

01-017

## Implementation of performance indicators for project control

Guillermo Montero Fernández – Vivancos<sup>1</sup>; Javier Pajares Gutiérrez<sup>2</sup>; Luis Onieva Giménez<sup>1</sup>

<sup>1</sup>Universidad de Sevilla; <sup>2</sup>Universidad de Valladolid;

Many studies consider that measuring a project's performance is a critical factor in its success. Using a "base table" of indicators a methodology was developed to implement in any kind of project.

The systematics was applied to different types of projects validating the performance indicators for project management, their characterization and after identificating the specific project's indicators.

**Keywords:** indicators; metrics; kpis; performance; project management; monitoring

## Implantación de indicadores de rendimiento para el control de proyectos

Muchos estudios consideran que la medición del rendimiento de un proyecto es un factor crítico del éxito del mismo. Utilizando un "cuadro base" de indicadores se desarrolla una metodología para implementarlo en cualquier tipo de proyecto.

Se ha aplicado la sistemática a distintos tipos de proyectos validando los indicadores de rendimiento de la gestión de proyectos, su caracterización e identificando indicadores propios del proyecto.

**Palabras clave:** indicadores; métricas; kpis; rendimiento; gestión de proyectos; monitorización

Correspondencia: Guillermo Montero [gmontero@us.es](mailto:gmontero@us.es)



## 1. Introduction

The use of indicators focused on management performance is relatively new; it really appeared in the past few decades (Nudurupati et al. 2011). A relevant number of authors consider that their use is a key factor in project management (Bourne et al. 2000; Bryde 2005; Frinsdorf et al. 2014; Mir & Pinnington 2014; Cooke-Davies 2002). These measures should add value to one or more of the stakeholders (Rajegopal et al. 2007; Venning 2007).

Implementation is the longest and most challenging phase of the life cycle of any given project. During this period, the project management focus shifts to executing, monitoring and controlling activities where the use of valid metrics becomes an essential instrument for successful completion. The choice and use of such metrics is critical, particularly when often the concepts of project monitoring and project management monitoring are confused (Bryde 2005; Bryde 2003; De Witt 1988). A project should always consider both aspects, however, project monitoring indicators are fully dependent on the nature of the particular project while project management monitoring are more general and can be shared between different projects regardless of their nature (Kerzner 2011).

This research is the continuation of an earlier one (Montero & Onieva 2016) in which a set of indicators was identified from the application of the Delphi methodology. Using this technique, a dashboard of 26 indicators narrowed from the original 83 has been created after using three consultation rounds with a high level of consensus and a stable and homogeneous response from a panel of seven experts.

The validation of indicators is interesting to move from a theoretical perspective of identifying indicators to a practical perspective based on concrete projects. The purpose is to enrich and refine the study in order to standardize the use of these indicators in projects and project offices. It establishes a system for the validation process, which allows then go different groups of validating the proposed indicators.

## 2. Selection of Performance Indicators for Project Management

The validation of indicators is interesting to move from a theoretical perspective of identifying indicators to a practical perspective based on concrete projects. The purpose is to enrich and refine the study in order to standardize the use of these indicators in projects and project offices.

The starting point for the validation of project management indicators is the following table of indicators, resulting from the application of the Delphi method with a group of project management experts (Montero et al. 2015; Montero & Onieva 2016).

**Table 1: Base Set of Performance Indicators for Project Management.**

1. Delivery deadline met.	14. To complete performance index (cost).
2. Project milestones missed.	15. To complete schedule performance index.
3. Project delay	16. Project issues identified.
4. Overdue project tasks.	17. Open non-conformities.
5. Budget at completion.	18. Open complaints.
6. Cost variance.	19. Customer satisfaction.
7. Schedule variance.	20. Project resource utilization.
8. Variance at completion.	21. Performance appraisal.
9. Cost performance index.	22. Productivity.
10. Schedule performance index.	23. Employee satisfaction.
11. Cost schedule index.	24. Timely production of management reports.
12. Estimate at completion.	25. Risks.
13. Estimate to completion.	26. Possible risks.

This technique is widely known and used in a variety of applications and can be defined as “a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem” (¡Error! No se encuentra el origen de la referencia.).

The iterative process introduced by the technique is concluded once valid results are obtained (Dalkey & Helmer 1963; Hasson et al. 2000; Okoli & Pawlowski 2004).

The Table 2 displays the characteristics of the Delphi method application, which concluded with the consensus among the experts, stable and homogeneous response, as well as with a level of significance in the results.

