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**ARIS-based Reference Model
for Benchmarking**

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1. Introduction

Benchmarking is today an emerging strategy for improving the competitiveness of the enterprise. Its importance significantly increases when it is a part of a business process (re)engineering project, and serves as a basis for taking process perspective and creating process vision (Davenport, 1993). Conducting a benchmarking study usually is a taxing job that requires a great deal of specialized information in order to perform the work well. According to American Productivity and Quality Center (APQC), a study can range anywhere from over \$100 000 to \$ 5 000, depending mainly on company's knowledge and competency in benchmarking, the studied objects and the benchmarking partners. Moreover, recent research of APQC's International Benchmarking Clearing House revealed that 95% of respondents believe most companies do not know how to benchmark (Biesada, 1992).

The objective of our work is to create a sound and consistent basis to capture benchmarking expertise and to document it properly. To resolve the above discussed situation, we propose to use the concept of reference models (Hars, et al, 1993). We first develop a holistic benchmarking definition and, then, we integrate all relevant aspects of the benchmarking process in a reference model that helps both companies and academic institutions conduct benchmarking studies according to a disciplined and documented procedure.

The paper is structured as follows: In the section 2, we review some benchmarking concepts that are proven to be good scientific and engineering practices. Section 3 delivers a reference model for benchmarking developed by using of ARIS-methodology. Future research problems are discussed in section 4.

2. Benchmarks and Benchmarking: a Definition Analysis

2.1. The Term Benchmark

The original meaning of the word benchmark refers to a metric unit on a scale by means of which a length of a material could be measured. Nowadays this term is interpreted in another way: *a benchmark is a standard against which objects can be assessed and compared*. This interpretation is in accordance to the meaning of the term, reported by some well-known dictionaries:

1. *Webster's Seventh New College Dictionary (1994)*:

Benchmark is a point of reference from which measurements of any sort may be made.

2. *Webster's New Encyclopedic Dictionary (1994)*:

Benchmark is something that serves as a standard by which other may be measured.

3. *Oxford Advanced Learner's Dictionary (1993)*:

Benchmark is a mark to indicate a point of known height, used as a reference in measuring other heights for a survey, a standard against which other things can be measured, assessed.

The analysis of these definitions, as well of those given in the reference of this paper allows us to identify the following peculiarities of a benchmark:

1. *Multiple interpretation*: The benchmark can be interpreted as both an object and an object attribute. It is an object (for example, an enterprise, a process, etc.) by means of which other objects can be compared among themselves. But, it has also an attribute nature, e.g. it reflects a certain property (or a set of properties) of compared objects. For example, a comparative study of business units means to compare their productivity, cost structure and cost level (Clayton, 1994).

2. *Quantifiability*: The benchmark implies quantification which permits comparison with other objects.

3. *Understanding in terms of a standard*: The benchmark shows the difference between a current object's state and the excellent one, e.g. the quantified value of a benchmark is an objective which should be reached.

2.2. Benchmarking Evolution

The process of developing and using benchmarks to learn from comparison among objects, is denoted as benchmarking (Fig. 1). Learning from comparative studies means to uncover enterprise's bottlenecks, strengths, and process capabilities, to check a compliance between objects (products, processes) and established standards, to select the most appropriate alternative to achieve a given objective.

To clear the understanding of benchmarking a lot of authors consider it in relation with reverse product engineering (Horvath and Herter, 1992, Talmar, 1993), competitive analysis (Meffert, 1994, Frehr, 1993, Eschenbach, 1995), market-oriented cost estimation (Firer, 1993), product imitation (Martin, 1992, Wallek et al., 1993, Camp, 1994). Although the starting points are different, all research conclude that benchmarking is more than a method applicable in only one of these areas.

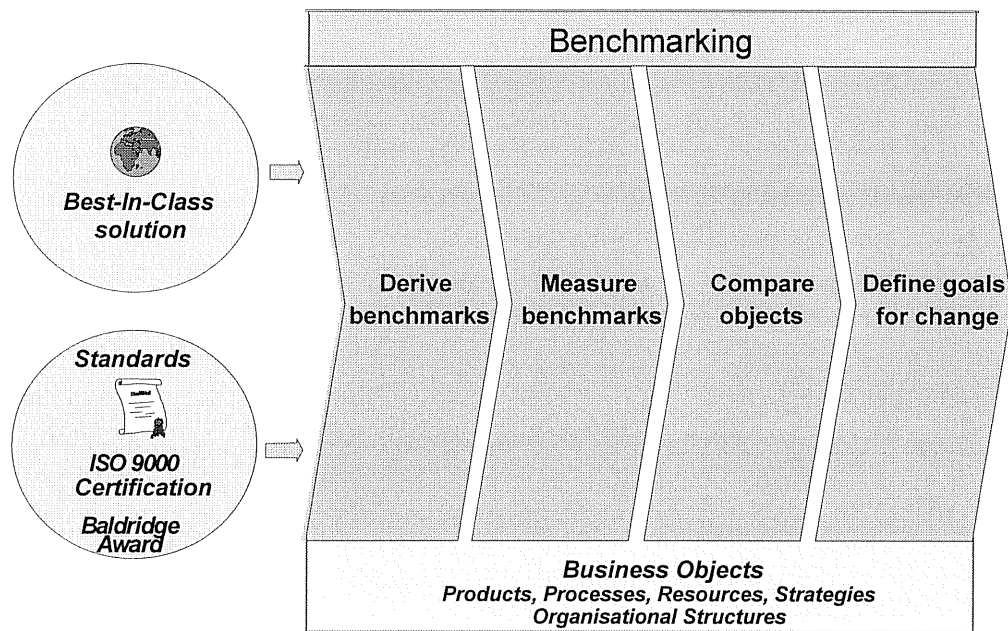


Fig.1. The Benchmarking Process.

Benchmarking was first introduced in 1979 by Xerox Corp., USA. This company found itself in a precarious situation due to quality and cost problems: the firm Canon, a direct Xerox’ competitor, set prices which were below the production costs of Xerox regarding the same product class. To react to the crisis, Xerox developed the “Leadership Through Quality“ Program which comprised three components: *personal motivation*, *benchmarking*, and *quality improvement* process. *Motivating personnel* implied the creation of cultural commitment and high degree of organizational discipline. Next, *continuous improvement* based on the notion of „zero defects“ and statistical process control focused on changes concerning narrowly defined functions or subfunctions (Fromm, 1994). A continuous improvement program aimed at avoiding all defects in work processes and communication, and bridging information gaps. Finally, Xerox introduced the concept of *benchmarking* to denote “the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry leaders“ (Camp, 1989).

