Selection and Implementation of a Set of Key Performance Indicators for Project Management

Guillermo Montero[1], Luis Onieva[2], Roberto Palacin[3]

[1] Part-time professor at Department of Industrial Management and Business Administration II of the University of Seville, Spain.

[2] Professor at Department of Industrial Management and Business Administration II of the University of Seville, Spain.

[3] Senior Researcher-Head at NewRail – Centre for Railway Research, Newcastle University, School of Mechanical and Systems Engineering, UK

Abstract

The use of indicators focused on management performance is relatively new and only really appeared in the past few decades. A relevant number of authors consider that their use is a key factor in project management. These measures should add value to one or more of the stakeholders. Project delivery and project management require different sets of metrics to monitor their successful progress. While the first relies on the characteristics of the specific project, the latter can be generalised, as the process is often similar across projects, regardless of their nature. In the literature review of this subject, most of the references are focused to particular aspects of the project management, such as earned value analysis, risks, project evaluation or maturity models. This paper describes a comprehensive set of performance indicators suitable for implementing any project management and project monitoring management activities. The significant collection of metrics identified in the research (over 300) form the basis of the methodology developed for this paper and based around the Delphi method. Using the Delphi 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. This research had taken into account different ways to analyse this consensus and stability, selecting the one based on the coefficient of variation. Within The flexibility and customising capability of this set of indicators has been validated using a case study based on a consultancy project.

Keywords

Project Management, Delphi, key performance indicators, KPIs, metrics, performance, monitoring

Introduction

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 [1, 2]. 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. Similarly, there is a need to differentiate between the diverse concepts related to metrics and indicators [3, 4]. Specifically, the following definitions are being considered:

- A measure records a directly observable value;
- An indicator can be defined as "a description of the project's objectives in terms of quantity, quality, target group(s), time and place" [5];
- A metric, performance measure or performance indicator is considered the degree to which objectives are established and performance is weighed up;
- Key Performance Indicator (KPI) is considered as a selected metric for monitoring the performance of a strategic objective or key result area. The origins of KPIs can be traced to the publication of an article in Business Week, titled "Corporate 'War Rooms' Plug into the Computer" [6].

Literature review

Indicators have been common use for almost a century in areas such as accounting [7- 9] and Quality Control, [10-19]. However, the focus on measuring and monitoring particular aspects related to management performance is relatively new and only really appeared in the past few decades [20, 21]. The popularity of using indicators in project management performance [22] originated from the publication of books such as "Relevance Lost - The Rise and Fall of

Management Accounting" [23] as well as papers such as "The Balanced Scorecard" [24]. Until then several relevant authors had considered the use of this type of performance metrics but only for finance applications [25- 28]. However a number of authors started considering the use of metrics beyond their original finance application in areas such as operations management [29- 31]. Currently there is a high level of interest in the measurement of performance regardless of the application, frequently leading to the unsuccessful implementation of balance scorecards [32].

The literature related to the use of performance measurements in project management is limited with the exception of a few specific areas i.e. Earned Value Analysis, Maturity Models or project evaluation. A significant number of authors consider the implementation of Earned Value Analysis (EVA) a very useful tool [33, 34], although some indicating that so far the use of EVA in commercial projects is not common and presents certain limitations [35, 36], for example:

1. Quality is never considered;
2. Planned Value is the baseline and comes from a set of uncertain predictions;
3. the shear cost to implement;
4. the shear amount of time to collect the actual cost data, especially in large projects.

Maturity models have been applied to project management as part of software tools based on capability maturity models [37]. The use of these methodologies is considered to add value to a company's operations in project management [38- 42]. Just in 2001, there were seventeen such models identified most of which have been subject of details assessment [43, 44].

A third specific area where performance measurement in project management is used is project evaluation. The Logical Framework Approach (LFA) is a tool developed for this application and mainly used for designing, monitoring and evaluating international development projects. It considers the Objectively Verifiable Indicators (OVIs) as an instrument for the evaluation of the project objectives [45- 48]. In this context, the relative influence of key performance indicators towards overall project performance indicated that time and costs are the most relevant aspects (indicators) to be considered. Other relevant aspects are dependent on the application sector e.g. safety for construction projects [49].

