INNOVATION SCORECARD

Ondřej Žižlavský

Innovation Scorecard

Conceptual Performance Measurement and Management Framework for Innovation Process

by
Ondřej Žižlavský

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Ondrej focuses on performance measurement systems and innovation. His research primarily aims to understand what drives the success of innovation, how to measure and develop an innovative performance in the company. Part of his active research consists on studying the innovation process in a company and its performance measurement. He combines financial and non-financial metrics to set up a complex innovative performance measurement system for the Czech enterprises. A second avenue of Ondrej's work studies the innovative potential and its development.

His work has been published in two monographs (Innovation Process Performance Measurement, published in 2011; Handbook of Innovative Performance Assessment, published in 2012), in a number of scientific peer-reviewed journals indexed in Web of Knowledge, Scopus, EBSO, DOAJ etc., book chapters (e.g., Entrepreneurship: Creativity and Innovative Business Models, published in 2012; Management Development in Theory and Practice, published in 2010). He has been a speaker at conferences on the subjects of innovation, performance management and innovative potential development.

Ondrej is a member of the Advisory Board of the American Academic & Scholarly Research Center (AASRC) and serves on the editorial board of many international scientific journals.

PREFACE

When I met Ondřej Žižlavský at the European Interdisciplinary Forum in Vilnius with the title „Drivers for Progress in the Global Society“ we were all presenting fascinating researches and case studies. Ondřej mentioned his research project about innovation and the Balanced Scorecard and more. I didn't think about the BSC as a driver then. Some time later I am honored to write this preface.

Since I explored innovation related to the theories about Nudge, Design Thinking or Participatory Design in marketing during my case studies in Zurich I touched instruments like the Balanced Scorecard as well. Like the one experience I had when a management sent the yearly Balanced Scorecard to the marketing department asking for the total of visitors of the website only. This one figure didn't unfold the Balanced Scorecard based scanning process for innovation in this corner of the company. That was not a driver.

The need for increased innovation often is triggered by a changing or challenging business environment like the Swiss machinery industry now and then suffering from the high value of the Swiss Franc. The centralised support of the Swissmem association offers for example growth workshops as well and implementation of an environmental management and the 2,259 companies (Swiss Statistics Office, 2015) themselves face the urgency of rethinking profitability and using new methods, theories, instruments; innovation for products, processes marketing and organization. Including suitable measurements like the Balanced Scorecard. Remark: so far the majority is still investing in a bit one-dimensional way into product innovation.

Measuring the immeasurable? Like for many organisations in Switzerland still today that question applies for other markets and industries as well. Innovation on one hand and a significant measurement system on the other hand. How to bridge that? Ondřej approached the issue about measurable innovation with a careful and intense research design. For instance the Likert scale which allows to look at the management's attitude as well within the data collection. To wrap it up: there is more than measuring financial factors and this book plays an important role when it comes to the demystification of measuring innovation.

Ondřej leads us with his rich data collection into the manufacturing industry of the Czech Republic where he started his research in 2013 with a target population of 11,000 companies. The random sample of 2,877 innovative companies resulted in 354 completed questionnaires – a response rate of 12%. The cross sum of the different research results show one effect in particular: innovation means commitment, knowledge about the managerial instruments related to performance measurement systems available and the readiness to enhance existing point of views. 28.53% of the companies confirmed that they already use a performance measurement system. About the commitment – 76.55% carry out innovation irregularly. To make it short – there is room for improvement. Not only in the Czech Republic.

The intense data collection and research results in this book encourage to enhance the existing Balanced Scorecard or to reach the next level by adding an innovation scorecard. The embedding of new non-financial factors like human resources or talent management led to new (marketing) areas like Employer Branding and number of new ideas as well as failure rate could change the awareness of a management team. But before going into seductive metrics the innovation strategy is a must – like the integration of employee skills into the innovation process or the implementation of a regular innovation training for selected groups.

The PMS as an interface to the innovation scorecard is covering an important aspect within the growing need for predictive analysis. Expanded by or melted with a BSC the power of facts ranges from turnover increase to productiveness value and much more. The broad discussion chapter works like a cascading inspiration flow, a fact-based eye-opener – drivers for innovation development coming out of research. Impressive accuracy. It may lead to behaviour change – workers, customers, the company and its environment. Well done, ready to put into action.

–**Maurice Codourey**
MAS ZFH Education Management, based in Zurich, Switzerland
West Pomeranian University of Technology, Szczecin, Poland
January 2016

INTRODUCTION

What the book is about

The subject of this book is innovation performance measurement and management control. You will obviously want to ask whether it is at all possible to assess the innovative efficiency of a company, and if it is possible whether companies have a need for this today? I am convinced that the answer is yes.

Innovation is currently becoming an entrepreneurial phenomenon. On the other hand, no matter how great the investment in innovation might be there is no guarantee that it is being spent efficiently. Therefore it is necessary to innovate wisely and with focus. Such activity requires that the company is capable of the continuous evaluation of on-going innovation projects and of using this data to make decisions on whether to continue or not.

However, establishing effective forms of performance measurement and management control for innovation processes undertaken at either the industrial or academic level is a very challenging task. Moreover, Adams et al. (2006) stress the absence of frameworks for innovation management measurement indicators as well as "the relatively small number of empirical studies on measurement in practice".

What you will get out of the book

The aim of the book is to present knowledge and findings in the field of innovation performance and management control as these areas are currently being dealt with in Czech as well as foreign expert literature and in practice in Czech manufacturing industry.

This book takes as its starting point the current state of affairs and the specific conditions arising from today's business environment. Based on findings from long-term empirical research carried out under the auspices of the Czech Scientific Foundation (research project no. 13-20123P) in the years 2013 to 2015 it attempts to provide an overview of the issues of evaluating innovation performance. This publication is based specifically on project management, Balanced Scorecard input–process–output–outcomes model and Stage Gate approach. The aim is not to provide a detailed explanation of these methods, but attaches great importance to the logic of the explanation. In doing so, the book has the following unique outcomes:

- A clear view of what innovation means from a business point of view.
- Conceptual framework of innovation process reflecting the key characteristics that are identical or similar in many other definitions.
- An overview on history of innovation process understanding.
- A summary of innovation critical success factors based on desk research.
- Key insights and tools derived from the latest academic research, consulting companies' publications and practitioners' experience.
- Case studies underlining the importance of innovation and its impact on corporate performance.
- Comprehensive results on how the Czech companies measure and control performance of their innovation processes.
- An extensive discussion about the current situation and possible development trends in innovation performance measurement and management control.
- A road map to developing a management control system called Innovation Scorecard.
- A list of concrete innovation metrics to be inspired from.

What you will not get out of the book

- Philosophical debates about what qualifies as innovation and what does not.
- A survey of the latest general innovation management techniques.
- Step-by-step recipes or one-size-fits-all formulas pretending to provide universal solutions for the innovation performance measurement and management control challenges companies face.
- Detailed explanations of methods for innovation performance measurement and management control.

How the book is organized

The book is divided into eight main chapters. Chapters 1 and 2 present the main aims of the research and take us through its background, the details of the methods used and how the results were processed.

In order to understand the attitude to innovation performance measurement and management control, it is first necessary to clarify the scope and purpose of innovation. Therefore, Chapter 3 reviews what innovation means and entails from a business perspective. The introduction to the issue is the definition of innovation, explanation of the difference between innovation and invention and the classification of innovation by the degree of novelty. What follows is a section defining innovative companies and the innovative potential of a company. The chapter concludes with a brief description of the impact of innovation on corporate performance.

Chapter 4 characterises the individual phases of the innovation process including the development of the concept over the last century. The supporting part of the fourth chapter is made up of the identification of key factors in innovation success, on the basis a study of secondary data. The chapter concludes with a description of the basic types of effects of innovation and presents methods for their measurement.

Chapter 5 presents two case studies to shed light on the issue of why innovation performance measurement and management matters. The first case study focuses on European manufacturing industry in order to illustrate the link between R&D expenditure and performance through a statistical model. The second case study from the Czech manufacturing industry utilizes company-specific time-series data to study differences in R&D expenditure structure depending on company ownership.

Chapter 6 provides an overview of the data used for this study and the main characteristics of the research sample. This section investigates the correlation between the innovation management control system (R&D expenditure, approach to innovation project evaluation, methods utilised, tools, period of innovation evaluation system implementation, etc.) and company size, since it is the most important contingency factor. It presents the comprehensive results of an empirical investigation into the Czech manufacturing industry. This section also summarises statistical tests of research hypotheses and there is a discussion in which the author tries to offer where possible a comprehensive interpretation of the findings.

Chapter 7 deals with basic approaches to measuring the effects of innovation, i.e. the use of financial and non-financial metrics or more precisely their combination in complex matrices. This section compares these indicators, investigates their pros and cons, and discusses the shortcomings revealed. Moreover, this section is also dedicated to specification of the Balanced Scorecard as the most appropriate approach for introducing a complex system of innovation management control.

Chapter 8 proposes, on the basis of this literature review, an original management control system approach to innovation performance measurement suitable for Czech SMEs, called the Innovation Scorecard. The basic structure of the Innovation Scorecard is first presented before the phases of its implementation are discussed. In addition, the Innovation Scorecard framework provides a set of factors and for each factor a set of inspiration metrics to choose from or be inspired by.

–Ondřej Žižlavský
January 2016

ISSUE DEFINITION AND RESEARCH AIM

1

Innovation contributes to the winning of competitive advantages. Successfully launched innovation to the market is one of the basic preconditions for the long-term survival of a company. In practice success goes to those companies that manage to mobilise their innovative potential in the form of knowledge, technological prowess and experience, to create something new. Innovations are normally the result of creativity of the employees and draw on the results of scientific and technological development. They are the comprehensive reactions of a company to new business opportunities and must always be focused on customers – offering them higher value.

