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Quality & Quantity
International Journal of Methodology

ISSN 0033-5177
Volume 47
Number 1

Qual Quant (2013) 47:465-483
DOI 10.1007/s11135-011-9530-1

Springer

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Quality improvement and redesign of performance measurement systems: an application to the academic field

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Published online: 2 July 2011

Abstract The increasing competition both in the public and private sectors gave rise to a growing interest in quality improvement and in designing and implementing Performance Measurement Systems (PMS). Academic organizations also recognized the need for implementing performance measurement systems. Some recent works on PMS in the higher education make use of the Kaplan and Norton's Balanced Scorecard (BSC) to translate the characteristic strategic goals (e.g. research and teaching excellence) into performance measures. However, a PMS needs to be updated when external or internal changes influence the organization modus operandi. In this way a continuous quality improvement of organization performance is required. This paper describes a methodology based on the BSC model to redesign a current PMS. In detail, a reference BSC-check matrix is proposed. A "mapping analysis" of the current PMS is developed to understand if all the operational aspects involved in goals achievement are considered and if proper indicators have been defined. As an example, the methodology is applied to a Department of the authors' own University. The paper shows also how the proposed approach can be extended to other contexts.

Keywords Performance measurement system redesign · Quality improvement · Performance measurement · Indicators · Balanced scorecard · Higher education

1 Introduction

Increasing competition both in the public and private sectors raises the interest in measuring performance to better allocate resources (Jordan and Mortensen 1997; Juhl and Christensen 2008). Many organizations concentrated their efforts on designing and implementing adequate Performance Measurement Systems (PMS) to manage and improve their Quality performance.

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Sectors as scientific research and higher education have also been involved in this phenomenon. In the U.S. 90s laws and executive orders established the need for systematic development and application of performance information to continuously improve research programs. In detail, the programs were requested to demonstrate the relevance and value added to national social and economic needs (Jordan and Mortensen 1997). Another example is that of Canadian Federal Government which institutionalized a Performance Framework Approach for Science and Technology organizations (Teather and Montague 1997). Target clients, key co-delivery partners and stakeholders as well as the mechanism through which activities and outputs are transformed into results are considered. In the same context, great attention received also the evaluation of multi-departmental programs (Montague and Teather 2007).

The dominant idea of higher education as a social institution has also changed. Now Universities are perceived as a specific sector of the economy. Their purpose is to educate some of the workforce, advance economic development and perform research (Juhl and Christensen 2008).

This transformation started 25 years ago in U.S. (Gumport 2000) and now is a global tendency which influence the way universities are organized and managed. As an example, Karathanos and Karathanos (2005) analyze the Baldrige Award Criteria in the context of education and Yu et al. (2009) cite the application of performance measurement systems in the University of Edinburgh, University of Southern California, Ohio State University and University of Akron.

Recently also in Italy and other European countries were defined national models for research evaluation (CIVR 2010; RAE 2010; AERES 2010). In some cases, Universities and research centres developed proprietary *ad-hoc* PMS (Tutuncu and Kucukusta 2010; Coccia and Rolfo 2002).

Overall, a model often used by organizations to identify performance measures is the Kaplan and Norton's Balanced scorecard (Kaplan and Norton 1992, 1996, 2001). The authors introduced the *balancing* concept with the aim to overcome the shortcomings of traditional PMSs which rely only on financial outcomes. Balanced scorecard consider four perspectives (see Fig. 1):

(1) *Financial*: it is relative to the organization financial aspects.
(2) *Customer*: it considers what an organization has to do for its customers in order to ensure financial success.
(3) *Internal business process*: it concerns which processes most influence customer satisfaction.
(4) *Learning and growth*: it concerns what improvements can be made to ensure sound business processes and satisfied customers.

The strategic objectives of an organization are translated into performance measures on the basis of these four perspectives. This ensures a balance between the perspectives and their indicators as well as between short and long term objectives, leading and lagging indicators, financial and not financial measures.

One of the first applications of the BSC for evaluating research programs was that of Jordan and Mortensen (1997). In their work the authors described the performance management approach developed in collaboration with the U.S. Department of Energy (DOE).

Some of the most recent papers on performance measurement based on the BSC model in the higher education are reported in Table 1.