The importance of using metrics to achieve the expected project results is acknowledged in the literature [50, 51]. There is a clear relationship between project management performance

and project success [52, 53]. The use of metrics in projects, programmes and portfolios is considered in itself as a success factor to get feedback or anticipate future behaviour [53-56]. Of all these metrics, performance indicators have highest impact over project implementation [57]. Existing research has examined the use of metrics for measurement of success or assessment the impact of choosing a given criteria has over the project management performance, instead of managing the KPIs for the monitoring and controlling processes in the project or portfolio management. Also, research results have shown that project results analysis, presented through the definition of critical success factors, key performance indicators and performance-measuring process have a relevant influence on knowledge acquisition and knowledge transfer [58].

The performance of a single project affects the overall performance of a portfolio and therefore key performance indicators can also be used for measuring the achievements or monitoring risks in whole projects portfolios [59]. These measures should add value to one or more of the stakeholders [60, 61]. In addition to signifying the importance of these measures, some authors also put forward several examples of metrics or indicators applied to project management [3, 4, 62-64]. These outcomes form the basis of the research methodology developed for this paper and based around the Delphi method.

Research Methodology

The structured indicators scorecard for project monitoring that forms the set of KPIs presented in this paper has been developed using the Delphi method. 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” [65].

The use of the Delphi method allows generating a subjective, systematic and iterative process focused on obtaining valuable opinions. Applying such subjective judgement involves information procurement after a filter applied by an individual or a group through its understanding, expectations and opinions as well as from its experiences, facts and accumulated data [66].

The application of the Delphi method in project management has been mainly focused on project risk management [67-71]. In addition, this technique has also been applied to a lesser degree to other project management areas such as decision making through Analytical

Hierarchy Process (AHP) [72], maturity models [43], software tools applications [73], project managers' skills [74] and critical factors for project efficiency [52].

The use and suitability of a group technique (Delphi method) as the core methodology for carrying out the research presented in this paper is justified by the following aspects:

- A larger and more significant number of resources, e.g. expertise, skills, experience and information [75].
- Removal of the probability of random errors being introduced by using individual judgements aggregation [66]).
- Possibility of integrate in the group elements directly involved to the problems to solve [76].

The iterative process introduced by the technique is concluded once valid results are obtained [77- 79]. Figure 1 shows the schema of the process, where the iterations continue to take place until the answers become stable [80].

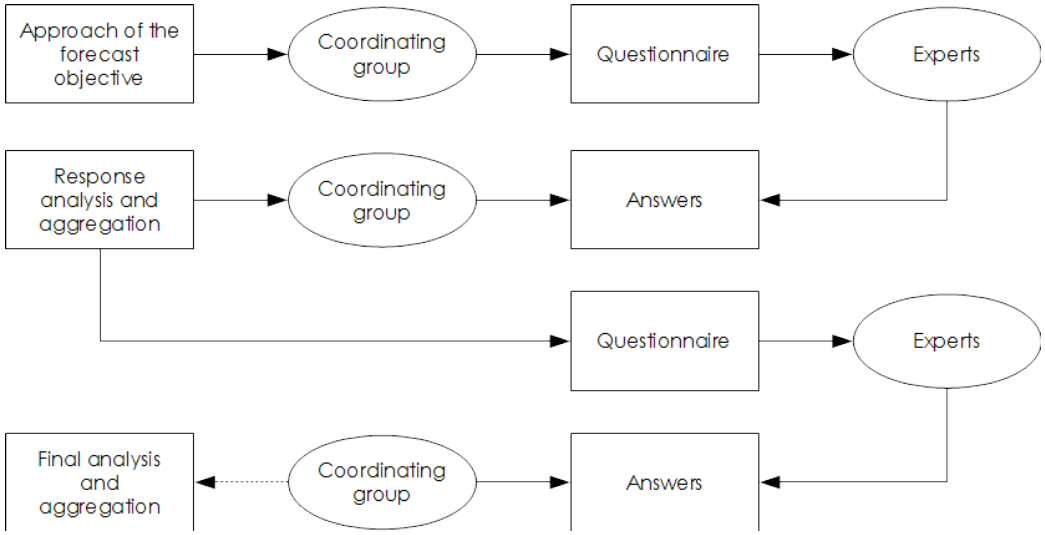

Figure 1: Global schema of the Delphi process (Soldevilla et Grande, 1987).

