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Benchmarking as a Controlling Tool in Information Management

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Abstract

This paper reports a study on the interfaces between benchmarking and information management controlling. Based on a definition analysis and an ARIS-based reference model for benchmarking, we explore the use of benchmarking as a controlling tool with respect to three main concerns: how benchmarking supports management of business processes, application systems, and infrastructures.

Keywords

Benchmarking, IM-controlling, reference model

1 INTRODUCTION

Information Management (IM) controlling and benchmarking have been a primary focus on research in the current decade. The motivation for using IM-controlling tools are twofold. On one side, controlling provides coordination for the operative applications. On the other side, it ensures the cost-efficient utilization of information processing (Scheer, 1995). Simultaneously, high attention on benchmarking has become a part of the total quality movement, which swept through the manufacturing industry and spread to the service sector and non-profit organizations.

Given the heightened attention on both IM controlling and benchmarking, it is surprising that little research has been conducted to examine the linkages between these two concepts in depth and to integrate them properly.

This paper presents how benchmarking fits with IM controlling. Specifically, we explore the use of benchmarking as a controlling tool with respect to three main concerns: how benchmarking supports management of business processes, application systems, and infrastructures.

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2 BACKGROUND

To establish the linkages between the concepts of benchmarking and IM, the following prerequisites are required:

- the creation of a holistic understanding of benchmarking.
- the development of a reference model for benchmarking capable to guide our research on its role in IM.

Next we are going to propose our solution regarding these issues.

2.1. Deriving a holistic definition

The development of a holistic view to benchmarking is based on the analysis reported in (Heib and Daneva, 1995) where we considered 42 benchmarking definitions and derived 11 relevant dimensions that characterize the benchmarking process (Table 1).

Table 1 Benchmarking-Dimensions

Dimension	*Instance*
Focus	Process-focused, Tool-focused
Benchmarking Goal	Radical Redesign, Incremental Improvement
Benchmarking Object	Product, Process, Function, Resource, Strategy
Application Context	Marketing, Research and Development, Controlling, Total Quality Management, Strategic Management, Reengineering
Organizational Implementation	Benchmarking Project Team, Routine
Information Source	Primary, Secondary
Benchmarking Network	Multi-Client, Single-Client
Benchmarking Partnership	Friendly, Unfriendly, Anonymous
Cultural Background	American, Japanese, European
Decision Level	Strategic, Tactical, Operational
Benchmarking Scope	Internal, Competitive, Cross-branch

These are further used as a basis for formulating a new benchmarking definition. Our motivation behind it was that the definitions available in the reference basically concern particular benchmarking aspects, and do not explicite the relation between company's goals and benchmarking. We propose to use the following definition:

Benchmarking is a business management tool for defining feasible change goals. It is a continual assessment of business objects against the best-in-class ones or a standard, based on measurable characteristics. It is aimed at keeping or regaining company's competitive edge.

2.2. Reference Model for Benchmarking

To ensure the holistic understanding of benchmarking and to provide a mechanism for structuring the information about benchmarking practices, a reference model for benchmarking is developed. It is an universally applicable model that is adaptable to the company's specific goals and describes feasible benchmarking approaches. The model does not focus on a particular benchmarking case, but at structures typical for a set of enterprises that might be classified according to common characteristics (Hars et all, 1992). Therefore, the development of a reference model results from a thoughtful analysis of both theoretical considerations and empirical studies concerning the problem domain. In our work, we account the theoretical analysis given in the previous section, as well as, several empirical benchmarking studies (Hirsch et all, 1994, Rolstaadas, 1994) and some US Government and industry guides.