To develop the notion of benchmarking, Xerox’s starting point was the concept of reverse product engineering, which is a practice of analyzing competitors’ product components. The contribution of Xerox in extending the reverse product engineering concept was twofold. First, Xerox introduced enterprise functions, processes, strategies, technologies as target objects in benchmarking studies. Second, Xerox created a vision not only on its own industry, but also on others. Thus, the firm initiated benchmarking to improve distribution by studying L.L.Bean, a mail order company. The distribution process of Xerox was compared with those of L.L.Bean in regard to the following criteria: orders per man/day, quantity per man/day, and flow per man/day (a flow describes the way to the distributor). Xerox’s major benchmarking initiatives are summarized in Table 1.

<i>Year</i>	<i>Benchmarking Partner</i>	<i>Benchmarked Business Process</i>
1987	L.L.Bean	Distribution/Logistics
1989	American Express	Invoice Processing
1990	Sony	Frequency of Capital Flow

Table 1. *Benchmarking Studies at Xerox Corp.*

Furthermore, Xerox introduced benchmarking in personal training programs, and used it as an instrument for creating organizational culture and supporting the process of continuous improvement.

After the successful application in Xerox, the benchmarking practice was experienced in a lot of American companies: Motorola, IBM, Ford, AT&T, Honeywell, GTE, Alcoa (Horvath and Herter, 1992). Later, it was accepted by Far Eastern and European companies, as well. Although the term benchmarking is not used widely in Europe, many companies have an intuitive understanding of benchmarking's nature. Almost all companies compare themselves with their direct competitors in regard to market power, market share, return on investments, etc. Many firms conduct competitive analysis to audit themselves and to identify areas where processes are within or outline a given norm, to learn from others' successes and mistakes, to model competitors' practices and to accommodate them to its own business.

2.3. Characterization of Benchmarking

The thorough analysis of the benchmarking concept requires the identification of parameters on which it can be characterized. On the basis of our study on 42 benchmarking definitions, we propose to consider eleven benchmarking dimensions (Heib and Daneva, 1995):

- **Benchmarking Focus** is the central issue of a benchmarking definition. The various definitions proposed in recent books and articles by both practitioners and academicians, can be grouped into two classes depending on its focus.

<i>Process-focused Definitions</i>	<i>Tool-focused Definitions</i>
Benchmarking is the process of continually searching for best methods, practices and adopting or adapting the good features and implementing them to become the best of the best. (B. Baker, 1994)	Benchmarking is a basic ingredient of a re-engineering initiative, which is a comparison with competitors and „best of breed“ organizations in other industries. The benchmarking results are used to create the catalyst for change and provide input into key stages of the exercise. (Talmor, 1993)
Benchmarking is a continuous process of identifying business performance gaps between the own enterprise and the best-in-class one. and implementing best practices to close the gaps and to become the best. (Burckhard, 1993)	Benchmarking is a business management tool, a system for comparing detailed business processes or functions. (Clayton, 1994)
Benchmarking is an analytical process for rigorously measuring a company's operations against the best-in-class companies inside and outside its market. (Furey, 1987)	Benchmarking is a planning instrument for comparing the own enterprise with the best class competitor regard to market opportunities in other businesses (Eschenbach, 1995)

Table 2. *Benchmarking definitions: a focus-based consideration.*

The first group are **process-focused** definitions which are based on the process view of the business. This implies a strong emphasis on how work is done within an organization instead of product focus's emphasis on what (Davenport, 1993). Thus, benchmarking is considered as an independent and institutionalized business process, and is explained in terms of process engineering and process management. It is a structure of action and involves a set of activities across time and place with a certain duration and with unambiguous defined inputs and outputs (Davenport, 1993). Benchmarking comprises tasks allocated among organizational units to be performed and documented. On the other hand, there are **tool-focused** definitions which highlight the role of benchmarking as a resource (instrument, method, tool, approach). It is then subordinated to a certain process, and used for achieving a goal within that process. This consideration reflects intense interest in the integration of benchmarking in the company's core processes. The **tool-focused** view deals with any benchmarking initiative as a preliminary phase of a certain process improvement project. Examples of process and tool-focused definitions are given in Table 2.

- **Benchmarking Strategy** refers to the rationale behind the benchmarking exercise. Generally, we differentiate between incremental continuous improvement and radical redesign (reengineering). The first goal implies the enhancement of company's performance by changing existing processes step-by-step. In contrast, the redesign is a radical change, it refers to the view of the enterprise in which all the old rules are out and managers are charged with finding a new way to manage the business (Hammer/Champy, 1994).

- **Benchmarking Network** reflects the number of participants subjected to benchmarking. In this paper we follow M. Cunnane (Cunnane, 1995) who draws the distinction between Multi-Client and Single-Client benchmarking. The first network type implies at least two benchmarking partners, and the second one emphasizes on comparison of a company against industry data (average statistical business information, standards).

- **Benchmarking Object** denotes the target object in benchmarking studies. Benchmarking can deal with the following objects: products, processes, functions, resources (organizational structures, technologies, methods, etc.) and strategies.

- **Application Context** refers to the background area, which benchmarking is associated to. The literature overview allows us to distinguish the following business areas: Marketing (Meffert, 1994), Controlling (Horvath, 1994, Ohinata, 1994), Research and Development (Mertins, 1995), Total Quality Management (Fromm, 1994), Strategic Management (Furey, 1987, Baker, 1994, Clayton, 1994, Österle, 1995), and Reengineering (Davenport, 1993, Talmar, 1993, Hammer/Champy, 1994, pp. 171-172).

- **Organizational Implementation** refers to the mode in which the benchmarking concept is put into practice. Benchmarking can be implemented in a routine way by integrating it in the core business processes. Thus, benchmarking becomes a routine activity performed within a given process. Alternatively, a project team consisting of members from different departments may be temporarily assigned for benchmarking implementation. In this case, an external expert support (benchmarking consulting company) may as well be involved.

- **Information Source** concerns the manner of providing the benchmarking initiator with relevant information. Two source types (Horvath and Herter, 1992) can be differentiated: primary (unprocessed) and secondary (processed). Examples of primary benchmarking information sources are: company's reports, profiles, accountancy balances, enterprise's data bases. Next, secondary sources represent: business performance overviews and analysis in commercial magazines, commercial handbooks, statistical yearbooks, scientific papers in management science (e.g. marketing and controlling), conference and workshop proceedings, EU-project deliverables (ESPRIT, COST), e-mail data bases bulletins, WWW-Services.

