

Chapter 2

Performance Management

Abstract This chapter introduces basic terms and definitions. First, the nature and characteristics of invention and innovation are examined. The review shows that the commercial success of an innovation does not only depend on the quality of inventions generated in research and/or development and that both invention and innovation represent components of a process of managing innovation that extends over the entire value chain of a company. Furthermore, the following concepts are distinguished: Innovation Management, Technology Management and R&D Management in order to also understand in detail differences between the functions: research and development. The following questions are answered: What is meant by research and by development; what are the roles and tasks of the units; what kind of technological knowledge do they produce; what is the purpose of Performance Management; what are its components; and, what are industrial research departments?

Keywords Goals and goal setting • Innovation management • Invention versus innovation • Key performance indicators (KPI) • Measures, metrics, and indicators • Performance management and measurement • Research and development (R&D)

2.1 Introduction and Fundamentals

In this chapter, the formal foundations of our study will be developed. The discipline, nature, and area of our research interest will be outlined and the main definitions in the field of performance management will be introduced.

2.1.1 *Invention and Innovation*

Private companies and the public sector¹ are seeking ways to increase their profits or stimulate the economy as a whole. Inventions and innovation have become key to improved global competitiveness in many business sectors and are seen as a means of achieving economic wealth. To be able to understand the dynamics of these phenomena, the definitions of innovation and invention will be analyzed, and the differences elaborated upon.

Understanding the difference between the two phenomena helps us to comprehend the nature of each individually. This in turn helps us monitor and identify their emergence and to better match them to the place (environment) and time (phase) when they occur. The ability to do this is important because in the thesis, we will separate R&D, which is commonly seen as one single function, into two departments: research and development and examine only the former. The major goal of a research department is to investigate future trends and to foster innovation within a company. In general, the output of research departments is represented by inventions and it is of utmost importance for companies to transform their inventions into innovations.

There are a variety of definitions of the term “innovation” in the literature, but a generally accepted standard definition does not exist.² From the Latin translation of the original term *innovatio*, the elements of originality, newness and novelty can be derived. The different approaches to defining the concept of innovation all refer to the change and the uniqueness of a state or process.³ Schumpeter,⁴ who initially in 1911 coined the term ‘innovation’ in the field of economics, gives five pragmatic examples⁵ of innovations:

¹ There are many national, European and international studies about the nature of inventions and innovations by e.g., OECD, NIST and various private consulting companies. Both innovations and inventions are seen as success factors for technological change, which strongly influences economic growth. Innovative economies typically exhibit the following characteristics: higher rates of economic growth, greater growth in employment, higher productivity, greater investment in people and capital and greater capacity for the economy to attract and retain highly-qualified people.

² Brockhoff (1994), pp. 27–28, Specht and Beckmann (1996), p. 15, Hauschildt (1997), p. 3, Geschka (1983), p. 823.

³ Hauschildt (1997), p. 25, Pleschak and Sabisch (1996), p. 1.

⁴ Translated from Schumpeter (1964): “...so bedeutet Innovation “die neue und andersartige Kombination dieser (vorhandenen) Dinge und Kräfte” – the “new and different combination of existing things and forces””.

⁵ Translated from Schumpeter (1964): “Fünf Fälle der Innovation: (1) Herstellung eines **neuen Produkts** oder einer neuen Produktqualität; (2) Einführung einer **neuen**, in einem Industriezweig noch unbekannten **Produktionsmethode**, die jedoch nicht auf einer neuen Erfindung beruhen muss; (3) Erschließung eines **neuen Absatzmarktes**, auf dem ein Industriezweig noch nicht eingeführt war, egal, ob dieser Markt schon vorher existierte oder nicht; (4) Erschließung einer **neuen Bezugsquelle** von Rohstoffen oder Halbfabrikaten; (5) Durchführung einer

- Production of a new product or new product quality;
- Introduction of a new, production method in an industry sector, which, however, does not need to be based on a new invention;
- Development of a new sales market to an industry sector regardless of whether this market previously existed or not;
- Tapping into a new source of raw materials or semi-finished products;
- Implementation of a re-organization such as the establishment or breaking-up of a monopoly.

Therefore, from our view, *innovation* in business can be seen as the implementation of new technical, business-related, organizational, or societal solutions in companies. Innovation aims to attain company goals in new ways.

An innovation can therefore be considered as the logical successor to an *invention*, which we define for the context of this thesis as the first technical realization of an existing problem as a result of R&D activities. An invention becomes an innovation once it is introduced to the market or is used in the production process. The commercial success of an innovation requires scientific, technological, organizational, financial and commercial activities.

The term “innovation” (Table 2.1) implies the creation of something new. In this regard it is often equated with the term “invention”. Fagerberg (2003) states: “An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process while innovation is the first attempt to carry it out in practice”.⁶ He acknowledges that the distinction is sometimes unclear because in some cases (e.g. biotechnology) innovation and invention are closely linked. An important characteristic, however, is the considerable time-lag between the two. He specifies other features such as the different requirements for working out ideas and carrying them out in practice, along with different locations: inventions may be carried out anywhere, while innovations occur mostly in firms in the commercial sphere. Furthermore, he lists other requirements such as production knowledge, skills and facilities, market knowledge, a well-functioning distribution system, sufficient financial resources, which a firm has to combine in order to turn an invention into an innovation.

Neuorganisation wie Schaffung einer Monopolstellung oder Durchbrechen einer Monopolstellung”.

⁶ Fagerberg (2004), p. 4.

Table 2.1 Definitions and comparisons of the terms “invention” and “innovation”

Author	Invention	Innovation
Fagerberg (2003) ^a	“Invention is the first occurrence of an idea for a new product or process”	“Innovation is the first commercialization of the idea”
Norman (1994) ^b	“An invention is a new manmade device or process. A new device which qualifies as an invention may take such forms as a new physical product, a new biological life form, or a new piece of software. A process, on the other hand, is a chemical, physical, or biological chain of events that produces a product or service”	“Innovation . . . (is) a better way of doing things. Individuals and institutions innovate in all their goal-directed behavior, which is defined as an effort of an individual or an institution at achieving performance as measured by a criterion, whether objective or subjective. With respect to such goal-directed behavior, a formal definition of an innovation is the creation or implementation of a new alternative which achieves higher performance as measured by the respective criterion”
Specht and Beckmann (1996) ^c	“Invention means as much as a discovery/creation of something new. This is the technical implementation of new scientific findings, or new combinations of existing scientific findings, or a combination of the two”	“The term innovation can be interpreted in a narrow and broad sense. In the narrow sense it affects the market launch of a new product or the start of a new production process. In the broad sense it is the entire innovation process of invention and innovation” ^d

^aFagerberg (2004), p. 4

^bNorman (1994), pp. 4–5

^cSpecht and Beckmann (1996), p. 15

^dTranslated from Specht and Beckmann (1996), p. 15, “Der Begriff Innovation kann eng und weit interpretiert werden. Im engeren Sinne betrifft er die Markteinführung eines neuen Produkts oder das Anfahren eines neuen Produktionsprozesses. Im weiteren Sinne wird unter Innovation der gesamte Prozess der Invention und Innovation i.e.S. verstanden. Wenn von Innovationsprozess gesprochen wird, so ist meist Innovation i.w.S. gemeint”

Table 2.2 is a summary of the main characteristics that distinguish “invention” and “innovation”.

To summarize and highlight the difference between invention and innovation definitions,⁷ one can make the following conclusions:

- I-1. An innovation does not directly require an invention;
- I-2. If it does occur, an invention will happen before an innovation;
- I-3. An invention becomes an innovation only once it is successfully deployed in a commercial context;
- I-4. Several inventions can contribute to a single innovation.

To illustrate the difference between invention and innovation, three examples are given. A current example of a successful innovation is the iPod. The iPod is a

⁷ Gurel (2007a).

Table 2.2 The main differences between “invention” and “innovation”

Element	Invention	Innovation
Order	Predecessor (occurs first, in the form of an idea)	Successor (first attempt to implement the idea)
Nature	Often concerns a single product or process	Often involves a combination of products and processes
Time-lag	5–20+ years	
Location	May occur anywhere (universities, research organizations, R&D departments)	Most likely occurs in commercial firms
Skills	Inventor skills: narrow, deep, domain-specific	Innovator skills: broad, entrepreneurial

portable media player designed by Apple that was launched in 2001. The iPod, as an MP3 player, was not invented by Apple and such devices previously existed. It is, however, the mixture of the iPod’s design, the functionality of the iTunes software, and the iTunes store that in combination made the iPod an innovation.⁸ This example illustrates that an innovation may be based on several existing (quite old) inventions: in this case it was the MP3 from Fraunhofer in 1991, the portable audio device from Kane Kramer in 1979, and the hard drive as a storage technology that were incorporated into a single device.

Conversely, there are several examples of great inventions where the inventors failed to successfully deploy their invention in a commercial context (cf. I-3.). In 1947, a group of scientists at the AT&T laboratories created the world’s first transistor. The invention was patented, but the organization was not able to find an application for the new device. They did an outstanding job with the invention but failed to develop the innovation. Precisely for this reason, in 1952, AT&T decided to license out the transistor. For a mere \$25,000, companies like Texas Instruments, Sony, and IBM acquired a technology that would produce enormous revenue in the future.⁹

Xerox is another company to have witnessed their inventions being turned into innovations by other firms. Many of the achievements of modern computer technology can be traced back to the famous Palo Alto Research Center (PARC). At PARC, the first personal computer was developed (years before Apple or IBM), in addition to the first graphical-oriented monitor, word-processing software, a workstation, a laser printer, a local area network, a hand-held mouse, the concept of the laptop (Alan Kay’s Dynabook), one of the first computer games, and many more. With the exception of the laser printer, Xerox management did not recognize the potential of PARC’s inventions. The success was reserved for other companies like Apple and Microsoft, and for employees leaving PARC to found their own companies to market their inventions. The most prominent examples are Bob Metcalfe, founder of 3Com, who marketed Ethernet, and John Warnock, founder of Adobe, who marketed his invention “Interpress” under the name “Postscript”. In the end, Xerox profited from almost none of these breakthrough inventions.¹⁰

⁸ Gurel (2007b).

⁹ Cohen et al. (2000).

¹⁰ Smith and Alexander (1999).

Examples of this kind from industry were important catalysts for the change in management thinking and brought the importance of both invention and innovation to the attention of managers. In this way, innovation management gained in importance in modern management as described in the following section.

2.1.2 Innovation Management

From our examination of invention and innovation, it seems obvious that the commercial success of an innovation does not solely depend on the quality of the invention in research and/or development. Moreover, the effective management of all components that belong to the very complicated process of managing innovation, which embraces all functions in the entire company play a role in determining the success of the innovation.

The interdisciplinary and multifunctional management of innovation focuses on the improvement of competitiveness and effectiveness of firms.¹¹ Innovation management covers all of the tasks that are required to create technology know-how and to transform this know-how into marketable innovations.¹² Innovation management is often a part of corporate strategy and may refer to products, services, manufacturing processes, organizational structures, management processes etc. In addition, the development and commercialization of non-technological change processes is within the remit of innovation management. In summary, innovation management deals with the design of processes and functions, which are tailored to the creation and commercialization of innovative things.¹³

As mentioned in the previous chapter when defining the terms invention and innovation the contemporary German literature on innovation management suggests a distinction between innovation management in a broader sense and in a narrower sense, see Table 2.2.

While innovation management in a narrower sense deals with the implementation and diffusion of innovation, innovation management in the broader sense embraces the whole process from the early fuzzy front end¹⁴ phases to the subsequent recycling and withdrawal from the market. Products are often initiated within research and development departments, especially in an industrial

¹¹ Tidd et al. (2005).

¹² Hauschild (1997), pp. 25–27.

¹³ Specht and Beckmann (1996), p. 15, Uhlmann (1978), p. 1, Little (1997), p. 1.

¹⁴ The term “Fuzzy Front End (FFE)” is used in various sources to describe the early phases of the innovation process; examples are: Khurana and Rosenthal (1998): “. . . we define the front end to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews”. Kim and Wilemon (2002): “Thus, we define the FFE as the period between when an opportunity is first considered and when an idea is judged ready for development.” Reinertsen (1994): “We call the time between when you could have started development and when you actually do, the ‘fuzzy front-end’.”