Innovations are very expensive and over time consume a significant part of the exploitable resources of the company. The efforts and means expended on innovation must show a return if the company is to have a chance of surviving in a tough competitive environment. Unfortunately, it is a sad reality that a significant amount of innovations either does not end with the launch of a new product into the market, or else results in a new product that is not a success (see Box 4). The majority of companies manage to achieve only partial success, and that with problems. However, if an innovation does not make it, it still provides valuable information on what to do differently next time (see Box 3).

In the interest of the business success the management of the company has to regularly evaluate the performance of their current innovations. This evaluation must be carried out comprehensively. In each phase of the innovation process a question must be asked as whether it makes sense to continue with the task, and not just from a technical perspective but also in marketing terms. It is essential to ascertain whether the set of technical parameters can be achieved and whether the innovation will have any prospect of success on the market. If it does not take this approach then there is a risk that the company will repeat the same mistakes.

How do Czech companies actually measure their innovation performance? This was the aim of the research, which is positioned in the field of innovation, performance measurement and management as well as management control systems.

The main aim of the research project no. 13-20123P – Innovation Process Performance Assessment: a Management Control System Approach in the Czech Small and Medium-sized Enterprises – is **to amplify present research in the field of innovation performance measurement and management, then to define the basic criteria and to set the right metrics, and to further propose a management control system approach to the assessment of innovation performance on a micro-level suitable for Czech small and medium-sized companies (SMEs).**

This refers to the main problem. There are many indicators for assessing the success of a company in a wide sense, but if we refer to innovations it can be difficult to choose the right ones.

For better understanding, the main aim is broken down into two interconnected aims – cognitive and creative.

Cognitive Aim
To learn and study the current state of the art of innovation process performance measurement and management control from contemporary Czech and foreign professional literature and especially Czech corporate practice.

To achieve this first aim it will be necessary to fulfil the following minor goals:

- To define the basic terms associated with innovation issues, the performance measurement and management control, etc.
- To compile secondary research from Czech and foreign literature on the issues of innovation and the innovation process, innovation critical success factors, effects of innovations, innovation metrics, performance measurement systems, etc.
- To analyse the current state of the art, and to assess the suitability of individual approaches (indicators).
- To conduct primary research into Czech SMEs – to gather data using a questionnaire survey and one-to-one interviews with executive officers and individuals from middle and higher management, and to evaluate the data.

Creative Aim
To contribute to the study of innovation management by a proposal for a conceptual performance measurement and management framework for innovation processes suitable for Czech SMEs.

To achieve this second aim it will be necessary to fulfil the following minor goals:

- To identify the critical success factors of innovations.
- To present the possible methodological procedures for the evaluation of the expected effectiveness of innovation activities that can be used in companies under our conditions.
- To formulate proposals for the improvement of methods for innovation performance measurement.

Considering Czech manufacturing companies and the main research aim, the following research hypotheses are addressed:

Hypothesis 1: *Innovations have an influence on company performance.*

Hypothesis 2: *Innovations are mainly performed by companies controlled by foreign owner (or with foreign participation).*

Hypothesis 3: *Innovations are mainly performed by medium and large-sized companies in the Czech business environment with sufficient resources.*

Hypothesis 4: *Large companies perform innovation regularly – it is part of their business.*

Hypothesis 5: *Large companies tend to invest greater sums of money into innovation (measured by percentage of annual budget).*

Hypothesis 6: *Large companies tend to evaluate their innovative activities more than SMEs.*

Hypothesis 7: *Large companies have implemented their innovation performance measurement system for a longer time than SMEs.*

Hypothesis 8: *Large companies implement "modern" techniques of innovation performance measurement.*

Hypothesis 1 illustrates a link between R&D expenditures and performance through a statistical model. Consequently, whether and how innovation influences performance is tested (see Section 5.1). For this purpose, R&D expenditures (the independent variable) and other financial indicators of the company's performance (the dependent variables) are considered. Companies from manufacturing industries have been chosen as the examined sample. The data was obtained from the Amadeus database in the period 2007 to 2012. From a managerial point of view, such a model should be useful in predicting how companies might invest in new R&D capabilities in the future.

Hypothesis 2 investigates and explores the role of company ownership in relation to R&D expenditure (see Section 5.2). For this purpose, data from a survey conducted annually by the Czech Statistical Office are studied. The period from 2007 till 2013 is examined.

Hypotheses 3 to 8 investigate the correlation between innovation performance measurement and the management control system (tools and methods) and company size, since the most important contingency factor (see Chapter 6). Therefore, as its exploratory aim, this study investigates the role of company size in innovation performance measurement and management control. For this purpose, data from original primary research conducted in Czech innovative manufacturing companies in 2014 are considered.

RESEARCH DESIGN

2

2.1 Methodical Background

The fundamental unit of research interest is the company. This book presents a shift from a macroeconomic level of exploration to the sector and especially the level of the individual business (see Sections 2.3, 2.7 and 6.3). This level of investigation requires the application of particularly qualitatively based methodological procedures, and allows a deeper understanding of the analysed phenomena.

In the stated approach the innovation performance of the company is looked at in the context of its internal and external environment. It therefore involves not only focussing on innovation in outputs (products and services), but at the same time innovation in the company's resources, on which the implementation of innovation is dependent, and not least on innovation in further significant relations of the company with the external environment. Emphasis is placed on a comprehensive approach to problem solving.

When dealing with the relationship to the external environment, research is focused on analysing the relevant trends in our emerging post-industrial and new knowledge-based society, as shown in the particular areas of the increasing quality, technical difficulty and greening of products, in their customisation for individual clients, in the expanding share of services and particularly the rise and rapid expansion of information technologies and at the same time the birth of entirely new kinds of services. These trends create a call for innovation in existing companies and are at the same time the driving force in the development of entirely new areas of business.

With the aim of affecting the essential potential for innovation performance of the internal environment of the company, the focus is not only on factors that can easily be quantified by economic indicators, but also others perceptible only via qualitative analysis, such as organisational structure, organisational culture, the innovative climate, etc. We can make the justified supposition that it is precisely these factors that have a significant influence on innovation performance and the overall effectiveness of the company (e.g., Calabrese et al., 2013; Gronun et al., 2012; Mansury & Love, 2008 ; López-Nicolás & Meroño-Cerdán, 2011; Rosenbusch et al., 2011).

The theoretical background for the solving of the issues in question is made up not only of innovation management, but also financial management, performance measurement, management control, etc. The methodological background, and to a certain extent also the framework, is made up of standard methods for the evaluation of the business environment, innovation performance and the quality of sources.

Nonetheless, given that the object of research interest is the company, it is useful to extend and deepen the methodological inventory with the aim of creating a comprehensive methodological approach, conceived as a separate method – the Innovation Scorecard.

The Innovation Scorecard presented in Chapter 8 specifically extends the work of Kerssens-van Drongelen et al. (2000) and Pearson et al. (2000) by integrating popular innovation management frameworks – the input–process–output–outcomes model (Brown, 1996), and the Stage Gate approach (Cooper, 1998), with the Balanced Scorecard (Kaplan & Norton, 1996) – to present a framework to show how companies can link resource commitments to innovations and the company's strategic goals. This integrated approach ties measures of the company's competencies to traditional financial return measures and value-based management metrics.

The underlying premise is measuring financial performance in the context of overall strategic and operational goals to provide a practical means to consider innovation performance measurement. Shareholder value implications are considered as they relate to balancing strategic and financial objectives. The Stage Gate approach is cited to evaluate and measure investment into innovations to demonstrate the applicability and relevance of the BSC framework.

While a company may choose not to adopt a formal BSC management system, it can learn from and use the key concepts. The BSC helps managers to implement strategy through the development of an integrated set of relevant financial and non-financial measures. The non-financial measures, if properly selected, should be drivers of sustained profitability.

Within the research project a representative survey of a research sample of about 3 000 companies is assumed. A survey of this extent requires, aside from careful content/specialist preparation, also highly demanding organisational/technical preparation, including the choice of an appropriate structure of the research sample, especially in the choice of companies, and last but not least the finding and implementing of means to motivate companies to provide the cooperation needed. Alongside the large-scale survey, attention will also be focussed on specific surveys of a smaller number of selected companies that will be analysed with respect to worthy cases of innovative activity by conducting semi-structured in-depth interviews.

By means of empirical surveys we will mainly gain valuable content knowledge. Moreover, it also provides practical verification and further refinement of the proposed Innovation Scorecard method. In both, the results are an integral part of the outputs of the research project no. 13-20123P – Innovation Process Performance Assessment: a Management Control System Approach in the Czech Small and Medium-sized Enterprises – supported by Czech Science Foundation and will serve as a source of information for further research. Therefore, the book is supposed to motivate researchers to conduct more large-scale studies in the area of innovation performance measurement system implementation in different business sectors and areas.

This concept of the innovation performance solutions depends on the following premises:

- The company is the source of innovation (see Section 2.3).
- Innovation performance, that is the ability to carry out the desired innovation, can be seen as one of the most significant factors in the competitiveness and efficiency of a company (see Section 3.6).
- Innovations are, in the context of the subject of the research, in the economic/organisational (not technical) category (see Chapter 1 and Section 4.5).
- Innovative outputs from companies cannot be restricted to the innovation of products, as steadily greater significance is being ascribed to the remaining types of innovation (according to the Oslo Manual (OECD 2005)), and that is true even in companies of a production character (see Chapter 1).
- Innovation is not just a matter of the company's outputs, but also changes in the sources of the internal environment of the concern and relations between these and changes in relationships with relevant entities in the external environment (see Chapter 1).
- The condition for innovative outputs (products and services) is comprehensive innovation, which represents a purposeful chain of all the mentioned changes in the internal and external environments of the company (see Section 4.4).

