Computer-based Performance Measurement in SMEs: Is there any option?

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ABSTRACT: *Performance measurement has been recognised as a crucial element in improving business performance. The aim of this paper is to show that IT is an enabler in the creation of multidimensional performance measurement systems that are based on automated data collection procedures. Several measurement approaches are discussed and evaluated against the needs of SMEs.*

Keywords: Performance management, measures, data collection, data warehouse, ERP, workflow system.

1. INTRODUCTION

Fifty years ago we learnt from W. Deming that business and quality improvement should be regarded as a 4-phase cycle: (1) make a plan; (2) execute the plan; (3) check/study the results; and (4) take corrective action. This approach is known as the Deming Cycle 'Plan, Do, Check, Act'.

In the past, the 'check' step often had a shadowy existence. So-called controllers checked whether the plans and goals were met. However, this was done by studying a number of financial figures such as revenue, return on investment or cash flow (Eccles 1991, p. 132). Non-financial aspects were usually left out. In addition to this, traditional performance measurement has focused on short-term goals (e.g. on monthly reports). Long-term aspects such as employee attitude or public responsibility were neglected or seen as optional and informal. Focusing solely on financial performance measures does not only lead to a limited, narrow perspective, and hence, to an unbalanced assessment of the current business, but it also restricts the power of continuous improvement, since the non-financial aspects are the drivers of future performance.

2. REQUIREMENTS OF SMEs REGARDING PERFORMANCE MEASUREMENT

In order to define the requirements of SMEs, we first discuss the requirements PMSs (Performance Measurement Systems) should fulfil – independent of company size. In a second step the special needs of SMEs are outlined.

2.1 General Requirements of a Performance Measurement System

PMS is understood to be an IT system which gathers performance-relevant data from various sources, compares the current values against historical and target values, and communicates the results to the actors. A PMS has to meet the following requirements:

- As performance is a multidimensional concept (Eccles 1991, Grant/Higgins 1996, Kitchenham 1996), a PMS has to manage both financial and non-financial performance indicators.
- Depending on the PMS framework being applied (e.g. Bititci/Carrie (1998), Kaplan/Norton (1996), Kueng (2000), McNair et al. (1990), Neely/Adams (2000)), different dimensions and PIs (Performance Indicators) are relevant. Therefore, it is necessary that PIs can be defined freely.
- A modern PMS not only measures the performance of functional units (such as business units or divisions), but it also takes into account entire business processes and value chains.
- The collection of performance-relevant data must be automated. If employees are distracted from their original work by gathering performance-relevant data, the use of a PMS may become difficult or even impossible.
- The data analysis facility of a PMS should make it possible to drill down along one dimension and to aggregate PIs across various levels.
- A PMS must support the communication of results. The system should support both push-based and pull-based communication.
- Several authors (e.g. Kaplan/Norton 1996) have stressed the difference between leading and lagging PIs. To verify whether the underlying hypotheses are correct, an ex-post analysis of the gathered performance data is necessary. Consequently, a PMS should provide a facility to assess cause-effect relationships that may exist between the applied performance indicators.

2.2 Strengths and Weaknesses of SMEs regarding Performance Measurement

According to an empirical study, SMEs do not emphasise performance measurement and continuous improvement as much as large companies do. In particular "… larger firms were more apt to collect data, to use benchmarking, to measure customer satisfaction. (…) Finally, respondents from small firms rated their products lower than the larger firms" (Gulbro et al. 2000, p. 78).
Some shortcomings of SMEs in the context of performance measurement are listed below:

- The main focus of SMEs is survival in a highly competitive environment. Small companies are engaged in "… fire-fighting with day-to-day operational matters" (Levy et al., p. 253). Long-term strategies are usually inexistent or very vague.
- SMEs do not deploy IT as intensively as large companies and the use of MIS is low (Levy et al. 1999, p. 253).
- Since SME managers deal very intensively with operational matters, it is difficult for them to carry out company-internal projects.
- SMEs suffer from a shortage of special skills that are needed to successfully implement a PMS.
- Financial resources are clearly limited and it is hard for SMEs to invest large sums in a single project.

SMEs do not have only disadvantages, they have two important strengths. Firstly, the degree of bureaucracy is lower (Vinten 1999, p. 114) and the internal lines of communication are shorter (Winch/McDonald 1999, p. 50). Secondly, managers of SMEs have more intensive relationships with their customers. However, while in the past many SMEs were acting on local markets, today web-based technologies and community networks are changing the basis of competition. More and more SMEs are now exposed to the forces of global competition. From this point of view, it is unlikely that PMSs are exclusively useful to large corporations.