• **Benchmarking Partnership** explicates the relation between the initiator and other participants in the study. The case studies in the reference show that three kinds of partnership are possible: friendly, unfriendly and anonymous (indifferent). The first kind implies a high extent of confidence among partners, and, as a consequence, simplifies benchmarking information exchange. In contrast, the “unfriendly” partnership reflects the initiator’s intent to “steal the best idea around”, rather than studying an object of interest in a stepwise manner (Martin, 1992). Third, anonymous partnership is a term we refer to when the partner is neither interested in, nor participates in a study, and the initiator does not communicate directly with him, but conducts the benchmarking on the basis of published wide-spread (secondary) information.

• **Cultural Background** is focused on cultural issues influencing the goal of benchmarking and the selection of target objects and partners. We propose to consider three cultural types: American, Japanese, and European. The American understanding of benchmarking emphasizes on how to become “the best of the best”: the best within the organization, best-in-class, or world best (Camp, 1994). In contrast, Japanese benchmarking practices reflects “me too” mentality of Far Eastern companies that look for original concepts to develop similar products as soon as possible (Ohinata, 1994). Finally, European attitude towards benchmarking reflects the complex situation, when all EU member countries are fused into the “common market“. This urges the Europeans to look for a strategic benchmarks relevant to major shifts of market boundaries.

• **Decision Level** refers to the scoped of decisions based on the benchmarking results. By analogy to management science’s considerations, we account three decision levels: *strategic, tactical and operational*. *Strategic* benchmarking is “the development of measures for a business unit which quantify its key strengths and weaknesses, to give some external reference to the strategic planning process“ (Clayton, 1994). Such studies set overall direction and show managers how others have succeeded in similar circumstances. Next, *tactical* benchmarking is characterized by focus on company’s annual operating issues, for example, customer satisfaction, marketing mix. *Operational* benchmarking deals with specific (detailed) processes and functions and indicates standards which should be achieved in day-to-day operations, given the willingness to learn. Examples of operational benchmarking are studies on product reliability, bid preparation time, order processing performance, etc.

• **Benchmarking Scope** is defined by the relations among the organizational units participating in the study. Benchmarking partners can be different units within one enterprise (internal benchmarking), direct competitors (competitive benchmarking) or companies of different industries - cross branch benchmarking (Österle, 1995, Camp, 1994, Mertins et al, 1995).

The dimensions of benchmarking are summarized in Table.3.

<i>Dimension</i>	<i>Instance</i>
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

Table 3. *Benchmarking Dimensions.*

2.4. Developing a Benchmarking Definition

The presented characterization of benchmarking is further used as a basis for formulating a new benchmarking definition. Below we give some factors encouraging us in searching for a new definition.

1. We need a formulation which encompasses all variants of benchmarking generated by the instances of the dimensions identified. The definitions available in the reference basically concern particular benchmarking aspects. Thus, the new definition should be general enough to cover all possible benchmarking situations.

2. We argue that the relation between company's goals and benchmarking should be explicated. Hence, the benchmarks have to be derived from specific enterprise goals.

Generally speaking, independent of the particular goal a company tries to achieve by conducting a benchmarking study, the main objective of a benchmarking exercise is to keep company's competitive edge.

We propose to use the following definition of benchmarking:

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.

Our definition is distinguished from others by the following:

1. We consider benchmarking as a *business management tool*. We respect the fact that it can be an ingredient of any business process, i.e. the benchmarking is integrated in

company's core processes in order to support them. Conducting benchmarking is meaningless unless it is related to a certain business process. We also account the process nature of benchmarking which means it has to be considered as a structured set of activities allocated in time and place and with specific inputs and outputs.

2. The definition highlights the importance of *goals* for the benchmarking practice. The goal clarifies the reason why benchmarking is undertaken and determines the business objects to be studied.

3. The definition uses the general term of *business object* to denote what can be benchmarked, e.g. products, processes, functions, resources and strategies. In this way we overcome the dependence of benchmarking definitions on the application context.

4. The definition encompasses the *basic activities* included in benchmarking. The details of a specific benchmarking practice can vary, but the involvement of several key activities is critical for the successful initiative. These include: choosing objects to be benchmarked, selecting objects' characteristics to serve as benchmarks, assessing and comparing the objects based on the characteristics selected, defining change goals to keep or regain the company's competitive edge.

3. Reference Model for Benchmarking

3.1. Motivation

To ensure our 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 al, 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 (University of Bremen, Software Productivity Research Ltd, and Fibry Ltd.). In addition, we consider some US Government and industry guides, for example, those of American Army (ARDEC). It is an adaptation of the AFMC Benchmarking document (AFMCI 90-301, Organizational Comparison and Benchmarking Process) which is known as the "best in class" of the documents reviewed.

Our motivation behind creating a reference model for benchmarking is summarized below:

- we intent to ensure a higher degree of transparency which supports benchmarking discussions, promotes benchmarking initiatives and gains management commitment.
- we search for a sound and consistent basis to compare and to integrate different benchmarking approaches.
- we intend to identify a starting point for developing enterprise-specific benchmarking models. The reference model is a promising concept for deriving particular benchmarking processes. It is open for modifications regarding the business objects, company's understanding of benchmarking and its organizational implementation.
- the management staff needs to develop a strategy for integrating the benchmarking in the core business processes. The reference model can serve as a basis for identification of the right strategy regarding how to incorporate benchmarking in company's day-to-day activities.
- we aim at reusing benchmarking knowledge and capturing all relevant expertises, i.e. at creating a benchmarking knowledge base. The reference model is automatable and transportable knowledge about benchmarking which helps managers to systematize and plan benchmarking activities. It also provides a sound and consistent documentation of the benchmarking process.
- we intent to provide a holistic description of benchmarking documentation which integrates all relevant aspects (data, function, organization and process) of the benchmarking process. The documentation should be exact enough to serve as a starting point for an EDP implementation.

3.2. The ARIS Architecture as Modelling Methodology

To present a holistic characterization of the benchmarking process and to ensure a high flexibility of process documentation, the ARIS (Architecture of Integrated Information System) methodology for information modelling proposed by (Scheer, 1995), 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) as depicted in Fig.2. Thus, it consists of 12 components. For each component a set of suitable and integrated description methods is previewed. The languages used for enterprise modelling at requirements definition level are: extended Entity-Relationship Model for describing the data view, hierarchy diagram for the function view, organizational charts for the organization view, and extended process chain diagrams for the control (process) view.