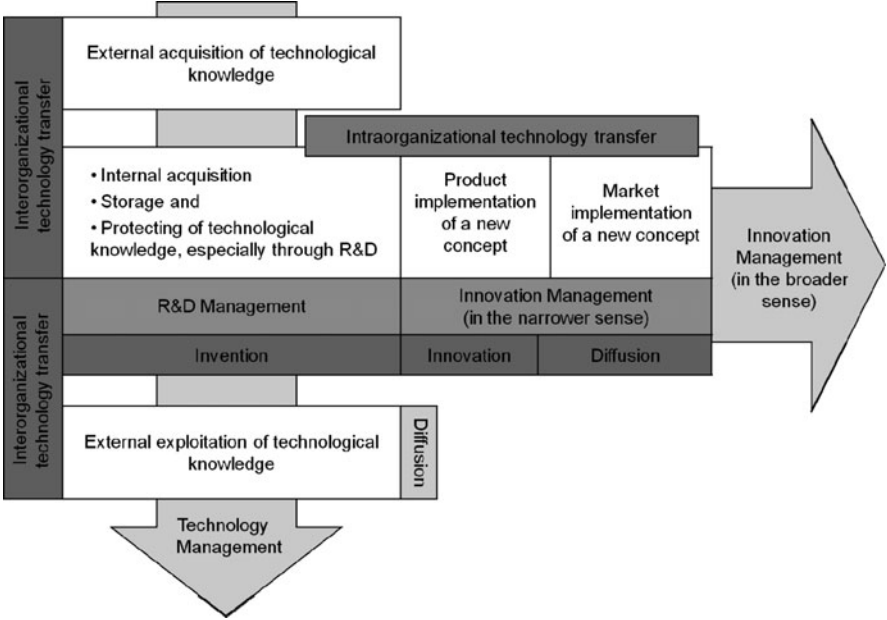


Fig. 2.1 Innovation management, technology management and R&D management¹⁵ (Source: Diagram based on Brockhoff 1994 and Betz 1998)

environment. Therefore, one of the tasks of innovation management in the broader sense and the specific task of R&D management is to determine the need for technology know-how and to foster its creation. Figure 2.1 illustrates the building blocks of the disciplines: Innovation Management, Technology Management and R&D Management, which literature often addresses separately.

Following these considerations the next chapter focuses on the early phases of the innovation process and discusses the (rather blurred) borders between research and development. This leads us to shape the term “Industrial Research”.

2.1.3 Research and Development

Research and Development (R&D) is a widely-used term. However, its contents are ambiguous and the use of the term itself is not uniform.

The term “R&D” in everyday language, especially within the industrial context, can be applied in two ways: (1) R&D is an organizational unit; (2) R&D describes a set of activities¹⁶ that are conducted in the early phases of the

¹⁵ Adapted from Brockhoff (1994), p. 51, Betz (1998), p. 27.

¹⁶ O’Donnell and Duffy (2005) consider an activity to be a fundamental element of a process, p. 18.

innovation process. These two interpretations are related in the sense that the organizational unit in general conducts part of the activities described by R&D.¹⁷ The spectrum of activities, which the term “R&D” covers according to general literature is much broader than the specific R&D activities conducted by a specific R&D department. Therefore, two different R&D organizations can only be considered comparable if their corresponding sets of R&D activities are fully juxtaposed.

For the purpose of this thesis we use the term “R&D” whenever we refer to activities, and the term “R&D department” or “R&D organization” when referring to an organizational unit.

We will now take a closer look at definitions of R&D in the literature. According to Specht and Beckmann, R&D is defined as “activities and processes that lead to *new* tangible and/or intangible artifacts”.¹⁸

Since it is essential for this thesis to separate research from development,¹⁹ the word “*new*” in this definition requires further attention.

Brockhoff as well as Specht and Beckmann discuss two dimensions of “newness”²⁰:

1. Content dimension: what is new?
2. Two aspects can be examined for the purpose of diagnosing newness: the newness of the very fact and the degree of newness.

Subjective dimension: new for whom?

The subjective dimension considers the opinion of four possible subjects: (1) any individual or expert, which could be either (2) a manager (from a business-oriented point of view), (3) a manager (from the eco-system perspective, including customers and partners), and (4) groups of experts (often expressed through national patent offices).

Hauschildt adds two extra dimensions²¹ for the whole innovation process:

3. Process-related dimension: where (in the process) does the “new” start and where does it end?

Since Hauschildt refers to the overall innovation process, this dimension is of less relevance to us.

4. Normative dimension: does “new” equal “successful”?

The normative dimension asks whether the “new” is also successful. Some literature suggests using the term “innovation” for products or processes, which allow for an “improvement” to the status quo. Along with this, the goal system of a user is referred to and as a consequence, the degree of goal

¹⁷ This view is also shared by Porter (1985) in his work on corporate strategy. He considers organizations as *a bundle of activities to deliver products and services*. In every company activities are therefore the means by which the work gets done and performance is accomplished.

¹⁸ Specht and Beckmann (1996), p. 16.

¹⁹ For the purposes of assessing the performance of industrial research departments, the question of separation between research and especially development will be further discussed in Sect. 3.1.5.

²⁰ Brockhoff (1994), p. 35, Specht and Beckmann (1996), p. 16.

²¹ Hauschildt (1997), pp. 7–23.

achievement after deploying the innovation should be higher than prior to the innovation. Hauschildt discusses that it is assumed that a goal system exists in which the goals can be articulated in a way that (1) they can be recognized by third parties, and (2) that these goals can be generalized. In addition, it is imperative that, (3) from the extent of the “goal achievement”, an assessment of the “achieved improvement” can be derived. Furthermore, it is assumed in this context that (4) it is possible to agree upon a uniform success measure and that all evaluators arrive at a similar assessment in terms of such success measure. Hauschildt discusses the consequences of these four assumptions in detail and concludes that it is not possible to use this dimension to characterize innovation.

The relevance of this dimension will be later addressed in the context of performance management (see Sect. 3.2)

Brockhoff’s two dimensions are supported by the Frascati Manual²² (FM). According to the FM, research and experimental development – abbreviated as “R&ED”²³ – comprise creative work undertaken on a systematic basis in order to both increase the amount of knowledge, including knowledge of man, culture and society, and to extend the use of this knowledge to devise new applications.

“New” in the context of the FM is the “... *appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e., when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned*”.²⁴ Within the first part of this definition, the content dimension is reflected (appreciable element ... technological uncertainty), and the subjective dimension is substantiated in the second part of the clause (someone familiar ... the area concerned).

Using this definition, the FM makes finer distinctions and identifies within the term “R&ED” the following three activities: basic research, applied research and experimental development, as shown in Table 2.3. The FM does not provide a name for phases comprising activities beyond experimental development. We therefore introduce the term *product development*, which comprises activities that are necessary after ED but before the beginning of the production phase.

²² The Frascati Manual is a Proposed Standard Practice for Surveys on Research and Experimental Development, published in 2002 by the Organization for Economic Co-operation and Development (OECD) dealing with the measurement of scientific and technological activities. The Frascati Manual is based on experience gained from collecting R&D statistics in OECD member countries. It has been developed over the last 40 years on the concept of science and technology indicators and developed a series of methodological manuals known as the “Frascati Family”, which includes manuals on: R&D (Frascati Manual), innovation (Oslo Manual), human resources (Canberra Manual), technological balance of payments and patents as science and technology indicators.

²³ The Frascati Manual’s definition of development (the “D” in R&D) does not include product development: instead it only includes experimental development. In order to distinguish between the two definitions of development, R&ED is used wherever a reference to the Frascati Manual is made.

²⁴ OECD (2002), p. 34, clause 84.

Table 2.3 Definitions of R&ED in the Frascati Manual^a

Activity	Definition	Focus																											
Basic research (BR)	Experimental or theoretical work undertaken primarily to acquire new knowledge, or the underlying foundation of phenomena and observable facts <i>without any particular application or use in view</i>	The creation of knowledge in general																											
Applied research (AR)	Also original investigation undertaken in order to acquire new knowledge. It is, however, <i>directed primarily towards a specific practical aim or objective</i>	The creation of marketable knowledge																											
Experimental development (ED)	Systematic work, <i>drawing on knowledge gained from research</i> and practical experience that is directed to produce new materials, products and devices; to install new processes, systems and services; or to substantially improve those already produced or installed	The development or improvement of new products, processes, systems or services																											
Beyond experimental development ^b	<p><i>The FM does not provide detail or definitions of activities beyond ED. However, the FM does explore activities that are on the borderline of or beyond ED. Examples of these are:</i></p> <table> <tr> <th>Item</th><th>Treatment</th><th>Remarks</th></tr> <tr> <td>Prototypes</td><td>Include in R&D</td><td>As long as the primary objective is to make further improvements</td></tr> <tr> <td>Pilot plants</td><td>Include in R&D</td><td>As long as the primary purpose is R&D</td></tr> <tr> <td>Industrial design and drawing</td><td>Divide</td><td>Include design required during R&D. Exclude design for production process</td></tr> <tr> <td>Industrial engineering and tooling up</td><td>Divide</td><td>Include “feedback” R&D and tooling up industrial engineering associated with development of new products and new processes. Exclude for production processes</td></tr> <tr> <td>Trial production</td><td>Divide</td><td>Include if production implies full-scale testing and subsequent further design and engineering. Exclude all other associated activities</td></tr> <tr> <td>Routine tests</td><td>Exclude</td><td>Even if undertaken by R&D staff</td></tr> <tr> <td>Data collection</td><td>Exclude</td><td>Except when an integral part of R&D</td></tr> <tr> <td>Public inspection control, enforcement of standards, regulations</td><td>Exclude</td><td></td></tr> </table>		Item	Treatment	Remarks	Prototypes	Include in R&D	As long as the primary objective is to make further improvements	Pilot plants	Include in R&D	As long as the primary purpose is R&D	Industrial design and drawing	Divide	Include design required during R&D. Exclude design for production process	Industrial engineering and tooling up	Divide	Include “feedback” R&D and tooling up industrial engineering associated with development of new products and new processes. Exclude for production processes	Trial production	Divide	Include if production implies full-scale testing and subsequent further design and engineering. Exclude all other associated activities	Routine tests	Exclude	Even if undertaken by R&D staff	Data collection	Exclude	Except when an integral part of R&D	Public inspection control, enforcement of standards, regulations	Exclude	
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Source: OECD (2002)

^aOECD (2002), Frascati Manual, p. 41, clause 110^bThe FM does not provide a name here; it only discusses activities beyond ED

The FM uses a strictly functional approach for these definitions, i.e., “*the nature of the R&D activity of the performing unit, rather than its principal (economic) activity, is examined*”.²⁵ In this context, principal activity refers to the organizational role within the performing unit within the innovation lifecycle. Consequently, the FM covers both “*formal*” R&ED in R&D units and “*informal or occasional*” R&ED in other units.²⁶ This is in line with the approach that we have chosen for the term “R&D”.

A logical temporal sequence for research (basic and applied) and experimental development is assumed. The definition of ED implies the extrapolation of research (basic and applied) results within this phase: “*a ... work, drawing on existing knowledge gained from research. ...*”

The FM itself acknowledges: “*there are many conceptual and operational problems associated with these categories*”.²⁷ The phases of knowledge gain are intertwined, partially influence each other, and cannot be considered independently.²⁸ The distinction between these phases is criticized because of the fuzzy demarcation of the phases. The Illinois Institute of Technology Research explicitly illustrated this fact in an empirical study on the overlapping of activities between phases by analyzing five important innovations.²⁹ We would like to point out that this phenomenon is also apparent for the later product development and production phases.³⁰ Nonetheless, Brockhoff³¹ states that the problem in distinguishing terms (i.e., basic research, applied research and experimental development) leads to a more applicable structure either by eliminating borders or by an even more subtle differentiation, i.e., by creating new borders. Although this approach sounds promising at a first glance, the context-based classification of activities stated in the FM provides a counter-argument to the feasibility of the approach.

Since this thesis focuses on research in an industrial environment, it is necessary to put the term ‘industrial research’ into context.³² The role and dynamics of

²⁵ OECD (2002), Frascati Manual, p. 76, clause 236.

²⁶ OECD (2002), Frascati Manual, p. 17, clause 14.

²⁷ OECD (2002), Frascati Manual, p. 79, clause 251, note also that the FM acknowledges that possibly the greatest source of error in measuring R&D is the difficulty of locating the cut-off point between experimental development and the related activities required to realize an innovation.

²⁸ Schätzle (1965), p. 19, Hauber (2002), p. 24.

²⁹ Illinois Institute of Technology Research (1968), p. 15, Brockhoff (1994), p. 41.

³⁰ Brockhoff (1994), p. 40.

³¹ Brockhoff (1994), p. 39.

³² Depending on the business sector, discipline and individual organizational setup of companies, there are often overlaps of different phases that are affiliated to the research function, and there are also different names for these phases. A widely-used term in literature that describes the phase beginning somewhere within industrial research, sometimes starting before the “grey zone” and sometimes after and continuing with product development is “New Product Development (NPD)”. Another name is “Advanced Development (AD)”, or just “Development (D)”. These phases are beyond the scope of this work; the separation from development, however, will be discussed in detail.

industrial research is acknowledged, for example, by the European Commission, as a one of the important facilitating forces behind innovation. The European Commission carefully monitors a variety of research activities in the European Union and pays special attention to statistics and figures such as research investment³³ by top European firms.

As discussed above, the borders between the phases are blurred, and in terms of this thesis, we must focus our attention on the borders of industrial research in order to identify its activities. This problem has often been discussed in literature. In order to better understand the core questions: “where does industrial research start/end?” and “where the development starts?” we review the literature on the definition of the term “industrial research” in the following sections.