**Table 2: Basic descriptors for the Delphi method application.**

Coordination	Responsible Research Group
Problem to study	Selection of indicators for project management
Objective	To get a consensual KPIs' scorecard for project management controlling
Criteria for the experts selection	- Theoretical and practical knowledge about Project Management. - Experience in Project Management. - Motivation for participate in the method. - Easy of contact and speed of responding.
Experts' geographical area	European Union
Number of participants	Invited experts: 10 Experts who accept: 7 Experts who answer: 7
Kind of experts	Specialists
Communication way	Electronic mail
Consensus measure	Coefficient of variation, $\sigma$ , less than 0.5
Stability measure	Variation of coefficient of variation $\sigma$ less than 0.25
Homogeneity measure	Rank Correlation Coefficient of Spearman, $r_s$
Significance measure	Randomness test

### 3. Validation Process

The followed steps for the process of validation are:

1. In the first place, a series of project management indicators agreed by experts is proposed to the project management team to evaluate the suitability of applying them in their projects.
2. The management team of the same can eliminate those that consider and add some if it considers it necessary for the control of the management of the project and of the own Project. It also analyses aspects related to the indicators such as capture period, frequency of the measurement, responsible for the measurement, etc.
3. Complementarily, relevant indicators of the project in which the metrics are to be used should be identified and proposed.
4. Finally, the values of the indicators are recorded according to the periodicity agreed during a period established with the project management team.

This validation process also allows outlining some of the characteristics established a priori for the indicators.

#### 4. Practical Application

Figure 1 includes a complete characterization used for the indicators: definition, type of indicator unit, the area of knowledge to which the indicator corresponds, the desired trend, the calculation formula, and the capture period and calculation frequency.

**Figure 1: Outline of the detailed list of indicators.**

Identification	Indicator	Definition	Unit	Area	Desired trend	Formula	Collection period	Measure frequency
AIC-01-213	Delivery deadline met	Measures the percentage of service delivery request that were met on time out of the total delivery requests.	%	Scope	Negative	$\frac{\# \text{ Delivery deadline met}}{\# \text{ Delivery requests}} * 100$	Functional	Monthly
AIC-02-235	Project milestones missed	Measures the percentage of milestones missed during the project out of the total number of project milestones.	%	Scope	Positive	$\frac{\# \text{ Missed milestones}}{\# \text{ Total Milestones}}$	Month	Monthly

**Annotations:**

- Indicator identifier:** Points to the Identification column.
- Indicator Name:** Points to the Indicator column.
- Sort of measure unit:** Points to the Unit column, listing # number, % percentage, \$m monetary unit.
- Knowledge area in PMBOK:** Points to the Area column.
- Mathematical formula related to the measurements on which it is based:** Points to the Formula column.
- Concrete definition of the Indicator in business terms:** Points to the Definition column.
- Trend of indicator records that are considered positive results:** Points to the Desired trend column.
- Period in which the results of the indicator are measured:** Points to the Collection period column.
- Frequency of obtaining the data for the indicator:** Points to the Measure frequency column.

The pilot implementation of these indicators was a strategic consulting project, lasting five months. This project was based on:

- Definition of a Strategic Territorial Plan to improve the competitiveness of its SMEs.
- Geoenvironmental diagnosis and the business fabric.

The complete set of 26 proposed KPIs is shown in Table 3, including definitions, characteristics (e.g. units) and how to calculate them. This table was used to debug not only the performance indicators, but also the proposed parameters as data capture period or reporting period.

It must be noted that the parametric representation is project-specific. For instance, the entries under “Data Capture Period” and “Reporting Frequency” have full dependency on the type and duration of a project which in turn might also be influenced by the project manager or the stakeholders’ expectations.

On this basis and following the previous scheme, the work team validated the proposed indicators by adding some within the project management shown in Table 4, with their corresponding characterization.