The participants, being experts or stakeholders, taking part in the process, represent the central axis of the method [80]. Therefore, it is essential that the following aspects are being considered:

- Who the experts are and selection criteria used;
- Ideal number of experts;
- Weight factor for each expert's opinion.

For the purpose of this research, the authors have considered that an expert is an individual who has wide knowledge of its subject and can produce relevant contributions [81]. These experts have been classified into three different categories, namely i) specialists ii) stakeholders and iii) facilitators. The selection process has been based on cost, expertise, motivation and proximity criteria [82]. In addition, the research methodology used in this paper requires taking into consideration the adequate number of experts participating in the study. There is a degree of discrepancy on the literature on what this adequate number of participant is [66, 83, 84]. In it common that in this type of experiments the measured error between the final forecast and the median of the real value decreases exponentially with the sample size. As an indication, the minimum number of experts is considered to be seven [85] while more than thirty would not be appropriate nor effective due to the cost and effort increase generated. For the purpose of this study, the number of specialist was set on seven. Table 1 describes their expertise.

Expert	Qualification	PM Experience (years)	Certification	Organization	Area
Expert A	Ph.D.	15	No	Private firm	Engineering
Expert B	Ph.D.	30	IPMA B	Private firm	RTD
Expert C	Ph.D.	25	IPMA C	University	Engineering
Expert D	MSc	18	PMP	Private Firm	TI
Expert E	Ph.D.	27	No	Technological Centre	Transport
Expert F	Ph.D.	35	PMP	Public Administration	Pharmaceutical industry
Expert G	BSc	21	PMP	Private Firm	Construction

Table 1: Summary of experts' profiles.

The Delphi survey process follows a common pattern with an initial round of open questions, followed with several rounds using increasingly more specific questions for statistical assessment purposes [86, 87]. The literature is inconclusive in terms of what is the ideal number of iterations. While some studies consider that the results converge within only a few iterations [88], other has shown that the results get worse after a number of iterations [85].

For the purpose of this research, the classical criterion that determinates that the process only ends when there is a consensus situation between experts' answers. This can be defined using different methods [89]. The authors have considered the use of a coefficient of variation, agreed in advance by the participants which is calculated as the ratio of the standard deviation to the mean:

$$\vartheta = \frac{\sigma}{\mu} \qquad (1)$$

Where ν is the coefficient of variation, σ is the standard deviation and μ represents the mean.

In addition, the change rate of the coefficient of variation will also be considered [90, 91]:

$$\text{Variation } \nu = \nu_k - \nu_{k-1} \qquad (2)$$

In order to also take into account the homogeneity of the final answer, this research has used Spearman's coefficient for rank correlation [92].

$$r_s = 1 - \frac{6 \cdot \sum_{i=1}^{n} (X_i - Y_i)^2}{n\left(n^2 - 1\right)} \qquad (3)$$

Table 2 shows the descriptors used for the application of the Delphi method.

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, ϑ, less than 0.5
Stability measure	Variation of coefficient of variation ϑ less than 0.25
Homogeneity measure	Rank Correlation Coefficient of Spearman, r_s

Table 2: Basic descriptors for the Delphi method application in the study.

It must be noted that several authors have considered that a coefficient of variation (ν) smaller than 0.5 implies a good level of consensus, while values between 0.5 and 0.7 could imply the need for an additional consultation round, which becomes necessary if the value exceeds 0.7 [91, 93, 94].

Possible limitations of the Delphi method have been considered in the literature by some authors [65, 87, 95, 96] including lack of clarity due to the anonymous process or the possible experts' interpretations, poor worded questionnaires or superficial responses. However, the Delphi method, conducted properly, produces results far superior to other forecasting groups

techniques [97]. In order to supplement the research presented in this paper, we have validated the KPIs panel within several projects in different contexts.