Within research into this issue we encounter several basic terms. It has to be said that behind each of these terms there is usually a theory that legitimises the given term and normally understands it as being of central importance. This greatly complicates the situation when defining the relationship between terms and it often happens that in the literature the meaning of these terms overlaps, leading to redundancies or complete misinterpretations.

Terminology is dealt with in Chapter 3 in order to make the text comprehensible and to create a logically constructed methodological basis and not at all with the ambition of creating a unified, generally accepted definition of terms for the subject. In the context of the research the relationship between innovation, innovation performance and competitiveness is essential. In the concept of the research assignment there is an implicit assumption that there is a direct relationship between innovation performance and competitiveness.

This however does not apply generally, and even where it does apply it is not as a rule a simple linear relationship. It can be said that in the actual conditions of the Czech economy many companies lose their competitiveness due to the backwardness of their innovation performance, while those which have much higher innovation performance are competitive. Of course this does not mean that in all circumstances we can infer that to achieve a high degree of competitiveness it is essential to innovate to the maximum extent.

Generally it can be said that a company reacts to the dynamic development in the internal and external environment by innovating. It is therefore important to correctly establish:

- What innovation should affect (object).
- What should be the character of the innovation (innovative procedure).
- When the innovation should be carried out (appropriate moment).
- What other innovations are needed for the realisation of the innovation in question.

It is a question of optimising innovation activity and not maximising it, where the criterion of optimality is the benefit derived from the activity, as reflected in the long-term efficiency of the company.

It is argued that the research presented in this book is valuable for several reasons. First, it is one of the few comprehensive studies to address the question of what methods of innovation performance measurement are implemented in innovative Czech manufacturing companies.

Second, the research takes into account the specifics of the investigated issue, such as measurement in soft systems (see Section 2.2), the core micro-level of measurement (see Sections 2.3 and 2.7), and the specifics of the Czech business environment after the financial crisis (see Section 5.2).

Third, only few recent studies provide an attempt to develop a BSC framework for innovations. Garcia-Valderrama et al. (2008a) developed a general BSC model that is designed and delimited to innovations, and both Garcia-Valderrama et al. (2008b) and Eilat et al. (2008) proposed an integrated data envelopment analysis (DEA) and BSC approach to evaluating innovation projects.

2.2 Measurement in Soft Systems

An increasingly important subject of research in measurement science is the analysis of measurability conditions (e.g., Mari, 2007; Mari et al., 2009; Rossi, 2007) for non-physical properties, to which physical transducers cannot be applied, by transferring to such “soft“ properties what have been learned in measurement of physical quantities in many centuries of scientific and technological development. In the current literature this borderline field of analysis is termed “measurement in soft systems”, or sometimes (more appropriately) “measurement of soft quantities”, or even simply “soft measurement”. Recently, an authoritative contribution to the analysis of measurement in soft systems has come from the “Guide to the expression of uncertainty in measurement (GUM)” (BIPM, 2008), which has thrown some new light on the classical distinction between “direct“ and “derived“ (or “indirect“) measurement. The basic hypothesis is that the property intended to be measured, called in this context the “measurand”, must be characterized by a suitable model describing, in particular, the relations between the measurand itself and other properties, generically called “input quantities to the measurement model“ and including in particular all relevant influence quantities that could affect the measurand value. Hence, it is acknowledged that several components generally contribute to the measurand value and uncertainty, so that any measurement in which such components must be combined should be dealt with as an indirect process that includes an information processing stage. The considered measurand is indeed the output quantity obtained by processing one or more input quantities by a functional relationship that the GUM calls the (mathematical) measurement model.

In principle, such measurement models have thus the same structure for both hard and soft systems – what makes the difference is the lack of a generally agreed theory embedding a system of relations among soft quantities, analogous to the International System of Quantities (ISO, IEC, 2012) for physical quantities. That is why measurement in soft systems is mainly concerned with the problem of suitably selecting input quantities (in this context usually called “indicators“, plausibly to emphasize their role of co-determining the measurand) and algorithmically combining them to obtain a value for the searched quantity, i.e., the measurand.

In this context the fundamental issue arises of how to characterize measurement with respect to generic assignment of numerical values to quantities, as it could be performed by, e.g., estimation, guess, etc., so to guarantee the epistemic significance of the results. Accordingly, the attempt here is to apply some general principles of measurement in soft systems to R&D, in order to identify a model able to give as much as possible a robust and reliable measurement to innovation performance. Such a model should be able to operatively support the identification of the conditions for an objective and inter-subjective numeric characterization of innovation performance, such as they are required to consider it a "proper case" of measurement (e.g., Mari, 2003; 2007):

- Objectivity: Measurement results should convey information on the considered system and not the surrounding environment (which typically includes the subject who is measuring). In physical measurement systems objectivity is obtained by guaranteeing a sufficient stability and selectivity of the system, so to make its output invariant to the effects of the environment, i.e., to the variations of the influence quantities. Hence, objectivity is a condition of reliability for the information produced by the evaluation process.
- Inter-subjectivity: Measurement results should be interpreted in the same way by different subjects. In physical measurement systems inter-subjectivity is obtained by calibration, that makes the system output traceable to a standard, so that different systems traced to the same standard produce comparable results. Hence, inter-subjectivity is a condition of public interpretability for the information produced by the evaluation process.

Furthermore, the problem of characterizing measurement is made complex by its polysemy, as the following diagram highlights (see Figure 1). A data acquisition process *(1)* applied to an empirical object, i.e., the system under measurement *(s)*, produces an information entity *(x)*, which is in turn processed *(2)* leading to a further information entity *(y)*. Hence, the concept of (physical) measurement can be recognized as twofold:

- Measurement as data acquisition *(1)*: this is traditionally called fundamental (or also direct) measurement.
- Measurement as data acquisition + data processing (*1* + *2*): this is called derived (or also indirect) measurement.

Furthermore, when taking into account some, usually non-physical, quantities a third meaning is adopted:

- Measurement as data processing *(2)*, to obtain the value *(y)* for a property of the object of interest *(s)* from some raw data *(x)*, under the hypothesis that such raw data actually were obtained from that object in some reliable way.

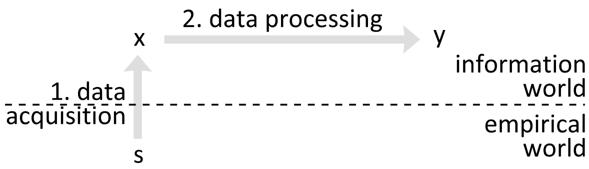

Figure 1 Measurement as data acquisition and possibly data processing (Lazzarotti et al., 2011, p. 213)

Innovation performance is not generally considered a physical property, so that no physical transducers sensitive to performance can be exploited. Some analysis on the concept of derived measurement can be useful at this regards, also aimed at identifying the structural elements on which objectivity and inter-subjectivity could be obtained in this case.

2.3 Innovation Performance Measurement Levels

The use of different dimensions and levels is a precondition for the success of performance measurement systems (PMSs). Correlations within performance levels as well as level spanning correlations can be visualized and used for steering (Gleich, 2001). Figure 2 demonstrates the above dimensions of innovation management complemented by innovation projects and innovation fields. The innovation strategy plays a particular role, as fundamental strategic decisions have a major influence not only on the other dimensions, but also on the concrete innovation fields.

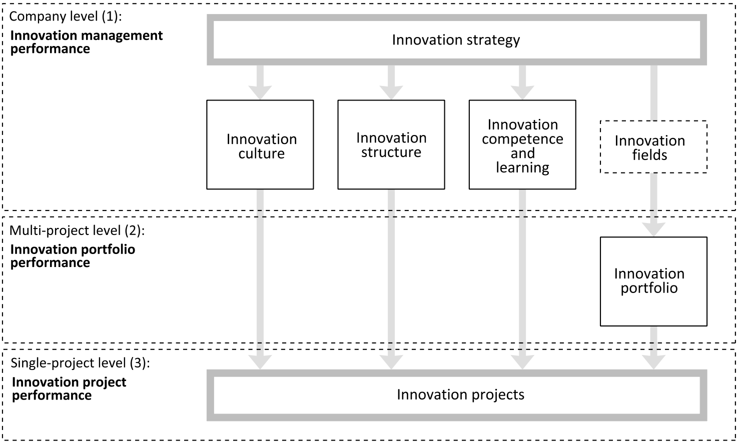

Figure 2 Levels and dimension of an IPMS (Schentler et al., 2010, p. 306)

As seen in Figure 2, innovation performance measurement can be classified into three different levels:

- **Company level** – innovation management performance. This includes innovation culture, innovation competences/learning, innovation structure and innovation strategy. The aspects on this level of the innovation performance measurement system are the basis for the innovation projects as well as for the innovation portfolio. Therefore, they are a prerequisite for putting innovation management into action.
- **Multi-project level** – innovation portfolio performance. Portfolio management is defined as a dynamic decision process in which a company's active innovation projects are constantly updated and revised. This level has a sandwich position between project and company level. It should enable different projects in different innovation fields of a company to be linked with overall strategy.
- **Single-project level** – innovation project performance. A project represents a team-based approach to execute innovation processes. Practice shows that projects are the most common and important organisational form to put innovations into action. Each innovation project needs to be considered as a planning and management control object. The aggregated project performance represents the input for the project portfolio level. Thus activities from early stages of the innovation process to the market launch of new products account for this level. Status report of single projects are aggregated and used as an input for the second performance level, multi-project level performance.