3. TECHNICAL APPROACHES TO MEASURING PERFORMANCE

In the past many tools and techniques to assess performance have been proposed. Among the most popular techniques are activity-based costing, balanced scorecard, competitive benchmarking and statistical process model. Independent of the chosen technique, performance measurement includes the following tasks: (1) the units of evaluation must be determined; (2) the PIs to be measured must be defined; (3) the data sources must be identified; (4) the collected performance data must be stored permanently; (5) mechanisms to access and disseminate the results must be established (Kueng/Krahn 1999).

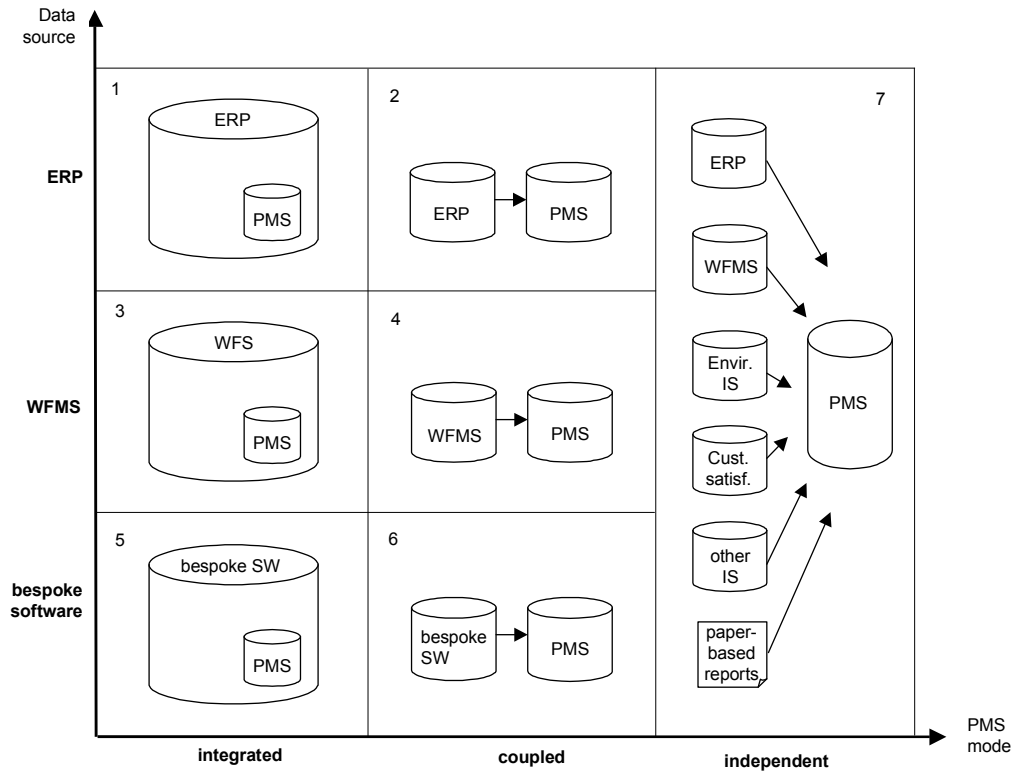

Figure 1: Conceptual design of various PMS options

As stated above, the collection of performance-relevant data should be automated as much as possible. From this point of view, the operational IT systems which are in place in the company should be used as a primary data source. In this paper we take into consideration three kinds of data sources/operational IT systems: (1) ERP systems, (2) workflow management systems, and (3) bespoke software. Once the primary data source is identified, one has to decide on the appropriate architecture. In this paper we consider three options: (1) the PMS is an integral part of the operational IT system; such an architecture is referred to as an *integrated PMS*. (2) The PMS is external to the operational IT system but the two IT systems are mutually adjusted, i.e. the design of the operational IT system influences the design of the PMS; this architecture is called a *coupled PMS*. (3) The operational IT system and the PMS are completely separate and the PMS may collect performance-relevant data from several sources; this architecture is referred to as an *independent PMS* since the design of the operational IT systems does not affect the design of the PMS; see Figure 1.