The term ‘industrial research’ became popular in the American literature in the 1960s and 1970s. Chorafas identifies industrial laboratories as one of seven types of research establishment. Stating the difficulty of an exact separation of pure research and applied research and development, he says³⁴: pure research consists of the exploration of something previously unknown in order to scientifically formulate physical or technical singularities; applied research consists of a transformation of the discoveries of pure research into practical products. Chorafas continues describing development as the continuous improvement of these products up to the highest degree of perfection and the determination of the most optimal production run. He argues that the difference between industrial research and other research establishments is manifested in the intent of the work rather than the working methods. He also notices that industrial research departments are established to tackle certain research areas and to seek solutions that are industrially exploitable.³⁵

Schätzle takes up these considerations and states that exponents of business economics and engineers who manage research activities within companies favor the term ‘industrial research’ instead of ‘research and development’. He concludes that the term ‘industrial research’ is identical to the term R&D, provided that the research is aimed at technology research, and the activities are conducted by industrial companies.³⁶

³³ The European Commission collects and analyzes policy-relevant information on corporate R&D through its ‘*industrial research and innovation monitoring and analysis activities*’ (IRIM) at the Joint Research Centre’s Institute for Prospective Technological Studies (JRC-IPTS), in co-operation with DG Research. The EU Industrial R&D Investment Scoreboard, the EU Survey on Business Trends in R&D, the Digest of Industrial R&D and the Industrial R&D Economic and Policy Analysis are some of the products of this work (for more information on these reports see <http://iri.jrc.ec.europa.eu>). EC-JRC (2008), p. 5.

³⁴ Reine Forschung bestehe in der Erforschung des bisher Unbekannten, um entdeckte physikalische oder technische Eigenheiten im naturwissenschaftlichen Sinne zu formulieren. Angewandte Forschung dagegen bestehe in der Umgestaltung der Entdeckungen der reinen Forschung in brauchbare Produkte. Ihr folge die Entwicklung mit einer stetigen Verbesserung dieser Produkte bis zu einem hohen Grad der Vollkommenheit und der Bestimmung des günstigsten Herstellungsganges.

³⁵ Chorafas (1963), p. 19.

³⁶ Schätzle (1965), pp. 11–12.

Bruggmann, for his part, defines industrial research in a narrow sense as technology research, and in a broad sense to also include business-oriented research related to technology research.³⁷

The European Union provides a more precise definition of industrial research: the planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services or for bringing about a significant improvement in existing products, processes or services. It comprises the creation of components of complex systems, which is necessary for the industrial research, notably for generic technology validation, to the exclusion of prototypes as covered by “experimental development”.

These definitions of industrial research are quite inconsistent. They range from basic research, to product development in its broadest definition, to applied research only in its narrowest definition. Additionally, the implied sequence and separation,³⁸ as for example, defined by the FM, rarely exist in practice as – in general agreement – the borders between the phases are rather blurred and somewhat overlapping. The execution of these three types of R&D can happen within the same department by essentially the same staff.³⁹ Hence, the mapping of individual activities to a dedicated phase can be a very difficult task and strongly depend on the context in which the corresponding activities are conducted.⁴⁰ Furthermore, recent trends such as open innovation and shortened innovation life cycles confirm this observation. Figure 2.2 summarizes the discussion above and integrates the terms

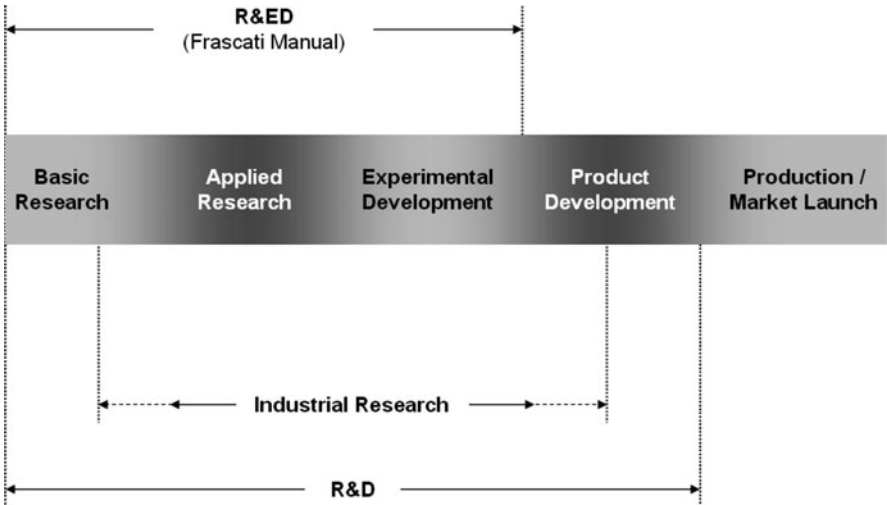


Fig. 2.2 Scope of activities in industrial research (Source: The figure was derived from the literature review by the author)

³⁷ Bruggmann (1957), p. 4f.
³⁸ Refer to Schätzle (1965), p. 21, OECD (2002), pp. 77–79, clauses 240–250.
³⁹ OECD (2002), Frascati Manual, p. 79, clause 251.
⁴⁰ FM discusses this in terms of project contexts, OECD (2002), p. 34, clause 85.

‘research and development’ (R&D), R&ED according to the FM, and our view of industrial research. Our view, which is that industrial research in the narrower sense encompasses applied research and experimental development, is based on the initial ideas of the FM, which we subsequently validated with the case studies (cf. Appendix D). Due to the blurring of the different phases, industrial research in the broader sense may, however, also cover activities starting at the end of basic research and ending within the product development phase.⁴¹ In the following thesis, we will always use the term ‘industrial research’ in its broader sense.

As a final remark in this section we would like to point out that industrial research sometimes tends to cultivate self-perpetuating dynamics within an organization. This is due to the very different nature of a research department compared to other company departments. A research department, for example, that conducts public-funded research projects has to nourish its own eco-system. This eco-system, according to Beck and Völker, includes external groups such as academia, industrial partners, political bodies, media and internal units. Of these internal units, the foremost would be the development department, as well as the communication and marketing departments, top management, etc.⁴²

2.2 Performance Management – Basic Terms and Definitions

2.2.1 Performance

The subject of this study is performance measurement and therefore the term ‘performance’ is defined. A review of relevant literature shows that no uniform definition of the term ‘performance’ exists. Management literature, in particular, has many proposals as how to measure performance without precisely defining it first.⁴³ Originally, the term “performance” meant a play or piece of music, according to Wettstein’s⁴⁴ citing of Andersen and Fagerhaug “. . . *performance is believed to have originated in the fifteenth century to mean a play or exhibition of some type*”.

The Oxford English Dictionary defines performance as: “*Performance. The action of performing, or something performed. . . The carrying out of a command, duty, purpose, promise, etc.; execution, discharge, fulfillment. Often antithetical to promise. . . The accomplishment, execution, carrying out, working out of anything ordered or undertaken; the doing of any action or work; working, action (personal*

⁴¹ Product development comprises activities that are beyond ED activities. However they are necessary ahead of the production phase.

⁴² Beck and Völker (2009), p. 34.

⁴³ Krause (2005), p. 17.

⁴⁴ Wettstein (2002), p. 15.

or mechanical); spec. the capabilities of a machine or device, now esp. those of a motor vehicle or aircraft measured under test and expressed in a specification. . . . The observable or measurable behaviour of a person or animal in a particular, usu. experimental, situation. . . . The action of performing a ceremony, play, part in a play, piece of music, etc. . . .

The dictionary definition shows that the term has kept its original definition but has gained additional meanings. “Accomplishment”, “efficiency”, “capability”, and “satisfaction” are listed as synonyms. The definitions encompass many different aspects; this is reinforced by the often cited statement of Meyer and Gupta: “there is a massive disagreement as to what performance is and that the proliferation of performance measures has led to the paradox of performance, i.e. that organizational control is maintained by not knowing exactly what performance is”.⁴⁵

In the performance measurement literature we encountered many different definitions. Different fields use different definitions in different contexts: For example, production management accentuates the activity, the organizational context focuses on fast and optimal cost processes; economics sees performance as productivity; business studies often translate performance into monetary value; management accounting sees performance as an output of a company in financial terms; change management defines performance as generating results and emphasizes stakeholders e.g. shareholders, customers, personnel.

Table 2.4 shows some relevant definitions and is ordered by publication date.

Performance is not an absolute but a relative measure of success. Hauber⁴⁶ reports that performance can be assessed for: (a) set objectives (planned/actual comparison, planned/will be comparison), (b) other defined periods (intertemporal comparison), and (c) an object of comparison (competitive comparison/benchmarking). A comprehensive overview of the different facets of the term “performance” can be found in the work of Krause.⁴⁷

All definitions above have one common characteristic; they all are related to two terms: effectiveness and efficiency. These two terms are well defined in the literature, with the most common citation being by Drucker: “Effectiveness is the foundation of success – efficiency is the minimum condition for survival after success has been achieved. Efficiency is concerned with doing things right, effectiveness is doing the right things”.⁴⁸ However, in colloquial language these terms are mis-used as synonyms for profitability or goal-oriented behaviour.

The definition of efficiency and effectiveness implicitly presumes the existence of a pre-defined goal as both can only be evaluated against a goal. As a consequence, all definitions examined above are similar with regards to the existence of

⁴⁵ Meyer and Gupta (1994), p. 309.

⁴⁶ Hauber (2002), p. 54.

⁴⁷ Krause (2005), pp. 17–22.

⁴⁸ Drucker (1974), p. 45.

Table 2.4 Definitions of the term “performance”

Source	Definition
Venkatraman and Ramanujam (1986)	“Performance is the time test of any strategy” ^a
Cordero (1989)	“Effectiveness (i.e. measuring output to determine if they help accomplish objectives)” “Efficiency (i.e. measuring resources to determine whether minimum amounts are used in the production of these outputs)” ^b
Lebas (1995)	“Performance is about deploying and managing well the components of the causal model that leads to the timely attainment of stated objectives within constraints specific to the firm and to the situation” ^c
Neely et al. (1995)	“Efficiency and effectiveness of purposeful action” ^d
Rolstadas (1998)	“A complex interrelationship between seven performance criteria: effectiveness, efficiency, quality, productivity, quality of work life, innovation, profitability/budget-ability” ^e
Dwight (1999)	“The level to which a goal is attained” ^f
Hoffmann (1999)	“The term “performance” describes an evaluated contribution to the attainment of organizational goals. This contribution can be generated by individuals and groups of employees within the organization, as well as by external groups, e.g., suppliers” ^g
Andersen and Fagerhaug (2002)	“We believe it is sufficient to have reached a point where performance has replaced productivity and is generally accepted to cover a wide range of aspects of an organization – from the old productivity to the ability to innovate, to attract the best employees, to maintain an environmentally sound outfit, or to conduct business in an ethical manner” ^h
Grüning (2002)	Performance is understood as the ability of a company to achieve goals, i.e. meet expectations, and is therefore influenced by results in a wider sense, ⁱ but also by the corresponding goal setting ^j
Hauber (2002)	“The term “performance” describes the contribution of specific systems (organizational units of differing sizes, employees, and processes) to attain and validate the goals of a company” ^k
Wettstein (2002)	“Performance can be understood as the degree of stakeholder satisfaction” ^l
EFQM (2003)	“Performance is the level of attainment achieved by an individual, team, organization or process” ^m
Krause (2005)	“Performance refers to the degree of the achievement of objectives or the potentially-possible accomplishment regarding the important characteristics of an organization for the relevant stakeholders. Performance is therefore principally specified through a multidimensional set of criteria. The source of the performance is the actions of players in the business processes” ⁿ

^aVenkatraman and Ramanujam (1986), p. 802

^bCordero (1989), p. 185, note that Cordero hypothesizes that overall performance is a function of both technical performance and commercial performance

^cLebas (1995), pp. 29

^dNeely et al. (1995), pp. 80–116

^eRolstadas (1998), pp. 989–999

^fDwight (1999), pp. 258–275

^gTranslated from Hoffmann (1999), p. 33: “Unter Performance/Leistung wird der bewertete Beitrag zur Erreichung der Ziele einer Organisation verstanden. Dieser Beitrag kann von Individuen und Gruppen von Mitarbeitern innerhalb der Organisation sowie von externen Gruppen (z.B. Lieferanten) erbracht werden”

^hAndersen and Fagerhaug (2002), cited from Wettstein (2002), p. 17

ⁱThe formulation “in a wider sense” emphasizes the fact that “results” do not only refer to periodical revenue figures

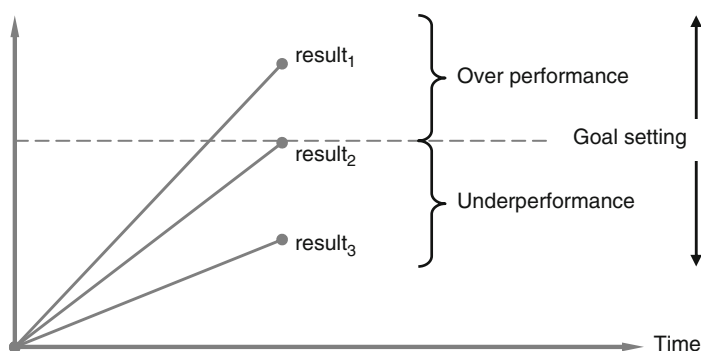
^jTranslated from Grüning (2002), p. 5: “Performance wird hier als die Fähigkeit eines Unternehmens verstanden, Ziele zu erreichen, also Erwartungen zu erfüllen und ist somit sowohl von Ergebnissen im weiteren Sinne, wir aber ebenso durch die entsprechende Zielstellung beeinflusst”

