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A maturity model for performance measurement systems

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Abstract

Organizations are constantly seeking performance improvement through new technology, processes, and instruments. One instrument that received considerable attention during the last years is called Performance Measurement System (PMS). A PMS tracks actual performance of an organization, helps identifying weaknesses, and supports communication and decision-making processes. The aim of this paper is to develop a Maturity Model for Performance Measurement Systems. The Maturity Model suggested can be applied as a framework for *judging* PMSs in place, and it can be used as an instrument for *improving* running PMSs as well.

1 Why should performance be measured?

Performance Measurement has become a field of intensive interest. In the last decade a large body of literature, that discusses various aspects of performance measurement, has been published; e.g. Fitzgerald et al. (1991), Lynch/Cross (1991), Simons (1999). However, it is worth to note two points: firstly, performance measurement is not only of academic interest, but it is of high practical relevance as well (Haspeslagh/Boulos, 2001). Secondly, performance measurement is not particularly new, it has been applied for decades; see Eccles (1991). However, traditional performance measurement focused on financial aspects whereas modern performance measurement approaches take a multidimensional, stakeholder-based perspective.

The reasons why performance is measured are manifold. To illustrate this, a few questions are enlisted:

- Why does the mission control center of NASA supervise the space shuttle flights? To check whether the space shuttle in on track.

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- Why does the doctor measure the babies' weight regularly? To see whether it grows according to a standard.
- Why do people on diet measure their weight regularly? To check whether action taken (e.g. a substitution of protein by carbohydrates) has an impact on loss of weight.
- Why do the marathon runners measure the time for each sub-discipline separately in their training sessions? To identify weaknesses and points for improvements.
- Why do car drivers check the speed meter in inner cities regularly? For not violating regulations.
- Why do seismologists constantly monitor earth vibrancies? To receive early warning signals.
- Why do meteorologist measure wind strengths around the globe? To make forecasts more reliable.

As the list above shows, performance measurement has different aims. Probably the most important objective of performance measurement is to *replace intuition by facts*.

Today, most businesses are exposed to intensive competition and, therefore, companies are forced to improve their performance steadily. Companies doing business in a competitive environment must measure their performance regularly to quantitatively assess whether the set goals are met. In addition, they should measure different facets of performance (e.g. customer retention, service quality, employee motivation, sales revenue) to better understand the interrelationships between business-relevant aspects. This generated knowledge may be used to initiate appropriate action to improve overall business performance.

2 Performance Measurement System: a definition

What is a Performance Measurement System? Is it a management process? Is it a collection of tools whose aim is to control business performance? Is it a modern management information system? Or is it a piece of software?

Neely et al. (1995) define a PMS as follows: "A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions" (p. 81). Other authors emphasize the relevance of IT when describing the term PMS. Bititci (1997) for instance states: "At the heart of the performance management process (i.e. the process by which the company manages its performance), there is an information system which enables the closed loop deployment and feedback system. This information system is the performance measurement system which should integrate all relevant information from relevant systems." (p. 47).

In this paper, the term PMS is used as follows: *A Performance Measurement System (PMS) is a system that tracks the performance of an organization (or part thereof), supports internal and external communication of results, helps*

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managers by supporting both tactical and strategic decision-making, and facilitates organizational learning.

From a more technical view, a PMS can be characterised as an information system which:

(1) gathers – through a set of financial and non-financial indicators – performance-relevant data from various sources;
(2) compares the current performance values against historical and target values;
(3) disseminates the results (current value, performance gap, and trends) to the actors.

Principally, a PMS does not necessarily include Information Technology. However, for a PMS to be efficient and effective, the use of IT is required. The five basic elements of a PMS are people, procedures, data, software, and hardware (Kueng et al., 2001). Table 1 shows the five components of a PMS in more details .

