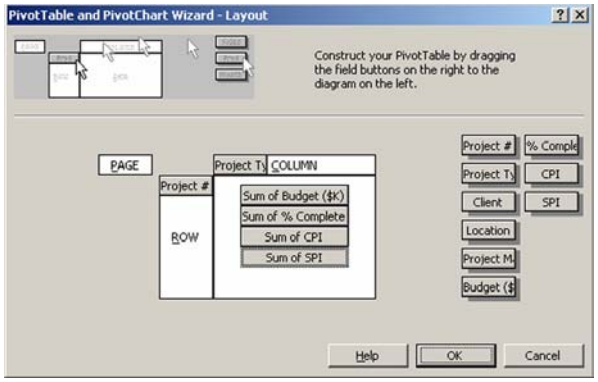
To get an ability to perform the calculations in Excel spreadsheets we first cluster a_i, b_i, c_i, s_i by project types using the powerful, but often underestimated tool, the Excel *PivotTable*.

To use this tool we select *Data/PivotTable and PivotChart Report* menu item. A PivotTable Wizard guides us through three steps of creating a Pivot Table. The results are shown in Figure 3. For convenience we placed this Pivot Table on a new worksheet. Pivot Table automatically calculates and reports grand totals for the columns and totals for each group of projects. Of course, only totals for budgets make sense, so we ignore all other totals.

The most important step in creating a Pivot Table is the third one, when we select PivotTable Wizard menu item *Layout*. This step is not quite obvious; so in Figure 4 we show a PivotTable dialog box with a layout for constructing a Pivot Table of projects clustered by project type.

We always place *Project #* on *Row* field of the diagram. The attribute we use to cluster our data is placed on the *Column* field. In our case this attribute is *Project type*. On the *Data* field of the diagram we place the data we want to cluster: CPI, SPI, Budget, and % Complete. Note that the Pivot Table will be created in a format that is unacceptable for our needs. To get the Pivot Table format we need, we click on *Format Report* menu item and select *Report 6* to receive exactly what we need. To activate *Format Report* menu item we must highlight any cell in the Pivot Table range.

Figure 4. PivotTable Dialog Box



Now we have all data in the format needed for solving Equations (4) and (5) on Excel spreadsheet to find weighted average CPI and SPI for each type of projects and for overall corporate performance. The results are shown in Figure 5.

Figure 5. Weighted Average CPI and SPI

	I	J	K	L	M	N	O
1	Aggregated Data on Multiple Project Performance						
2							
3	Project Type	W. Aver. CPI	W. Aver. SPI	CPI St.Dev.	SPI St.Dev.	Aver. Budget	W. Aver. %Complete
4	CONST	0.87	0.80	0.04	0.19	5000	33.27
5	ENG	1.01	1.01	0.07	0.11	1161	74.17
6	IT	0.52	0.50	0.22	0.21	956	87.27
7	OVERALL	0.81	0.78	0.24	0.25	1655	58.66

To find the weighted average CPI and SPI for different project types we use the data from our PivotTable (Figure 3). For weighted average CPI for construction projects we use Excel's *SUMPRODUCT* function and enter a formula

=SUMPRODUCT($C$5:$C$7,$D$5:$D$7,E5:E7)/SUMPRODUCT($C$5:$C$7,$D$5:$D$7)

in cell J4. In a similar way we find CPIs for engineering and IT projects in cells J5 and J6. To find a weighted average CPI for overall corporate performance we use data from the original table in Figure 1. We have this data on a separate worksheet called "Original Data". So, for weighted average overall CPI we enter a formula

=SUMPRODUCT('Original Data'!$F$4:$F$23,'Original Data'!$G$4:$G$23,'Original Data'!H4:H23)/SUMPRODUCT('Original Data'!$F$4:$F$23,'Original Data'!$G$4:$G$23)

in cell J7.

To find the weighted average SPIs we copy cells J4:J7 to cells K4:K7.

For calculating standard deviations we use Excel's *STDEV* function. To find a standard deviation of CPI for construction projects we enter a formula

=STDEV(E5:E7)

in cell L4. In a similar way we calculate all other standard deviations.

For calculating average budgets we use Excel's *AVERAGE* function. To find average budget of construction projects we enter a formula

=AVERAGE(C5:C7)

in cell N4. In a similar way we calculate all other average budgets.