(continued)

Table 2.4 (continued)

Source	Definition
^k Translated from Hauber (2002), p. 54: “Unter Performance wird der Beitrag spezifischer Systeme (Organisationseinheiten unterschiedlicher Größe, Mitarbeiter, Prozesse) verstanden, die Ziele des Unternehmens zu erreichen und zu überprüfen”	
^l Translated from Wettstein (2002), p. 17: “Performance kann aufgefasst werden als Grad der Zufriedenheit der relevanten Anspruchsgruppen”	
^m EFQM (2003)	
ⁿ Translated from Krause (2005), pp. 17–21: “Performance bezeichnet den Grad der Zielerreichung oder der potenziell möglichen Leistung bezüglich der für die relevanten Stakeholder wichtigen Merkmale einer Organisation. Performance wird deshalb erst durch ein multidimensionales Set von Kriterien präzisiert. Die Quelle der Performance sind die Handlungen der Akteure in den Geschäftsprozessen”	

one or several goals of which the degree of attainment can be determined. Grüning, for example, defines performance as the ability of a company to achieve its goals (cf. Fig. 2.3). Performance depends on the one hand from the results (over or under performance) and on the other hand from the goal setting.⁴⁹

**Fig. 2.3** Performance as goal attainment (Source: Grüning 2002)

Effectiveness and efficiency in this context can therefore be understood in an abstract sense as performance measures that need to be appropriately quantified to evaluate goal attainment: Effectiveness as an indicator of the degree of a goal attainment, and efficiency as an indicator of the resources that were consumed to reach the level of achievement. For an overall evaluation of the performance, the relative importance of each aspect should be appropriately considered. In this thesis, the term “performance” is used as the level/degree of goal achievement of an organization/department rather than of individuals. Individual work performance is very much addressed in the area of applied psychology.

⁴⁹ Grüning (2002), p. 5.

2.2.2 Goals and Goal Setting

The way in which the term “performance” has been defined in the previous section immediately raises the following question: What are “goals” and/or “organizational goals”?

In organizations a number of individuals simultaneously work on different activities with different or at least slightly different interests. In order to bundle the interests and direct them in a strategic direction for the overall organization, an instrument is required. A means to achieve this alignment are explicitly formulated, as are jointly-accepted goals e.g. management by objectives.⁵⁰ Within this context, how this alignment process takes place is of major significance. We initially revisit definitions of the term “goal” found in the literature.

The Merriam-Webster dictionary⁵¹ defines the term “goal” as the end towards which effort is directed. Synonyms are “objective”, “aim”, and “intent”. According to Nagel, within the business-organizational context, “goal” should be used when that which is strived for is relevant for action and has a direct connection with the concrete problem and its solution.⁵² Dörner points out that individual’s goals can be contradictory due to their different interests.⁵³ He concludes that the major purpose of goal setting is discovering and issue-related handling of conflicts. Hamel cites the first German-speaking investigation by Schwantag in 1951.⁵⁴ The definition of the characteristics of a “goal” include: reference to the future, assignment of a positive valence, determination of a state, event, process, and effect.

Within organizational psychology authors define goals as:

- What the individual is consciously trying to do⁵⁵;
- Where levels of performance sought appear to be common elements in attempts to motivate performance; success is associated with goal achievement and failure with performance below the goal level⁵⁶;
- What an individual is trying to accomplish; it is the objective or aim of an action⁵⁷;
- A target state or condition the organization wants to achieve.⁵⁸

⁵⁰ Nagel (1992), p. 2626.

⁵¹ Merriam-Webster’s 11th Collegiate Dictionary (2004) [goal].

⁵² Nagel (1992), p. 2627.

⁵³ Dörner et al. (1983), pp. 37–38.

⁵⁴ Schwantag (1951) cited from Hamel (1992), p. 2634.

⁵⁵ Locke (1968), p. 159.

⁵⁶ Frost and Mahoney (1976), p. 328.

⁵⁷ Locke et al. (1981), p. 126.

⁵⁸ Griffin (1990), p. 161.

For this thesis we use the term “goal” as per the definition of Hamel⁵⁹:

A goal is an envisaged and intended future state, an anticipated vision of the impact of actions.

Hamel adds to the definition that in contrast to (pure) forecasts, goals show the character of activity; within the goal, the intent of attainment or completion is logically included.⁶⁰

Nagel⁶¹ deals with goal setting in the context of the problem solving process. He develops a hierarchical (top down) approach for goal setting and describes goal setting as a *process* where goals are cascaded and refined six times for seven levels. Specht and Beckmann also support the process view. They argue that within the phases of problem recognition and the evaluation of alternative solutions the matter of goal creation should be seen as a process across a period of time and not as an act that occurs at a specific point in time.⁶²

Following Specht and Beckmann⁶³ we define the goal setting process as:

A systematic reduction of complexity, which can be realized, on the one hand, by the initial decomposition of the goal followed by subsequent structuring in a goal system and, on the other hand, through the iterative involvement of goal creation in the problem-solving process.

2.2.3 Measures, Metrics, and Indicators

The performance measurement literature relies on a variety of definitions to describe metrics that are applied to assess goal attainment in organizations. In this section we analyze the different terms and select which term to be use in this thesis. The following terms, inter alia, have been found in the performance measurement literature: “performance metrics”, “performance criteria”, “performance measures”, “performance indicators”, “key result indicators”, “critical success factors”, “key success indicators”, “indexes”, “strategic measures” and “success

⁵⁹ Translated from Hamel (1992), p. 2634: Als Ziel kann man folglich “einen vorgestellten und gewollten zukünftigen Vorgang oder Zustand, eine antizipierte Vorstellung der Wirkung unseres Handelns” verstehen. Ziele weisen im Gegensatz zu (reinen) Prognosen den Charakter von handlungssteuernden Vorgaben auf; im Ziel ist die Erreichungs- oder Erfüllungsabsicht definitionsslogisch enthalten, also Bidlingmaier (1964).

⁶⁰ Hamel (1992), p. 2634.

⁶¹ Nagel (1992), p. 2627.

⁶² Specht and Beckmann (1996), p. 18, p. 125.

⁶³ Derived from Specht and Beckmann (1996), p. 125: “Der Zielbildungsprozeß kann als eine systematische Komplexitätsreduzierung, die zum einen durch Zielzerlegung mit anschließender Strukturierung in einem Zielsystem und zum anderen durch iterative Einbindung der Zielbildung in den kognitiven Problem-Lösungs-Prozeß realisiert werden kann, verstanden werden”.

measures”. Krause notes that the use of the terms: “performance measures”, “performance metrics”, “performance indicators”, and “key performance indicators” has gained in importance recently.⁶⁴ In order to assess things (e.g. activities, products, services) adequate measurement instruments are required. For this thesis, the definitions and differences between the following terms will be elaborated on: measure, metric, performance indicator and key performance indicator (Table 2.5).

Table 2.5 Key terms in Performance Measurement

Terms to be defined in this chapter
Measure
Metric
Performance Indicator
Key Performance Indicator

- The Merriam-Webster-Dictionary⁶⁵ describes the term “*measure*” as:
- (a) A fixed or suitable limit (1a (3));
 - (b) The dimensions, capacity, or amount of something ascertained by measuring (1b);
 - (c) An estimate of what is to be expected (1c);
 - (d) A measured quantity (1d (1));
 - (e) Amount, degree (1d (2));
 - (f) A standard or unit of measurement. . . (2b);
 - (g) A basis or standard of comparison (6).

The complete dictionary entry contains additional aspects to those listed above; we have only selected those that are most relevant for our context.⁶⁶ Our selection already hints at many different facets and suggests that the exact meaning of the word depends heavily on the context in which it is used as well as on subjective interpretation. Within our context, definitions (d) and (f) have the best match as they both suggest an “indication of a quantity”. For our work we use the definition closest to (d) and define measure as “*a quantifying value*”.

⁶⁴ Krause (2005), p. 21.

⁶⁵ Merriam-Webster’s 11th Collegiate Dictionary (2004) [measure].

⁶⁶ For example music, dance or instruments were not considered in our selection.

Geisler⁶⁷ provides the following definition for *metrics*: they “may be used generically to describe a system of measurement that includes: (1) the item or object that is being measured; (2) units to be measured, also referred to as “standard units”, and (3) value of a unit as compared to other units of reference”.

Comparison of the terms “measure” and “metric” suggests that the major difference between them is that a metric embodies additional information about the referent. *A metric puts a measure into a certain context (e.g. the distance between two points in a two-dimensional plane) which is given by an item or an object or a set of those, defines a unit of measure (e.g. meter) and a reference unit (the definition of 1 m).*

Within the context of performance measurement there is often no one single adequate metric that allows us to exactly determine the degree of goal achievement. Geisler states that “in the social, managerial, and behavioral environments and sciences, the phenomenon under consideration is much less precise. In most instances the phenomenon of interest is in the form of a process, or at least as a set of events”.⁶⁸ According to Gladen,⁶⁹ numbers that try to picture complex issues in a simple manner have, in a broader sense, more or less the character of *indicators*. He states that indicators in narrower sense are not obtained through the consolidation of quantitative information and he defines indicators as “auxiliary metrics, whose characteristics or changes allow some conclusions on the characteristics or changes of another measure which is considered important”.⁷⁰ He adds that indicators are needed for facts or parameters that are not directly measurable or observable, and mentions that their validity is less than those of the original facts.

Following this explanation, we define a performance indicator in the context of organizational performance measurement as follows:

A performance indicator is an auxiliary metric that partially reflects the performance of an organizational unit.

The following definitions of “performance indicator” have been found in the literature (Table 2.6):

⁶⁷ Geisler (2000), p. 34.

⁶⁸ Geisler (2000), p. 35.

⁶⁹ Gladen (2005), p. 14.

⁷⁰ Translated from Gladen (2005), p. 14: “(Indikatoren) Sie sind Ersatzgrößen, deren Ausprägung oder Veränderung den Schluss auf die Ausprägung oder Veränderung einer anderen als wichtig erachteten Größe zulassen”.

Table 2.6 Definition of the term “Performance Indicator”

Source	Definition
Ahaus (1994)	“Description of a subject, measurement scale and a measurement procedure. A performance indicator is the operationalization of a non-measurable goal” ^a
Neely et al. (1995)	“A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of an action” ^b
Kerklaan et al. (1996)	“An instrument to measure a predefined part of the performance of a process in order to monitor the development of this performance. A complete indicator consists of a measure, a norm, a measurement instrument and a registration technique” ^c
Kerssens-van Drongelen (2001)	“A performance indicator is a variable which indicates the effectiveness and/or efficiency of a process, system or part of a system when compared with a reference value” ^d
Gladden (2005)	“... (in a broader sense) are the quantitative information which have been prepared for the specific needs of business analysis and management” “... are alternate parameters, whose characteristic or variation allow the inferring of the characteristic or variation of another parameter which is considered to be important”

^aAhaus (1994), p. 143, cited from Kerssens-van Drongelen (2001), p. 74

^b Neely et al. (1995), p. 80. In our interpretation, this definition of Neely et al. is more closely related to the concept of performance indicators

^c Kerklaan et al. (1996), p. 208, cited from Kerssens-van Drongelen (2001), p. 74

^dKerssens-van Drongelen (2001), p. 81

We can conclude from the above definitions that performance cannot be seen as something absolute and it is difficult to capture and quantify performance precisely – thus indicators for performance are needed. Concluding from Gladden’s definition that indicators are alternatives that provide approximations it is obvious that in general performance cannot be sufficiently quantified by means of one single indicator. Sound statements need a set of performance indicators.⁷¹

Arguing that the information to be reported to upper management should be presented in a reduced form, Gladden explains information reduction through consolidation (qualitative and quantitative) and that reduction through selection exists. With reduction through selection he suggests the existence of key performance indicators and in this way justifies their use.⁷² Some definitions found in the literature are listed below (Table 2.7):

⁷¹ Bösch (2007), pp. 104–105.

⁷² Gladden discusses six types of consolidation adopted from Birk (1991): Informationsentlastung durch Verdichtung und Informationsentlastung durch Selektion, Gladden (2005), p. 13. This view will be further analyzed in Chap. 3.