To represent the benchmarking process, the ARIS (Architecture of Integrated Information System) methodology for information modelling proposed by (Scheer, 1992), is selected. Generally, the objective of ARIS is to facilitate the specification and implementation of information systems supporting business processes. The ARIS methodology predefines four descriptive views (data, function, organization, and control view) and three levels (requirements definition, design and implementation). For each level and each view a set of suitable and integrated description methods is previewed (Scheer, 1995). We developed our reference model at the requirements definition level. The model consists of four description views: data, function, organization and control (process) views. The languages used for enterprise modelling are: extended Entity-Relationship Model, function trees, organizational charts, and event-driven process chains, respectively. Due to the space limitations, we describe in details the data view only (Figure 1).

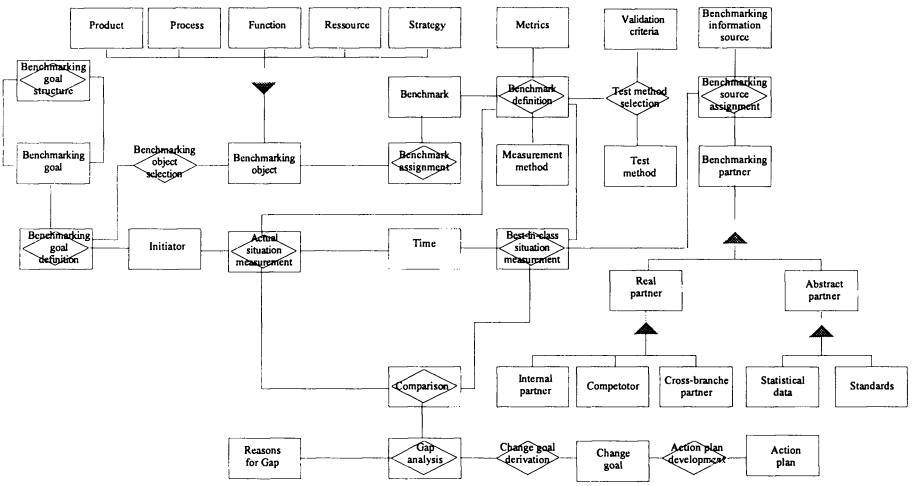

Figure 1 A reference model for benchmarking: the data view.

The entity type BENCHMARKING GOAL assigns a BENCHMARKING OBJECT to the INITIATOR. Next, the entity BENCHMARK DEFINITION should be established. It is an aggregation of a BENCHMARK, a METRIC and a MEASUREMENT METHOD. The first two entities address some quality (or performance) attributes of the BENCHMARKING OBJECT that are to be investigated. We differentiate between METRICs and complex BENCHMARKs. The latter are quantified by assessing one or more facts about the BENCHMARKING OBJECT. Each fact to be assessed is called a METRIC. Moreover, the MEASUREMENT METHOD is a detailed step-by-step instruction on how a particular benchmark measurement is to be carried out. It does not specify any benchmarking case, but describes in general terms the measurement philosophy that is to be adopted. It can be expressed by a rule how to evaluate a METRIC or by a formula for calculating the value of a BENCHMARK. Any BENCHMARK DEFINITION implies a selection of relevant VALIDATION CRITERIA. These show how a series of measurements would be judged to have passed or failed and also are used to confirm that what we have measured is what we want to measure. The BENCHMARK DEFINITION has to be applied to both the INITIATOR and the BENCHMARKING PARTNER, and this measurement results in determining ACTUAL SITUATION's measure and BEST-IN-CLASS one. Both the measures should be considered with respect to the TIME when the measurement study takes place. We use the generalization concept of BENCHMARKING PARTNER to encompass both cases when the INITIATOR assesses itself against existing organizations (INTERNAL PARTNER, COMPETITOR, CROSS-BRANCH PARTNER), and against empirical industry data (STATISTICAL DATA, STANDARDs).

The entity type COMPARISON means to establish a diagnosis showing how much the ACTUAL SITUATION differs from the BEST-IN-CLASS one. The COMPARISON helps the INITIATOR focus on particular issue that offers the greatest opportunity for improvement. Next, the GAP ANALYSIS identifies the REASON that has lead to the existing gap. Based on the COMPARISON and the REASON, the entity types CHANGE GOAL and ACTION PLAN represent the final results of the benchmarking exercise.