The measurement of performance on all three levels allows a detailed understanding of innovations and results as well as of innovation strategy implementation. It is of great significance to link the different levels and aspects to each other. Starting top down, the innovation strategy needs to be considered in the innovation culture, innovation competences/learning and innovation structure, as well as via the different innovation fields, in the innovation portfolio. The strategic decisions made on the first level need to be translated into specific goals and activities as input for the other dimensions and levels. The goals of the multi-project landscape need to be split into different projects. Thinking bottom up, the status reports of single projects are aggregated as an input for the portfolio management on the second performance level, the portfolios themselves in the overall level.

The whole concept of the research and consequently this book, focus on the last single-project level because of many reasons. First, as mentioned above, innovations are implemented in practice as a project; second, the single-project level represents the basis of overall innovation management; and third, there are not many suitable approaches to innovation performance measurement on this kind of level in the Czech scientific and business environment as well.

Therefore, this book examines a first dimension – a single-project level – along which innovation performance measurement can be undertaken and studied. At this first level, academics have studied how metrics to measure innovation performance should be selected. Brown and Svenson (1988) suggest that companies should use a limited number of objectives and external indicators to measure innovation performance, focused on results and outcomes (see Section 8.6) rather than behaviour. Nixon (1998) underlines the importance of ensuring a strategic orientation in the selection of innovation indicators. These metrics should mirror the critical success factors (see Section 4.3), they should be easy to understand and use and capable of encouraging change in behaviour. Several authors (Bremser & Barsky, 2004; Driva & Pawar, 1999; Presley & Liles, 2000; Werner & Souder, 1997) state that the most effective measurement approaches to innovation are those that balance quantitative with qualitative (financial and non-financial) metrics (see Sections 7.3 and 7.4).

Furthermore, given that economic-financial metrics are often questionable since it is very difficult to give a monetary evaluation of intangible and distant-in-time elements, as typically happens in innovation process (Frattini et al., 2006), they are often integrated by non-financial metrics, which can be more easily estimated.

2.4 Project Schedule

Scientific knowledge presents a continuity algorithm for individual activities in the process of recognition, starting to formulate a solution to the problem and ending with a concluding evaluation of the results obtained. When carrying out the research project several steps were undertaken directed toward fulfilling the goals set out.

Stage 0 (till 2012): The preparation of the research project and its preliminary solutions has focussed on an approach of defining the problem, establishing aims and gaining a detailed overview of the current state of the issue of measuring and managing the innovation performance of a business.

Stage 1 (year 2013): The first phase involved problem formulation. The project deals with an area which is currently gaining in significance. Therefore, answering questions in this field is a significant challenge in the current scientific and business environment. This cognitive phase also dealt with gaining information on the given issue and collecting secondary data. In line with the goal of the project it was necessary to study the individual definitions, processes and means of measuring and managing innovation performance as available in the current state of scientific thinking (see Chapters 3, 4 and 7). This review phase was oriented in the study of Czech and foreign specialised literature as found in books, articles in journals, information servers, databases of libraries, universities and other organisations. The study of secondary data made it possible in the next step to come up with hypotheses which were then tested in primary research in businesses.

Stage 2 (year 2014): The subsequent primary research phase was performed following the primary research procedure presented in Section 2.7. The survey consisted of the preparation, processing and evaluation of questionnaires and the subsequent semi-structured in-depth interviews with managers from middle and higher management as well as experts in the selected companies, making use of their practical experience. The purpose of these interviews was to provide any missing qualitative data, to supplement concrete data, to allow for a subsequent discussion over the conclusions drawn, and to test the possibility of their implementation in practice. Such data provided a basis for processing the proposal for conceptual innovation performance measurement and management framework.

Stage 3 (year 2015): Synthetic work has begun to make it possible to summarize the findings gathered in innovation process performance measurement and to publish them in this book. Therefore, data from primary research are evaluated with the help of statistical methods in the Minitab® 15.1.1.0 statistical software (see Section 6.2). Based on performance measurement design methodology (see Section 2.8), a conceptual innovation performance measurement and management framework called Innovation Scorecard has been proposed as well (see Chapter 8).

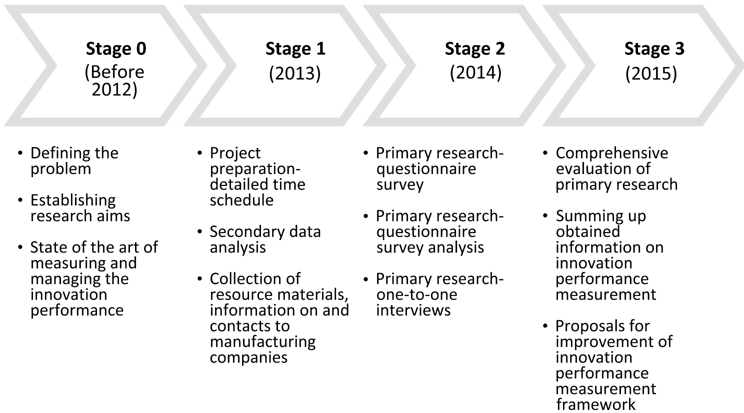

Figure 3 Progress chart of the research project

The research process was deliberately designed as one that had to be facilitated. As can be seen from the process outline provided above, guidelines covering both – who should be involved and what procedure should be adopted during each phase of the process – were developed in advance. Specific check sheets to enable the necessary data to be captured were used. The aim of the process design phase, then, was to establish a practical performance measurement system design process, building on the best of academic theory and industrial practice.

2.5 Applied Research Methods

Methodology deals with the systematisation, evaluation and proposing of research methods and strategies (see Hendl, 2008). The subject of this discipline is the tools of science. The kind of research we carry out depends on our views on the nature of the social world (ontology), on what it is possible to know about it, on our ideas of the nature of knowledge and how we can gain it (epistemology), on value and ethical perspectives. It is also dependent on the main aim of the research (see Chapter 1), on external influences on the research and our immediate environment (Hendl, 2008).

When deciding which method to adopt for a research study, there were many factors that should be considered. First, all methods have their strengths and weaknesses, so it is important to evaluate each method's appropriateness regarding the research project. Second, because a research project is usually made up of different types of data (namely primary and secondary data) a number of methods might be used in order to be able to address the research problem. As a consequence of the difference between these types of data, a collection of various methods has to be adopted. A survey as a starting point seems most appropriate because of the purpose of this study (see Section 2.7).

Surveys are commonly used for research that are based on a descriptive and an exploratory approach. Collecting and processing information can be done in different ways, either by adopting a qualitative, quantitative, or triangulation (a combination of the two) method. Multiple data sources or research methods (e.g., data analysis, interviews), can be used to provide a consistent body of evidence that increase the reader's confidence in the result.

Quantitative data are primarily used when the aim of the research is to answer questions such as who, what, where, how often, how much, and how many (Yin, 2013). This sort of data are often used when analysing data from a large population. On the other hand, qualitative data are better suited for research projects that use data that cannot easily be quantified, and qualitative data are often suitable for research projects that aim to understand or find a specific pattern within the investigated area. This study use a combination of qualitative and quantitative data to address research hypotheses.

Research work relies mainly on the systemic approach, which is standardly applied for its ability to consider situation in the context of external and internal circumstances. It employs a combination of different methods and techniques from various scientific disciplines – triangulation.

With the term triangulation we understand a combination of various methods, differing studied groups of persons, varying local circumstances and theoretical perspectives, which apply to the research. In this case two types of triangulation are taken into account; (i) data – the use of varied data sources; and (ii) methodological – the use of a combination of data gained with the aid of questionnaires, analysis of available materials and semi-structured interviews.

Analysis involves dividing up the whole into its components and investigating how these elements function as relatively independent elements and how they relate to each other. Every analysis is characterised by a certain degree of exploration. This means that in the process we carry out research and exploratory activities. On the contrary synthesis involves rather the merging of parts into a whole and of describing the main organising principle that governs the whole depending on its parts (Hendl, 2008).

In particular, analysis is used as a method for obtaining new information and its interpretation. When processing secondary data, the method of secondary analysis is utilised. A source of secondary data was the professional literature, especially foreign – books, journals, articles from scientific and professional databases (Web of Science, Scopus, Emerald, EBSCO, etc.), with respect to their professional level and relevance.

In order to ascertain the real situation in innovation performance measurement in Czech companies, a questionnaire survey was conducted in our manufacturing SMEs (see Chapter 6). This stage strived to contact as many companies as possible to obtain a sufficient amount of data.

Comparison is utilised for the results of the questionnaire inquiry of individual companies. This basic benchmarking approach selected more innovative companies for further personal interviews with the company's management.

Inquiry with the objective of acquiring particular data and following discussion about results acquired and verification of their implementation and realization in practice was carried out in the form of personal interviews with companies' management, i.e., especially with members of the top management, executive agents, or owners of production facilities.

Content analysis is applied to the study of texts processed and acquired in the course of interviews with managers of selected companies (personal supporting documents acquired from respondents).

Synthesis is primarily used to announce the results (see Section 6.2), formulate conclusions (see Section 6.3), and produce a methodological proposal for the management control of innovation process performance (see Chapter 8).

Deduction consists of drawing logical conclusions from a number of other assertions that we consider true. We call these assertions premises (see Section 2.1). Deduction can proceed from the general to the specific, from the general to the general or from the specific to the specific. In empirical research we use deduction to subject a particular case to certain rules.

Induction is based on the observation that the subjects of a given phenomenal category categorised by certain properties, and from this it is considered that similar subjects will also show this property. In other words, from the regularity of the investigated events we draw general conclusions concerning a regularity that applies to other events in other places or at other times. Induction is used in empirical research to convert regularity in the examined collection of data into general rules.