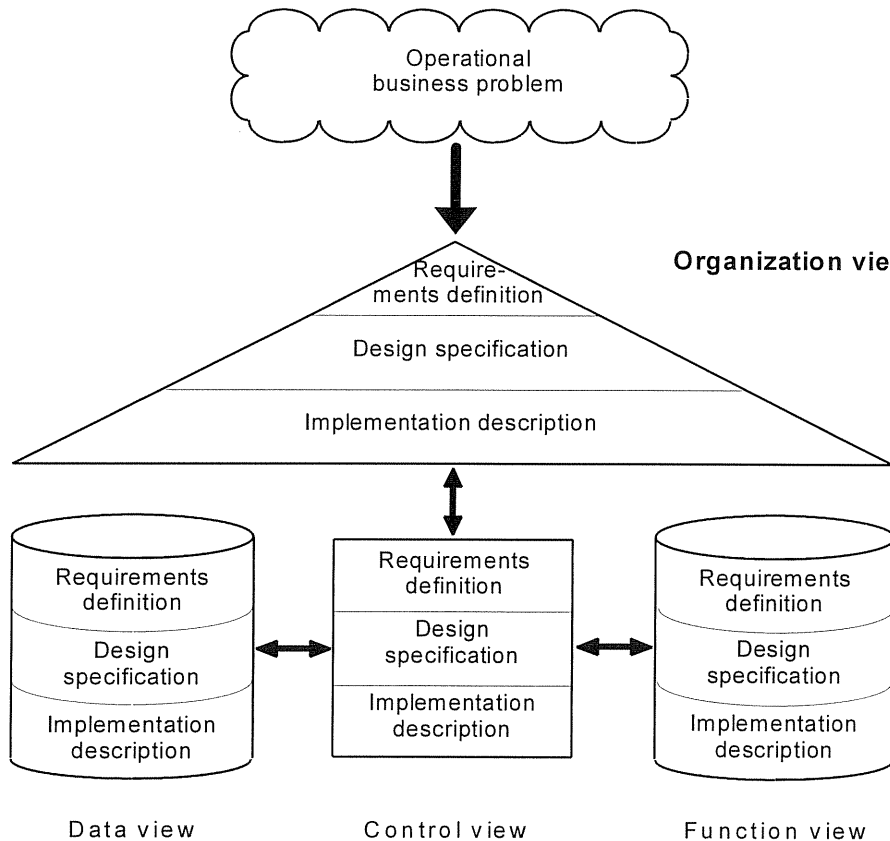


Fig.2.ARIS Methodology.

The application of the ARIS methodology is facilitated by means of the ARIS-Toolset (IDS Prof. Scheer GmbH, Saarbrücken, Germany), whose functionality covers the creation and the modification of reference models, and the derivation and the configuration of specific enterprise models from reference ones.

In this work, we develop our reference model by focusing on the requirements definition level. This level is of particular significance because it is both a long-term repository of collective business knowledge and serves as a starting point in generating the design and the implementation descriptions of an information system (Scheer, 1995).

3.3. Components of the Reference Model

According to the ARIS methodology, the reference model consists of four description views: data, function, organization and control (process) views. These are briefly discussed as follows.

3.3.1. Data View

The data view (Fig.3.) presented in terms of the extended Entity-Relation Model (Scheer, 1995) shows information objects for benchmarking.

The entity type BENCHMARKING GOAL assigns a BENCHMARKING OBJECT to the INITIATOR. The INITIATOR should identify and prioritize candidates BENCHMARKING OBJECTs on their importance in achieving the BENCHMARKING GOAL. The INITIATOR should concentrate his improvement efforts on the most critical business objects first in order to achieve the maximum benefit. Candidate objects should be scrutinized using quality and analytical tools to ensure selection of objects critical to improving performance.

Next, the entity BENCHMARKING DEFINITION should be established. By this entity type several benchmarks can be allocated to an BENCHMARKING OBJECT. The BENCHMARKING DEFINITION is an aggregation of a BENCHMARK, a METRIC and a MEASUREMENT METHOD. The first two objects address some quality (or performance) attributes of the BENCHMARKING OBJECT to be investigated. We differentiate between METRICs and complex BENCHMARKs. A benchmark is a metric (simple) if a predefined value exists in a form of an object's characteristic. A benchmark is complex, if it is composed from subordinate benchmarks (Daneva, 1995). Both of them (METRICs and BENCHMARKs) are used to identify areas to target as improvement/reengineering projects. Moreover, the MEASUREMENT METHOD represents the way we gain benchmarking information. It explains how to elicit information and how to quantify benchmarks. The INITIATOR, in conjunction with the BENCHMARKING PARTNER, decide on the information elicitation technique, i.e. if they are going to use checklists, conduct interviews, or mail questionnaires to collect the information they need. The MEASUREMENT METHOD also 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 also expressed by means of a formula for calculating the value of a BENCHMARK with respect to a given BENCHMARKING OBJECT, or as a rule how to evaluate a METRIC.

Any BENCHMARKING 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 BENCHMARKING 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 denotes processing benchmarking information to establish a diagnosis showing how much the actual situation differs from the best-in-class one. The COMPARISON helps the INITIATOR to focus on particular issue that offer the greatest