3 IM CONTROLLING THROUGH BENCHMARKING

The holistic benchmarking definition and the reference model were used to develop a documented and disciplined procedure for studying the potentiality of benchmarking as an IM-controlling tool. We established a systematic and structured research method that could be applied to any of the three IM-levels, i.e. to business process management, application system management and infrastructure management. The procedure includes the following steps:

1. *Systematize benchmarking goals.*
2. *Identify relevant objects to be benchmarked.*
3. *Assess the applicability of the current benchmarking practices in IM-controlling.*
4. *Find out typical illustrative examples for benchmarks.*
5. *Identify potential problems and further research opportunities.*

We followed this procedure with respect to all IM-levels. A summary of our findings is given in Table 3 at the end of this section.

3.1. Benchmarking in Business Process Management

To study the interface between benchmarking and business process management, two issues should be considered: business processes and business process models.

Business Process Benchmarking

Benchmarking Goals

Business process benchmarking is principally concerned with company's efforts to achieve long-term competitive and customer advantages. One way that benchmarking is very useful, is the identification of non-value added enterprise's activities. This leads to target activities for removal or reduction which are adding cost but not value to company's processes. Another way to employ benchmarking as a process controlling tool is to use it in sensitive (what-if) analysis: by conducting benchmarking, we can explore the costs associated with the TO-BE business situation, and thus, we determine how much improvement would be gained by the change.

Benchmarking Objects

Process-related benchmarking studies primarily compare business processes as a whole. In case of complex processes, it is reasonable to divide the process in manageable and logically structured subprocesses. These can be benchmarked, then.

State of the Art Benchmarking Practices

Nowadays, both practitioners and academicians agree with the statement that process benchmarking is especially fruitful if it is applied to enterprises from different branches (Mertens, 1995, Camp, 1994, Davenprort, 1993). Davenport even suggests that looking for process innovation does not obligatory mean searching for best practice: „even a poorly performed process in a poorly performing company can have innovative aspects". Thus, it is essential to benchmark distinctive uses of process innovations. Even relative narrow aspects of processes can be worthy of analysis. For example, several companies that have decided to reengineer their order management processes, have studies the division of AT&T whose personnel exploits laptop computers and portable networking to work without offices. Although this detail do not comprise a whole process, it can be considered as an essential element of an order management method.

The current systematic approaches to the development of performance measurement systems for business processes (Brenner, 1994, Rolstaadas, 1994) rely on the analysis of critical success factors. Following Brenner (SAP AG), these factors fall in three groups: strategic, environment and company-specific. The first group involves factors concerning a certain enterprise's process, e.g. time to market, process profit, etc. Next, the environment factors concern two process levels: performance and implementation. The process performance level refers to the benefits the process delivers to its customers. In contrast, the implementation level deals with all elements (resources, inputs, outputs) bundled in the process. Benchmarks referred to the performance level are: time, cost, quality, flexibility, and measures relevant to the implementation level are: capacity, efficiency, etc.

Finally, process-specific success factors can been derived from analysis of responsibilities and interests of the participants in the process („stockholder analysis").

Example of Benchmarks/Metrics

An excellent example of process benchmarking is presented in (Hirsch et all, 1994), where bid preparation processes conducted in three multinational companies (ABB, Krüger Engineering,

and Guehring Automation) are evaluated and compared. Significant is the fact that - although the ABB subdivision in Srommen, manufactures rolling stock for railways, Krüger Engineering, Copenhagen, is engaged in environmental protection, and Guehring Automation, Frohnstetten produces grinding machines, the anticipated bid preparation bottlenecks are similar and thereby independent on the product. The enterprises' processes were examined regarding the following issues: bid project management, inquiry assessment, product design, cost estimation, product scheduling, sales price fixing, bid document compilation.