Data Analysis and Results

Using the research methodology described in "Research Methodology", a conceptual approach for the set of KPIs was established based on the outcomes of the first iteration resulting from the application of the Delphi technique. The scorecard used by the experts was designed so it should include at least the following aspects:

- Contents should consider project indicators, economical/financial ratios, earned value analysis and indicators related to project risks;
- Data must be as specific and accessible as possible;
- Data collection needs to be efficient and cost-effective;
- Stakeholder's perspective has to be considered;
- The scorecard should be transferable.

Subsequent iterations required the experts evaluating a list of indicators. This list was based on relevant measures identified during the analysis of the literature as well as the opinion from the experts' panel. The first iteration resulted in a set of 83 proposed indicators. The experts evaluated individually each of these 83 indicators using a one-to-five scale (where one is the lowest, more negative value and five the highest/more positive). The evaluation criteria for the scorecard were set so an indicator would be considered a valid item when the consensus value resulting from the experts' assessment is equal or higher than four. Table 3 shows a sample of the experts' valuations (the full set of valuations is included in the appendix). The indicator coding on this table is based on the PMBOK guidance [**Error! Reference source not found.**]

Identifier	Indicator	Exp 01	Exp 02	Exp 03	Exp 04	Exp 05	Exp 06	Exp 07	μ	σ	υ
GEN-01-243	Active projects	5	3	1	1	1	2	2	2.14	1.46	0.68
GEN-02-203	Project proposals	4	2	1	1	1	2	2	1.86	1.07	0.58
GEN-03-236	Predictability of project completion	4	4	3	3	4	3	4	3.57	0.53	0.15
...	...	...	...	...	...	...	...	...	...	...	...
CAD-08-211	Use of consumed feeding buffer in relation with the percentage of completed feeding chain	4	3	2	1	1	2	3	2.29	1.11	0.49

Table 3: Extract of the consensus analysis in the first round of the Delphi method.

The analysis of these results using the evaluation criteria described previously reduced the number of agreed indicators from 83 to 49, as shown in Table 4. These new consensus was then used as input for the next iteration in order to analyze their stability.

The outcomes included in table 4 have been ratified during the second iteration according to the validation criteria i.e. only indicators with an average value equal or higher than four have been considered. In addition, the experts have been required to repeat the valuation process for those indicators that do not reach consensus status. This iterative process has been replicated in every round until a stable outcome has been achieved.

Based on the outcomes of the first round, the second iteration started with a questionnaire focusing on the characteristics of the three distinct groups of indicators:

- Provisionally accepted indicators;
- Provisionally non accepted indicators;
- Items without consensus.

Identifier	Indicator	μ	σ	υ
GEN-03-236	Predictability of project completion	3.57	0.53	0.15
ALC-01-213	Delivery periods completed	3.29	1.60	0.49
ALC-02-235	Failed milestones	4.14	0.69	0.17
TIE-02-230	Delay in building	4.00	0.58	0.14
TIE-03-225	Overdue tasks	4.14	0.69	0.17
TIE-05-210	Consume of Project Buffer in the Critical Chain	1.71	0.76	0.44
COS-12-193	Average revenue stream project	2.71	1.11	0.41
COS-15-222	Variation between order value and the original value of the contract	3.57	0.98	0.27
COS-17-111	Planned value	4.14	0.90	0.22
COS-18-113	Real cost	4.14	0.90	0.22
COS-19-112	Earned value	4.14	0.90	0.22
COS-20-246	Budget at completion	4.57	0.53	0.12
COS-21-244	Change in cost	4.86	0.38	0.08
COS-22-245	Schedule variance	4.86	0.38	0.08
COS-23-247	Changes to the conclusion	4.86	0.38	0.08
COS-24-227	Cost Performance Index	4.86	0.38	0.08
COS-25-215	Schedule performance index	4.86	0.38	0.08
COS-26-216	Cost Index - Schedule	4.86	0.38	0.08
COS-27-226	Estimate at completion	4.71	0.49	0.10
COS-28-248	Estimate to complete	4.00	0.82	0.20
COS-29-224	Job performance index complete (cost)	4.29	0.76	0.18
COS-30-218	Performance Index work to complete (timeline)	4.29	0.76	0.18
CAL-01-221	Issues identified in the project	4.29	0.49	0.11
CAL-02-238	Open nonconformities	3.57	0.98	0.27
CAL-03-234	No third party conformities identified during inspections	2.71	1.11	0.41
CAL-04-239	Open complaints	4.29	0.49	0.11
CAL-12-091	Made suggestions	2.57	1.27	0.49
CAL-13-082	Customer satisfaction	4.00	0.82	0.20
CAL-15-071	Litigation	2.57	1.27	0.49
REC-03-021	Overtime	2.29	0.76	0.33
REC-04-212	Earned man-hours	3.29	0.49	0.15
REC-05-214	Project resources utilization	3.86	0.38	0.10
REC-06-079	Performance Evaluation	3.57	0.79	0.22
REC-07-013	Productivity	4.29	0.49	0.11
REC-08-072	Work force satisfaction	4.00	0.58	0.14
REC-09-075	Promotions	1.71	0.76	0.44
REC-10-076	Wage increases	1.71	0.49	0.28
REC-11-078	Transfer requests	1.14	0.38	0.33
REC-12-187	Average total cost of a resource (person)	2.00	0.82	0.41
REC-13-070	Employee complaints	3.14	0.69	0.22
REC-14-074	Employee Turnover	2.43	0.53	0.22
REC-15-223	Conflicts in the project	3.43	0.53	0.16
REC-18-062	Absenteeism	2.86	0.69	0.24
REC-19-077	Training activities	2.14	0.90	0.42
COM-01-219	Timely management reporting	3.14	1.21	0.39
RIE-01-240	Risks	4.71	0.49	0.10
RIE-02-241	Possible Risks	4.71	0.49	0.10
CAD-07-209	Used buffers	2.29	1.11	0.49
CAD-08-211	Use of consumed feeding buffer in relation with the percentage of completed feeding chain	2.29	1.11	0.49