Table 2.7 Definition of the term “Key Performance Indicator”

Author	Definition
Dransfield et al. (1999)	“Tactical measures, or key performance indicators, are a set of enterprise-level measures that collectively capture the overall performance of the enterprise and act as predictors of future success, that is, of future values of the success measures” ^a
Hauber (2002)	“Performance measures provide information in a quantified and condensed form about the performance of organizational units, employees and processes and are, therefore, an important basis of information for managers to use when supervising a company” ^b
Meyer (2002)	“... drivers of financial performance, that is non-financial measures describing internal processes, products, and customers, at the level of the entire firm or its business units (Meyer also calls them aggregate measures)” ^c
Gladen (2005)	“(in a narrower sense) are measures, which are deliberately/intentionally/willfully heavily compacted to absolute and relative numbers so as to being able to report in a concentrated form about a numerically ascertainable facts/data” ^d
Parmenter (2007)	“Key performance indicators represent a set of measures focusing on those aspects of organizational performance that are the most critical for the current and future success of the organization” ^e

^a Dransfield et al. (1999), pp. 99–150. Furthermore, authors distinguish between “strategic measures” defining performance on an investment level and “operational measures” on the work processes of the enterprise

^b Translated from Hauber (2002), p. 54: “Performance Measures sind Kennzahlen, die in quantifizierter und verdichteter Form Auskunft über die Performance von Organisationseinheiten, Mitarbeitern oder Prozessen geben, und daher für das Management eine wichtige Informationsbasis zur Unternehmenssteuerung sind”. In our interpretation, this definition of Hauber is more closely related to the concept of key performance indicators

^c Meyer (2002), p. 9, uses a similar definition to Hauber’s “non-financial” measures term, which expresses his motivation for performance indicators and the notion of holistic view “level of the entire firm” demonstrates the character of key performance indicators. Meyer also notes that the information about performance is obscured by aggregate performance measures. The aggregation conceals the sources where the performance is poor and where it is excellent. They are lumped together and in the end do not indicate where to place corrective actions

^d Translated from Gladen (2005), pp. 11–12, “Kennzahlen im ‘weiteren Sinne’: Das sind quantitative Informationen, die für die spezifischen Bedürfnisse der Unternehmensanalyse und -steuerung aufbereitet worden sind”. Gladen subsumes Indicators falling into this category. “Kennzahlen im ‘engeren Sinne’: Diese sind Maßgrößen, die willentlich stark verdichtet werden zu absoluten und relativen Zahlen, um mit ihnen in einer konzentrierten Form über einen zahlenmäßig erfassbaren Sachverhalt berichten zu können”

^e Parmenter (2007), p. 3. Parmenter distinguishes between three types of performance measures: (1) Key result indicators (KRIs) describing how you have done in a given perspective; (2) Performance indicators (PIs) telling you what to do; and (3) Key performance indicators (KPIs) suggest what you should do to increase performance. His concept will further be discussed in Sect. 3.3.1

The common ground shared by these definitions is that in the “last” step, the focus is on aspects that are deemed critical to the organization. This leads us back to the earlier idea that a reasonably complete impression of the overall performance of





an organizational unit typically requires a set of Key Performance Indicators (KPIs).⁷³

Building on the terms “measure”, “metric” and “performance indicator” presented above, we define the term “key performance indicator” in the following way:

Key performance indicators are a set of performance indicators, which have been selected or defined upfront by management that strongly reflects the critical factors that are of particular interest for performance of an organizational unit.

Below is a summary of the terms defined in this chapter (Table 2.8):

Table 2.8 Definitions: measure, metric, PI and KPI

Term		Definition
Measure		A quantifying value
Metric		A metric puts a measure into a certain context. The context is given by an item or an object or a set of items or objects. It defines a unit of measure and a reference unit
Performance Indicator		A performance indicator is an auxiliary metric that partially reflects the performance of an organizational unit
Key Performance Indicator		Key performance indicators are a set of performance indicators that are selected upfront and agreed on by management to be the most representative and/or critical performance indicators. A key performance indicator is an element of this set

2.2.4 Performance Management

Simply knowing the level of attainment or performance does not improve the performance itself. The performance has to be actively managed. Performance management and performance measurement are sometimes mistaken for each other. Klingebiel states that the literature is inadequate on the conceptual, contextual and definitional differences between performance management and performance measurement.⁷⁴ Lebas claims “management could hardly exist without measurement”. He argues that performance management and performance measurement are closely intertwined and therefore inseparable. His clarification regarding their dimensions: “performance management precedes and follows performance measurement, in a virtuous spiral and performance management creates the context for measurement”, suggests performance measurement is a

⁷³ Note that all the definitions that we found use the term in the plural indicating “a set of KPIs”.
⁷⁴ Klingebiel (1999), p. 9.

part of performance management.⁷⁵ The distinction between the terms is essential for this thesis because they differ in the functions they cover and therefore help us to define the scope of the thesis.

Many different definitions of performance management exist in the literature. To help provide a consistent view on performance management, the definition for performance management *system* will also be reviewed. The interpretation of the term “system” is often ambiguous. Therefore, before studying “performance management” and “performance management system” we briefly analyze the definition of “system”. System can be defined as a uniformly-ordered whole. System concepts provide a useful way to describe many organizational phenomena, including the information system, features of applications and development processes.

Organized, purposeful structure regarded as a ‘whole’ consisting of interrelated and interdependent elements (components, entities, factors, members, parts etc.). These elements continually influence one another (directly or indirectly) to maintain their activity and the existence of the system, in order to achieve the common purpose (the goal) of the system.⁷⁶

On the one hand, the system can be interpreted as the interplay of all integrated components and their interdependencies; on the other hand it is often interpreted as an information system that monitors the overall performance. The following definitions for the terms “performance management” and “performance management system” have been found in the literature. Performance management system definitions will be mentioned at the end. The order is by publication date (Table 2.9).

The definitions suggest that performance management encompasses all “management” activities: planning, organizing, co-ordinating, leading, controlling, staffing and motivating. This supports the fact that management is the larger domain and includes performance measurement as a component.

Wettstein⁷⁷ draws on the general concept of corporate management⁷⁸ determined by Rühli.⁷⁹ Rühli defines management as the entirety of institutions, processes and tools that provide a basis for will-formation (*planning* and *decision*) and will-enforcement (instructions and control) in the context of problem-solving by a community (with complex interpersonal relationships). From the four constitutive elements of *planning*, *decision*, *instructions/order* and *control*, Wettstein assigns *control* and partly *planning* to performance measurement, while *decision* and *instructions/order* he clearly assigns to the concept of management. This approach is also supported by Brunner who limits performance measurement to “measurement/assessment” by means of performance indicators. He also highlights

⁷⁵ Lebas (1995), p. 23.

⁷⁶ Business Dictionary (2009).

⁷⁷ Wettstein (2002), p. 27.

⁷⁸ Rühli (1985), p. 30 follows Gutenberg (1976) in his definitions and uses the following terms synonymously: Führung = Leitung = Management.

⁷⁹ Rühli (1985), p. 28.

Table 2.9 Definitions of the term “Performance Management”

Author	Definition
Lebas (1995)	“A philosophy which is supported by performance measurement. Achieving congruence as to the definition of the parameters of performance and the causal model(s) that lead to it is one of the essential functions of (performance) management” ^a
Brunner (1999)	“A company-wide management system which transforms the process of the operationalization of company strategies and objectives into a permanent management system. The achievement of objectives (of the relevant stakeholders) is supported by the combination of strategies, strategic initiatives and the planning, controlling and monitoring of the relevant management quantities” ^b
Gomez et al. (2002)	“An approach to connect value-based strategic planning (financial value) with a measurable strategic implementation in order to resolve currently-existing deficits in strategic management and to point to new ways towards value-based corporate governance” ^c
Hoffmann (2000)	“Includes techniques which enable managers, in coherence with the overall company objectives, to plan, guide and improve the performance of their employees” ^d
Hauber (2002)	“Performance management is the process of planning, managing and controlling quantified variables that refer to the resources (inputs) and their transformation (throughput) in the performance (outputs) of a company’s specific systems” ^e
Cokins (2004)	“The process of managing an organization’s strategy through a fully integrated system of business improvement methodologies, metrics, processes, software tools and systems that manage the performance of an organization” ^f
Krause (2005)	“Performance management encompasses all activities that are aimed at the optimization of stakeholder benefits through the constant improvement of the players’ professional competence and social skills, and at the same time, that minimize the financial, physical, temporal, emotional and social effort” ^g
<i>Definition of the term “Performance Management System”</i>	
Krause (2005)	“A performance management system (PMS) is a management system based upon indicators that support the tasks aimed at optimizing the benefits to an organization’s stakeholders. Therefore, effective PMSs must represent the correlation between performance goals, goal achievement indicators, success-critical value-added activities and techniques for the improvement of the performance on all levels and along the entire value chain of an organization” ^h

^a Lebas (1995), p. 34^b Translated from Brunner (1999), p. 11: “Performance Management ist ein unternehmensweites Managementsystem, das den Prozess zur Operationalisierung der Unternehmensstrategien und –ziele in ein permanentes Führungssystem überführt. Durch die Verknüpfung von Strategien, strategischen Initiative und der Planung, Steuer und Kontrolle der relevanten Steuerungsgrößen wird die Zielerreichung (der relevanten Anspruchsgruppen) unterstützt”^c Translated from Gomez et al. (2002), p. 426: “Performance Management ist ein Ansatz, der die wertorientierte Strategieplanung (finanzieller Wert) mit einer messbaren Strategieimplementierung verbindet, um dadurch heute bestehende Defizite im strategischen Management zu überwinden und neue Wege zu einer wertbewussten Unternehmensführung zu weisen”.^d Translated from Hoffmann (2000), p. 29: “Performance Management beinhaltet Techniken, mit denen Manager in Abstimmung mit den übergeordneten Unternehmenszielen die Performance ihrer Mitarbeiter planen, lenken und verbessern können”.^e Translated from Hauber (2002), p. 56: “Unter Performance Management wird der Prozess der Planung, Steuerung und Kontrolle quantifizierter Größen verstanden, die sich auf die Ressourcen (Input) und deren Transformation (Troughput) in Leistungen (Output) von spezifischen Systemen eines Unternehmens beziehen”^f Cokins (2004), cited from Krause (2005), p. 38^g Translated from Krause (2005), p. 39: “Performance Management umfasst alle Aktivitäten, die unter ständiger Aktualisierung der Fach- und Sozialkompetenz der Akteure auf die Optimierung des Stakeholder-Nutzens gerichtet sind und dabei gleichzeitig den finanziellen, materiellen, zeitlichen, emotionalen und sozialen Aufwand minimieren”^h Translated from Krause (2005), pp. 17–21: “Ein Performance Managementsystem (PMS) ist ein indikatorenbasiertes Managementsystem zur Unterstützung der Aufgaben bei der Optimierung des Stakeholder-Nutzens einer Organisation. Daher müssen effektive PMS den Zusammenhang zwischen Performance-Zielen, Indikatoren für die Zielerreichung, erfolgskritischen Wertschöpfungsaktivitäten und Maßnahmen zur Verbesserung der Performance über alle Ebenen und entlang der gesamten Wertschöpfungskette einer Organisation abbilden”

“management” and thus the *planning, management and control* of performance within the performance management term.

Performance management can also be explained in terms of management cybernetics.⁸⁰ Like planning, completion and control, the processes of feed-forward and feed-back belong to performance management. Both feed-forward and feed-back are information loops which contribute to the target state of the system. In order to return the imbalances to a target state within a system, the system during the feed-back process⁸¹ has to communicate the information about the output. This has to trigger counteraction until the state of the system matches the set goals. This control mechanism leads to a system that always returns to the target state. The control mechanism compares the current values with set goals, and in the case of difference, takes corrective action until the current values match the goals.⁸²

The advantage of a feed-back information loop is that management, as the control authority, does not require much information in order to match the system and goals. The system can be seen as a “black box” and control activities can be confined to optimize input and output relationships. The disadvantage lies in the time lag and consequently the fact that the corrective actions can occur only after the result or output is known. The goals can usually be achieved only after additional loops and therefore with considerable time delay.

In the process of feed-forward, the system requires information regarding the anticipated deviation of goals before the result or output occurs. Corrections can be triggered at an early stage until the result complies with defined targets. The main advantage of a feed-forward process, compared to feed-back, is that the detection of imbalances happens at an early stage, and not after the deviation is identified. The intervention of corrective action does not happen as it does with the feed-back process. It happens through early anticipation of negative factors rather than by feed-back. The disadvantage of the feed-forward processes is that management does not have comprehensive information. The precondition for the feed-forward control is the knowledge about the relationships within the system and their inherent cause and effect. According to Grüning⁸³ the performance measurement system translates the cybernetic process control for the multidimensional goal

⁸⁰ “Management cybernetics is the concrete application of natural cybernetic laws to all types of organizations and institutions created by human beings, and to the interactions within them and between them. It is a theory based on natural laws. It addresses the issues that every individual who wants to influence an organization in any way must learn to resolve. This theory is not restricted to the actions of top managers. Every member of an organization and every person who to a greater or lesser extent communicates or interacts with it is involved in the considerations”, Beer (1959). http://en.wikipedia.org/wiki/Management_cybernetics.