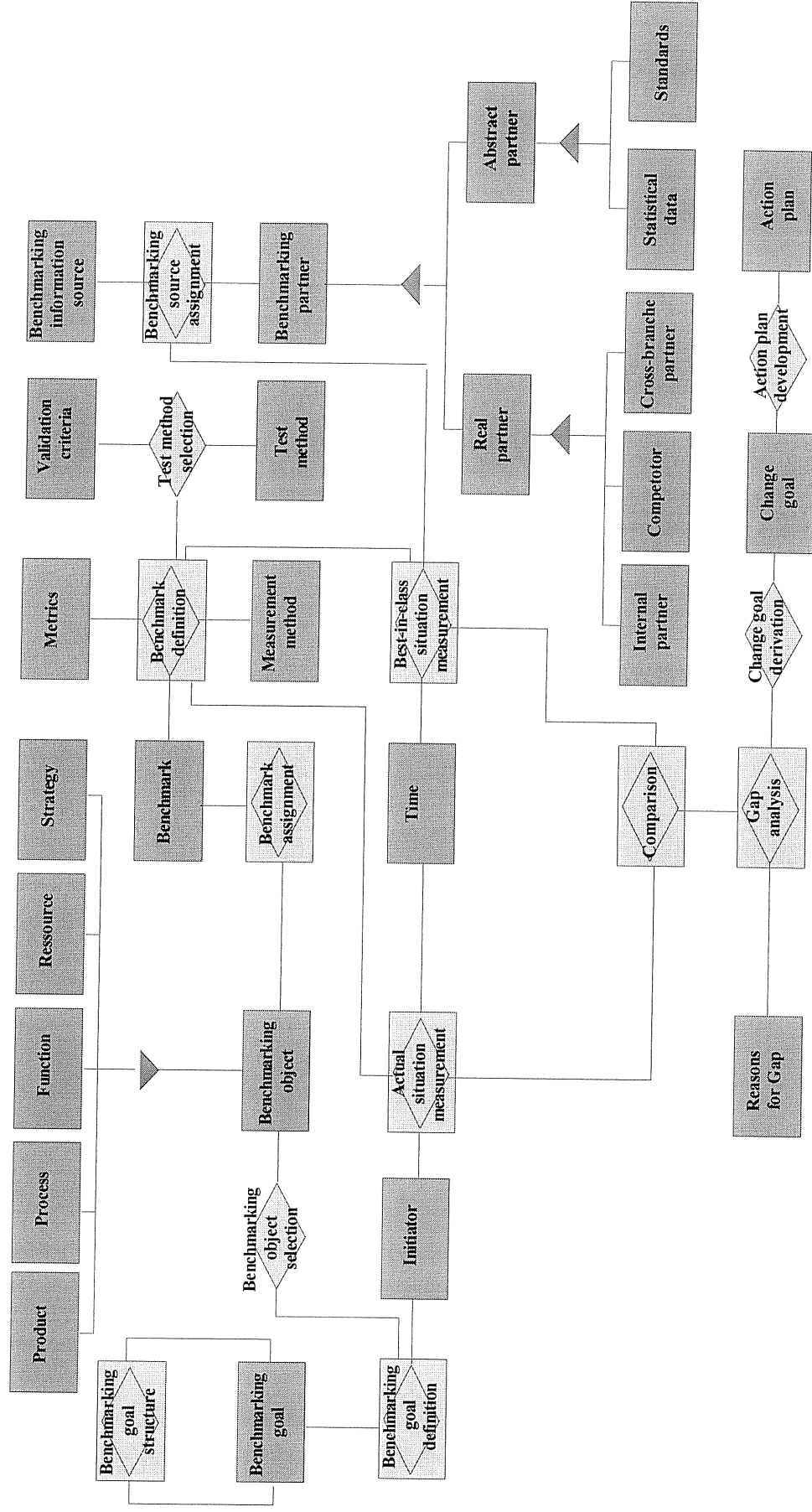


Fig.3. Benchmarking Modelling: the Data View.

opportunity for improvement. Next, the gap analysis identifies the REASON that has led to the existing gap.

Based on the COMPARISON and REASON, the entity types CHANGE GOAL and ACTION PLAN represent the final results of the benchmarking exercise. The CHANGE GOAL formulated on the basis of benchmarking results should be expressed by an ACTION PLAN, whose implementation has to close the gap identified in the previous phase. Action is an object-independent specification of some work, a verbal description of some task, process or procedure (Mertins et al., 1994). Moreover, the ACTION PLAN details the specific actions to be accomplished, those responsible, and milestones.

In this model we differentiate between master data (BENCHMARKING OBJECT, BENCHMARKING DEFINITION, BENCHMARKING PARTNER), which is constant during a certain benchmarking study, and variable data (the rest of objects), which is time dependent.

3.3.2. Function View

The functions describing the „what“ factors in benchmarking are depicted in Appendix 1. The main functions of the model corresponds to the phases of the benchmarking process, and the subfunctions - to the specific activities carried out during each phase. The model conforms with the data view above described. Any function handles objects among the given in Fig.2. Following Scheer's approach (Scheer, 1995), we determine the functional structure by dividing subfunctions according to their logical sequence.

The benchmarking process comprises several phases, each of which implies a certain set of specific tasks to be performed. The company Xerox considers five phases: planning, analysis, integration, action, and maturity (Camp, 1994). Although other authors distinguish four or three stages (Table 4.), they have formulated sets of tasks which coincide with the „ten steps“ defined by Xerox.

<i>Reference:</i>	<i>Phases:</i>	<i>Steps (Tasks):</i>
(Camp, 1994)	Planning, Analysis, Integration, Action, Maturity	17
(Burghardt, 1993)	Problem Identification, Partner Selection, Analysis and Implementation, Improvement	10
(Horvath, 1994)	Preliminary Preparation, Analysis, Implementation	12
(Fromm, 1994)	Planning, Data Collection, Analysis, Implementation	14
(Ohinata, 1994)	Planning, Team Building, Partner Selection, Data Collection and Analysis, Preparation of Action Plan	-

Table 4. *Benchmarking Phases.*

Main benchmarking activities will be explored here:

- **Preparation:** This process is often carried out by the management staff. It involves defining benchmarking goal and organizing the benchmarking exercise. This means that a team responsible for benchmarking should be able to trace a path from a successful benchmarking project to the final definition of change goals. The process of preparation can be considered as a sequence of the following decisions that have to be made: what to benchmark, on which characteristics the objects should be compared, what measurement method to use, how to validate the benchmark, etc. The **preparation** is typically the longest phase of the benchmarking process, taking up to 50% of the total time to complete a benchmarking study (ARDEC, WWW-page,

1995). Additionally, the team must determine who handle similar objects in a way recognized as significantly better than the own organization.

- **Information Collection:** It is the measurement, recording and storage of data required for benchmarking. It also involves checking whether validation criteria have not been violated. If it is so, the responsible staff should identify the reasons for the failure in measurement.
- **Analysis:** During this phase, the benchmarking team compares its object and associated performance with the benchmarking partner's object to find the differences and determine what magnitude of improvement can be achieved. A number of analytical approaches are available to the benchmarking team to analyze measurement results. They range from rather simple techniques, such as matching and showing similarities between these objects, to using sophisticated comparative procedures capable of identifying existing gaps between partners and forecasting future gaps.
- **Plan for Change:** This is the process whereby the change is communicated to a benchmarking team and then carried out. The team should identify potential areas of resistance and address those concerns. Typically, resistance to change comes from fear of losing jobs, status, control, resources, and familiarity with the status quo. Company's leaders need to be fully informed about the expected benefits so they will support commitment of any needed resources. Finally, it's crucial to gain the cooperation of suppliers and other competitive partners for a complete improvement effort. The benchmarking study ends with a re-calibration which is a proactive activity to determine if the desired result are produced and if not, identify what changes are necessary to meet benchmarking goals. The objective of re-calibration is to maintain and update current benchmarks to ensure that they are continuously based upon the best methods and practices.

3.3.3. *Organization View*

In this section, we consider the case when benchmarking is conducted by a team and is treated like a project with its own time schedule and financial means. The organizational structure depicted in Fig.4 represents a benchmarking role model. It is formed according to function-oriented structural criteria. We consider the given organizational structure to be very generic and adaptable to any benchmarking case.