**Table 3: Detailed list of KPIs related to the project management.**

Indicator	Definition	Desired trend	Data Capture Period	Reporting Frequency
Delivery deadline met	Measures the percentage of service delivery request that were met on time out of the total delivery requests.	Negative	Spot	Monthly
Project milestones missed	Measures the percentage of milestones missed during the project out of the total number of project milestones.	Positive	Month	Monthly
Project delay	Measures the total delay of the project by summing the delays registered in each of the stages of project implementation.	Negative	Year to date	Monthly
Overdue project tasks	Measures the percentage of overdue tasks out of the total number of current project tasks.	Negative	Spot	Weekly
Budget at completion	Measures the sum of all budgets established for the work to be performed.	Within range	Spot	Monthly
Cost variance	Measures the difference between earned value and actual cost	Positive	Spot	Monthly
Schedule variance	Measures the difference between the earned value and the planned value	Positive	Spot	Monthly
Variance at completion	Measures the difference between the budget at completion and the estimate at completion	Positive	Spot	Monthly
Cost performance index	Measures the ratio of earned value to planned value.	$\geq 1$	Spot	Monthly
Schedule performance index	Measures the percentage of service delivery request that were met on time out of the total delivery requests.	Within range	Spot	Monthly
Cost schedule index	Measures the likelihood of recovery for projects that are late and/or over budget.	Positive	Spot	Monthly
Estimate at completion	Measures the sum of the actual cost to date and the estimate to complete.	Negative	Spot	Monthly
Estimate to completion	Measures the expected cost to finish all the remaining work.	Positive	Spot	Monthly
To complete performance index	Measures the projection of cost performance that must be achieved on the remaining work to meet a specified management goal, such as the budget at completion or the estimate at completion.	$\leq 1$	Spot	Monthly
To complete schedule performance index	Measures how much percentage of efficiency the assigned resources should work on project so that it can be on track.	Positive	Spot	Monthly
Project issues identified	Measures the number of new project issues that are identified and need to be addressed after the initiation of the project.	Negative	Week	Weekly
Open non-conformities	Measures the number of open non-conformities or corrective actions in course.	Negative	Quarter	Quarterly
Open complaints	Measures the percentage of open complaints over the total at that time of the project.	Negative	Quarter	Quarterly
Customer satisfaction	Measures the customers' global satisfaction with the project.	Positive	Year to date	Quarterly
Project resource utilization	Measures the percentage of resources dedicated for the project, expressed in man-hours that are actually used out of the total resourced allocated.	Positive	Spot	Weekly
Performance appraisal	Measures the different team members' performance and the appraisal.	Positive	Year	Yearly
Productivity	Measures the effective time within the project based on the ration between man-hours in production and the total man-hours at that point of the project.	Positive	Month	Monthly
Employee satisfaction	Measures feelings about the job or cognitions about the job.	Positive	Year to date	Quarterly
Timely production of management reports	Measures the percentage of management reports produced on time out of the total management reports due.	Positive	Spot	Monthly
Risks	Measures the number of identified risks.	Positive	Spot	Quarterly
Possible risks	Measures the percentage of risks that could happen at that time of the project.	Negative	Spot	Monthly

**Table 4: Project management indicators added for a consulting project.**

Indicator	Definition	Desired trend	Capture period	Reporting frequency
Deliverables produced	It measures the percentage of deliverables produced in the project.	Positive	Spot	Monthly
Incomes	It measures project revenue.	Positive	Month	Monthly

At the same time, the project management team should identify those project indicators that allow it to follow up on it. For this case, Table 5 considers the specific project indicators.

It is not the object of this investigation to draw conclusions about the performance of the indicators from the record of the measurements. Although the project management team must make the decisions according to compliance and, above all, the non-compliance with the desired trends or any other incidents detected.

**Table 5: Set of specific performance indicators of the strategic consulting project.**

Indicator	Definition	Desired trend	Capture period	Reporting frequency
Sectors analysed	It measures the number of sectors analysed within the study.	Positive	Spot	Weekly
Interviews number	Measure interviews with experts or stakeholder representatives.	Positive	Spot	Weekly
Panels number	Measure the number of panels with experts or stakeholder representatives.	Positive	Spot	Weekly
Business opportunities	It measures the number of identified business opportunities.	Positive	Spot	Weekly
Objectives identified	It measures the number of objectives identified.	Positive	Spot	Weekly
Initiatives	It measures the number of initiatives identified.	Positive	Spot	Weekly
Actuations proposed	It measures the number of proposed actions identified.	Positive	Spot	Weekly

In the validation of these outreach indicators it was found that the desired trend for the delivery deadline indicator had to be changed.

Once the project was completed, it was detected that the information collected by the three scope indicators could be redundant, so that the indicator introduced for "deliverables produced" will be rejected for future projects.

When it comes to validating the indicators, it has been observed that it would be interesting to consider control ranges in the characterization of the indicators, either from their definition or in the initial phase of work of the project management team.

Likewise, in certain cases, a target value could replace the desired trend characteristic.

Most of the project cost indicators link to the value analysis. The work revealed some aspects like:

- The information that includes the cost variation (CV) indicators and the cost variation index (CPI) is equivalent; so you could do without one of them. The same happens with the schedule variation (SV) and the schedule variation index (SPI). In this project, the team chooses to use CV and SV, although the cost variation index (CPI) was used for the calculation of variation at the conclusion (VAC), which is a useful indicator.

- The project team suppresses the indicator cost - schedule (CSI) for the following applications of the indicator.

Although, in the reporting, the project team gives less importance to the rest of the indicators than to the performance index of the work to be completed (TCPI) and the index of performance of the work to be completed (TSPI), in future implementations will continue to be used at the information level.

Throughout the project, the project team considers that for the short duration of the project, it only made sense to make a single assessment of customer satisfaction. The project management team conducted a survey of the project's key stakeholders.

In the validation of the indicators related to the resources, the team modified some aspects, such as the period of data capture for the use of project resources and job satisfaction, as well as the frequency in the measurement also for the use of Resources and performance evaluation.