Table 4: Table of consensual agreement results in the first Delphi iteration.

This process resulted in a new consensus for each of these three groups was achieved. However, nine indicators did not meet the established stability criteria. Table 5 shows these values. The last column in the table indicates the change rate of coefficient of variation, where values are higher than the established reference rate i.e. $\nu = 0.25$.

Identifier	Indicator	Exp 01	Exp 02	Exp 03	Exp 04	Exp 05	Exp 06	Exp 07	μ	σ	υ	Δυ
GEN-01-243	Active projects	3	3	4	2	4	2	2	2.86	0.90	0.31	0.37
GEN-02-203	Project applicants	2	2	3	3	2	2	2	2.29	0.49	0.21	0.36
INT-01-130	Revisions of the project sub-component plans	3	3	5	3	3	3	2	3.14	0.90	0.29	0.29
ALC-01-213	Delivery deadline met	5	4	4	4	4	5	4	4.29	0.49	0.11	0.37
COS-01-095	Overall liquidity	4	2	3	3	4	3	3	3.14	0.69	0.22	0.29
COS-10-108	Quality of the debt	2	2	3	2	3	3	2	2.43	0.53	0.22	0.30
CAL-07-030	Work interruptions	2	3	3	3	3	3	2	2.71	0.49	0.18	0.39
CAL-08-165	Duration until mistakes' resolution	3	4	2	3	2	2	2	2.57	0.79	0.31	0.26
COM-01-219	Timely production of management reports	4	4	4	3	4	4	4	3.86	0.38	0.10	0.29

Table 5: List of indicators not meeting the established stability criteria.

These indicators were then subject of a further consultation iteration with the experts' panel where the questionnaire was exclusively dedicated to them. The analysis of this new iteration outcome is shown in Table 6. The results show that the consensus and stability conditions are both met and therefore the Delphi assessment concludes at this point.

Identifier	Indicator	Exp 01	Exp 02	Exp 03	Exp 04	Exp 05	Exp 06	Exp 07	μ	σ	υ	Δυ
GEN-01-243	Active projects	3	3	3	2	3	2	2	2.57	0.53	0.21	0.11
GEN-02-203	Project applicants	3	3	3	3	2	2	2	2.57	0.53	0.21	0.01
INT-01-130	Revisions of the project sub-component plans	3	3	3	3	3	3	2	2.86	0.38	0.13	0.15
ALC-01-213	Delivery deadline met	4	4	4	4	4	5	4	4.14	0.38	0.09	0.02
COS-01-095	Overall liquidity	4	2	3	3	4	4	3	3.29	0.76	0.23	0.01
COS-10-108	Quality of the debt	3	3	2	2	3	3	2	2.57	0.53	0.21	0.01
CAL-07-030	Work interruptions	3	3	3	3	3	3	2	2.86	0.38	0.13	0.05
CAL-08-165	Duration until mistakes' resolution	3	4	3	3	3	3	3	3.14	0.38	0.12	0.19
COM-01-219	Timely production of management reports	4	4	4	4	4	4	4	4.00	0.00	0.00	0.10