With the aid of the terms induction and deduction two basic relationships between data and theory can be described. The first of these is characterised by coming up with deductive assertions from theory which we then test on the data. We are then speaking of the use of deductive theory. The project is then given by the relationship: Theory → Assertion: Data.

In the inductive approach the relationship is reversed. We use data for the inductive derivation of a theory: Data: Assertion → Theory.

In the inductive case the process of their development usually includes the simultaneous application of a deductive approach, because we use the data both for deriving and testing elements of the emerging theory. The comprehensiveness of this process is captured by the concept of abduction (see Peirce, 1931).

Induction (generalization) is utilised especially when generalizing all the findings achieved in the questionnaire survey, and it is also applied when general principles are defined of the methodological proposal for the assessment of innovation process performance based on specific data from individual companies. Verification of found dependencies was verified by application of deduction.

Feedback method allows a reconsideration of every step in research to make sure the research does not deviate from its original aim and its starting points.

Statistical methods (see following Section 2.6) are utilised when analysing primary data and their results are presented in tables and charts in Chapters 5 and 6. In particular, Minitab® 15.1.1.0 statistical software is utilised for hypotheses tests and verification.

2.6 Data and Methods for Data Analysis

Three basic sources of information are used while carrying out the project:

- Information made available publicly.
- Information from questionnaire surveys.
- Information from interviews.

For the purposes of the empirical survey public information is taken; in particular data from the Amadeus database provided to the company Bureau Van Dijk and the Czech Statistical Office, which monitors the characteristics of R&D using a direct statistical survey VTR 5-01. This survey has been carried out in the Czech Republic since 1995 and is a part of the Program of Statistical Surveys. The program is made public under Act No. 89/1995 Coll., On the State Statistical Service, as amended. Data from 2007 and 2013 serve as support and a basis for the primary research in its publications.

In the primary analysis (see Chapter 6) the frequency of responses to individual questions on the questionnaire was evaluated. The results were processed in a unified manner in the form of standardised tables and graphs, including commentaries interpreting the presented numerical and graphical information. Evaluation is carried out on the research collection as a whole as well as on component files, broken down by the size of the company.

By this means a whole range of partial information is gained on the investigated companies. A basis is created for the interpretation of the data gained at the same time obtaining many suggestions for further processing. Concurrently businesses were suggested for the second stage of the primary research – the conducting of semi-structured interviews. An integral part of the primary analysis is data cleaning and its preparation for use in further steps in the process.

Statistical methods are used in the analysis of primary data and the results are presented in tables in the text. The statistical software Minitab® 15.1.1.0 was used for testing the proposed hypotheses. Specifically it involves the following methods.

Chi-square test
Chi-square test for independence is applied when we have two categorical variables from a single population. It is used to determine whether there is a significant association between the two variables.

The test procedure is appropriate when the following conditions are met:

- The sampling method is simple random sampling.
- The variables under study are each categorical.
- If sample data are displayed in a contingency table, the expected frequency count for each cell of the table is at least 5.

The test consists of four steps: (i) state the hypotheses, (ii) formulate an analysis plan, (iii) analyse sample data, and (iv) interpret results.

State the hypotheses
A chi-square test for independence is conducted on two categorical variables. Suppose that Variable A has *(r)* levels, and Variable B has *(c)* levels. The null hypothesis states that knowing the level of Variable A does not help you predict the level of Variable B. That is, the variables are independent. The alternative hypothesis states that the variables are not independent.

Let suppose that Variable A has *(r)* levels, and Variable B has *(c)* levels. The null hypothesis states that knowing the level of Variable A does not help you predict the level of Variable B. That is, the variables are independent.

H0: Variable A and Variable B are independent.
H1: Variable A and Variable B are not independent.

Formulate analysis plan
The analysis plan describes how to use sample data to accept or reject the null hypothesis. The plan should specify a significance level and should identify the chi-square test for independence as the test method.

Analyse sample data
Using sample data, find the degrees of freedom, expected frequencies, test statistic, and the P-value associated with the test statistic.

$$DF = (r-1) * (c-1)$$

Equation 1 Degrees of freedom

Where
(r) is the number of levels for one categorical variable, and *(c)* is the number of levels for the other categorical variable.

The expected frequency counts are computed separately for each level of one categorical variable at each level of the other categorical variable. Compute *(r*c)* expected frequencies, according to the following formula.

$$E_{r,c} = \frac{(n_r * n_c)}{n}$$

Equation 2 Expected frequencies

Where
$(E_{r,c})$ is the expected frequency count for level *(r)* of Variable A and level *(c)* of Variable B, (n_r) is the total number of sample observations at level *(r)* of Variable A, (n_c) is the total number of sample observations at level *(c)* of Variable B, and *(n)* is the total sample size.

Then, the test statistic is a chi-square random variable (X^2) defined by the following equation.

$$X^2 = \sum \frac{(O_{r,c} - E_{r,c})^2}{R_{r,c}}$$

Equation 3 Chi-square random variable

Where
$(O_{r,c})$ is the observed frequency count at level *(r)* of Variable A and level (*c)* of Variable B, and $(E_{r,c})$ is the expected frequency count at level *(r)* of Variable A and level *(c)* of Variable B. The P-value is the probability of observing a sample statistic as extreme as the test statistic.

Interpret results
If the sample findings are unlikely, given the null hypothesis, the researcher rejects the null hypothesis. Typically, this involves comparing the P-value to the significance level, and rejecting the null hypothesis when the P-value is less than the significance level.

T-test
The t-test with equal or rather unequal variances procedure can be described as follows. Let there be two independent random samples $(X_1,\ldots, X_n)$ from distribution $N(\mu_1;\sigma^2)$ or respectively $(Y_1,\ldots, Y_m)$ from distribution $N(\mu_2;\sigma^2)$. We assume that $n \geq 2$; $m \geq 2$; $\sigma^2 > 0$. The t-test tests a null hypothesis, that the difference between the mean of both groups (μ_1, μ_2) is equal to some constant (Δ), in most cases zero $(\Delta=0)$, i.e:

$$H_0\colon \mu_1 - \mu_2 = \Delta$$

Equation 4 Null hypothesis

Against the alternative hypothesis

$$H_1\colon \mu_1 - \mu_2 \neq \Delta$$

Equation 5 Alternative hypothesis

The test criterion, under the assumption of equal variances can be written in the following form:

$$|T| = \left| \frac{\overline{X} - \overline{Y} - \Delta}{\sqrt{(n-1)S_x^2 + (m-1)S_y^2}} * \sqrt{\frac{nm(n+m-2)}{n+m}} \right| \geq t_{n+m-2(\alpha)}$$

Equation 6 Test criterion – equal variances

Where

$$\overline{X}, \overline{Y}, S_x^2, S_y^2$$

are characteristics of the two random samples.

$$S_x = \frac{1}{n-1}\left(\sum_{i=1}^{n} X_i^2 - n\overline{X}^2\right) \qquad S_y = \frac{1}{n-1}\left(\sum_{i=1}^{m} Y_i^2 - m\overline{Y}^2\right)$$

$$S = \sqrt{\frac{S_x^2}{n} + \frac{S_y^2}{m}} \qquad v_x = \frac{S_x^2}{n} \qquad v_y = \frac{S_y^2}{m}$$

The test criterion, under the assumption of unequal variances can be written as follows:

$$\frac{|\overline{X} - \overline{Y}|}{S} \geq \frac{v_x t_{n-1}(\alpha) + v_y t_{m-1}(\alpha)}{v_x + v_y}$$

Equation 7 Test criterion – unequal variances

Spearman correlation coefficient

Spearman's correlation coefficient is a statistical measure of the strength of a monotonic relationship between paired data. In a sample it is denoted by *(ρ)* and is by design constrained as follows:

$-1 \leq \varrho \leq 1$

And its interpretation is: the closer *(ρ)* is to ± 1 the stronger the monotonic relationship. Correlation is an effect size and so we can verbally describe the strength of the correlation using the following guide for the absolute value of *(ρ)*:

- 0.00–0.19 very weak
- 0.20–0.39 weak
- 0.40–0.59 moderate
- 0.60–0.79 strong
- 0.80–1.00 very strong

The calculation of Spearman's correlation coefficient and subsequent significance testing of it requires the following data assumptions to hold:

- Interval or ratio level or ordinal.
- Monotonically related.

Unlike Pearson's correlation, there is no requirement of normality and hence it is a nonparametric statistic.

$$\rho = \frac{6\sum_{i=1}^{n}(p_i - q_i)^2}{n(n^2 - 1)}$$

Equation 8 Spearman's correlation coefficient

Where

(p_i) or (q_i) refers to the ranking of (x_i) or (y_i) values for the random quantity *(X)* or *(Y)*, *(n)* refers to the number of observations/number of values (x_i) or (y_i)

Scaling – Likert Scale

Scaling is normally characterised as a means of "measuring the immeasurable" and is used particularly in sciences that work with so-called soft data, such as psychology, sociology, economics and political science (Rod, 2012).

According to Kozel et al. (2006) scaling serves for the expression and subsequent measurement of the attitudes and opinions of the respondent. It is a technique in which the respondent translates their attitude onto the scale provided, by which the interviewer manages to turn a difficult-to-measure subjective attribute into a mark that can be statistically compared.

This chapter deals with Likert scaling, which was used in this work to evaluate the significance of factors (i.e. implemented innovations, individual metrics and methods of measuring innovation performance).

Since this case deals with a one-dimensional method it is essential that the essence of the researched question be focussed only on one concrete subject. In order that the respondent can be correctly placed on the scale, it is crucial not only to correctly polarise the scale, but also to formulate in an appropriate and unambiguous manner the assertion to which they are to react.