Tapinos et al. (2005) discussing the alignment between an organization strategy and performance measurement, report the example of the Warwick University (UK), where the BSC

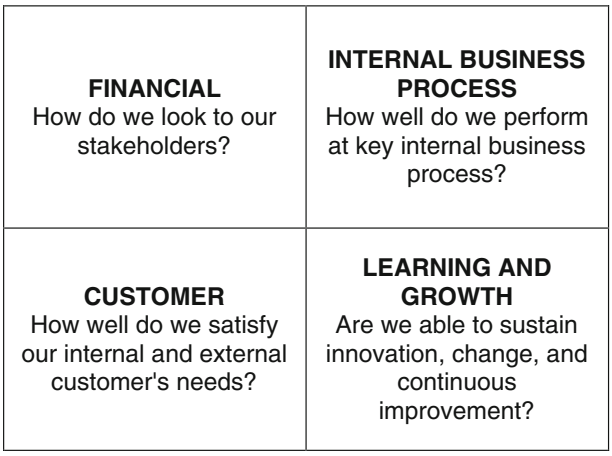

Fig. 1 Four basic perspectives in Kaplan and Norton's Balanced Scorecard (Kaplan and Norton 1992, 1996, 2001)

Table 1 Some examples of Balanced Scorecard applications in the higher education

Authors	Context of application
Tapinos et al. (2005)	Hospitality Services, Warwick University (U.K.)
Chen et al. (2006)	Chi-Min Institute of Technology of Taiwan
Papenhausen and Einstein (2006)	College of Business, University of Massachusetts – Dartmouth (U.S.A.)
Asan and Tanyas (2007)	Engineering Management Graduate Program (Turkey)
Umashankar and Dutta (2007)	Higher education programs/institutions (India)
McDevitt et al. (2008)	University division, Connecticut (U.S.A.)
Juhl (2008)	Comparison across Danish Universities
Yu et al. (2009)	Sample of an academic staff of Malaysian University

is applied to Hospitality Services. The case study reveals that the measurement of performance is used by top management as a mean of enhancing their learning on the institution's strengths and weakness.

In order to face financial difficulties, Chen et al. (2006) present the BSC as a tool for the reorganization of the Chi-Min Institute of Technology of Taiwan. Papenhausen and Einstein (2006) suggest that the BSC approach is well suited to a higher education framework and apply it to the College of Business of the University of Massachusetts. They point out that a successful BSC implementation requires active contributions by everyone in the organization.

Asan and Tanyas (2007) merge the BSC and the Hoshin Kanri tool for strategic management to monitor an Engineering Management Graduate Program, while Uhmashankar and Dutta (2007) discuss in what way the BSC approach may be applied to higher education in India.

McDevitt et al. (2008) describe the process and benefits from developing a custom Balanced Scorecard to revitalize a faculty strategy. Juhl and Christensen (1997) use the BSC to analyze the set of performance measures proposed by the Ministry of Science to allocate resources among Danish Universities.

Finally, Yu et al. (2009) propose a pilot study to investigate the adoption of an electronic Balanced Scorecard (e-BSC) for managing the performances of an academic staff.

From the analysis of these papers emerges that:

- Although there is no scientific evidence that the implementation of the BSC always leads to improved performances (Paranjape et al. 2006) the approach is generally well suited for PMS design in the higher education.
- A list of performance indicators to be included in a PMS is often proposed, but a procedure for the analysis and redesign of a current set of indicators is not suggested.

The aim of this paper is to describe a new methodology based on BSC to redesign a PMS.

The manuscript is structured as follows. In Sect. 2 a brief review of the literature about PMS redesign is made. In Sect. 3 the methodology for PMS redesign is introduced. The so called *reference BSC-check matrix* is described and the *mapping analysis* is discussed. Section 4 develops an application example of the proposed methodology. The reference BSC-check matrix is built for a Department of the authors' own University and the existing PMS is analyzed through the mapping analysis. Section 5 remarks pros and cons of the proposed methodology. Finally, Sect. 6 sums up the main contributions of the paper.

2 PMS redesign: literature review

A Performance Measurement System may lose its effectiveness over time if it is not redesigned to better attend new environmental and organisational demands (Neely 2005).

The redesign is a basic process related to performance measurement. It should be settled as an embedded functionality of a strategic management system (Pinheiro De Lima et al. 2008) in order to ensure an improvement of Quality performance.

In detail, four main processes are associated to performance measurement: design, implementation, use and refreshing. The refreshing process could be broadly understood as the continuous PMS redesign or review (Bourne et al. 2000; Kennerly and Neely 2002, 2003; Mast and Bergman 2006).

Over the years, the issue of PMS redesign has been addressed by different authors.

It was first considered in the mid-1980 when the irrelevance of the traditional accounting and financial performance measures stands out and the need for better integrated performance measurement emerged (Johnson and Kaplan 1987; Eccles 1991; Neely et al. 1995).

Kaplan and Norton (1993) recognized the periodic review as a stage of the BSC implementation. BSC metrics are revisited annually as a part of the processes of strategic planning, goals setting and resources allocation.

Vitale and Mavrinach (1995) identify seven warning signs that might indicate that a PMS need redesign. For example, if no one notices when performance measurement reports are not produced, this means they don't provide useful information to managers.

A survey (Lingle and Schiemann 1996) found that one of the characteristics of organisations which are at the tops in their industry is the regular updating of their strategic scorecard.