Table 6: Response analysis for the last iteration of Delphi method.

In order to measure the homogeneity of the response, a multivariate statistical analysis was used. Specifically, the Spearman's rank correlation coefficient, r_s, for each of the seven expert's valuation (X) was compared with the group valuation (Y). Table 7 shows the results of this analysis, which clearly indicate a strong and positive statistical significance defining a very homogenous response.

	Exp01	Exp02	Exp03	Exp04	Exp05	Exp06	Exp07
Spearman's rank correlation coefficient	0.87	0.73	0.82	0.79	0.86	0.84	0.82

Table 7: Spearman's rank correlation coefficient for final valuation.

In the concluding phase of this study the experts' panel selected the final set of 26 KPIs, shown in Table 8:

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.

Table 8: List of Key Performance Indicators identified using the Delphi methodology.

In order to validate the set of KPIs identified and to further investigate their applicability, the indicators dashboard has been applied to different specific case studies:

- Consultancy projects for a strategic plan or a market research;
- Engineering projects (transport and network, renewable energy, installations and infrastructure, …)

At the inception phase, the project manager was given the opportunity to evaluate and assess the applicability of the proposed KPIs dashboard and to propose if needed additional ones better suited to the actual project.

The complete set of 26 proposed KPIs is shown in Table 9, 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.

Id.	Indicator	Desired trend	Formula	Data Capture Period	Reporting Frequency
SCO-01-213	Delivery deadline met	Negative	Delivery deadlines met / Delivery requests	Spot	Monthly
SCO-02-235	Project milestones missed	Positive	Milestones missed / Project Milestones * 100	Month	Monthly
TIM-02-230	Project delay	Negative	Σ Project delay during stage i	Year to date	Monthly
TIM-03-225	Overdue project tasks	Negative	Tasks overdue / Current tasks * 100	Spot	Weekly
COS-20-246	Budget at completion (BAC)	Within range	BAC	Spot	Monthly
COS-21-244	Cost variance (CV)	Positive	EV - AC	Spot	Monthly
COS-22-245	Schedule variance (SV)	Positive	EV - PV	Spot	Monthly
COS-23-247	Variance at completion (VAC)	Positive	BAC - EAC	Spot	Monthly
COS-24-227	Cost performance index (CPI)	Greater or equal than one	EV / AC	Spot	Monthly
COS-25-215	Schedule performance index (SPI)	Within range	EV / PV	Spot	Monthly
COS-26-216	Cost schedule index (CSI)	Positive	CPI * SPI	Spot	Monthly
COS-27-226	Estimate at completion (EAC)	Negative	AC + BAC - EV BAC / CPI	Spot	Monthly
COS-28-248	Estimate to completion (ETC)	Positive	EAC - AC	Spot	Monthly
COS-29-224	To complete performance index (TCPI)	Less or equal than one	(BAC - EV) / (BAC- AC)	Spot	Monthly
COS-30-218	To complete schedule performance index (TSPI)	Positive	(BAC - EV) / (BAC - PV)	Spot	Monthly
QUA-01-221	Project issues identified	Negative	Project issues identified	Week	Weekly
QUA-02-238	Open non-conformities	Negative	Open non-conformities / Project Non-conformities	Quarter	Quarterly
QUA-04-239	Open complaints	Negative	#Open complaints / Project complaints	Quarter	Quarterly
QUA-13-082	Customer satisfaction	Positive	Global satisfaction	Year to date	Quarterly
HUM-05-214	Project resource utilization	Positive	Project resources used / Project resources allocated	Spot	Weekly
HUM-06-079	Performance appraisal	Positive	Average (Performance appraisal items)	Year	Yearly
HUM-07-013	Productivity	Positive	Performed man-hours in production / Global performed man-hours	Month	Monthly
HUM-08-072	Employee satisfaction	Positive	Average (Employee satisfaction)	Year to date	Quarterly
COM-01-219	Timely production of management reports	Positive	Management reports produced on time / Management reports due	Spot	Monthly
RIS-01-240	Risks	Positive	Risks number	Spot	Quarterly
RIS-02-241	Possible risks	Negative	Possible risks / Risks number	Spot	Monthly

Table 9: Detailed list of KPIs related to the project management.