Table 1: Components of a Performance Measurement System

People	**Procedures**	**Data**	**Software**	**Hardware**
Owner of PMS People accountable for the units measured People setting-up and maintaining the PMS Data suppliers Internal and external users/ stakeholders of the PMS	Procedures and rules for definition of performance indicators Rules for data collection Rules for data management Rules for data communication Rules for use of performance results	Performance-relevant data (as-is values) To-be values of performance indicators Performance results (calculated data) Meta-data: description of performance indicators	Software for extraction, transformation and loading of data Database Management software/ Data Warehouse software Data analysis software Presentation and communication software	Personal Computer or other visual display unit Server Communication infrastructure Storage system

In general terms, the aim of a PMS is to evaluate the success of a system's implementation and to continuously improve the performance of the system (e.g. an organization) measured. A PMS can be seen as an instrument that converts an open-loop system into a closed-loop system.

3 Two classical maturity models

In Information Systems literature the term Maturity Model has been used by two schools: *Richard L. Nolan* from Harvard Business School and *Watts S. Humphrey* from Carnegie Mellon University.

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The Nolan model has been widely recognized and utilized by both practitioners and researchers alike. Nolan's initial model describes four distinct stages. These are the following: Initiation, Expansion, Formalization, and Maturity (Gibson/Nolan, 1974), cf. Fig. 1.

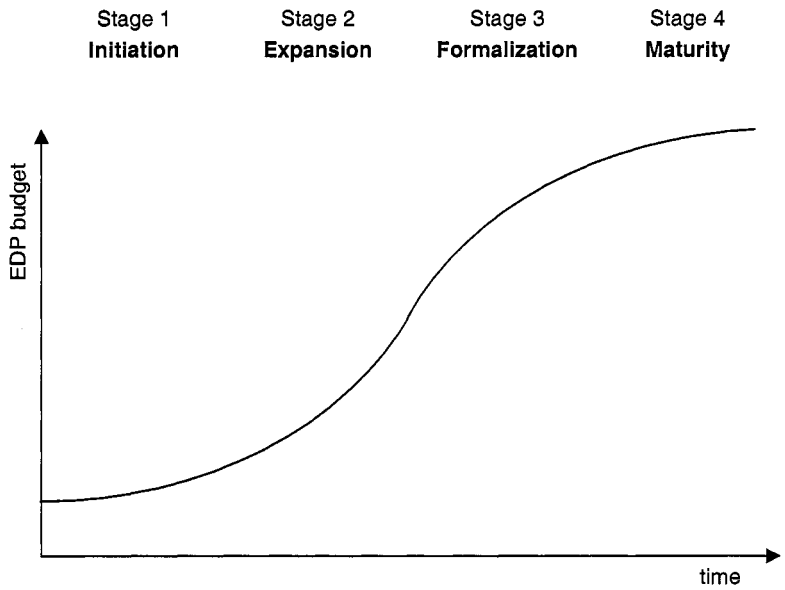

Figure 1: Four stages of growth (amended from Gibson/Nolan, 1974)

The Nolan model is based on the companies' spending for electronic data processing (EDP). In their original article from 1974, Gibson and Nolan describe the suggested model as follows: "The basis for this framework of stages is the recent discovery that the EDP budget for a number of companies, when plotted over time from initial investment to mature operation, forms an S-shaped curve. (...) The turnings of this curve correspond to the main events – often crisis – in the life of the EDP function that signal important shifts in the way the computer resource is used and managed. There are three such turnings, and, consequently, four stages." (p. 77). The Nolan maturity model is based on three underlying types of growth: (1) a growth in computer applications – from simple payroll applications to complex management systems; (2) a growth in the specialization of EDP personnel; (3) a growth in formal management techniques and organization – from lax management practices to resource-oriented planning and control. In 1979, Nolan transformed the original four-stage model into a six-stage model by adding two new stages; the stages Integration and Data Administration were put in between Formalization and Maturity. For a more detailed and also critical analysis of the Nolan curve see Galliers/Sutherland (1999) and van der Riet et al. (1997).