Flapper et al. (1996) state that, due to external or internal changes, a PMS may be modified in three ways: a new PI is introduced, a PI is deleted, the target value(s) for a PI are changed.

Waggoner et al. (1999) summarize the key forces driving and demanding changes in PMS. They are: customers, information technology, the marketplace, legislation (public policy), new industries, nature of the work and future uncertainty.

Bititci et al. (2000) identify the need for dynamic PMS that should include an external monitoring system (to monitor developments and changes in the external environment), an internal

monitoring system (to monitor developments and changes in the internal environment) and a review system which use the internal and external monitors to redesign internal objectives and priorities.

Bourne et al. (2000), considering the updating process of PMSs in different companies, highlight two different aspects. First, performance measures evolve since the management team reflects on their use. Second, targets, measurements and the set of measurements changed as a result of the review process.

Kennerly and Neely (2003) state that measurement systems have to be modified as current environment and strategies change. There should be a continuous evolutionary circle of a PMS which follows three phases: reflection (on the existing PMS to identify where it is no longer appropriate and where enhancements need to be made), modification (to ensure alignment to new circumstances) and deployment (to manage the new organization performance). Moreover, the authors recognized external and internal drivers to change (e.g. actual performance, dysfunctional behaviour) and barriers to change (e.g. corporate culture, internal capabilities, technology) (Paranjape et al. 2006). The presence of barriers to redesign a PMS in SMEs (Small and Medium Enterprises) is also discussed by Hudson et al. (2001).

Nowadays the problem of PMS redesign is still open. Basing on an extensive literature review, Gomes et al. (2004) claim that many manufacturing companies are attempting to redesign their PMS in order to make them more practical, realistic and integrated.

Neely, proposing a research agenda in the field of performance measurement for the next years, includes as a main issue how to develop dynamic rather than static PMS (Neely 2005).

A survey from a sample of manufacturing firms (Henri 2009) suggests that even though the current business environment is characterized by fast changes, manufacturing organizations do not appear to revise their PMS to a great extent.

Pinheiro et al (2009). also recognize that the enterprises' operations systems and environments are characterized by an high degree of complexity and dynamics. This is challenging the strategic operations management models which need a redesign.

From the analysis of the previous papers, it may be observed that there are many factors enabling or contrasting PMS review as well as warning signals that suggest the need for redesign. However, a structured procedure to deploy the redesign of a PMS is still not proposed.

In this paper we present a methodology for PMS redesign. This activity concerns the check of the consistency of the conceptual model underlying performance measures and the analysis of the appropriateness of the overall sets of performance indicators.

3 The reference BSC-check matrix and the mapping analysis

A performance measurement system provides data to be collected, analyzed, reported and ultimately used to make sound decisions. The strategic plan of an organization is the basic element to be considered in establishing a PMS.

We remind that building a PMS aims at operationalizing organizational goals. Performance indicators are tools to operationalize such goals (Franceschini et al. 2006, 2007). However, due to the business environment changing, new strategic goals may be defined over time.

As an example, suppose that the new strategic goals of an academic institution are set out as follows (Papenhausen and Einstein 2006):

- offering high quality graduate and undergraduate programs;
- conducting valuable basic, applied and pedagogical research;
- supporting regional economic health and development.

The current PMS could not monitor in an exhaustive way the new goals. In order to support the checking of the exhaustiveness of a current set of performance indicators, a tool based on the Balanced Scorecard perspectives may be developed. The structure of the *reference BSC-check matrix* is reported in Fig. 2. According to the Papenhausen and Einstein (2006) notation, the different strategic goals are reported on the columns, while the BSC perspectives are identified on the rows. In each cell one or more indicators are defined. The reference BSC check-matrix becomes the leading framework for the redesign of a PMS.

In order to make explicit how the reference BSC-check matrix is developed, we analyze it for a generic goal G_j. Figure 3 shows how specific performance indicators can be generated.

The reference BSC-check matrix may be considered as the starting point for a "diagnostic" evaluation of a current PMS. Periodically, an organization investigates the need for PMS redesign due to internal or external context changes. If significant changes intervened, then the following steps may be followed (see Fig. 4):

1. identification of a conceptual model leading PMS redesign (hereafter the BSC);
2. formulation of strategic goals and development of a reference BSC-check matrix;
3. allocation of each performance indicator within the reference BSC-check matrix framework. The reference BSC-check matrix may be seen as an overall map of the areas that should be monitored to verify goals achievement. Mapping analysis is developed as follows:
   - 3.1 identification of the uncovered performance areas. Indicators of the reference BSC-check matrix that monitor these areas are included in the existing PMS.
   - 3.2 Comparison between indicators of the current PMS and those of the reference BSC-check matrix. Indicators are compared in order to verify if they are still relevant.