In the following three sections the various PMS options shown in Figure 1 are discussed. For each option it is observed to what extent the evaluation of the business' performance is supported. The performance-relevant aspects we are looking at are financial aspects, customer aspects, process aspects, employee aspects and societal aspects; this is a subset of the EFQM (2000) model.

4. ERP SYSTEMS AS A DATA SOURCE

Today, a majority of large companies has an ERP system in place (e.g. R/3™ by SAP or OneWorld™ by JDEdwards). These systems have in common that (a) they are based on a central, relational database, (b) they are built on a client-server architecture, and (c) they consist of various functional modules such as modules for general accounting, budgeting, fixed assets, sales order management, procurement, inventory management, customer service management, etc. ERP systems may support most functional units and processes of a company – if its structures and working procedures are not too far from the mainstream. If SMEs deploy ERP systems, many performance-relevant data are generated and are stored in the database of the operational system; e.g.

- *financial aspects*: sales revenue per employee, costs per order or per item sold
- *customer aspects*: proportion of orders delivered on the date wished by the customer
- *process aspects*: cycle time for the order process; amount of waste in a manufacturing process
- *employee aspects*: number of days used for training per employee
- *societal aspects*: volume of fuel and gas used for heating

As outlined in Figure 1 the PMS (i.e. the features and functionalities) may be *integrated* in an ERP system. This means that the ERP system determines the performance reports that can be created. In the past, ERP systems offered very limited facilities to evaluate and analyse business performance. This is changing now. The vendors of ERP systems have enhanced the reporting functions of their products. However, a closer examination shows that today's ERP systems still lack a comprehensive performance evaluation. From the point of view of an SME with limited skills, a PMS that is integrated into an ERP system offers the advantage that the PIs are predefined and given by the system. At the same time, pre-defined PIs may not be accepted by the non-highly specialised employees of SMEs for whom these might be too complex and not sufficiently transparent.

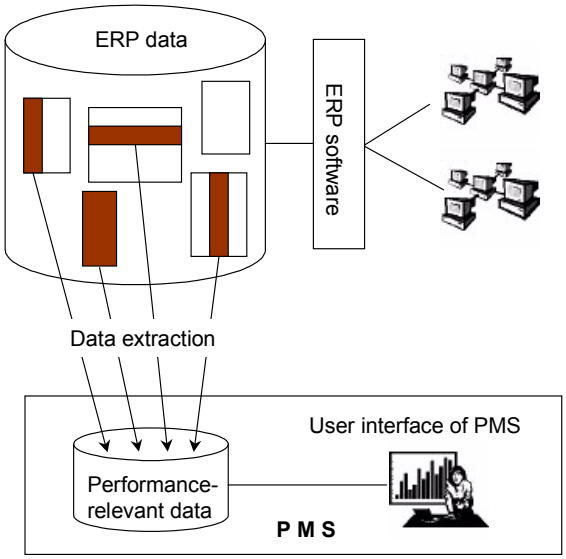

Figure 2: An ERP system as a primary data source for a PMS

If an ERP system is in place the PMS may also operate separately, in the *coupled mode*. This kind of PMS was created in a collaborative project between Fribourg University and a pharmaceutical company. The conceptual design of that system is shown in Figure 2. In this project the operational IT system was R/2™ from SAP. The extracted data were stored on R/3™ running on a Unix system. Through a graphical user interface the managers were able to access the performance data, to compare the current performance with target values, etc.

The creation of a PMS that is coupled to an ERP is time consuming and requires a considerable financial investment. On the other hand, this approach makes full use of the potential information that is stored in an ERP system. Of course the potential of information that resides on an ERP system depends on the number of modules that are implemented, and generally speaking, this is lower in SME lower than in large corporations.