Potential Problems
Successful process benchmarking relies on exact definition of criteria for dividing business processes in subprocesses, as well as on controlling methods that should enhance the efficiency of the benchmarking process itself (Weber et all, 1994). Reliable solutions regard to these two problems, can render process benchmarking initiatives in a primary vehicle for IM-controlling.

Process Model Benchmarking

Benchmarking Goals
Comparisons of business process models can serve for many purposes, some of which are enumerated below:
- to control the process of enterprise modelling, and to ensure model quality in efficient and effective way.
- to anticipate fallacies and pitfalls in integration of submodels and/or customization of reference models.
- to optimize reference models.

Benchmarking Objects
Examined objects can be either integrated business process models, or submodels, e.g. data models, functional models, etc.

State of the Art Benchmarking Practices
Till now, there exist a few references reporting about comparative model analysis (Maier, 1995). All of them focus on modelling methodologies. Recent research on reference model assessment (Hars, 1993) lead us to two hypothesis:
- benchmarking of process models provides information needed for conceptualizing business processes.
- the comparison between a reference model and an enterprise's process models can be considered as a model validation approach.

Examples of Benchmarks/Metrics
The development of benchmarks for models follows hierarchical building principles. Currently, four measures can be used (Hars, 1993): size (the quantity of elements needed to represent a business process), complexity of the model structure, detail level (the extent to which the model represents the universe of discourse in detail) and modularity (the model's ability to be divided into smaller units).

Potential Problems
Benchmarking of business process models concerns the following problem domains:
- defining and systematizing of model benchmarks (measures).
- validating the expressive power of benchmarks.

3.2 Benchmarking in Application Systems Management

IM-controlling at the level of application management refers to strategic decision making on software life cycle and software development paradigms (Scheer, 1995). The interfaces between benchmarking and IM-controlling at this level are focused on both standard and application software systems.

Benchmarking Goals
Both standard and application software systems are benchmarked with the following objectives:
- to compare different software packages of a certain type in order to select the most capable of meeting some requirements.
- to compare different releases of one product in order to control the quality enhancement.

Benchmarking Objects
The software product can not be differentiated from the benefits it provides the users with. Software service, user training programs, product guarantees, and software brand image are treated as complements to any software system. Hence, each of them can be selected as a benchmarking object.

State of the Art Benchmarking Practices
The problems of software benchmark design and use have been discussed in (Daneva, 1995). During benchmarking of standard software two basic activities should be carried out: assessment and comparison. Software assessment means to construct an assessment specification and to report measured values (SCOPE, 1991). Next, software products are typically compared by using the additive-weight method. This practice is accepted by world wide testing organizations such as DATAPRO, VARBUSINESS, National Software Testing Laboratory (USA). Another usable method for software ranking are Anderson's algorithm and QR method (Daneva, 1995) which build rank numbers by considering certain inferiority and superiority measures in software product quality.

Examples of Benchmarks/Metrics
Software benchmarks are usually represented by a quality three consisting of complex benchmarks and metrics. The elements at the bottom of the hierarchy are assessed by counting how many of a certain quality the product posses. For example, the SCOPE-research team introduced countable software metrics that can be used to compute the following complex benchmarks: modularity, generality, portability, redundancy, integrity, complexity, execution and storage efficiency.

Potential Problems
The current problems related to software benchmarking refer to the software product model and the benchmark systems:
- till now there exist no unifying approach to product modelling. Only particular solutions addressing specific purposes (certification, assessment) are proposed (SCOPE, 1991).
- there exist no sound model for the user satisfaction from standard software. With a few exceptions, the current software benchmarks do not concern the user.

3.3 Benchmarking in Infrastructure Management

IM-controlling in infrastructure management is defined as a process at operative level that includes controlling information system's (IS) units (application programmers), managing repositories, coordinating the communications between internal and external networks (Scheer, 1995). Hence, the relevant dimensions we should study at this IM-level are: software processes, IS environment and IS-organization.