In the context of division of the scale, Pecáková et al. (2004) state that is essential to think through the number of presented categories, and they recommend five to seven categories. A lower number of categories could seriously restrict the ensuing analysis of the data gained, while respondents can find that a higher number significantly complicates making a choice that corresponds to their attitude.

Chrástka (2007) also places Likert-type scales among the most significant. The advantage of these scales is that it allows a respondent to express an opinion or require that the respondent expresses the extent of their agreement or disagreement with a statement on an evaluation scale. The requirements for the creation of a Likert scale are, according to Rod (2012), generally understood quire clearly – the scale should be polarised from disagreement to agreement (not unilateral), and with an odd number of degrees.

Cronbach's Alpha Coefficient
Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. A "high" value for alpha does not imply that the measure is unidimensional. If, in addition to measuring internal consistency, we wish to provide evidence that the scale in question is unidimensional, additional analyses can be performed. Exploratory factor analysis is one method of checking dimensionality. Technically speaking, Cronbach's alpha is not a statistical test – it is a coefficient of reliability (or consistency). Reliability coefficient of 0.70 or higher is considered "acceptable" in most social science research situations.

$$\alpha = \frac{N\overline{c}}{\overline{v} + (N-1)\,\overline{c}}$$

Equation 9 Cronbach's alpha

Where
(N) is equal to the number of items, *(c-bar)* is the average inter-item covariance among the items and *(v-bar)* equals the average variance.

2.7 Primary Research Procedure

As concerns the methodological approach, following recent examples (Baird et al., 2004; Carenzo & Turolla, 2010; CZSO, 2012; CZSO, 2014; OECD, 2009; Sulaiman & Mitchell, 2005; ZEW, 2013), a questionnaire-based survey was implemented to gather information and determine the real state of solved issues of performance measurement and management control of innovations. The survey method is often used to collect systematic data since it is time and cost-efficient and allows carrying out a statistical analysis (Groves et al., 2009). In addition, the replication of questions is possible and thus consents a comparison of results and pattern analysis.

The first step was to define the research sample. Before the research commenced, the circle of respondents was duly considered. Research could have been limited based on a company's size, the field, and distribution of companies in the Czech Republic. After careful consideration, it was decided to carry out the research via a random selection of various-sized innovative companies from manufacturing industry in the Czech Republic.

This choice is related to the fact that managerial tools were primary originated, and subsequently developed, in manufacturing companies. The second feature was the fact that manufacturing industry is considered as the most significant industry for development of the Czech economics since it is the largest sector of the Czech economy. This allows sufficient number of companies to be contacted to participate in the study. It is estimated that the target population consists over 11,000 manufacturing companies.

According to Czech Statistical Office and its survey in 2012, 51% from 5,449 innovative companies belong to manufacturing industry. Moreover, these companies participated in total revenues by 45.4% in 2012 in mentioned part of Czech economics (CZSO, 2014, p. 15).

In order to establish innovation success, it is first necessary to decide at what level the process will take place. Innovation effects can be measured at (i) a macro level (distinguishing national and sector levels), (ii) meso level (the level of the company's product family), and (iii) micro level (the level of innovation projects).

At the macro level, there is a wide range of known and sophisticated means of measuring innovation potential and performance such as the Innovation Union Scoreboard (EC, 2014a) and the Regional Innovation Scoreboard (EC, 2014b) in Europe. In the Czech Republic innovation surveys are regularly performed by the Czech Statistical Office as well as the Centre of Economic Studies at the University of Economics and Management (CES, 2013). The macro level has been the subject of abundant research and studies in the past decades (e.g., Archibugi & Pianta, 1994; Brusoni et al., 2006; Casper & van Waarden, 2005; Cefis & Ciccarelli, 2005; Gourlay & Seaton, 2004; Malerba & Orsenigo, 1999; MEADOW, 2010; OECD 2007; OECD 2010a; OECD 2010b; Patel & Pavitt, 1994); therefore, the present work does not study this level and bases its considerations on the findings of the aforementioned studies.

There are several reasons for analysing the link between innovation and productivity at the firm micro-level. First, it is companies that innovate, not countries or industries. Second, aggregate analysis hides a lot of heterogeneity. Companies' performance and characteristics differ both across countries and within industries; countries' innovation systems are characterised by mixed patterns of innovation strategies which have an impact on companies' behaviour; and companies may adopt multiple paths to innovation, including non-technological ones. The advantage of micro-level analysis is that it attempts to model the channels through which specific companies' knowledge assets or specific knowledge channels can have an impact on these companies' productivity and therefore shed light on the role that innovation inputs, outputs and policies play in economic performance (OECD, 2009).

The key was to approach as many respondents as possible and so to acquire a sufficiently large data scale factor for evaluation of primary research. The inquiry itself provided quantitative, as well as semi-qualitative data on the current state of the issue in question. Simplicity and the relative brevity of the questionnaire, affecting a respondent's willingness to fill it out, was an important factor when creating the questionnaire. There were the following types of questions:

- With selectable answers and the option to select just one.
- With selectable answers and the option to select several answers.
- With pre-defined answers with an evaluation scale.
- Some questions had the option to fill in answers freely.

The questionnaire was web-based in order to facilitate access to a large number of respondents and was structured in two parts. The first part consists of general information about company, whereas the second part focuses on innovation measurement and management and applied management control tools and methods. Regarding the structure of questionnaire, questions in the first part relate primarily to:

- Size of the company (defined by a number of employees and turnover)
- Origin of the company (Czech, Czech with foreign participation, foreign).
- Geographic markets where the company sells its products or services (Czech regional market, Czech national market, EU market, Global market).
- Period in which the company implements innovations (irregularly and randomly, or regularly).
- Type of implemented innovations defined according to Oslo Manual (product innovation, process innovation, organisational innovation, and marketing innovation).
- Importance of implemented innovation (based on Likert scale: 1 – very important, 2 – important, 3 – neutral, 4 – not important, 5 – completely unimportant).
- Total amount of expenditure for innovation by percentage of annual budget.

To reduce its size the questionnaire focuses almost exclusively only on information that cannot be obtained from publicly available sources or by other means. The purpose of the use of the questionnaire was above all to obtain the ideas and estimates of the qualified, strategically minded representatives of the business.

The second part of the questionnaire had more analytical and less subjective character. Here, using scoring scales, numerical values, and in some cases other means, respondents evaluated the innovation process in the company and how it was measured and managed. The primary aim of the statistical evaluation that followed was to ascertain "what the businesses are like", and the secondary aim was then to identify which of their characteristics and their values lead the business to be or not to be economically successful and competitive in the long term.

Questions in the second part relate to:

- Implementation of innovation performance measurement system (PMS).
- Period, since when is PMS implemented in the company.
- Reasons for PMS implementation and its importance for strategy management.
- Responsibility for innovation performance measurement.
- Tools and techniques of innovation performance measurement and management utilized in the company.

The structured questionnaire also enables additional comments. Thereby, respondents could express their opinion on given questions regardless the degree of their own innovation. Gained data are presented in tables and graphs that are summarized in Section 6.2.

Once drawn up, the questionnaire should be tested on a sample population whether all items are understandable and clear. Therefore, the questionnaire was pre-tested by a number of academics and then send to several practitioners for further review. Minor adjustments in wording and layout were made in order to further understanding of the questionnaire. None of these respondents considered the questionnaire difficult to complete. After several iterations of item editing refinement, the questionnaire was administered to the full research sample.

The survey was composed of 18 questions and was conducted by sending a fully standardized questionnaire (see Appendix 6) by e-mail to the company (a link to the electronic questionnaire was included in the e-mail). The e-mail implied a brief introduction clarifying the purpose and objectives of the research project. It was send exclusively to CEOs, top managers, executive officers, or in small companies, directly to owners. The survey was anonymous, took approximately 10 to 15 minutes to complete, and was conducted from April to November 2014.

In addition, the survey respondents were asked to indicate whether they would be willing to participate in a follow-up interview. The aim of the follow-up interviews was to analyse questionnaire responses in greater depth. The interviews were semi--structured and conducted with a degree of flexibility. A list of the main questions was sent in advance to facilitate the interviews. Although the questionnaire was semi-structured individual questions were understood rather as topics for discussion. Numerous incentives revealed during meeting with businessmen and have the form of extended comments in Sections 6.2 and 6.3.

2.8 Methodology of the Innovation Scorecard Design

Neely et al., (1996, p. 424) propose definitions of performance measurement, a performance measure, and a performance measurement system:

- *"Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action."*
- *"A performance measure can be defined as a metric used to quantify the efficiency and/ or effectiveness of action."*
- *"A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions."*

Figure 4 shows how a set of performance measures, a performance measurement system, can be examined at three different levels; (i) the individual performance measures, (ii) the PMS as an entity, and (iii) the relationship between the PMS and the environment within which it operates.

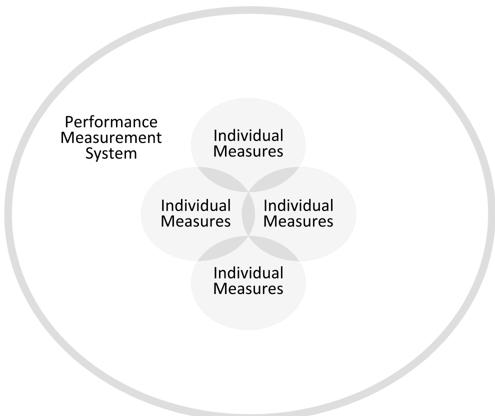

Figure 4 A framework for PMS design (Neely et al., 1996, p. 424)

The starting point is an analysis of the state of art of performance measurement and management control techniques, in order to devise the framework proposed for innovation process (see Chapters 4 and 7). This has been done by means of a review of the bibliography and by discussion with academics experienced in innovation management. By this approach it is expected to obtain a very high degree of consensus on the best way to measure each of the variables included in each dimension of proposed Innovation Scorecard.