		Strategic goals		
		G_1 High quality graduate and undergraduate programs	**G_2 Conducting valuable basic applied and pedagogical research**	**G_3 Supporting regional health and development**
BSC perspectives	**P_1 – Financial**	$I_{11(1)}$, $I_{11(2)}$	I_{12}	$I_{13(1)}$, ..., $I_{13(3)}$
	P_2 – Customer	I_{21}	I_{22}	I_{23}
	P_3 – Internal Process	I_{31}	$I_{32(1)}$, $I_{32(2)}$	I_{33}
	P_4 – Innovation and learning	$I_{41(1)}$,..., $I_{41(4)}$	I_{42}	I_{43}

Fig. 2 Structure of a general *reference BSC-check matrix*. For each strategic goal (Papenhausen and Einstein 2006) one or more indicators are proposed for each Balanced Scorecard perspective. The indicator $I_{ij(k)}$ is the *k-th* indicator which monitors the goal G_j from the perspective P_i

		Goal G_j
BSC perspectives	**P_1 – Financial**	Which financial indicators better represent G_j achievement?
	P_2 – Customer	Which indicators better represent the customer's perspective in G_j achievement?
	P_3 – Internal Process	Which process indicators better represent G_j achievement?
	P_4 – Innovation and learning	Which indicators better represent the continuous improvement of the organization in order to satisfy G_j?

Fig. 3 Development of BSC-indicators matrix for a generic goal G_j

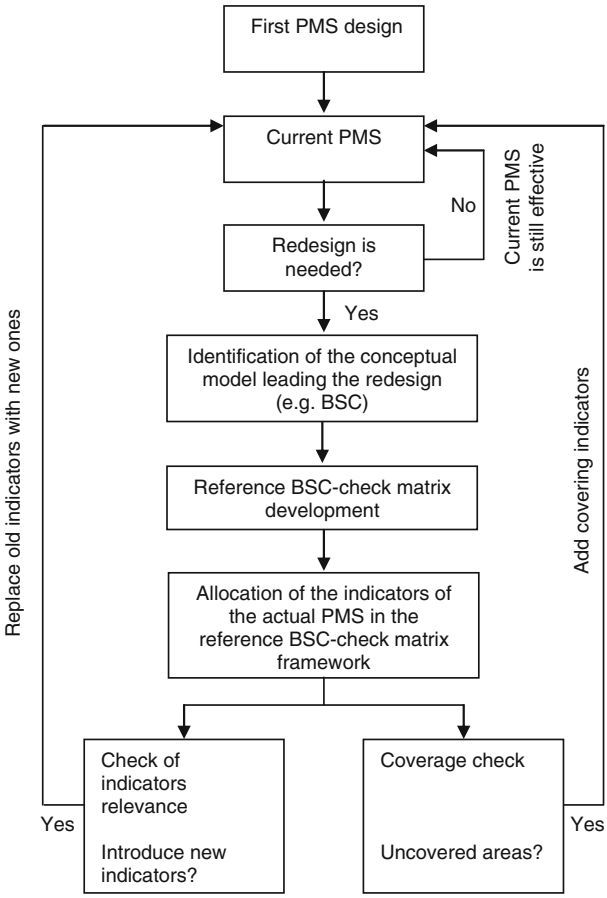

Fig. 4 Methodology for a PMS redesign. The BSC is considered as the conceptual model leading redesign. Once the strategic goals have been identified, the reference BSC-check matrix is built. Then the mapping analysis is carried out. The indicators of the current PMS are allocated within the reference BSC-check matrix framework and the areas which are not covered are identified. Finally, indicators referred to common areas are compared to check if indicators are still relevant

The outcome of this analysis are respectively:

– the performance areas that are not covered by the current PMS;
– new indicators covering the various performance areas.

In the following Sections an application example concerning reference BSC-check matrix building and its employment for mapping analysis is reported. The redesign of the current PMS of the authors' Academic Department is considered.

4 Application example

4.1 The current PMS

Before delving into the description of the current PMS, the organizational structure of the considered University is described.

Synthetically speaking, the University is organized in Faculties and Departments, which are not hierarchically dependent (see Fig. 5).