It must be noted that the parametric representation is project-specific. For instance, the entries under “Data Capture Period” and “Reporting Frequency” in Table 9 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.

The manager of the validation consultancy project considered the use of most of the proposed KPIs, with the simplification in the measures of the variances from the approved baseline (either CV and SV or CPI and SPI). In addition, he also considered two new measures related to project management, as shown in Table 10. Table 11 shows the specific KPIs designed to address this particular project.

Id.	Indicator	Desired trend	Formula	Data Capture Period	Reporting Frequency
SCO-04-249	Produced deliverables	Positive	Produced deliverables / Deliverables number	Spot	Monthly
COS-31-250	Income	Positive	Project income	Spot	Monthly

Table 10: Detailed list of KPIs related to the project management.

Id.	Indicator	Desired trend	Formula	Data Capture Period	Reporting Frequency
PRO-01-301	Local stakeholders	Positive	Local stakeholders number	Task advance	Weekly
PRO-02-301	Meetings with local agents	Positive	Meetings with local agents	Task advance	Weekly
PRO-03-301	People surveyed	Positive	#People surveyed / Sample size	Task advance	Weekly
PRO-04-301	Sampling error	Positive	Depending on the sampling or variable kind	Task advance	Weekly
PRO-05-301	Analyzed municipalities	Positive	Analyzed municipalities / Municipalities in the region	Task advance	Weekly
PRO-06-301	Business sectors	Positive	Analyzed business sectors	Task advance	Weekly
PRO-07-301	Points of interest	Positive	Points of interest	Task advance	Weekly
PRO-08-301	Strategic objectives	Positive	Strategic objectives	Task advance	Weekly
PRO-09-301	Strategic initiatives	Positive	#Strategic initiatives	Task advance	Weekly
PRO-10-301	Strategic programs	Positive	Strategic programs	Task advance	Weekly

Table 11: Detailed list of KPIs related to the project.

For the validation in a PMO of Engineering Corporation, the manager placed emphasis on the use of Earned Value Analysis metrics in their projects. Other proposed KPIs are shown in Table 12.

Area	Indicator	Area	Indicator
Finance	Guarantees made vs. received	Logistics	Benefits of freight forwarders
	Exchange rate risk		Delivery reliability
	Corporative guarantees		% tax incomes due to delay at customs
	Project Cash-flow	Acquisitions	Margin on acquisitions
	Cash-flow over margin		Time taken to pay suppliers
	% Positive cash-flow period		Retained amount
Taxation	% income taxes		NOC of corporate payment
	Tax implications	Insurance	Insurance coverage
Environment	Greenhouse gas emissions		Covered losses

Table 12: Proposed additional KPIs for Engineering PMO.

Conclusions

This paper has described research conducted to design and develop a comprehensive set of KPIs suitable for implementing any project management and project monitoring management activities. Using the Delphi technique, a dashboard of 26 indicators narrowed from the original 83 has been created after using three consultation rounds seeking consensus within a panel of seven experts. The consensus level obtained was high from the first round. Similarly, the variation between rounds shows that the experts' opinion was very stable. In addition, the outcomes of the Delphi study provide a homogeneous response from the experts, measured using the Spearman's rank correlation coefficient.

The customising characteristics of the proposed performance indicators have successfully been validated using two different case studies: consultancy projects and Engineering PMO. The authors believe that this approach make the results of this paper a suitable reference for project managers seeking a valid performance indicators dashboard that can be adapted to their specific needs.

Finally, future developments that may result from this work should be addressed to the application in other different kinds of projects, environments or conditions. The set of key performance indicators should to be a basis for these applications.

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