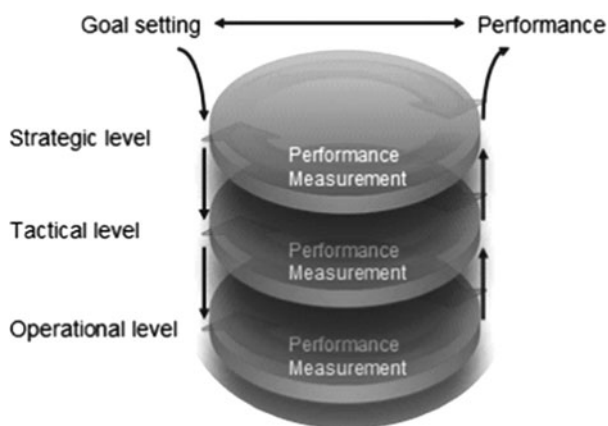
⁸¹ Herder-Dorneich (1993), pp. 47–48.

⁸² Beer (1962), p. 131, Gomez (1981), pp. 246–247 (five steps to design cybernetic process control), Hauber (2002), p. 57.

⁸³ Grüning (2002), p. 9.

system at all levels, from the strategic via tactical to the operational level⁸⁴ (cf. Fig. 2.4). This view is shared by Dransfield, Fischer and Vogel.⁸⁵

Fig. 2.4 Performance level model (Source: Bredrup 1995)



Having concluded our outlining and discussion of management concepts, a synthesis of the constitutive elements within performance management can be made. All of the definitions we have reviewed share at least four elements: *planning, measurement, analysis and review/improvement* (Fig. 2.5).

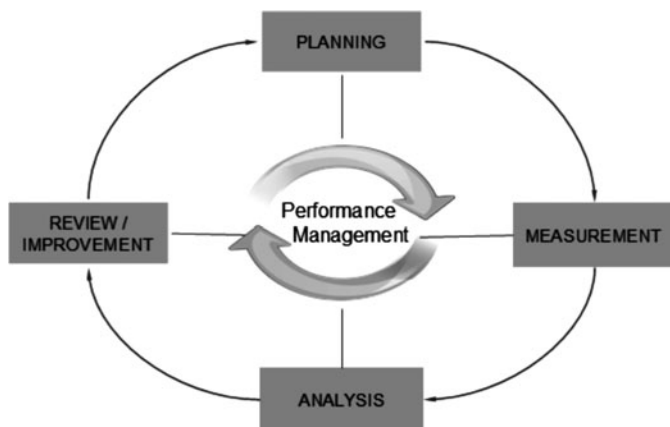


Fig. 2.5 The elements of Performance Management (Source: The figure was derived from the literature review by the author)

⁸⁴ Bredrup (1995), p. 174. Some parts of the literature state that the operational and tactical levels are identical, see Grüning (2002), p. 9.

⁸⁵ Dransfield et al. (1999) distinguish three basic zones of measurement arguing that strategic level contains external measures of success. They pool tactical and operational levels together stating that these mostly comprise internal measures.

- Planning, including general planning of strategy, defining goals and escorting them through the entire goal-setting process, defining to-be state or nominal values for later comparisons with actually achieved values, defining key performance indicators, deciding on timeframes for the planned strategy (short term, long term etc.).
- The measurement element includes the determination of the current status. Sometimes pure data collection is associated with this activity. This element is not explicitly mentioned in some definitions, e.g. in Hoffmann and Krause. However, in our opinion, the measurement element is implicitly included in their definition. This is because they subsequently refer to the analysis element, which requires an “as-is” state. If necessary, the measurement element can include breaking the KPIs down into the PIs which are actually measured. It can also work in the other direction, consolidating the PIs back into KPIs.
- Analysis includes the activities that go beyond pure measurement activities: evaluating, interpreting, projecting and forecasting from the current situation, determining the deviation from objectives and analyzing the effects of corrective actions resulting from interdependencies between goals and actions with ‘what if scenarios’. Within the analysis element it is not only deviations from goal attainment that are detected, but also information is provided with regard to “what happens if” the priorities (of goals or indicators) are changed.
- Review/Improvement concentrate on the identification of concrete activities to implement conclusions drawn from analyses. Some examples of short-term decisions are: periodic rewards or identification of necessary training or corrective actions such as budget cuts, travel restrictions or resource reassignments. Longer-term examples include the adjustment and reformulation of organizational goals and KPIs between periodical performance management cycles.

The performance management cycle can be seen as applied in both a long cycle (e.g. for a single goal-setting period) and in a shorter-cycle when assessing the goal achievement intermediately and taking corrective actions to improve goal achievement for the overall period.

2.2.5 Performance Measurement

In this section we analyze various definitions of performance measurement and performance measurement system found in the literature with respect to the elements identified above.

Since the late 1980s the problem of measuring work results and work performance within the English language management accounting literature has been addressed under the title “Performance Measurement”.⁸⁶ Although the term

⁸⁶ Bösch (2007), p. 103.

“Performance Measurement” is used frequently, its definition is incomplete.⁸⁷ In their literature review Neely et al., write: “Performance measurement is a topic which is often discussed but rarely defined”.⁸⁸ In the following section we will list and discuss definitions found in the literature of the term “performance measurement” and “performance measurement system”.

Table 2.10 contains definitions of “performance measurement” followed by “performance measurement system” that have been found in the literature. The order is chronological.

Table 2.10 Definitions of “Performance Measurement” and “Performance Measurement system”

Source	Definition
<i>Definition of the term “Performance Measurement”</i>	
Anthony et al. (1989)	“Performance measurement is the key to effective management supervision and control of people in organizations. But it is also an effective tool for guiding the direction of organizational subunits. The aim of performance measures is to minimize losses and to reward quality performance by comparing actual with desired performance” ^a
Sink and Tuttle (1989)	“Performance Measurement is relative measurement. In order to interpret performance measurement data, one must have something with which to compare the measures. Commonly used alternatives are standards, goals, or baselines” ^b
Emmanuel et al. (1990)	“A vital part of the control process, and one with which accounting is particularly concerned, is the measurement of actual performance so that it may be compared with what is desired, expected or hoped for. However, it is important to stress that performance measurement is but one stage in the overall control process; it is also necessary to set standards, and to take appropriate action to ensure that such standards are attained” ^c
Carter et al. (1995)	“If there is a unifying theme to performance measurement, then it lies in the genuflection to the perspectives of economy, efficiency, and effectiveness, and the production of measures of input, output and outcome” ^d
Gleich (1997)	“Performance measurement can be defined as the development and deployment of (often several) quantifiable measurements of various dimensions (e.g., cost, time, quality, innovation, customer satisfaction) which are applied to assess the effectiveness and efficiency of the performance and performance potential of different objects within the enterprise (organizational units of various sizes, employees, and processes)” ^e
Kerssens-van Drongelen and Cook (1997)	“The acquisition and analysis of information about the actual attainment of company objectives and plans, and about factors that may influence this attainment” ^f
Evangelidis (1992)	“The process of determining how successful organizations or individuals have been in attaining their objectives” ^g
Neely et al. (1995)	“Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action” ^h
Sinclair and Zairi (1995)	“The measurement (as a process) of performance at all levels within an organization” ⁱ
Hauber (2002)	“Performance measurement involves the process of quantifying and evaluating the goal achievement of organizational units, employees and processes” ^j
Wettstein (2002)	“The term “performance measurement” . . . encompasses the measuring, analyzing and communicating of the performance as well as the planning of actions and measures” ^k

(continued)

⁸⁷ Sometimes the literature uses the term “Performance Reporting”, Ramin and Fey (1998), p. 287.

⁸⁸ Neely et al. (1995), pp. 80–116.

Table 2.10 (continued)

Source	Definition
<i>Definition of the term "Performance Measurement System"</i>	
Neely et al. (1995)	"A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions" ^l
Gleich (1997)	"A Performance Measurement System is a planning and control concept, containing monetary indicators which are aligned to the objectives of a company. These indicators pertain, using measurements and ratios to complement each other, to all of the company's success and performance-relevant levels that influence its long-term financial viability. The indicators are designed to integrate the needs of stakeholders and are focused on continuous improvement and flexibility" ^m
Simons (1999)	"Performance measurement systems: information systems that managers use to track the implementation of business strategy by comparing actual results against strategic goals and objectives. A performance measurement system typically comprises systematic methods of setting business goals together with periodic feedback reports"
Hauber (2002)	"A performance measurement system is a coordinated set of performance measures of various dimensions which are interrelated, and thus, as a whole, provide complete information about the goal achievement of various entities within a company" ⁿ
Wettstein (2002)	"A performance measurement system (PMS) communicates the operational strategy and monitors the overall performance of an organization at all levels. The PMS supports effective communication of the performance to all stakeholders, provides managers with both operational and strategic decision support, gathers knowledge about the organization and simplifies the organizational learning process. To achieve this goal, the PMS defines processes and makes use of appropriate information systems" ^o
Grüning (2002)	"A performance measurement system is a system for measuring and managing business performance that is multi-dimensional, characterized by mutual interdependence and integrates strategic and operational aspects, based on a cybernetic process with elements of organizational learning" ^p
Baum et al. (2004)	"Performance measurement systems are used for the measurement and management of aspects of the company's success and its determining factors. These aspects are multidimensional and, by reciprocal interdependencies, are identified as both strategic and operational" ^q

^a Anthony et al. (1989), p. 142^b Sink and Tuttle (1989), p. 60^c Emmanuel et al. (1990), p. 31^d Carter et al. (1995), p. 35^e Translated from Gleich (1997), p. 112: "Als Performance Measurement kann der Aufbau und Einsatz meist mehrerer quantifizierbarer Maßgrößen verschiedenster Dimensionen (z.B. Kosten, Zeit, Qualität, Innovationsfähigkeit, Kundenzufriedenheit) verstanden werden, die zur Beurteilung der Effektivität und Effizienz der Leistung und Leistungspotenziale unterschiedlichster Objekte im Unternehmen (Organisationseinheiten unterschiedlichster Größe, Mitarbeiter, Prozesse) herangezogen werden"^f Kerssens-van Drongelen and Cook (1997), p. 346^g Evangelidis (1992), p. 45^h Neely et al. (1995), p. 80ⁱ Sinclair and Zairi (1995), pp. 145–168^j Translated from Hauber (2002), p. 29: "Performance measurement umfasst den Prozess der Quantifizierung und Evaluierung der Zielerreichung von Organisationseinheiten, Mitarbeitern oder Prozessen"^k Translated from Wettstein (2002), p. 19: "Unter dem Begriff Performance Measurement wird . . . das Messen, Analysieren und Kommunizieren der Performance sowie das Planen von Aktionen und Maßnahmen verstanden"^l Neely et al. (1995), p. 81

(continued)

Table 2.10 (continued)

Source	Definition
^m Translated from Gleich (1997), pp. 114–115:	“Ein Performance Measurement System ist ein Planungs- und Steuerungskonzept, das monetäre Kennzahlen beinhaltet, die auf allen erfolgs- und leistungsrelevanten Unternehmensebenen mit den Einflußgrößen der langfristigen finanziellen Leistungsfähigkeit des Unternehmens komplementiert sind, so daß die Maßgrößen bzw. Kennzahlen einander ergänzen, auf die strategische Zielsetzung des Unternehmens ausgerichtet sind, die Ansprüche der Stakeholder integrieren und auf kontinuierliche Verbesserung und Flexibilität ausgerichtet sind”
ⁿ Translated from Hauber (2002), p. 58:	“Ein Performance Measurement System ist die geordnete Gesamtheit von Leistungsmaßen verschiedenster Dimensionen, die in einer Beziehung zueinander stehen und so als Gesamtheit über die Zielerreichung unterschiedlichster Objekte im Unternehmen vollständig informieren”
^o Translated from Wettstein (2002), p. 24:	“Ein Performance-Measurement-System (PMS) kommuniziert die operationalisierte Strategie und überwacht die ganzheitliche Performance einer Organisation auf sämtlichen Ebenen. Das PMS unterstützt die effektive Kommunikation der Performance mit allen Stakeholdern, bietet Managern sowohl operative als auch strategische Entscheidungsunterstützung, sammelt Wissen der Organisation und vereinfacht das organisationelle Lernen. Um dieses Ziel zu erreichen, definiert das PMS geeignete Prozesse und bedient sich geeigneter Informationssysteme”
^p Translated from Grüning (2002), p. 10:	“Ein Performance Measurement-System ist ein System zur Messung und Lenkung der mehrdimensionalen, durch wechselseitige Interdependenzen gekennzeichneten, strategische und operative Aspekte integrierenden Unternehmensperformance auf Basis eines kybernetischen Prozesses mit Elementen organisationalen Lernens”
^q Translated from Baum et al. (2004), p. 49:	“Performance Measurement Systeme dienen der Messung und Lenkung der mehrdimensionalen, durch wechselseitige Interdependenzen gekennzeichneten strategischen und operativen Aspekte des Unternehmenserfolgs und seiner Einflussgrößen”

Common to many authors⁸⁹ definitions is the *attainment of objectives* and the *process* element. Kerssens-van Drongelen and Cook highlight the *analysis* aspect of the measurement.