Software Process Benchmarking

Benchmarking Goals
The main purpose of software process benchmarking for a company is to learn about its own technological opportunities by learning about other's similar operations.

Benchmarking Objects
The target objects are the software development process, or specific functions.

State of the Art Benchmarking Practices
Software benchmarking has been expanding from the product area into the domain of software process assessment. There are also hybrid approaches (Jones, 1996) that couples the collection of process data and product quality data. The currently available schemes for software process assessment and comparison could be grouped in three categories:

- certification-based frameworks, such as the standard ISO 9000, the Capability Maturity Model for Software (CMM), the BOOTSTRAP method, etc.
- metrics-technology-based approaches proposed by ESPRIT-consortia like AMI, METKIT, MARMAID, MUSiC, PYRAMID.
- workbench-supported evaluation methods such as Function Points and Feature Points, that capture quantitative information about software metrics automatically (Jones, 1996).

There are two types of procedures for software comparisons: heuristic approaches, based on heuristic rules derived from the practice, and probabilistic methods based on decision science.

Examples of Benchmarks/Metrics
The use of software measures is discussed in details in (Jones, 1996). On the base of a significant amount of large software projects, the author investigated the patterns contributing the most to project outcomes. For example, Table 2 illustrates the implication of automated software measurement and controlling for project's success.

Table 2 Probability of software project success or failure associated with Management Factors (Jones, 1996)

Factors	*Cancel*	*Delay*	*On-Time*	*Early*
Manual estimates Manual planning Informal tracking Minimal quality control	40%	45%	15%	0%
Automated planning Automated estimates Formal tracking Optimal quality control	1%	2%	78%	19%

Potential Problems
Software process benchmarking is a very complex problem domain because of its relative youth, of its multidisciplinary nature, and because of the great diversity, variability, and complexity of participants in software development process. Some high potential area of interest in software benchmarking are:
- the development of reference models for software business.
- the development of reliable data collection procedures to analyze the process execution against process objectives.

Hardware Benchmarking

Benchmarking Goals
Hardware systems benchmarking is conducted with two goals:
- to compare different systems on different platforms running the same application, for example SQL on an IBM AS/400 versus Informix on HP 900.
- to compare different machines in a computer family.

Benchmarking Objects
Typical objects under consideration are computer platforms.

State of the Art Benchmarking Practices
General guidelines about how to conduct computer benchmarking are provided by several world known consortia: Transaction Processing Council (TPC), System Performance Evaluation Corporation (SPEC), Business Application Performance Council. They provide also benchmarks that measure and record the performance of a system.

Examples of Benchmarks/Metrics
Computer benchmarks are classified along two dimensions (Crawford, 1994):
- Generic/ Domain specific. Generic benchmarks are often used as a rough estimate of the relative system performance and price/performance of a system. Performance is typically a throughput metric (work/second), while price is the cost over some period of ownership metric. Domain-specific benchmarks try to model the computer workload for specific applications for a given problem domain (e.g. CAD/CAM, CASE, etc.).
- Standard/ Custom. The TPC-A and B are now the only generally recognized standard benchmarks that checks different aspects of database performance. Next, a custom benchmark models the functionality of a real commercial system by using a subset of the user application.

Potential Problems
A basic problem in computer benchmarking is how to develop a common understanding among the benchmarker and the customer (Crawford, 1994). In a lot of cases the investigator' interpretation of the benchmark is different than that of the benchmarking sponsor.

IS-Environment Benchmarking

Benchmarking Goals
Benchmarking practices are used to gain insight into company's engineering environment.

Benchmarking Objects
Typical objects for environment benchmarking are: CASE-tools, programming languages, operation systems, graphical interfaces.

State of the Art
Since the IS environment elements can be considered as software products, the benchmarking practices used for standard software are suitable for studies on the IS-environment as well.