The second classical Maturity Model was developed by the end of the eighties by Watts Humphrey and his team from the Software Engineering Institute

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(SEI) at Carnegie Mellon University. Initially, the SEI model was simply called CMM (Capability Maturity Model). Meanwhile, SEI has introduced Maturity Models for different purposes, e.g. People Capability Maturity Model, Software Acquisition Capability Maturity Model, Systems Engineering Capability Maturity Model, Integrated Product Development Capability Model. The classical CMM is now called SW-CMM (Capability Maturity Model for Software). The SW-CMM is a model for judging the maturity of the software processes of an organization and for identifying the key practices that are required to increase the maturity of the underlying processes (SEI, 2001). The SW-CMM has become a de facto standard for improving software processes. The SW-CMM is organized into five maturity levels: Initial, Repeatable, Defined, Managed, and Optimizing; cf. Fig. 2.

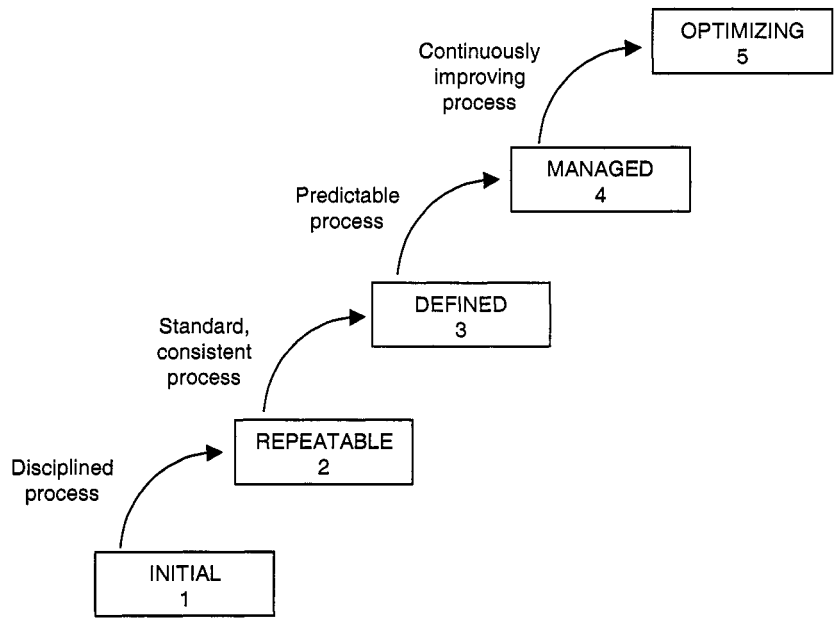

Figure 2: The five levels of software process maturity (Paulk et al., 1994, p. 16)

What are the differences between the Nolan model and the CMM? First, the Nolan model looks at a particular organizational unit (the EDP unit or IT function) whereas the CMM is focused on processes carried out within the IT function. Second, the Nolan model describes the changes of four dimensions (EDP budget, computer applications, EDP personnel, management techniques); the CMM considers solely the *quality* of processes. However, the CMM model addresses different so-called key practices – themes that must be taken into consideration when process maturity is to be incremented from one stage to the next (Paulk et al., 1994).

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4 A maturity model for performance measurement systems

In this section, a Maturity Model for Performance Measurement Systems is described. To create this new model, the two classical models – discussed above – have been used as a source of inspiration. Besides that, data of a multi-case study (Kueng, 2002) have been used. In particular, the Performance Measurement Systems of eight companies were analyzed regarding various dimensions; e.g. data collection procedures, storage of performance-relevant data, use of performance results; see Fig. 3.