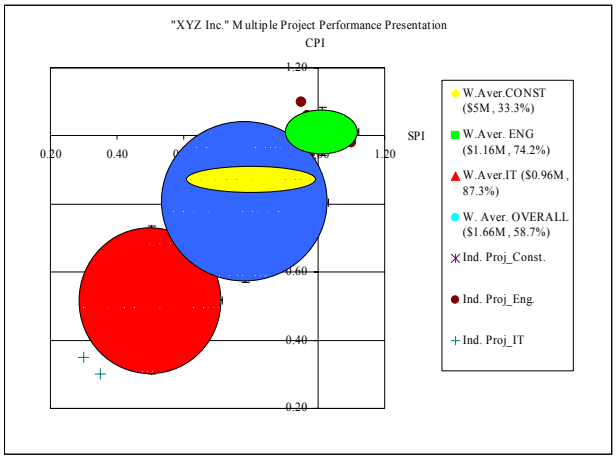
To calculate weighted average % complete for construction projects we enter a formula

=SUMPRODUCT(C5:C7,D5:D7)/SUM(C5:C7)

in cell O4. All other weighted average % complete are found in a similar way.

Now we are ready to create the one page graphical presentation of multiple project performance, which is shown in Figure 6. We use Excel's *Scatter Plot Chart* and enter data as *Series* plotting SPIs as the X values, and CPIs as the Y values. Circles and ovals are created manually, using *Draw* option in Excel, with one standard deviation radius in each dimension. Make sure that the circles and ovals are created in the plot area. To do it, click on the plot area before drawing the figures. To make finding the sizes easy use *X* and *Y Error Bars* in a dialog box, which opens when you click on a marker. Enter references to cells containing appropriate standard deviations as X and Y Error amounts. The *X* and *Y Error Bars* will show the dimensions of the figures.

Figure 6. "XYZ Inc." One Page Graphical Presentation of Multiple Project Performance Clustered by Project Type



This one page graphical presentation displays the following information on performance of multiple projects clustered by project type:

1. Weighted average CPI and SPI for each project type, as well as for overall corporate performance are shown by large markers of different shape and color.
2. Data dispersion (one standard deviation as radius in each dimension) for weighted average CPI and SPI are shown by the size and shape of circles and ovals.
3. Individual projects' CPI and SPI are shown by small markers of different shape and color.
4. Average budget size (shown in the legend to the right of the graph.).
5. Weighted average % complete (shown in the legend to the right of the graph).

Analysis of this presentation for our hypothetical example shows that "XYZ Inc." does excellent job on engineering projects. However, the company has real problems with IT projects. Weighted average % complete for IT projects is approaching 90%, but cost and schedule performance indices are in the area of 0.5, which means that in average actual costs of these projects are about 100% above their budgets, and the projects in average are about 50% behind the schedule. Another problem is high dispersion of both CPIs and SPIs for IT projects. This area requires immediate attention of company's senior management. Situation with construction projects is somewhat better than with IT projects. However, average size of construction projects is considerably higher than that of IT projects. So, smaller delays in schedule of construction projects and smaller percentage of their budget overruns may lead to even a higher negative impact on the company. It is interesting to note, that dispersion of SPIs for construction projects is much higher than dispersion of their CPIs. So this area should also be a concern for senior management of "XYZ Inc.".

One page graphical presentation of multiple project performance shown in Figure 6 represents overall corporate performance of twenty projects, as well as performance of projects, clustered by projects type. In a similar way the projects can be easily clustered by any other attribute.

Number of projects does not limit the ability to use this method and data in Figure 6 might well represent hundreds of projects being performed by a company. It does not take much time to build an Excel spreadsheet model for creating this presentation. Excel's PivotTable is insensitive to sorting original data. Regardless of how the original data is sorted, PivotTable will always report in an ascending order of projects' numbers. So, any kind of further analysis of the original data can be done without any damage to the model. Once a model is created, all it takes is updating the original data when project managers submit the updates. This is done by clicking at a *Refresh Data* menu item, which is activated when any cell in the Pivot Table is highlighted. The model automatically recalculates all values and updates the graph. The only manual operation to be performed is adjusting the circles and ovals of the graph. When new projects are added, the model is easily adjusted to a new data range.

4. CONCLUSIONS

The method described in this paper allows creating one page graphical presentation of multiple project performance, which can give senior management "the big picture" of what is going on in the company.

The method is based on *the earned value analysis*, which integrates scope, cost and schedule performance. It allows seeing both overall company's performance and performance of groups of projects clustered by project attributes such as project type, project location, project manager, contractor, client, etc.

The method is implemented in an Excel model with the help of the Excel PivotTable, and calculates average CPI and SPI weighted by projects' budgets and % complete. The model builds one page graphical presentation of multiple project performance, which includes information on weighted average CPI, weighted average SPI, data dispersion, average budget, and weighted average % complete.

REFERENCES

[1] PMI Standards Committee. (2000). *A Guide to the Project Management Body of Knowledge*. Newtown Square, PA: Project Management Institute, 123-124

[2] Hemsath, J.R., & Ra, J.W. (2002) Multiple Project Performance with Graphical Performance Indicators. *AACE International Transactions*.