Like any other project, the benchmarking initiative should be headed by a project leader and has to be handled by at least two working groups: for data collecting and analysis, and for providing the process with constancy and guidelines.

The project leader comes from mid-to-upper level management. This person must have enough authority to be able to gain and sustain support for the project. He is the liaison between the benchmarking team and upper management. The team leader provides direction, breaks barriers to team progress, and ensures members are properly trained.

The data collection and analysis staff can involve

- *personnel from the departments directly concerned by the study.* These are persons closest to the object being benchmarked, who has the authority to make changes to that object. These individuals identifies what benchmark characterizes which objects and how the benchmark could provide useful insight in the compyny's bottleneck.
- *personnel from other relevant organizational units* (financial department, etc.). Because benchmarking typically cross functions or departments, team composition should reflect the key enterprise functions involved.
- *individuals from external institutions* who have support functions (e.g. specialists from statistical institutes, universities, etc.).

Next, the consulting staff involves experts from benchmarking consulting companies and internal experts (e.g. from controlling department). These are called facilitators (ARDEC, WWW-page, 1995) and their main responsibilities are in methodological support and auditing.

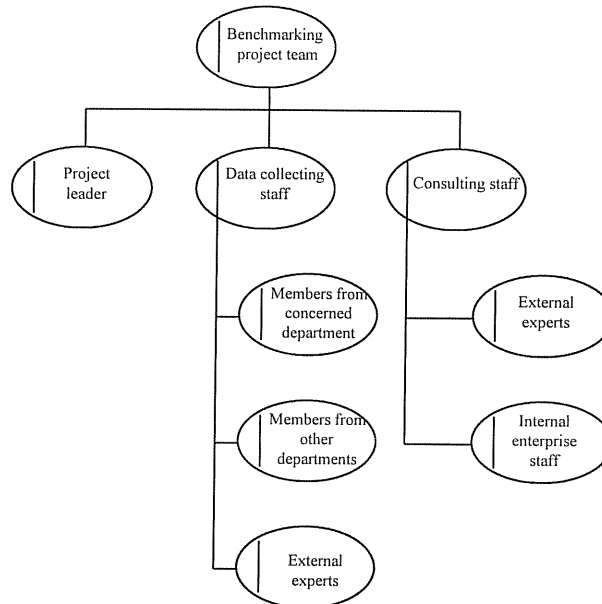


Fig.4. Benchmarking Modelling: the Organization View.

3.3.4. Control View

To present the dynamic aspects of the benchmarking process, we construct an event-driven process chain (Appendix 2). It provides the link between data and functions already discussed. An event is something that happens at a moment in time, and has no duration. More precisely, Scheer defines an event as „the occurrence of an object or change in a given instance of an attribute“.

Next, we present the content of the extended process chain diagram for benchmarking (Appendix 2.).

Any benchmarking initiative is started by recognizing the need of benchmarking. This event may be triggered by a customer who looks for the best alternative partner from his point of view, or by the company's management reacting to some problems within the enterprise. After this event happened, the process moves linearly through the stages: selecting benchmarking object, specifying benchmark, deciding on partners, measuring actual and best-in-class situations. Then, the validation of the gained benchmarking information, can result in one of the five events given below. If the benchmarking results can not be validated, we refine the benchmarking process. This is done in four ways:

- by re-measuring the actual and the best-in-class situation, if the validation fails due to a measurement error.
- by redefining a subordinate metric, if an incorrect metric definition impedes the validation process.
- by adjusting the measurement method, if it is not correctly selected.
- by specifying a new benchmark, if our validation study reveals that the attribute is not measurable.

If the data are validated, the process continues according to the linear structure depicted. The benchmarking findings are used to derive an action plan which should be further implemented. The after-implementation progress has to be checked, and thus, the event „Progress is measured“ indicates the termination of the benchmarking exercise.

4. Conclusions

The main points embodied in this paper are:

- The benchmarking process was characterized according to eleven dimensions: benchmarking focus, strategy, network, object, application context, organizational implementation, information source, benchmarking partnership, cultural background, decision level and benchmarking scope.
- Benchmarking was modelled by using the ARIS framework. The concept of reference models applied for benchmarking proved to be feasible and beneficial. The reference model we proposed is a result of our efforts to construct a holistic presentation of the benchmarking process by means of particular models reflecting functional, data, organization and process view of benchmarking.
- The reference benchmarking model we presented is a very general one. Applying it to a certain problem context, one may just use any given part of it. The created model allows a diverse set of benchmarking approaches to be accommodated within a single framework. It provides a guidance on what we believe to be effective benchmarking. In this sense, it can serve as a prescriptive, not only as a descriptive, benchmarking model.