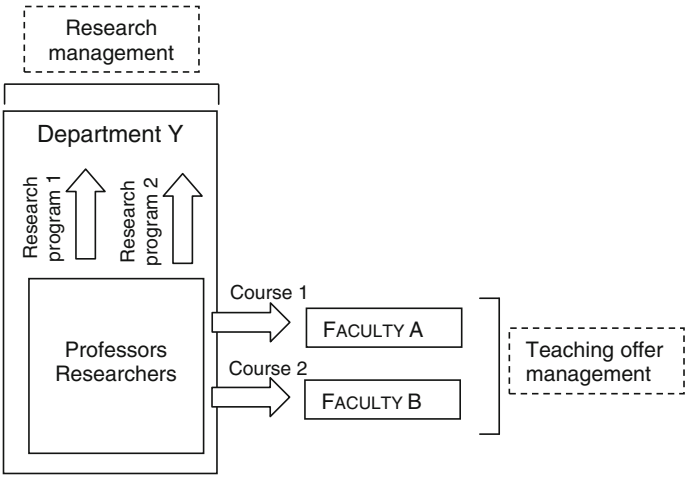

Fig. 5 Scheme of the organizational structure of the authors' own University. Departments manage research activities and Faculties provide the teaching offer

Table 2 Strategic goals for a generic Department of the Authors' own University

G_1	Goal 1 Research excellence	Excellence in scientific performance and international acknowledgment of the developed research programs
G_2	Goal 2 Teaching	Fulfilment of Faculties requirements
G_3	Goal 3 Resource management and funding	Efficient management of human and material resources Fund-raising

Faculties main functions are (Politecnico di Torino 2010a,b):

- annual review of course contents;
- management of the assigned economic resources in order to organize academic programs;
- coordination and monitoring of the teaching offer;
- tenure assignment for new researchers and professors;
- conferment of graduations.

On the contrary, Departments main activities are respectively (Politecnico di Torino 2010a,b):

- promotion and coordination of research activities;
- according to Faculties requirements, assignment of teaching duties to the academic staff;
- recruitment of academic staff;
- fund-raising for research activities.

Table 2 shows a structured list of strategic goals for a generic Department.

The current University Performance Measurement System is used to evaluate the results achieved by each Department and to allocate new human and economic resources. Each Department is assessed considering an overall score which is determined by a set of indicators. The higher this score, the larger the amount of human and economic resources assigned to the Department. Indicators are calculated every academic year. The current PMS is organized into two main parts as reported in Table 3.

Table 3 Current Department PMS

	Indicators		Weights
Costs	I_1	Personnel	0.30
	I_2	Expenses	0.20
Performance	I_3	Funding	0.10
	I_4	Teaching offer	0.10
	I_5	PhD students	0.10
	I_6	Scientific output	0.20

$O.D.S. = 0.3x\ I_1 + 0.20x\ I_2 + 0.1x\ I_3 + 0.1x\ I_4 + 0.1x\ I_5 + 0.2x\ I_6$

$D.A = A\ x\ O.D.S.$

O.D.S. Overall Department score, *D.A.* Department assignment, *A* University overall assignments.
O.D.S. is expressed in millesimal.

Table 4 Example of calculation of the Overall Department Score for two Departments X and Y

	Indicators		Department X	Department Y	Weights
Costs	I_1	Personnel [millesimal]	45.82	46.41	0.30
	I_2	Expenses [millesimal]	27.54	75.38	0.20
Performance	I_3	Funding [millesimal]	25.70	55.82	0.10
	I_4	Teaching offer [millesimal]	66.86	36.98	0.10
	I_5	PhD students [millesimal]	49.83	41.24	0.10
	I_6	Scientific output [millesimal]	36.03	98.76	0.20
O.D.S. [millesimal]			40.70	62.16	
A			2.471.000 €		
D.A. = A x O.D.S.			100.564 €	153.588 €	

Indicators are expressed in millesimal
O.D.S. Overall Department score, *D.A.* Department assignment, *A* overall assignments.

Costs section includes:

- I_1 - *Department personnel*. Performance indicators are related to the number of people working into a Department (professors, researchers and staff personnel).
- I_2 - *Expenses*. It considers the operating expenses of the Department.

Performance section includes:

- I_3 - *Funding*. Indicator considers the amount of funds raised by the Department from local, national and international research programs.
- I_4 - *Teaching offer*. It is related to the amount of teaching hours provided by the Department to the Faculties.
- I_5 - *PhD students*. Number of PhD students in the Department.
- I_6 - *Scientific output*. It evaluates the Departments scientific output on the basis of some bibliometric criteria.

To each indicator is assigned a weight to calculate the Overall Department Score (O.D.S) as shown in Table 3. The annual Department Assignment (D.A.) is determined on the basis of this score.

Indicators for each Department are expressed in millesimal. This value is obtained comparing the Department performance to the overall University results. An example is reported in Table 4. Two departments and their results are considered. Department X presents the 45.82 $^{0}/_{00}$ of the total University human resources (I_1). The Overall Department Score is calculated as described in Table 3. Since the O.D.S. of Department Y is higher then that of Department X, its economic assignment will be greater.

4.2 Development of the reference BSC-check matrix

As a starting point, we construct a reference BSC-check matrix to monitor Department performance. Each strategic goal (G_1, G_2, G_3) is monitored by one ore more indicators for each BSC perspective (see Fig. 6).