With the use of risk indicators, the project management team made the decision for upcoming projects for the single use of the possible risk indicator.

In addition, given the weight of the Earned Value Analysis indicators in the set of proposed indicators, additional research has been done for different types of projects:

- Industrial Engineering and Construction Project.
- Expansion of an Energy Facility Project.

Based on the application in the first project were determined a series of requirements that must comply to be able to apply the methodology of Value Analysis are the following:

- A cost planning and control tool should be available. In this case this functionality was developed with MS Project®.
- For the administrative management of the project it is advisable to have a powerful information system, which compensates for the availability of information required by the Analysis of Earned Value. In this case, this base was SAP®, since the company under study had it implemented as an administrative management program. To do this, a Project Structure Plan (PEP) must be created for each of the project control accounts. The reason for these requirements is that in addition to both tools, there will be an application in MS Project® that allows integration with SAP® through MS Excel®, and that would allow obtaining the Reports of Value Analysis of the project.

A key point identified in applying the indicators related to the Earned Value Analysis in this project was precisely the measurement of the earned value. For which there are different techniques and must be consistent taking into account whether it is considered discrete effort or level of effort. The use of one or another technique should be established in the project planning and the measurement of the progress of the activity was reported for its control periodically

## 5. Conclusions

A set of performance indicators to monitor projects should consider at least project-specific indicators, economic-financial ratios, value-for-lives analysis and risks, contain accurate and accessible data, capture should be effective, stakeholders and the table should be considered Should be repeatable.

The validation of the table in indicators in concrete projects allows to define a "practical" table of performance indicators.

At the time of making the validation, the researchers managed the indicators to debug them at different levels. In the putting into production, the validity is verified for its concrete use; which involves including and / or eliminating some. Allows calibrating the different characteristics of the same. It has also been seen that it would be interesting to consider control ranges in the characterization of the indicators, either from their definition or in the initial phase of work of the project management team.

Based on the results obtained, we propose the following lines for future investigations:

- The use of performance indicators can be analysed from a "mature" state of the organization in which it is implemented, for example using IPMA-OCB, as a step prior to the implementation of the methodology.
- The proposed scorecard did not take into account the use of triggers for project risk management. The research could be complemented with an analysis of its use in real projects.

## 6. References

- Bourne, M. et al., 2000. Designing, implementing and updating performance measurement systems. *International Journal of Operations & Production Management*, 20(7), pp.754–771.
- Bryde, D.J., 2005. Methods for managing different perspectives of project success. *British Journal of Management*, 16(2), pp.119–131.
- Bryde, D.J., 2003. Modelling project management performance. *International Journal of Quality & Reliability Management*, 20(2), pp.229–254.
- Cooke-Davies, T., 2002. The “real” success factors on projects. *International Journal of Project Management*, 20(3), pp.185–190.
- Dalkey, N. & Helmer, O., 1963. An experimental application of the Delphi method to the use of experts. *Management Science*, 9(3), pp.458–467.
- Frinsdorf, O., Zuo, J. & Xia, B., 2014. Critical factors for project efficiency in a defence environment. *International Journal of Project Management*, 32(5), pp.803–814.
- Hasson, F., Keeney, S. & McKenna, H., 2000. Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, 32(4), pp.1008–1015.
- Kerzner, H., 2011. *Project management metrics, KPIs, and Dashboards: A Guide to measuring and monitoring Project performance* I. I. for Learning, ed., New York (USA): John Wiley & Sons.
- Mir, F.A. & Pinnington, A.H., 2014. Exploring the value of project management: linking project management performance and project success. *International Journal of Project Management*, 32(2), pp.202–217.
- Montero, G. & Onieva, L., 2016. Uso de indicadores en la gestión de proyectos. *DYNA*, 91(1), p.127.
- Montero, G., Onieva, L. & Palacin, R., 2015. Selection and Implementation of a Set of Key Performance Indicators for Project Management. *International Journal of Applied Engineering Research*, 10(18), pp.39473–39484.
- Nudurupati, S.S. et al., 2011. State of the art literature review on performance measurement. *Computers & Industrial Engineering*, 60(2), pp.279–290.
- Okoli, C. & Pawlowski, S.D., 2004. The Delphi method as a research tool: an example,



- design considerations and applications. *Information & Management*, 42(1), pp.15–29.
- Rajegopal, S., McGuin, P. & Waller, J., 2007. *Project Portfolio Management: Earning An Execution Premium*, Project Portfolio Management.
- Venning, C., 2007. *Managing Portfolios of Change with MSP for Programmes and PRINCE2 for Projects*, TSO.
- De Witt, A., 1988. Measurement of project management success. *International Journal of Project Management*, 6(3), pp.164–170.