5. WORKFLOW SYSTEMS AS A DATA SOURCE

A WFMS is a system that "… defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications." (WfMC 1999). The execution of workflow instances is reported by the workflow engine. This data is known as an audit trail. In Figure 3 a sample audit trail is shown. It was produced while an instance of the process "bank loan" was carried out. The trail shows *who initiated* the process instance (viz. TW), *when* the process instance *started* (9:54 a.m. on 12 April 2000) and *when* it *ended*. In addition it shows that the process "bank loan" involves six activities and it specifies for each activity the owner, start date and end date. Such a trail may be analysed through a workflow monitoring and controlling tool such as PISA (zur Muehlen/Rosemann 2000).

```
Job: HWH
Process: bank loan
Owner: TW/uf,U001/uf,U002/uf,U003/uf,U004/uf,U005/uf,FF/uf
N Name  Owner  Initiator   Start date            End date              Status     Priority
1 HWH   TW/uf  TW/uf       4/12/2000, 9:54:53 A  4/12/2000, 3:46:13 P  Completed  2-medium
Activity Instance
N Name                     Owner    Start date             End date               Status
1 Request bank loan        FF/uf    4/12/2000, 09:56:41 A  4/12/2000, 09:57:17 A  Completed
2 Check pay slip           U001/uf  4/12/2000, 09:57:34 A  4/12/2000, 09:57:49 A  Completed
3 Check financial situat   U001/uf  4/12/2000, 09:58:15 A  4/12/2000, 09:58:21 A  Completed
4 Decision                 FF/uf    4/12/2000, 09:58:40 A  4/12/2000, 09:59:30 A  Completed
5 Letter of acceptance     TW/uf    4/12/2000, 11:28:45 A  4/12/2000, 11:29:15 A  Completed
6 Inform customer          TW/uf    4/12/2000, 02:08:42 P  4/12/2000, 02:38:00 P  Completed
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Figure 3: An example of an audit trail created by the workflow management system DominoWorkflow™

What kind of audit data – generated by a WFMS – can be used for performance measurement? This question shall be answered using the example above, i.e. the process "bank loan". In Table 1 some PIs are listed that may be evaluated. For example the number of instances processed (i.e. the number of requested loans) and the average lead-time can be analysed. There are other PIs, such as the proportion of customer complaints or the acceptance quote, which cannot be evaluated via the audit trails of one single process. To do this, audit data from two or more processes were needed. To facilitate such an evaluation, the audit trails of all workflow processes can be exported into a data warehouse (List et al. 2000) and analysed on that platform.

	Performance indicator	Operational definition	Data provided by WFMS
Financial aspects	Average sum of the bank loan	AVG(loan)	No
Customer aspects	Customer satisfaction		No
	Proportion of customer complaints	COUNT(Instances of process "complaints") divided by COUNT(Instances of process "bank loan")	partly
	Proportion of customers that fulfil contract		No
Process aspects	Number of instances processed	COUNT(Instances[process])	Yes
	Average lead time	AVG((end time[process]) minus (start time[process]))	Yes
	Acceptance quote	COUNT(Activity instances of "letter of acceptance") divided by COUNT(Instances of process "bank loan")	partly
Employee aspects	Productivity	SUM(handling time) divided by hours of work(presence)	partly
	Employee satisfaction		No
Societal asp.	Amount of toxic substances emitted		No

Table 1: Performance indicators provided by a WFMS (examples)

From an architectural point of view, the PMS may be integrated into a workflow system or it can be coupled to a workflow system. In the *integrated* mode the PMS (i.e. the monitoring component) is part of the workflow application. The functionality is very limited, e.g. generation of basic reports. In the *coupled* mode the monitoring component represents a separate application, the functionality is larger and the interface is more user-friendly.

Overall, WFMSs can generate useful performance information regarding process-related aspects. The customer and employee dimension is partly supported. PIs for financial aspects cannot be provided by a WFMS since audit data does not encompass operational data of the process instances; these data normally reside in the business applications.

6. BESPOKE SOFTWARE AS A DATA SOURCE

SMEs are less inclined to purchase off-the shelf business software packages (e.g. ERP software) than larger firms. Instead, many SMEs deploy bespoke software that is tailored to their company or industry. Most traditional bespoke software (sometimes referred to as custom-made software) has poor reporting facilities and often lacks vital elements such as components for marketing planning (e.g. database marketing), human resource management (e.g. skill inventory), customer relationship management, and process management. Nevertheless, bespoke software may be used to assess various dimensions and performance indicators; e.g.:

- *financial aspects*: sales revenue per article or article type, contribution margin
- *customer aspects*: proportion of active customers, sales revenue per customer
- *process aspects*: few or no process-related PIs
- *employee aspects*: level of education and training, labour turnover rate
- *societal aspects*: few PIs or none