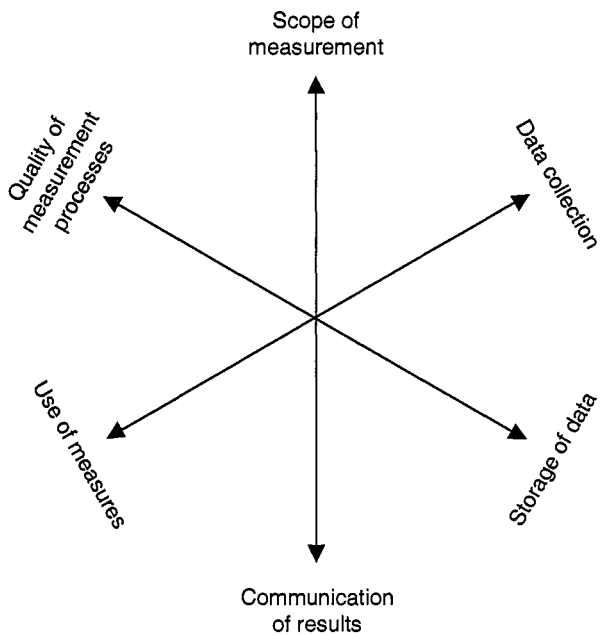

Figure 3: Evolution of a PMS along six dimensions

When designing the empirical study, the assumption was, that the different dimensions were independent one of the other. It was expected that the PMS of a particular company could be very advanced regarding one dimension, say data collection, and rather antiquated regarding another dimension, say communication procedures. However, the analysis of the cases revealed, that the development or growth of a PMS usually follows a pattern. For instance, companies who were enlarging the scope of measurement were also supporting data collection procedures more intensively via IT, performance results were therefore disseminated in a more structured way. In other words, it usually (not always) happens, that the evolution of the PMS takes places concurrently on different dimensions. The evolution of a PMS can be described by four stages/steps: Ad-hoc, Adolescent, Grown-up, and Mature; cf. Fig. 4.

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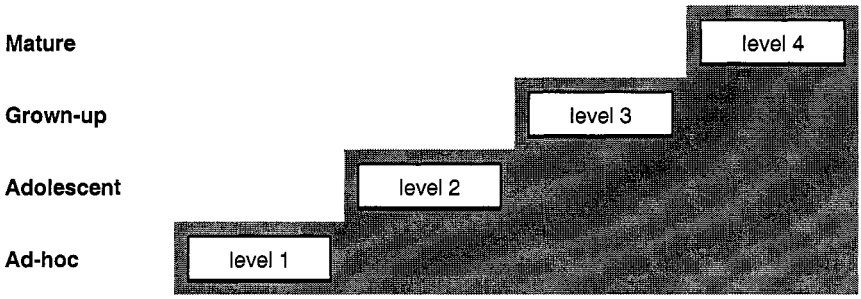

Figure 4: The Maturity Levels of Performance Measurement Systems

What is the difference between a PMS that belongs to stage Ad-hoc (level 1) and a PMS that can be characterized as Mature (level 4)? This question shall be answered by two levels of details. Let's start with the aggregated view. Using the schema of Leavitt (1965) – who describes systems according the four elements Task, Structure, Technology, and People – the transformation that takes place can be described as follows:

- The **task** of a PMS changes from reporting to planning to people involvement. The scope the PMS addresses changes from internal business-oriented emphasis to customer-oriented needs and to stakeholder emphasis.
- The **structure** changes from financial to integrated measurement, and from a decentralized to a centralized or a federated system.
- A PMS that belongs to level 1 is only marginally supported by **technology**, whereas a PMS on level 4 uses technology (in particular Information Technology) comprehensively.
- As the level of maturity increases, the kind of **people** that uses a PMS is changing, too. A PMS at level 1 is mainly used by traditional financial controllers. In contrast, a mature PMS is used by virtually all decision-making staff as well as by selected company-external people. A mature PMS covers the information needs of stakeholders, be they internal or external to the company.

At a higher level of details, the characteristics of each maturity level can be described along the six dimensions presented in Fig. 3. A detailed description of the Maturity Model and its building blocks (dimensions) is presented in Table 2.