Examples of Benchmarks/Metrics
In this section we review briefly environment benchmarking issues with respect to some of the above given target objects:

- CASE-tools: due to the role of software certification as essential company's image component, the CASE-tools are benchmarked to find out the most suitable tool for building a Quality Management System.
- Programming languages: These are benchmarked to reveal the best implementation strategy for a certain project, or to compare potentials of different programming paradigms (for example, structural versus object-oriented).
- Operation systems: currently, the operating systems are compared to establish the optimal number of concurrently working users. Typically studied systems' attributes are: price/performance, workload parameters, concurrency and consistency mechanisms, transaction models supported.

Potential Problems
Basic problem for IS-environment benchmarking is how to derive a benchmark system specific for a certain company by using given general recommendations (standards), for example, ISO 9000 or CMM.

Organizational Benchmarking

Benchmarking Goals
Much of the research on organizational benchmarking has concerned the efficiency and the effectiveness of an IS organizations. Fundamentally, these benchmarking studies have focused on the following goals:

- to find out the best way of using the IS in the organization so as to optimize IS-benefits.
- to establish the best workable solution to combine information from different separate sources.
- to establish the best programs for promoting cooperation and communication within the IS organization.

Benchmarking Objects
Typical objects for benchmarking are organizational units ranging from a single worker, project team, department, enterprise, to the corporation as a whole.

State of the Art Benchmarking Practice
Following Mertins (Mertins et all, 1995), organizational benchmarking involves an assessment of the unit and creating measurement figures. These can be organized along to five dimensions: times, costs, attractive work places, quality, innovative potential. Thus, organizational benchmarking studies consider not only the organizations themselves, but all functions contributing to the value adding process. The evaluation methodology employs the collection of objective data as well as making subjective judgments.

Table 3 Benchmarking in IM

IM Subprocesses	*Benchmarking Goals*	*Benchmarking Objects*	*State of the Art*	*Examples of Benchmarks*
IT-based Process Management	• to state business process goals. • to create process vision.	Business Processes Subprocesses	• SAP's process measure classification. • Cross-branch benchmarking approaches	Time Cost Quality
	• to ensure model quality efficiently, to validate process models, to control the process of enterprise modelling. • to anticipate pitfalls in integration of submodels and/or customization of reference models. • to optimize reference models, and to facilitate cost estimation for modelling.	Process Models	• Hars' measure set for reference models	Complexity Size Modularity
Application Software Management	• to compare software of a certain type in order to select the most capable of meeting some requirements. • to compare different releases of one product in order to control the quality enhancement.	Standard Software	• Assessment methods: SCOPE-methodology, hierarchical quality models (McCall) • Comparison methods: Additive-weight method, Anderson's approach, QR algorithm.	Ease of Use Ease of Learn Reliability Service
IT-Infrastructure Management	• to learn about company's own technological opportunities by learning about other's similar operation.	Software Process	• Standards: ISO 9000, Capability Maturity Model, BOOTSTRAP Method. • Approaches proposed by ESPRIT-metric projects: AMI, METKIT, MARMAID, MUSiC. • Workbenches: Function Points, COSMOS.	Organization Maturity Technology Maturity
	• to compare different systems. • to compare different machines in a computer family	Hardware Systems	• Methodologies proposed by SPEC, TPC, Business Application Performance Council	Price/perform. Throughput
	• to gain some recognized quality appraisal. • to gain insight into company's engineering environment	IS-Environment	• Standards: ISO 9000, DIN Norms regard to Software Development.	Usability in Life Cycle Software Mngm.
	• to optimize IS-benefits for the organizations. • to establish the right workable solution to combine information from different sources. • to establish the best programs for promoting cooperation within the IS organization.	IS-organization	• Mertins' approach to organizational benchmarking. • Extended profitability calculation. • „balanced scorecard". and „informed spectator" methods.	Customer Satisfaction Efficiency Job Satisfaction Financial Performance

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