SMEs using tailor-made software will probably opt for the *integrated* mode. The advantages of this option are the following: (a) the PIs can be fully customized to suit the individual goals and strategy of the company; (b) the PIs can be implemented stepwise whenever they are needed are needed; (c) PIs can be modified autonomously; (d) the data gathering process can be fully automated since all modules of the software can be accessed and modified; (e) the calculation and dissemination of the results can be automated; (f) the users are not forced to deal with an additional user interface; this reduces barriers for using the PMS. The *coupled mode* option on the other hand has a major disadvantage: the size and complexity of the software increases. Additionally, the cost for implementing and modifying the PIs might be higher than with an ERA- or workflow-based PMS.

Hankinson et al. (1997) have analysed some key factors of SMEs and found in their UK-based empirical study that SMEs are very much dependent on large companies. For instance “The majority of the SMEs dealt with two to five customers that produced 50 per cent of turnover” (1997, p. 173). If SMEs act mainly as suppliers of large enterprises, they have to respect the IT requirements set by their large customers. In such a scenario, an SME that uses bespoke software can be forced to implement additional software to support the supply chain of its main customer(s). Thus, it would not be appropriate to extend the customized software by an integrated PMS module; it would be more efficient to set-up an independent PMS.

7. COMPARISON OF THE APPROACHES AND CONCLUSION

In sections three to six, various options have been described for supporting computer-based performance measurement. In the following part, the approaches discussed above will be compared using the criteria mentioned in section two. We take into account two groups of requirements, SME-specific and PMS-generic criteria. The first group contains five, the second group contains ten criteria. Since both groups are regarded as equally important, the SME-specific criteria are weighted by a factor of two.

According to Table 2, the option “buy an independent PMS” gets the highest score. In the previous sections we did not differentiate whether an independent PMS would be created by the SME or whether the SME would buy it. However, if an SME decides to deploy an independent PMS that offers strong functional capabilities, it may not be appropriate to establish it company-internal, since SMEs have substantial limitations regarding financial investments and specialised skills.

An SME that uses an ERP system should opt for an integrated PMS since a coupled PMS, based on an ERP system, leads to considerable investment. The same holds for SMEs using workflow management systems. The coupled mode offers enhanced analysis facilities but the approach leads to increased costs that may not outweigh the additional technical features.

As indicated in Table 2, independent PMSs that use performance-relevant data from various sources (see Figure 1, option 7) may support performance measurement quite strongly. The PIs that can be evaluated are numerous, and the analysis and reporting facilities are enhanced. It would be beneficial to SMEs to set up an independent PMS from their own resources (i.e. not dependent on third parties). To support this approach, a framework

containing several templates that could be parameterised according to the SME's organisational and technical requirements would be needed. At Fribourg University we are currently evaluating the applicability of this idea.

PMS option / Requirements	ERP-based PMS		WFMS-based PMS		bespoke SW-based PMS		independent PMS	
	inte-grated	cou-pled	inte-grated	cou-pled	inte-grated	cou-pled	make	buy
SME-specific requirements:								
• design and implementation of PMS requires little time	++	.	++	+	+	.	.	+
• design and implementation of PMS requires little investment	++	.	++	.	+	.	.	+
• use of PMS leads to little costs	++	+	++	+	+	.	+	+
• design and implementation of PMS does not require special skills	++		+	+	.	.	.	+
• use of PMS does not require special skills	+	+	+	+	++	.	++	+
Scores regarding SME requirements (weight=2)	18	4	16	8	10	0	6	10
Requirements for PMS:								
• measurement of financial aspects	++	++	.	.	++	++	++	++
• measurement of customer aspects	+	+	+	+	++	++	++	++
• measurement of process aspects	.	+	++	++	+	+	++	++
• measurement of employee aspects	.	+	+	+	+	+	++	++
• measurement of societal aspects	.	.	.	.	.	.	+	+
• performance indicators may be defined freely	.	+	.	+	++	++	++	+
• user-friendly interface	+	++	.	++	+	++	++	++
• drill-down and aggregation facility	+	++	+	++	+	+	+	++
• calculation of cause-effect relationships	.	+	.	+	.	+	+	++
• analysis of time series	+	++	+	++	+	++	++	++
Scores regarding PMS requirements (weight=1)	6	13	6	12	11	14	17	18
Scores (total)	**24**	**17**	**22**	**20**	**21**	**14**	**23**	**28**

Legend: . criterion not fulfilled + criterion partly fulfilled ++ criterion fully fulfilled

Table 2: Comparison of the PMS options

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Due to space limitations only the most important references are listed. The entire list of references is available upon request from the first author.

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