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Table 2: A four-stage Maturity Model for Performance Measurement Systems

	Maturity Level 1: ad-hoc	**Maturity Level 2: adolescent**	**Maturity Level 3: grown-up**	**Maturity Level 4: mature**
Scope of Measurement	Only financial performance indicators are considered.	Financial performance indicators are measured. In addition, a few non-financial indicators are measured as well.	Both financial and non-financial performance indicators are measured. Performance measurement takes place at different organizational levels.	Financial and non-financial indicators are measured on a regular basis. The indicators in place reflect the stakeholders' interests. Key processes are measured in an integral way.
Data Collection	Most performance-relevant data is collected manually.	Financial performance data is collected from operational IT systems; however, some manual intervention is needed.	Collection of financial performance data is fully automated; collection of non-financial data needs some manual handling.	Internal and external data sources are exploited. The various operational IT systems are integrated. Thus, data collection does not require manual intervention.
Storage of Data	Performance data is stored in various formats (ring binder, spreadsheets, databases, etc.).	Financial performance data is stored in a central database; non-financial data is dispersed over different units.	Performance-relevant data is stored in local data warehouses using different formats.	Performance data is stored in an integrated IT system.
Communication of Performance Results	Performance results are disseminated on an ad-hoc basis.	Performance results are disseminated periodically to the upper and middle management.	Clear communication structures are established. Non-financial figures are integral part of reported data. Most results are communicated via push mechanism.	Financial and non-financial performance results are transmitted to the stakeholders electronically (push option). Additionally, performance results can be accessed electronically (pull option) at different level of aggregation.
Use of Performance Measures	The use of the performance results is not defined.	Performance data is used primarily for internal reporting.	Performance data is used primarily for analysis purposes and for communicating strategy and goals to staff.	Performance results are used (1) as a central managerial and planning instrument, (2) to support company-external communication, and (3) to get people involved.
Quality of Performance Measurement Processes	The measurement processes are not defined; success depends on individual effort.	A certain degree of process discipline exists; successful execution of the measurement processes can be repeated.	The measurement processes are documented and standardized. The execution of the processes is compliant to the description.	Quantitative goals for the measurement processes are set. Continuous improvement of the measurement processes takes place. New technologies and practices are identified.

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In order to create the Maturity Model for Performance Measurement Systems (see Table 2) three kind of input were used: First, the eight PMSs identified by an empirical study (see Kueng, 2002) were compared one against the other. Thus, rather simple PMSs were confronted with more sophisticated systems. While doing that, the dimensions explaining the key differences between the considered PMSs were elicited. Second, the interviewees were asked whether the PMS in place has been modified during the last few years and what the main alterations were. In additions, they were asked whether the PMS is going to be modified in the future and, if so, what the coming alterations will be. Third, the various options Information Technology can offer in order to support the measurement processes (e.g. data collection, storage, dissemination) were analyzed and integrated into the framework suggested. Overall, the information offered by the three sources was used to create a four-stage Maturity Model.

5 Conclusion

A case study-based analysis has shown that Performance Measurement Systems pass through a number of identifiable stages; so-called Maturity Levels. Based on the empirical data on the one hand, and an analysis of the two classical maturity models (the Nolan model and the Capability Maturity Model by SEI) on the other, a four-stage Maturity Model for Performance Measurement Systems has been developed. *The suggested Maturity Model makes it possible for a firm to see where it stands and how it can improve its Performance Measurement System.*

The overall maturity level of a PMS is determined by six dimensions. These are the following: scope of measurement, data collection, storage of data, communication of performance results, use of performance measures, and quality of performance measurement processes. The developed Maturity Models takes into account the main tasks of a PMS, the underlying processes, the Information Technology, and the people using the PMS.

Although the maturity model suggests that PMSs evolve sequentially from one stage to the next, the model does not imply that this must be true for all dimensions. In other words, it is possible that maturity levels can be skipped at dimension level. For instance, it is possible, that the PMS of a company can skip from level 2 to level 4 regarding the dimension 'storage of data'. However, skipping levels is not equally possible for all dimensions. The dimensions that are mainly determined by technical aspects are more easily to miss out than those dimensions that are process and people-related.

In future work the suggested Maturity Model should be verified. For instance, it should be tested whether the framework makes it possible to classify operational PMSs without ambiguity. In addition, it should be tested to what degree the approach can be applied to *improve* Performance Measurement Systems, and as to whether the improvements of the PMSs lead to economical benefit.

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