While Kerssens-van Drongelen and Cook stress the *acquisition and analysis of information*; Wettstein in addition incorporates the *communication and further planning of actions and tactics*. This could lead to the assumption that performance measurement is more than just a review and illustration of past achievements. Another important element of performance measurement seems especially to be the process of interpretation of results for improvement and the development and demonstration of actions and action opportunities.

In order to consistently derive the key elements for performance measurement, the definitions will be analyzed on the basis of the four elements extracted from performance management.

The table shows a particular emphasis on two elements: measurement; analysis.

⁸⁹ Here: Evangelidis, Neely et al., Sinclair, and Hauber.

Table 2.11 Comparison of Performance Measurement (system) definitions
Constitutive elements mentioned in Performance Measurement definitions

	Planning	Measurement	Analysis	Review/ improvement
<i>Source</i>	<i>Performance Measurement</i>			
Anthony et al. (1989)	(✓)	✓	✓	✓
Sink and Tuttle (1989)	(✓)	✓	(✓)	
Emmanuel et al. (1990)	✓	✓	✓	
Carter et al. (1995)		✓		
Gleich (1997)	✓	✓	(✓)	
Kerssens-van Drongelen and Cook (1997)		✓	✓	
Evangelidis (1992)		(✓)	✓	
Neely et al. (1995)		✓	(✓)	
Sinclair and Zairi (1995)		✓		
Hauber (2002)		✓	✓	
Wettstein (2002)		✓	✓	✓
<i>Source</i>	<i>Performance Measurement system</i>			
Neely et al. (1995)		✓		
Gleich (1997)	✓	✓	✓	✓
Simons (1999)	✓	✓	✓	✓
Hauber (2002)		✓	✓	
Wettstein (2002)	✓	✓	✓	✓
Baum et al. (2004)	(✓)	✓	✓	

✓ component is explicitly mentioned in the definition
(✓) component is not explicitly mentioned, but is implied by our definition (In those cases where the availability of an element has been put in parentheses the existence of the element is not explicitly mentioned in the cited source, nevertheless the definition implies its presence)

We therefore include the following aspects in our definition of performance measurement (see Table 2.11):

- A process in which:
- Relevant data for performance indicators (as-is data) is collected; and
 - The collected data is evaluated, analyzed and interpreted (comparison of as-is with to-be).

2.3 Summary

Figure 2.6 summarizes all terms that have been introduced in the context of performance management. The overall performance management cycle is based on four constitutive elements. Within the planning element, organizational goals are derived from the company strategy and are operationalized through KPIs. The performance measurement part concentrates on collecting adequate performance indicators and consolidates them into KPIs for the purposes of analysis of the current situation and also prediction. The review and improvement element assesses performance achievements by comparing KPIs as-is with KPIs to be, and draws conclusions on short-term corrective actions as well as on the adjustment of goals and KPIs in the next management cycle.

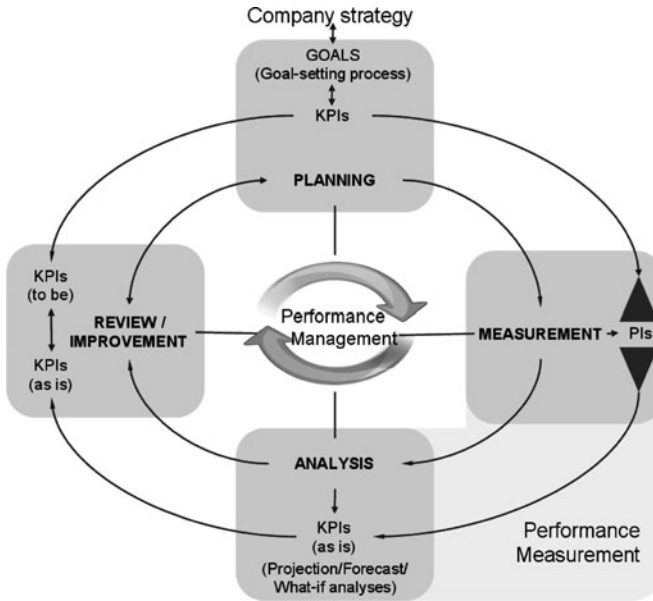


Fig. 2.6 Performance Management: putting the terms together (Source: The figure was derived from the literature review by the author)

2.3.1 Purposes of Performance Management/Measurement

According to Geisler⁹⁰ measurement plays an important role in everyday life: “Measuring the objects and the events in the world around us is not only a scientific necessity, but also the means to make sense of the complexity of natural phenomena. We continually live by measures of our surroundings. We measure the passage of time, the temperatures in our climate, our economic situations, and everything else with which we make contact.”

The question of *measuring or not measuring the performance of researchers*⁹¹ is a heavily discussed question in both theory and practice. The fact that rigorous measurement kills *creativity* is probably the most prominent argument for not measuring. *Creativity* is seen as an *indispensable* feature in the *search for* new ideas, new products, and innovations. This search for newness covers a significant part of the activity of industrial research organizations. Therefore it should be adequately reflected in a PMS in research organizations.

⁹⁰ Geisler (2000), p. xi.

⁹¹ In conducting our case studies we realized that some companies that were pre-selected did not measure performance within their research department. The desire not to constrain the freedom of researchers seems to be a major argument for not measuring their performance. These cases were taken into account, however they were not further considered for our case studies.

There are a number of contributions to the literature focusing on purposes for measuring performance, as outlined in Table 2.13 below. According to Sink and Tuttle,⁹² “The most important, and perhaps the only really valid, reason for measuring performance . . . is to support and enhance improvement”. In order to improve, *information* about the status quo is required, which in the end allows us to demonstrate that an improvement has actually been achieved. According to Specht and Beckmann⁹³ this information is also necessary for decision-making by management and has to be available in the right place at the right time, in the right quality and quantity, as well as at the lowest possible cost.

According to the literature, there are six major categories of reasons for performance management; two of them – communication and alignment – are strongly related to the context of *goal setting*. Another two have their background within the *evaluation* of goal attainment – determining the status quo and predicting attainment for a specific period. The final two have their origin in psychology and focus on *motivation* – *on the individual level as well as on the organizational level*. Table 2.12 illustrates these six categories and provides the structure which is used in the remainder of the chapter to classify the purposes of performance management as found in the literature.

Table 2.12 Purposes of Performance Management in industrial research

Categories of purposes of Performance Management					
1. Goal setting		2. Evaluating goal achievement		3. Motivation	
(a) Communication	(b) Alignment	(a) Status-quo	(b) Prediction	(a) Organizational	(b) Personal

Setting goals is a prerequisite for the assessment of the actual performance. *Communication* and *alignment* are two purposes within the goal setting category. *Communication* ensures that company goals get across into other parts of the organization. According to our definition of the goal setting process (cf. Sect. 2.2.2), the goals formulated at higher levels have to be decomposed and cascaded and *communicated* to lower levels. *Alignment* provides assurance that the sum of all cascaded goals reflects the overall goal at the next higher level. During the goal setting process *iterative communication and alignment* takes place by receiving, checking and giving feedback on whether the cascaded goals meet certain crucial characteristics as discussed by Locke.⁹⁴ Such information can be used to revise the performance indicators and potentially adjust the cascaded goals. These two

⁹² Sink and Tuttle (1989), p. 141.

⁹³ Note that Specht and Beckmann (1996), p. 332 discuss the control of R&D and its fundamentals. The analysis and integration of R&D control into performance measurement will be discussed in Sect. 3.2.2.

⁹⁴ (1) Each goal has to be clear so that people can carry out appropriate actions to reach the goal; (2) goals should not be too easy to attain, but at the same time, they must be attainable; and (3) goals should be accepted by the receivers, goals that are not accepted may have negative impacts on the performance. Locke (1968), p. 125, Tankoonsombut (1998), p. 12.

purposes primarily reflect the planning element of the performance management cycle as the goal setting takes place within this element.

Our definition of goal – an envisaged and intended future state; an anticipated vision of the impact of actions – directly motivates category 2 as it requires: determination of the *status quo* (2a), i.e. to provide the current performance level compared to the level aimed for; and to be able to *predict* (2b) the future achievable state; especially with regard to being able to support decision-making for corrective actions. Status quo evaluation and prediction respectively cover the measurement and the analysis elements of the performance management cycle.

Not only business economics but also other disciplines such as “Organizational and Occupational Psychology” and “Organizational Behavior and Human Performance” examine the performance of individuals in an organizational context. The motivation of employees impacts their individual performance, and consequently, organizational performance. This is a result of a great number of studies from applied psychology examining different behaviors and their impacts on performance. Therefore, it is not surprising that individual motivation is considered to be one of the most effective tools for governing performance. By *personal motivation* we mean rewards, career planning, etc., and this represents category 3b.

The demonstration of the contribution of subordinate goals to superior goals is often used as a means to justify the existence of an organizational unit. This especially occurs when instead of a clear quantitative (economic) outcome an organizational unit’s output can only be vaguely estimated. This aspect (existential justification) represents the organizational facet (3a) of the motivation category.

The motivational purposes mainly refer to the review/improvement element of the performance management cycle.

Figure 2.7 illustrates the discussed relationships between the constitutive elements of performance management with the described purposes.

In the following, by way of example, we discuss three sources that elaborate on purposes for performance management and map their findings to our categories. There are a variety of other sources, which are not further discussed here. The interested reader is referred to Table 2.13 where we list additional sources and indicate the purposes.

Landy and Farr⁹⁵ focus their research on the work performance of individuals. They state that the prediction of performance plays a major role in all personnel decisions and many other types of organizational decisions. They list three kinds of purposes why performance information may be collected and what it is used for: administrative purposes, guidance and counseling purposes, and research purposes.

1. Within the administrative part they mention promotion, lateral transfer, demotion and retention decisions; merit compensation decisions; training program assignments; and the establishment of scores for selection procedures.

⁹⁵ Landy and Farr (1983), pp. 3–4.

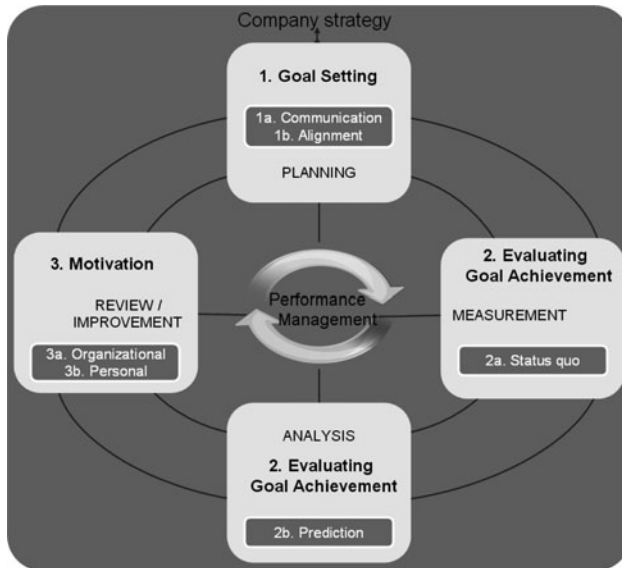


Fig. 2.7 Constitutive elements of PMS and their relationships (Source: The figure was derived from the literature review by the author)

These purposes are primarily reflected within our “motivation” category as the reasons mentioned mainly concern the implications for decision-making related to the performance of individuals.

2. Landy and Farr identify the improvement of job satisfaction and work motivation as general purposes for guidance and counseling performance information. This is required for providing information regarding the current individual performance level as well as for probable, and possible, future job assignments in the organization. In their opinion, guidance and counseling purposes may include supervisory feedback to subordinate personnel regarding their relative and absolute strengths and weaknesses. They also mention career planning and preparation in this context. The purposes mentioned are also related to individual motivation.
3. The third purpose is obtaining performance information as part of various projects assessing human-resource-related procedures and initiatives. Examples of these are the validation of selection procedures, the evaluation of training programs, and the evaluation of motivation and satisfaction-oriented interventions such as compensation plans and job enrichment programs. The purposes⁹⁶ described in this part best fit into the ‘status-quo’ aspect of our second category.

⁹⁶ See Table 2.13.

Butler⁹⁷ identifies nine possible reasons for measuring: (1) Improve organizational performance, (2) assist in decision making, (3) provide visibility of results, (4) improve understanding, (5) compare absolute performance, (6) improve motivation, (7) improve communication, (8) improve individual performance, and (9) retention of control. Reasons 4 and 7 cover the communication aspect (1a) of the “goal setting” category. Reason 9 in our context is partially related to the alignment aspect (1b) of “goal setting” and partially to organizational motivation (3a). Reasons 3 and 5 relate to the status quo category (2a) whereas reason 2 is reflected by the prediction aspect (2b) within our categories. Finally, reasons 1, 6 and 8 deal with motivational aspects where 1 refers to the organizational (3a) and the latter two to the personal (3b) category.