BSC perspectives are personalized to the specific academic context as follows:

- *Financial*: In general, this dimension considers the main incomes such as fees from students and funding from research programs of local, national and international interest as well as from collaborations with industry (Chen et al. 2006; Papenhausen and Einstein 2006). In this specific example, fees from students are not managed by Departments. They are handled by the University Central Administration.
- *Customer*: In literature one distinguishes between internal customers (teachers, administrators and students) and external customers (business, government, families, . . .) (Chen et al. 2006). In this paper we consider: public and private partners in research programs, funding agencies, research and teaching personnel and staff personnel.
- *Internal process*: It considers efficiency and efficacy of the most critical internal process that drive stakeholders satisfaction (Jordan and Mortensen 1997; Papenhausen and Einstein 2006).
- *Learning and growth*: it analyses the learning and growth opportunities for all the stakeholders (Jordan and Mortensen 1997; Chen et al. 2006; Papenhausen and Einstein 2006; Asan and Tanyas 2007).

4.3 Mapping analysis

The first step of the mapping analysis entails the identification of uncovered areas in the current PMS (see Fig. 4). Figure 7 shows how indicators are allocated within the BSC-check matrix framework. The presence of unfilled cells suggests that some goals are not monitored by all the BSC perspectives.

A second step of the mapping analysis consists of comparing indicators monitoring the same performance areas. The main aim is to verify if indicators of the current PMS are still relevant to monitor the system (see Fig. 4).

Different criteria to analyze the relevance of performance measures are proposed in literature such as the SMART test (University Of California, Laboratory Administration Office 2010), the Three Criteria test (Performance-Based Management Special Interest Group 2001), The Treasury Department Criteria test (U.S. Department of the Treasury 1994). According to these tests indicators should satisfy a set of properties in order to represent a system properly (Kennerly and Neely 2003; Franceschini et al. 2006, 2007; Caplice and Sheffi 1994). Table 5 reports a taxonomy of indicators properties.

In detail, properties are classified as general properties, properties of derived indicators (i.e. obtained combining the information of one or more sub-indicators) and properties referred to sets of indicators. They should be all considered in the mapping analysis. For example, exhaustiveness is checked in the coverage analysis, and so on.

			Detailed strategic goals			
			G_1 Research excellence	G_2 Teaching Satisfaction of faculties requirements	G_3 Resources management and funding	
					$G_{3.1}$ Efficient management of material and human resources	$G_{3.2}$ Fund-raising
BSC perspectives	P_1	Financial	▪ Internal bonus awarded for scientific research			▪ Amount of funding ▪ Assets value (new technical equipment)
	P_2	Customer	▪ Researchers satisfaction	▪ Students satisfaction ▪ Teaching personnel satisfaction	▪ Staff personnel satisfaction	▪ Funding agencies satisfaction ▪ Research partners satisfaction
	P_3	Internal process	▪ Number of publications ▪ Quality of publications (e.g.: h-index)	▪ Amount of teaching hours provided to Faculties ▪ Average number of students per course ▪ Average number of teaching hours per lecturer	▪ Ratio between operating costs and Department Assignment ▪ Operating costs per unit of personnel working into the Department	▪ Ratio between the amount of funding and Department Assignment
	P_4	Learning and growth	▪ Number of PhD students	▪ New courses organized for different Faculties	▪ Ratio between costs for technical equipment acquisition and overall operating costs	▪ Number of publications arising from funded projects ▪ Quality of publications arising from funded projects (e.g.: h-index)

Fig. 6 Reference BSC-check matrix for the Department considered in the application example

			Detailed strategic goals			
			G_1 Research excellence	G_2 Teaching Satisfaction of faculties requirements	G_3 Resources management and funding	
					$G_{3.1}$ Efficient management of material and human resources	$G_{3.2}$ Fund-raising
BSC perspectives	P_1	Financial			▪ I_2: Operating expenses	▪ I_3: Funding
	P_2	Customer				
	P_3	Internal process	▪ I_6: Scientific output	▪ I_4: Teaching offer	▪ I_1: Department Personnel	
	P_4	Learning and growth	▪ I_5: PhD Students			

Fig. 7 Mapping analysis of the current PMS using the reference BSC-check matrix. Cells highlighted in *grey* correspond to the non monitored areas

Table 5 Properties that may be considered in the analysis of indicators relevance (Franceschini et al. 2006, 2007)

Properties of indicators		
General properties	Consistency with the representation target	The indicator should properly represent the representation-target.
	Level of detail	The indicator should not provide more than the required information.
	Non counter-productivity	Indicators should not create incentives for counterproductive acts.
	Economic impact	Each indicator should be defined considering the expenses to collect the information needed.
	Simplicity of use	The indicator should be easy to understand and use.
Properties of sets of indicators	Exhaustiveness	Indicators should properly represent all the system dimensions, without omissions.
	Non-redundancy	Indicators set should not include redundant indicators.
Properties of derived indicators	Monotony	The increase/decrease of one of the aggregated indicators should be associated to a corresponding increase/decrease of the derived indicator.
	Compensation	Changes of different aggregated indicators may compensate each other, without making the derived indicator change.