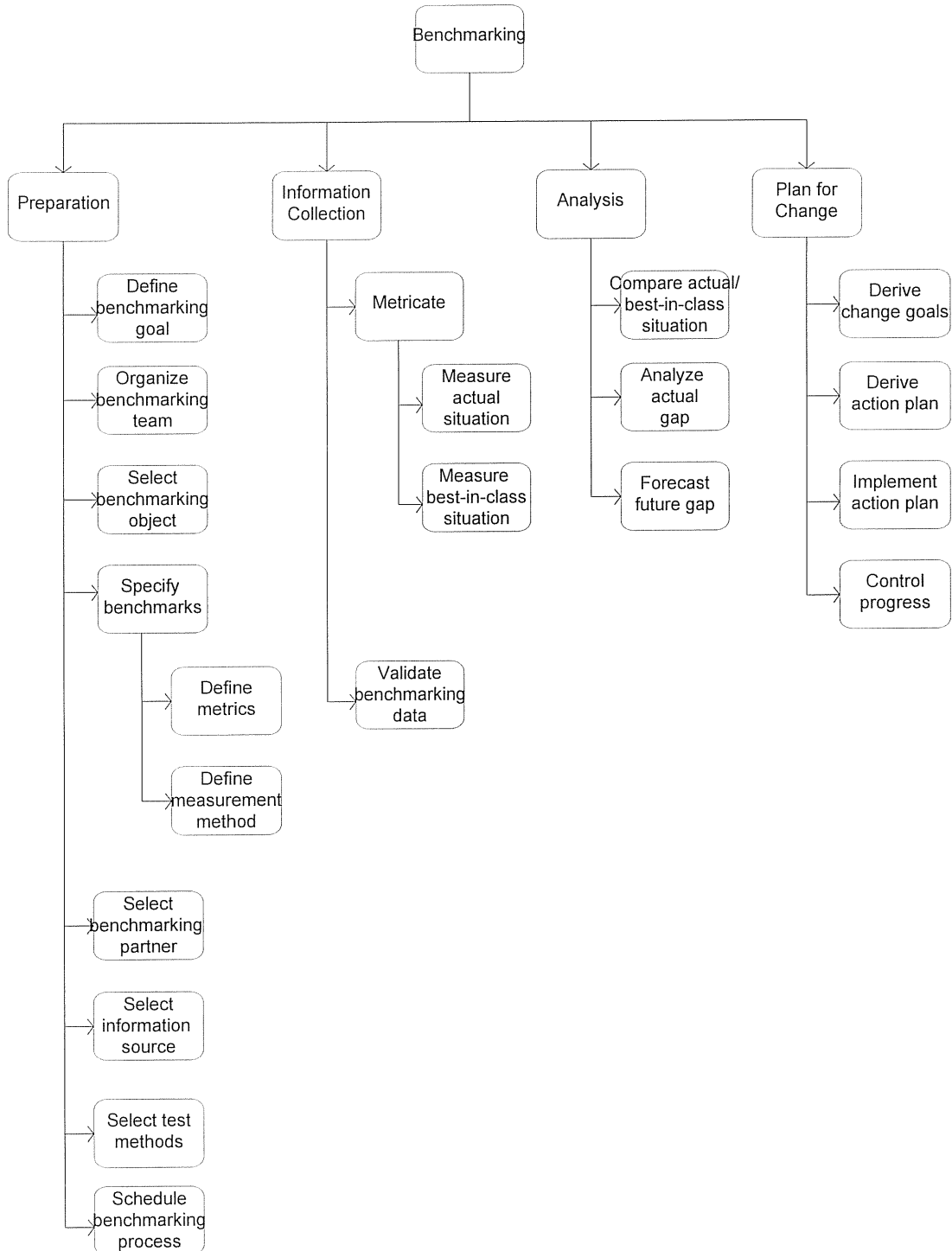
A variety of topics for further research and development can be identified. They include, for example, the use of concept of information management controlling to characterize additional situations in which one benchmarking method is more effective than other method. We can also investigate the development of a refined benchmarking model, in which the process dynamics are presented by using more complicated rules reflecting enterprise knowledge. Finally, research on methods for benchmarking processes, applications and IT-infrastructures can be pursued.

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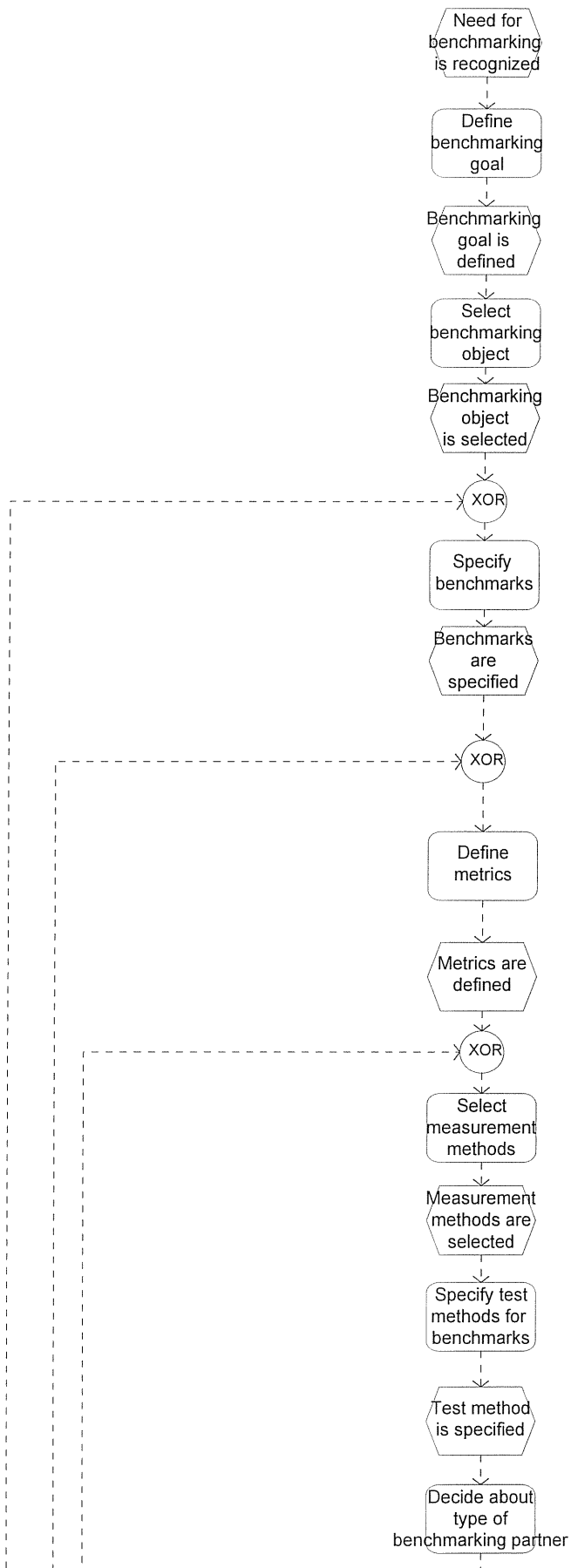
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Appendix 1
 A Reference Model for Benchmarking: the Function View