In empirical research on the innovation performance measurement and management control, as in other disciplines, the relationships between relevant variables are examined. However, an initial problem may be encountered. How to measure these variables as accurately and reliably as possible? Often, the conclusions obtained in research studies on the behaviour of innovative companies and its consequences are measured by the empirical observations of the researchers, and therefore errors of measurement are likely to occur. Research in this field is characterised by a scarcity of studies on the innovation management.

It is worth reviewing one other relevant stream of writing in the literature, namely that concerned with rules and guidelines for PMS design, rather than the actual process. Authors, such as Globerson (1985) and Maskell (1989) made early contributions to this literature. Globerson (1985), for example, states that:

- Performance criteria must be chosen from the company's goals.
- Performance criteria must make possible the comparison of companies that are in the same business.
- The purpose of each performance criterion must be clear.
- Data collection and methods of calculating the performance criterion must be clearly defined.
- Ratio based performance criteria are preferred to absolute numbers.
- Performance criteria should be under the control of the evaluated organisational unit.
- Performance criteria should be selected through discussions with the people involved (customers, employees, managers, etc.).
- Objective performance criteria are preferable to subjective ones.

Similarly Maskell (1989) offers the following seven principles of PMS design:

- The measures should be directly related to the company's manufacturing strategy.
- Non-financial measures should be adopted.
- It should be recognised that measures vary between locations – one measure is not suitable for all departments or sites.
- It should be acknowledged that measures change as circumstances do.

- The measures should be simple and easy to use.
- The measures should provide fast feedback.
- The measures should be designed so that they stimulate continuous improvement rather than simply monitor.

Latter, Bourne et al. (2003) show in their paper that:

- Performance measurement (as promoted in the literature and practised in leading companies) refers to the use of a multi-dimensional set of performance measures. The set of measures is multi-dimensional as it includes both financial and non-financial measures, it includes both internal and external measures of performance and it often includes both measures which quantify what has been achieved as well as measures which are used to help predict the future.
- Performance measurement cannot be done in isolation. Performance measurement is only relevant within a reference framework against which the efficiency and effectiveness of action can be judged. In the past, performance measurement has been criticised for judging performance against the wrong frame of reference and now there is widespread support for the belief that performance measures should be developed from strategy.
- Performance measurement has an impact on the environment in which it operates. Starting to measure, deciding what to measure, how to measure and what the targets will be, are all acts which influence individuals and groups within the company. Once measurement has started, the performance review will have consequences, as will the actions agreed upon as a result of that review. Performance measurement, is therefore, an integral part of the management planning and control system of the company being measured.
- Performance measurement is now being used to assess the impact of actions on the stakeholders of the company whose performance is being measured. Although this can be considered as quantifying the efficiency and effectiveness of action, in the case of measuring the impact of the company's performance on customer satisfaction, it is not as obvious in the cases of measuring the impact of the company's actions and performance on employee satisfaction or local community satisfaction.

Therefore, the concept of performance measurement used in this book refers to the use of a multi-dimensional set of performance measures for the planning and management of a business.

PMS Design Process

In the performance measurement literature, a wide range of performance measurement design processes is described (Keegan et al., 1989; Wisner & Fawcett, 1991; Azzone et al., 1991; Kaplan & Norton, 1993; Neely et al., 2000). These processes have been developed both jointly and severally, from theory and practice, by both academics and practitioners. Some have remained as theoretical models whereas others have been extensively tried and tested through application in commerce and industry.

To develop a PMS, Neely et al., (1996, p. 425) suggest the following procedure:

1. Decide what should be measured.
2. Decide how it is going to be measured.
3. Collect the appropriate data.
4. Eliminate conflicts in the measurement system.

Points 1 and 2 are considered in this book. Points 3 and 4 are not included in the following explanations, because these steps are specific for each company. To be able to conceptualize a performance measurement system for innovation and to decide what needs to be measured, a common understanding of innovation is necessary (see Chapter 3).

Categorising PMS design processes

However, there have been very few attempts to compare and contrast the different performance measurement design processes. Bititci et al. (2000) attempted to compare the characteristics of different frameworks, processes and systems using practitioner requirements as the criteria, but this approach did not fully distinguish between frameworks, systems and processes, nor did it attempt to create a categorisation.

Categorising the performance measurement design processes described in the literature is not an easy task. Some are no more than a brief description of a series of tasks (e.g., Sink, 1986); others are descriptions of single tools (e.g., Eccles & Pyburn, 1992) whilst a few are complete processes (e.g., Bitici et al., 1998; Neely et al., 1996). In addition, some are consultancy techniques that are only partially published (e.g., Davies & O ’Donnell, 1997; Kaplan & Norton, 1996b). However, the literature does provide sufficient information to attempt a categorisation.

The first theme that is immediately apparent from the literature is that the procedures are not the same. In fact, the underlying bases for developing the PMSs are very different.

However, as Platts (1994) demonstrated, procedure is not the only important criteria. From a change management or implementation perspective, how it is done (Duck, 1993), the process consultation (Schein, 1969), facilitation (Hunter, 2009) and the structuring of the debate (Martin, 1993) are all important aspects that cannot be ignored. These softer aspects of the process are less explicitly addressed in the literature and have to be gleaned from careful reading. Given that developing a new PMS is a learning process (Bourne, 1999) and that participation and engagement is critical for a successful outcome (Kim & Mauborgne, 1998), this creates a second source of categorisation.

In summary, the literature suggests that two distinct dimensions can be used:

- The underlying procedure, which could be considered the hard issues.
- The underlying approach, in terms of the role of the process leader, change agent or consultant, which could be considered the soft issues.

The procedures
From the literature, three distinctive procedures can be discerned. These are described here and labelled as (i) needs led, (ii) audit led, and (iii) model led.

- The needs led procedure is a top down procedure for developing performance measures, where the customer, business and stakeholder needs are severally or jointly identified and used as a basis for the development of performance measures. In this approach, the measures are designed to monitor the companies' progress towards achievement of these needs. Examples of this approach include the different processes for designing the BSC (Kaplan, 1994; Kaplan & Norton, 1993; Kaplan & Norton, 1996b; Neely et al., 1996; Neely et al., 2000).
- The audit led procedure can be considered more of a bottom up approach to the design of a PMS, starting with an audit of the existing performance measures. The information collected is then used to challenge the status quo and as a basis for amending the existing performance measures. Examples of this approach include the Performance Measurement Questionnaire (Dixon et al., 1990).
- The model led procedure uses a prescribed theoretical model of the organisation as a rationale for designing the performance measures that should be deployed.

The approach
In considering the soft issues, all the published process as are what might be considered partial processes (Bourne et al., 2002) in that they focus primarily on Lewin's (1951) phase of unfreezing, with little consideration to moving and

refreezing. Given this, there are still two distinct types of approach that can be identified in the literature. These have been labelled here (i) consultant led, and (ii) facilitator led approach.

- The consultant led approach is where the majority of work is undertaken by an individual (or group of individuals, usually consultants – hence the term used here) almost in isolation from the rest of the management team. The approach is typified by a small number of workshops, well spaced apart in time, where the work of the consultant is reviewed. Between the workshops, the consultant undertakes his or her work. Data collection is undertaken, usually through interviews with individual managers. The consultant then does the analysis and the results are presented back to the management team at the next workshop in the form of a report with recommended actions. Although it is at the senior management workshops that the main decisions are made, the majority of the work is done outside these meetings. An example of this is the approach of Kaplan and Norton (1993).
- The facilitator led approach is different in that the majority of the work is undertaken by the management team together in facilitated workshops. Consequently, the management team's role is not restricted to critiquing work done by others. In these workshops they are intimately involved in the discovery and analysis phases of the work. The role of the facilitator now revolves around eliciting information from the assembled group, structuring the debate, probing the assumptions and, if necessary, challenging the decisions made. An example of this is the later approach to developing balanced scorecards (Kaplan & Norton, 1996a; Neely et al., 1996; Niven, 2006; Norton, 1997).

UNDERSTANDING INNOVATION

3

For several decades companies all around the world have talked about innovation and paid different efforts to get this work at their organisations. The language of innovation and how people understand the term is vague and fuzzy at best, dangerous at worst. Moreover, the term innovation is subject to countless classifications, typologies and categorisations in professional literature. While named similarly, these categories can differ significantly in their meaning and vice versa. Thus, the term innovation carries broad shades of meaning (e.g., Birkinshaw et al., 2008; Boer & During, 2001; Fagerberg et al., 2004; Maital & Seshadri, 2007; Meeus & Edquist, 2006; Shavinina, 2003). If we focus solely on the literature on product innovation (e.g. Bisbe & Otley, 2004; Damanpour & Aravind, 2006; Davila, 2000; Davila et al., 2009; Fritsch & Meschede, 2001; Kaufman & Woodhead, 2006; Kleinknecht & Mohnen, 2002; Klepper, 1996; Kotabe & Murray, 1990; Kumar & Phrommathed, 2005), a huge amount of disorder and chaos is revealed.

Historically, research on the classification of innovations concentrated on the technological imperative of innovation, assuming that companies carry out innovative activities through research and development (R&D). As a result, several studies on and definitions of innovation have been produced, pertaining directly to R&D (e.g Gallouj & Weinstein, 1997; Mairesse & Mohnen, 2004; Miles, 2001). Many people, including managers, still understand innovation as something absolutely revolutionary, stemming from years of (laboratory) research. As a result, innovation is often confused with R&D in common parlance, although top innovative companies (such as 3M, Apple, BMW, Google, Hilti, Procter&Gamble or Toyota) do not combine these two terms (Sommerlatte, 2010).