Kerssens-van Drongelen⁹⁸ explores purposes and translates them into functions by developing a taxonomy of measurement systems. She identifies seven measurement system functions:

- 1. Provide insight into (expected) deviations from objectives/environmental factors to support the diagnosis by a manager as to whether, and if so which, steering measures to apply
- 2. Fuelling learning to improve the predictive model
- 3. Alignment and communication of objectives
- 4. Supporting decision making on performance-based rewards
- 5. Provide insight into (expected) deviations from objectives/environmental factors to support the diagnosis by subordinates as to whether, and if so which, steering measures to apply
- 6. Justification of existence, decision and performance
- 7. Motivating people through feedback

Functions 1 and 5 match with our status quo (2a) category as they detect the deviations from objectives, whereas function 2 fits to the prediction (2b) aspect. Function 3 reflects the category “goal setting” (1a and 1b); function 6 corresponds with the organizational (3a), and functions 4 and 7 with the individual (3b) motivation category.

Table 2.13 Comparison of purposes for Performance Management

Author	Categories of purposes of Performance Measurement					
	1. Goal setting		2. Evaluating goal achievement		3. Motivation	
	(a) Communication	(b) Alignment	(a) Status quo	(b) Prediction	(a) Organizational	(b) Personal
Landy and Farr (1983) ^a			✓ (3)			✓ (1, 2)
Sink and Tuttle (1989) ^b	✓		✓	✓		

(continued)

⁹⁷ Butler (1994), p. 21, see Table 2.13.

⁹⁸ Kerssens-van Drongelen (2001), p. 46, see Table 2.13.

Table 2.13 (continued)

Author	Categories of purposes of Performance Measurement					
	1. Goal setting		2. Evaluating goal achievement		3. Motivation	
	(a) Communication	(b) Alignment	(a) Status quo	(b) Prediction	(a) Organizational	(b) Personal
Butler (1994) ^c	✓ (4, 7)	✓ (9)	✓ (3, 5)	✓ (2)	✓ (1, 9)	✓ (6, 8)
Bonsdorff and Andersin (1995) ^d	✓ (2, 3)		✓ (4, 5)	✓ (6)		✓ (1)
Dhavale (1996) ^e						✓
Kaplan and Norton (1996) ^f	✓ (2)	✓ (2)			✓ (1)	✓ (1)
Kerssens-van Drongelen (2001) ^g	✓ (3)	✓ (3)	✓ (1, 5)	✓ (2)	✓ (6)	✓ (4, 7)
Loch and Tapper (2002) ^h		✓ (1)	✓ (2, 3)	✓ (4)		✓ (2)
Godener and Söderquist (2004) ⁱ	✓ (1)	✓ (1)	✓ (2)	✓ (2)	✓ (3, 5)	✓ (4, 5)
Schreyer (2007) ^j	✓ (1, 3, 7)	✓ (1, 2, 3, 4)	✓ (4, 5)	✓ (8)		✓ (6)

^a Landy and Farr (1983), pp. 3–4

^b Sink and Tuttle (1989), p. 1. “The most important, and perhaps the only really valid, reason for measuring performance ... is to support and enhance improvement”

^c Butler (1994), p. 21

^d Bonsdorff and Andersin (1995), p. 67

^e Dhavale (1996), p. 50: “Performance Measurements, evaluation systems, and reward systems are indispensable management tools. They can help motivate employees to work toward fulfilling the organization’s strategic perspectives. By contrast, poorly designed or poorly implemented performance measurement systems encourage dysfunctional and suboptimal behavior throughout an organization”

^f Kaplan and Norton (1996), p. 147. “The objective of any measurement system should be to (1) motivate all managers and employees to (2) implement successfully the business unit’s strategy”

^g Kerssens-van Drongelen (2001), p. 46

^h Loch and Tapper (2002), p. 186, highlight four main functions of R&D performance measurement: (1) alignment and prioritization; (2) evaluation and incentives; (3) operational control, and (4) learning and improvement. Furthermore the authors state that the fundamental purpose of performance measurement is to encourage behavior that achieves the goals of the organization

ⁱ Godener and Söderquist (2004), p. 197. (1) communicating objectives, agreements and rules; (2) defining corrective actions based on diagnosis and control; (3) allocating resources; (4) deciding on individual promotions, salary increases and other incentives (5) learning/continuous improvement

^j Schreyer (2007), p. 74: (1) operationalization of the company’s strategy, (2) identification of and focusing on success factors, (3) visualization of the interrelations, (4) planning and controlling of the employment of resources, (5) performance evaluation, (6) employee motivation, (7) communication processes, (8) learning effects

2.3.2 *The Information and Communication Technologies (ICT) Sector*

In comparison with some other industries mentioned, such as pharmaceuticals, chemicals, petrol and gas, steel and some sectors of electronics, the ICT sector is relatively young and very fast growing.⁹⁹ In an interim report “Benchmarking national and regional policies in support of the competitiveness of the ICT sector in the EU”¹⁰⁰ the authors report that the ICT sector overtook the traditional pillars of the European economy, such as the pharmaceutical and the automotive industries, in terms of annual turnover which in 2004 was about EUR 200 billion in Europe and about EUR 1,000 billion worldwide. Although the history of this sector dates back to the 1950s,¹⁰¹ definition of the ICT sector remains a challenge.

Looking at the relevant sources it is apparent that a generally agreed upon definition of the ICT industry does not exist. The different interpretations of the term are due to the fact that the sector is widespread, is subject to constant technological changes and is embracing and integrating more and more domains by delivering cross-domain solutions. ICT includes all hardware and software, which are necessary for transmitting, processing and utilizing digital data in any possible form. Data in this sense include texts, sounds and images.¹⁰²

Currently, there are three from several attempts succeeded to create a standardized form of accounting and measurement of scientific and technological activity within and across countries: OECD¹⁰³ and UNESCO, the U.S. National Science Board, and Japan’s National Institute of Science and Technology Policy (NISTEP). There are a few different standardization communities that have classified

⁹⁹ For example: at the end of 2008, from close to zero (only) 10 years ago, in the developing world, mobile phones have reached an estimated average 49.5% penetration rate, ITU (2009), p. 1.

¹⁰⁰ Friedewald et al. (2004), p. 7.

¹⁰¹ In particular, discussions about the role of research and development in high technology started around 1950 within the context of technological and economic competitiveness of the ICT producing sector, Friedewald et al. (2004), p. 7.

¹⁰² The OECD defines the ICT sector as a combination of manufacturing and service industries that capture, transmit and display data and information electronically.

¹⁰³ The Organization for Economic Co-operation and Development (OECD) is an international organization of 30 countries that accepts the principles of representative democracy and free-market economics. It originated in 1948 led by Robert Marjolin of France to help administer the Marshall Plan for the reconstruction of Europe after World War II. Later, its membership was extended to non-European states. In 1961, it was reformed into the Organization for Economic Co-operation and Development by the Convention on the Organization for Economic Co-operation and Development.

the ICT sector, with their various standards (SIC,¹⁰⁴ ISIC,¹⁰⁵ CPC,¹⁰⁶ NACE,¹⁰⁷ and NAICS¹⁰⁸). The definitions are revised on an irregular base. After having reviewed two standards: ISIC and NACE, we decided to use the most current definition provided by the OECD in 2007 for the thesis. This is based on the UN International Standard for the Industrial Classification of all Economic Activities (ISIC4). The standard applies the following general principle (definition) to identify economic activities (industries) related to ICT:

The production (goods and services) of a candidate industry must primarily be intended to fulfill or enable the function of information processing and communication by electronic means, including transmission and display.¹⁰⁹

The list of ICT industries (ISIC Rev. 4) that meet this condition is provided in the table below (Table 2.14).

Regarding our exploration and definition of ICT, it is necessary to exclude some of the subsectors. We are examining industrial research departments and their activities and it is clear to us that these departments will not engage in all of the subsectors listed. For example ICT-related research and development activities are not relevant to the subsector of ICT services called “Repair of computers and communication equipment”. For this reason we exclude these subsectors:

- 9511 Repair of computers and peripheral equipment, and
- 9512 Repair of communication equipment.

¹⁰⁴ The Standard Industrial Classification (abbreviated SIC) is a United States government system for classifying industries by a four-digit code.

¹⁰⁵ ISIC is the United Nations International Standard Industrial Classification of all economic activities. This classification is the international standard for the classification of productive economic activities. The main purpose is to provide a standard set of economic activities so that entities can be classified according to the activity they carry out. The hierarchical structure of the classification comprises: Tabulation Categories – one letter alpha code A to Q; Divisions – two-digit codes; Groups – three-digit codes; Classes – four-digit codes. The third revision of ISIC is used in the 1993 SNA.

¹⁰⁶ The Central Product Classification (CPC) of the United Nations Statistics Division constitutes a complete product classification covering goods and services. It was intended to serve as an international standard for assembling and tabulating all kinds of data requiring product detail including industrial production, national accounts, service industries, domestic and foreign commodity trade, international trade in services, balance of payments, consumption and price statistics, CPC (2002).

¹⁰⁷ NACE stands for The Statistical Classification of Economic Activities in the European Community and is a European industry standard classification system consisting of a 6 digit code. NACE is equivalent to the SIC and NAICS system.

¹⁰⁸ The North American Industry Classification System or NAICS is used by business and government to classify and measure economic activity in Canada, Mexico and the United States. It has largely replaced the older SIC system; however, certain government departments and agencies, such as the U.S. Securities and Exchange Commission (SEC), still use the SIC codes. The NAICS numbering system is a six-digit code.

¹⁰⁹ OECD (2007), p. 15.

Table 2.14 ICT sector according to ISIC Rev. 4Definition of the ICT sector^a (codes and sectors)*ICT manufacturing industries*

2610	Manufacture of electronic components and boards
2620	Manufacture of computers and peripheral equipment
2630	Manufacture of communication equipment
2640	Manufacture of consumer electronics
2680	Manufacture of magnetic and optical media

ICT trade industries

4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts

ICT services industries

5820	Software publishing
61	Telecommunications
6110	Wired telecommunications activities
6120	Wireless telecommunications activities
6130	Satellite telecommunications activities
6190	Other telecommunications activities
62	Computer programming, consultancy and related activities
6201	Computer programming activities
6202	Computer consultancy and computer facilities management activities
6209	Other information technology and computer service activities
631	Data processing, hosting and related activities; web portals
6311	Data processing, hosting and related activities
6312	Web portals
951	Repair of computers and communication equipment
9511	Repair of computers and peripheral equipment
9512	Repair of communication equipment

Source: OECD (2007)

^aNote that there is a growing recognition of inclusion of the “content industries” into the ICT definition. “Content industries” create and distribute content (e.g. text, audio, video), particularly those that create and distribute content to a wide audience. The definition of the content and media sector is provided in the Appendix A

2.3.3 The Software Industry

Having defined the ICT sector as a whole we position the software industry within the ICT sector in the next step. The European Commission initiated extensive studies to evaluate the contribution of information and communication technologies in economies, particularly monitoring the software industry. The software industry is described as “one of Europe’s best vectors of growth in innovation and competitiveness”.¹¹⁰

¹¹⁰Truffle 100 (2006), p. 1.

For a good overview of the economic principles, strategies and future trends among software providers and software industry, see Buxmann et al.¹¹¹

In its definition of software (SW), BITKOM¹¹² distinguishes between *system software* and *standard applications*:

- System software: System infrastructure software includes system management SW, network management, security SW, storage SW, server ware, system level SW. Application tools include data management SW, middleware, development tools, etc.
- Standard applications: consumer, content, collaboration, enterprise applications.
- Independently from software, BITKOM defines IT-services as Consulting: planning/design of IT-systems, including IT-related business consulting. Implementation: services such as procurement, configuration, installation, testing and management, development of customized solutions, IT-education and -training. Operations management: management of components of the IT infrastructure for customers including help desk services, asset management services, systems management, network management, software update management, application services providing, web hosting, facilities management, back-up/archiving/business recovery services. Support services: maintenance, telephone support, etc.

On a multi-company level, the definition of “software industry” is somewhat difficult. First of all, this is because software can be interpreted as (a) a good and (b) as a service. Secondly, there is a discussion about software publishing and broadcasting industries, in particular whether these industries, or components thereof, should be classified in the ICT services grouping or in the content and media grouping. The OECD states that software publishing (ISIC 5820) covers at least two distinct components: the publishing of productivity software and the publishing of multimedia software (i.e. games). Because the latter type of software is designed to inform, educate or entertain and has more in common with other types of content products such as newspapers, television programs, films or musical recordings, this industry should ideally be classified in the content and media sector according to some members of the board.¹¹³ However, due to the fact that ISIC recognizes only one software publishing industry that produces both types of software, this industry was included in ICT services.

According to the OECD the productivity software which is designed to facilitate information processing is classified more appropriately with technology-centric services such as telecommunications or hosting services (ISIC 62/631).

¹¹¹ Buxmann et al. (2008).

¹¹² BITKOM is a German Association for Information Technology, Telecommunications and New Media and stands for Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V.

¹¹³ The definition is based upon an agreement between the members of the “Working Party on Indicators for the Information Society” (WPIIS).

To summarize, according to the latest review of ISIC4, the ICT sector is comprised of ICT manufacturing industries, ICT trade industries and ICT services industries (including ICT repair industries). Regarding the definition of the software industry, it can be concluded that in essence the software producing sector is mainly represented in ISIC 62 Computer programming, consultancy and related activities.



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