The consistency of indicators with the representation target (i.e. the strategic goals) is one of the most ticklish property. It consists in verifying if performance measures properly operationalize the strategic plan (Franceschini et al. 2007). Moreover, also the economic impact of indicators should be carefully considered.

In the following some remarks about the mapping analysis of the current PMS are reported.

General remarks

A first general observation concerns the calculation of each indicator of the current PMS. As described in Sect. 4.1, performance are normalized and expressed in millesimal. The normalization implies that:

- the improvement of absolute performance (e.g. the increase of the expenses of a Department) is not easily detected;
- the comparison of performance over the years or among Departments may be not significant since the increase (or decrease) of indicators values does not imply a variation of absolute performance.

Table 6 Compensation among single performance in the current PMS

	Indicators		Department A	Department B	Weights
Costs	I_1	Personnel	32.51	30.33	0.30
	I_2	Expenses	24.48	26.05	0.20
Performance	I_3	Funding	29.40	23.78	0.10
	I_4	Teaching offer	28.18	30.19	0.10
	I_5	PhD students	29.21	36.08	0.10
	I_6	Scientific output	24.70	27.01	0.20
O.D.S.			28.27	28.72	

O.D.S. Overall Department score

Another criticality is related to the calculation of the Overall Department Score. The additive model used to determine the O.D.S. (see Table 3) fulfils the property of compensation. This implies that:

- Departments with the same O.D.S. may have different sub-indicators contribution. In Table 6 we see that Department A and B have very similar overall performance but they follow different strategies. For example, Department A attracts more funds (indicator I_3) but has a lower level of scientific output (indicator I_6) than Department B.
- The model introduces a substitution rate among different sub-indicators. If we consider again the PMS of Table 3 we have that:

$$\Delta(I_3) = -\frac{1}{2}\Delta(I_6)$$

When funding increases, for example, of a unit, the O.D.S. remains the same if the scientific output decreases of half unit. A substitution rate can be calculated among all other indicators. This may bring to different Departments' strategies. One can have departments specialized in teaching and others specialized in researching.

Remarks on the goal "Research excellence"

Observing Fig. 7, goal G_1 ("Research Excellence") does nor cover some perspectives:

- *Financial perspective*. Financial effects of high value research are not considered. Indicators such as the one proposed in the reference BSC-check matrix (bonus granted by the Central Administration for scientific research quality) may introduce an incentive scheme (see Fig. 6).
- *Customer perspective*. It may be considered, for example, the satisfaction of research personnel (for laboratories equipment, working environment, …).

Considering the Internal process perspective, the quality of scientific research may be evaluated using the most recent bibliometric indicators (Hirsch 2005; Sandström and Sandström; Franceschini and Maisano 2010a,b; Schmoch et al. 2010) (see Fig. 6, cell $G_1 - P_3$).

Remarks on the goal "Teaching"

For goal G_2 ("Teaching") it appears that Financial, Customer and Learning and growth perspectives are not covered (Fig. 7). Indicators which consider teaching personnel satisfaction

(cell $G_2 - P_2$), lecturers workload (cell $G_2 - P_3$), new or updated courses organized with Faculties for the improvement of the teaching offer (cell $G_2 - P_4$) should be introduced (see Fig. 6).

Remarks on the goal "Resources management and funding"

The goal G_3 ("Resources management and funding") is not covered by the Customer perspective (see Fig. 7). In detail:

- the satisfaction of the staff personnel is not assessed (cell $G_{3.1} - P_2$);
- the satisfaction of funding Agencies and research partners is not evaluated (cell $G_{3.2} - P_2$). A low satisfaction may induce a future reduction of funding.

Moreover, the goal $G_{3.1}$ ("Fund-raising") is not monitored by the Internal process dimension (P_3point of view). In this case, indicators to evaluate the attractiveness of a Department expressed as the ratio between the amount of fund-raising and the Overall Assignment may be introduced (see Fig. 6).

Also the perspective Learning and growth (P_4) is not covered for Goal G_3. The following indicators may be considered (Fig. 6):

- investments in laboratories equipment (cell $G_{3.1} - P_4$);
- quality and productivity scientific output (i.e. number and quality of papers deriving from funded research program) (cell $G_{3.2} - P_4$).

Referring to the Financial perspective, the goal $G_{3.2}$ may be better represented by the introduction of the indicator "Assets" (i.e. equipment used in the research activities). Assets may be considered as a factor of attractiveness for a Department.