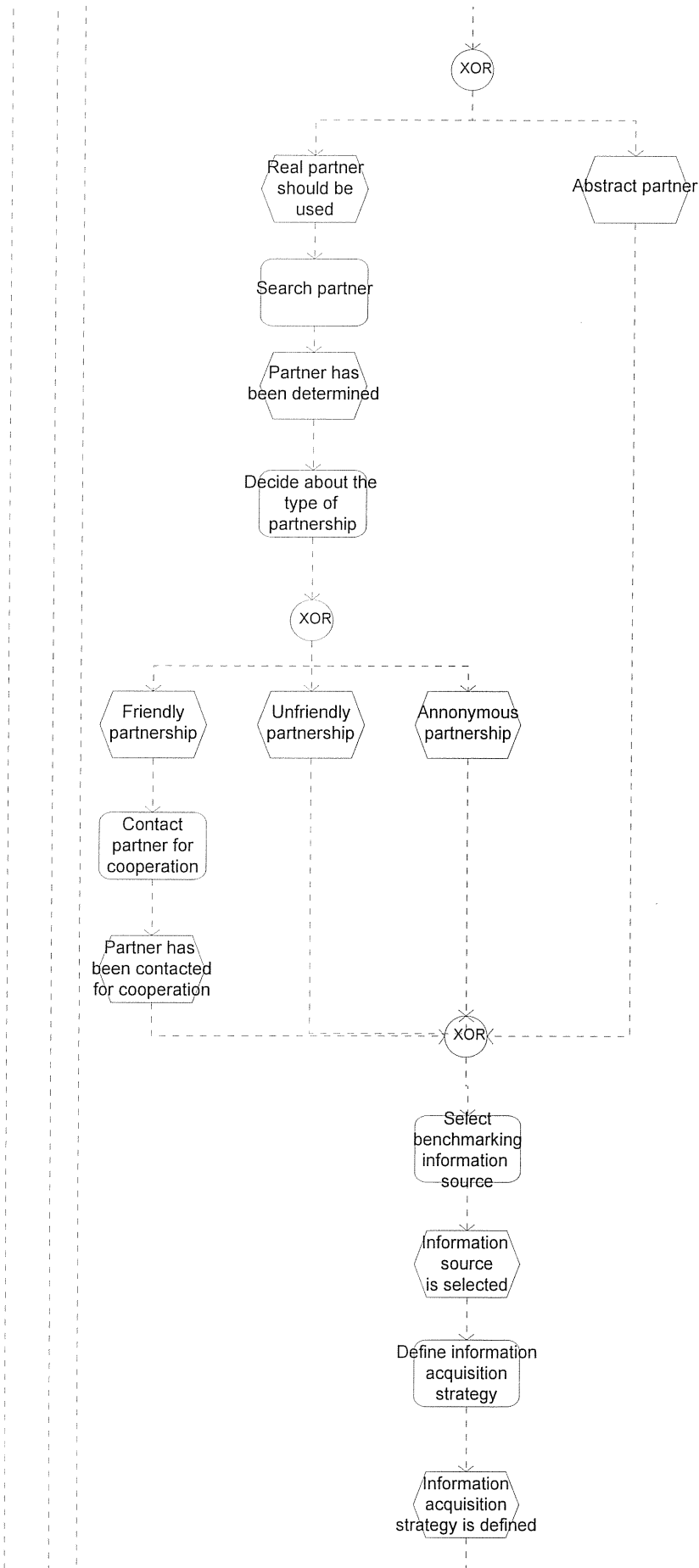
Appendix 2

A Reference Model for Benchmarking: the Process View

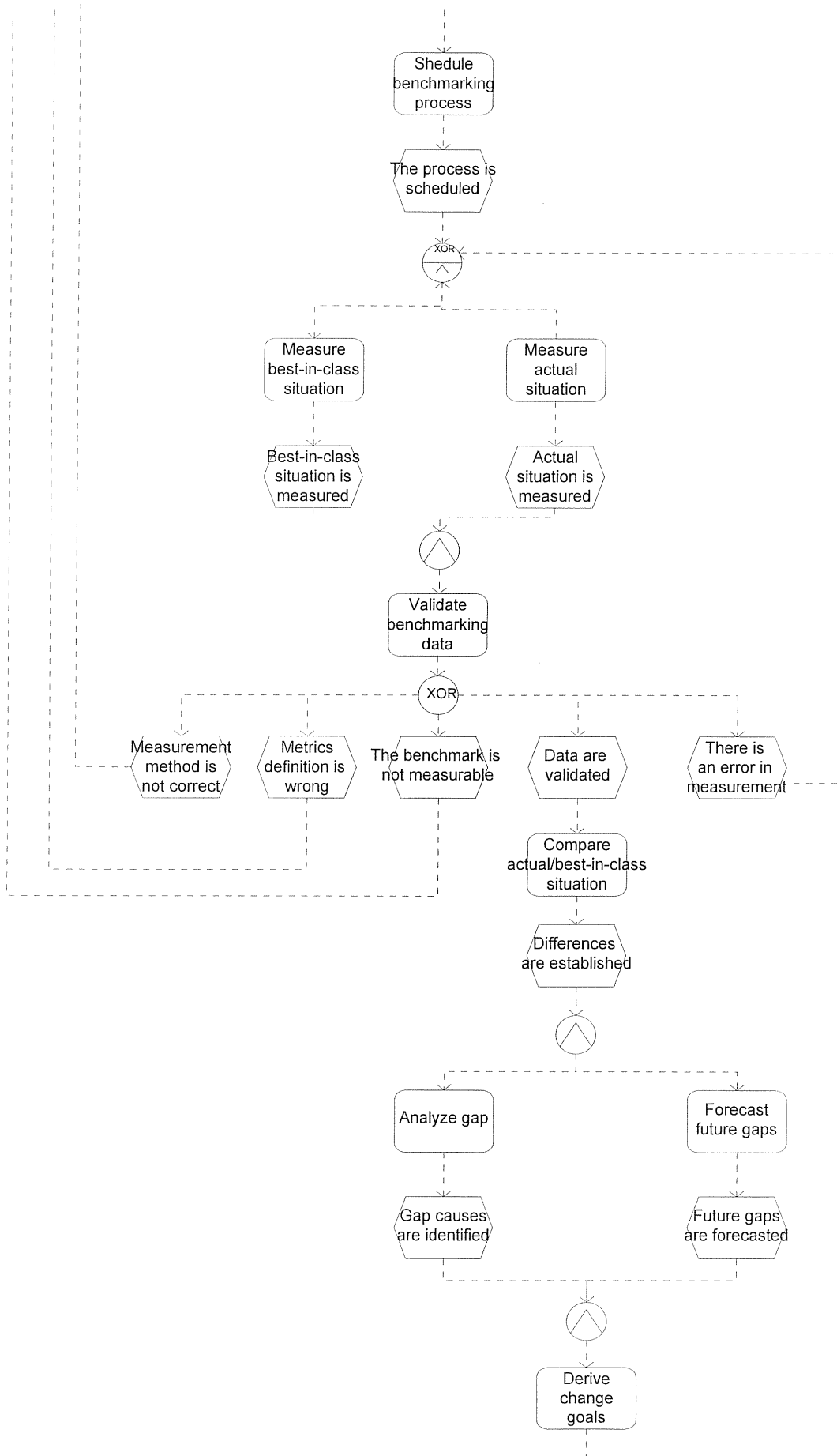


Appendix 2

A Reference Model for Benchmarking: the Process View

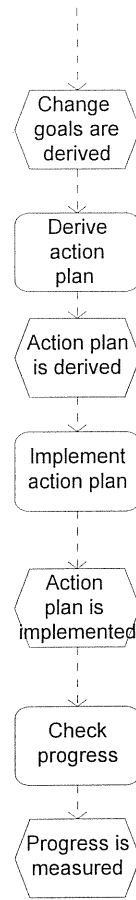


Appendix 2
A Reference Model for Benchmarking: the Process View



Appendix 2

A Reference Model for Benchmarking: the Process View



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