A critical aspect is the correlation among indicators. The current PMS evaluates both operating expenses and personnel (cells $G_{3.1} - P_1$ and $G_{3.1} - P_3$ of Fig. 7). However, these two indicators are correlated. At the increasing of the personnel, operating expenses are expected to growth too. The property of non-redundancy is not respected. The main consequence is that Departments with the highest operating expenses and personnel receive more economic assignments. This effect is reinforced by the high weights assigned to indicators I_1 and I_2 in the Department Overall Score (see Table 3).

Considering the efficiency of the Department, the Goal $G_{3.1}$ may be better represented by indicators such as the cost per personnel and/or the ratio between costs and the Department Assignment. These suggest how well resources are managed.

Figure 8 shows the redesigned PMS.

5 Pros and cons of the proposed methodology for PMS redesign

The main Pros of the proposed methodology can be summed up as follows:

- International rankings (e.g. THES—Times Higher Education Supplement's ranking, Shanghai Jiao Tong University's ranking, Webometrics Ranking of World Universities, SCImago institutions rankings) are increasingly considered in the comparison between Universities. A high position in the ranking allows a University to attract more funding and students from around the world. A well-designed and updated PMS enables to understand the reasons of a specific positioning and improve its Quality performance.

BSC perspectives			Detailed strategic goals			
			G_1 Research excellence	G_2 Teaching Satisfaction of faculties requirements	G_3 Resources management and funding: $G_{3.1}$ Efficient management of material and human resources	G_3 Resources management and funding: $G_{3.2}$ Fund-raising
BSC perspectives	P_1	**Financial**	▪ *Internal bonus awarded for scientific research*			▪ I_3: Amount of funding ▪ *Assets value (new technical equipment)*
BSC perspectives	P_2	**Customer**	▪ *Researchers satisfaction*	▪ *Students satisfaction* ▪ *Teaching personnel satisfaction*	▪ *Staff personnel satisfaction*	▪ *Funding agencies satisfaction* ▪ *Research partners satisfaction*
BSC perspectives	P_3	**Internal process**	▪ *Number of publications* ▪ *Quality of publications (e.g.: h-index)*	▪ I_4: Amount of teaching hours provided to Faculties ▪ *Average number of students per course* ▪ *Average number of teaching hours per lecturer*	▪ *Ratio between operating costs and Department Assignment* ▪ *Operating costs per unit of personnel working into the Department*	▪ *Ratio between the amount of funding and Department Assignment*
BSC perspectives	P_4	**Learning and growth**	▪ I_5: Number of PhD students	▪ *New courses organized for different Faculties*	▪ *Ratio between costs for technical equipment acquisition and overall operating costs*	▪ *Number of publications arising from funded projects* ▪ *Quality of publications arising from funded projects (e.g.: h-index)*

Fig. 8 Redesigned PMS. The performance areas uncovered by indicators of the previous PMS are highlighted in *grey*. New or revised indicators are in *italic*

- It is a structured approach which identifies a set of steps and tools supporting the redesign process. In particular, the reference BSC check-matrix enables to verify periodically if the current set of indicators is still relevant to monitor the organization performance.
- It is based on a leading model which is well suited for performance measurement in the higher education. However, it is worth noting that the BSC is not the unique reference model. The suggested methodology is flexible to the context of application. For example, possible reference models might be the European Foundation for Quality Management model (European Foundation for Quality Management 2010) or the Baldridge criteria (Baldridge National Quality program 2010) which may be applied independently of the type, size, and structure of the organization.
- Performance measurement in the academic field may be very critical for the presence of many intangible assets. The reference BSC-check matrix and the analysis of indicators properties support the reflection on what issues should be measured and how.

On the opposite, a list of the main cons is the following:

- Factors and frequency of redesign are not easily definable. The seven warning signals proposed by Vitale and Mavrinach (1995) may be for example considered.
- In the application example the barriers to PMS change are only partially considered. On the whole, a detailed analysis of the impact exerted on the organization by a redesigned PMS should be developed. Different criteria of impact should be identified and the effects of each indicator evaluated (Franceschini et al. 2007).

6 Conclusions

In this paper a methodology for Quality improvement of an academic organization by means of the redesign of its Performance Measurement System is presented.

Basing on the Kaplan and Norton's Balanced Scorecard (BSC), a *reference BSC-check matrix* is defined in order to analyze in a systematic way how each organizational strategic goal may be monitored by a BSC perspective.

A mapping-analysis is proposed in order to understand what performance areas are not covered or not adequately considered. By the structured comparison of the PMS and the proposed reference BSC-check matrix, the set of existing performance measures may be redesigned.

Due to the increasing interest in performance measurement in the academy field, an application example of the proposed methodology in the authors' own University is presented. The suggested approach enables to translate a Department's goals into indicators and to check the current PMS.

Future work will consider the analysis of the impact exerted on the Department behaviour by the redesigned set of indicators.

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