R&D includes creative work carried out on a systematic basis for the purpose of increasing the knowledge base and its use for new applications (for example, new or substantially improved products or services, processes and methods). According to ZEW (2013), this definition of R&D is in line with the approach of the Oslo Manual (OECD, 2005) as well as the Frascati Manual (OECD, 2002). Thus, innovation is the culmination of a whole series of scientific, research, technical, organisational, financial and commercial activities that collectively constitute the innovation process (see Section 4.1).

In reality, this is only a very small portion of what usually falls under innovation (Tabas et al., 2010). The professional literature refers to the broader meaning of the term innovation, which entails investments in R&D and technology (Lev, 2001), as well as new processes, products, and marketing and organisational changes (OECD, 2005).

We shall discuss the definition and classification of innovations from the very beginning. The term innovation comes from the Latin “innovare” – to renew. It is obvious from the meaning of the word that it refers to something new, a novelty or renewal in human activity, and innovation as such is then an inseparable part of human life and development. Innovation in fact forms part of human existence. Table 1 shows the most important inventions and innovations in human history in chronological order.

A study of the professional literature has revealed the first fundamental shortcoming – the absence of any agreement on what can be regarded as innovation (Yusof et al., 2010). It is not much of an exaggeration to say that while everyone has an idea of what innovation means or should mean, they all have a different meaning in mind (Sylver, 2006). This chapter provides some selected definitions for illustration and continue by looking at their common elements.

Table 1 The most important innovations in human history

B.C.	Invention/innovation
500,000	Fire (Homo erectus)
50,000	Homo sapiens (modern man) appears
20,000	Invention of the bow and arrow
7000	Pottery
4000	First use of metals – copper smelted for making tools
2800	Egyptians devise the 12-month, 365-day calendar (Egypt)
2737	Tea invented in China by Emperor Shen Nung
1550	Earliest surviving medical textbook (Egypt)
700	First purpose-made sundials appear
650	Standardized coins (Greece)
510	Greeks produce the earliest surviving world map
400	Catapult, the first artillery weapon (Greece)
100	Glassblowing invented in Syria

Table 1 The most important innovations in human history – continued

A.D.	
105	Paper (China, Ts'ai Lun)
1000	Gun powder (China)
1440	Printing press (Johanes Gutenberg)
1494	Double-entry accounting (Friar Luca Pacioli)
1642	Adding machine (Blaise Pascal)
1668	Reflecting Telescope (Isaac Newton)
1760	Bifocal glasses (Benjamin Franklin)
1783	Hot air balloon (Joseph a Jacques Montgolfier)
1800	Electric battery (Alessandro Volta)
1852	Elevator (Elizeus Graves Otis)
1866	Dynamite (Alfred Nobel)
1876	Telephone (Alexander Graham Bell)
1879	Light bulb (Thomas Alva Edison)
1889	Automobile (Karl Benz)
1903	Airplane (Orville a Wilbur Wright)
1913	Mass production (Henry Ford)
1928	Penicillin (Alexander Fleming)
1957	Contact lenses (Otto Wichterle)
1974	Post-it (Art Fry a Spencer Silver), Rubik's cube (Erno Rubik)
1976	Personal computer (Steve Jobs a Steve Wozniak)
1998	Google (Sergey Brin a Larry Page)
2001	iPod (Tony Fadell)

Source: www.ideafinder.com

3.1 Definition of Innovation

In the broadest sense of the term, innovation is understood as a human-proposed, targeted change relating to products (putting new or significantly improved products into production and placing them on the market), production methods (processes), the organisation of work and production (new organisational solutions of structural importance), and management methods used for the first time at least, as a minimum, by the company in question. Thus, according to some definitions, the main characteristics of innovations are change and considerable novelty (e.g. Barnett, 1963; Hauschildt & Salomo, 2007; Kotler & de Bes, 2003; Littkemann & Holtrup, 2008; Knight, 1967; Mohr, 1969, Porter, 1990; Roberston, 1967; Rogers, 2003; Schumpeter, 1912; Valenta, 1969; or Witfield, 1975). The novelty element can also be found in the OECD and European Commission definitions of innovations which are currently considered essential (e.g., EC, 1995; Gault, 2013; OECD 2002; OECD, 2005).

In contrast, other authors consider that the best definitions compare innovation and invention (Zaltman et al., 1973), defining the basic difference between them in that innovations do not necessarily represent something entirely new, while invention does (Heunks, 1998; Rouse, 1992). It has been recognised by a number of scientists that the criterion "novelty" cannot be the only criterion of innovation but inventions or ideas become innovations in course of their transformation into application that is used in practice (Mohr, 1969; Robertson, 1967; Walker, 2006).

Innovation does not relate just to a new product that would come into the marketplace. Innovation can occur in processes and approaches to the marketplace. Indeed, the adjective "new" appears in a large number of the existing definitions of innovation, although many do not describe innovation itself as "novelty". We can understand innovation as a way of transforming the resources of a company through the creativity of people into new resources and wealth. On the other hand, Drucker (2009) bases his definition on a relatively general change which, however, is to create a new dimension of performance.

The impacts of innovations on society as a whole are another common denominator of many definitions of innovation (Dakhli & de Clerq, 2004; Vergragt, 1988). Vaitheeswaran (2007) argues that the actual substance of innovation consists in open thought, leading to benefits for the community. Many authors combine innovations and knowledge in their definitions. Knowledge is a central variable in the process of creative destruction and application of new factors of production (Schumpeter, 1912).

Another widely used concept defines innovation as a tool for creation of new knowledge (Acs et al., 2002; Senge, 2005; Strambach, 2002). In this context, a new concept is based on the position that the use of new products, services, processes and paradigms that are embedded into existing innovation leads to new way of thinking and new knowledge. This iterative cycle of knowledge and creation of new knowledge, in turn leads to an intensification of the innovation processes. Moreover, some authors consider that innovations and the methods of their management should be described as art (e.g., Brophey & Brown, 2009).

Unlike inventions, innovations by definition create economic values and can be accessed by a large group of recipients (Garcia & Calantone, 2002; Kumar & Phrommathed, 2005; O'Sullivan & Dooley, 2009; Patterson, 2009). To speak about genuine innovation, implementation and commercialisation must be involved (Gailly, 2011; Tidd et al., 2005).

The book therefore discusses innovations as activities tied to improvement of the production of products and services, the production process and the economic potential of companies. While innovations based on experience gained in practical activities prevailed in the past, today's innovations are mostly obtained through the application of findings in science and technology.

The founder of the economic theory of innovations, Austrian economist Joseph A. Schumpeter, understands innovations as:

- The introduction of a new good (unknown to the consumer) or a new quality of a good.
- The introduction of a new method of production, i.e. a method which has not been applied in the given sector to date but is not necessarily based on a new scientific discovery.
- The opening of a new market, i.e. one which has not yet been occupied by products from the given sector and country, regardless of whether that market already exists.
- The conquest of a new source of supply of primary inputs (raw materials and intermediate inputs), again notwithstanding whether they already exist or must be newly created.
- The carrying out of a new organisation of industry, such as the creation or destruction of a market monopoly (Schumpeter, 1912).

Schumpeter understood innovations very broadly as product-related, procedural and organisational changes that need not stem from new scientific discoveries but may come as a new combination of already existing technologies or their application in a new context. They are approached generally and more broadly than scientific and technical progress and include especially practical application, in addition to technical and technological changes and improvements.

In his theory, Schumpeter draws a distinction between a simple producer and an entrepreneur. An entrepreneur is a producer or trader introducing "new combinations" (the first term for innovations), which bring him business profits exceeding the average profits achieved by simple, innovatively passive, producers and traders. Innovation is then something of a creative act in the economy, which requires an entrepreneurial spirit. Schumpeter emphasises that to be able to attain profit, an entrepreneur must constantly introduce new innovations. Schumpeter's understanding of innovations also helps to clarify the methodology and main pitfalls of the measurement of innovation performance. His concept of innovation became the basis for numerous studies and modern concepts in the sphere of innovation (e.g., Kline & Rosenberg, 1986; OECD 2005; Rothwell, 1992; Valenta, 2001).

A comprehensive theory of innovations in the Czech Republic was founded by František Valenta. In his approach, innovation is to some extent an organic part of the activities of every human being – its creator and implementer. Innovation means any changes in the internal structure of the production organism or production unit (Valenta, 1969).

In the years that followed, other prominent thinkers in world management used the following words to describe innovations:

"Companies achieve competitive advantage through acts of innovation. They approach innovation in its broadest sense, including both new technologies and new ways of doing things." – Michael Porter (1990)

"Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or a different service. It is capable of being presented as a discipline, capable of being learned, capable of being practiced." – Peter Drucker (1985)

"Innovation is understood as comprising the renewal and enlargement of a range of products and services and their associated markets; the establishment of new methods of design, production, supply and distribution; the introduction of changes in management, work organisation, and working conditions and skills of the workforce." – European Commission (1995)

The most commonly used substantive typology of innovation terms is the classification under the Oslo Manual (OECD, 2005) prepared by experts in the field of measurement and evaluation of innovations from OECD member states. According to the more recent, broader approach of the Oslo Manual, four main types of innovation are recognised:

- Product innovations.
- Process innovations.
- Marketing innovations.
- Organisational innovations (OECD, 2005).

The third edition of the Manual takes account of progress in the understanding of the innovation process and its economic impacts. For the first time it attributes the same innovation importance to nearly all operations taking place in a company and includes links among various types of innovation.

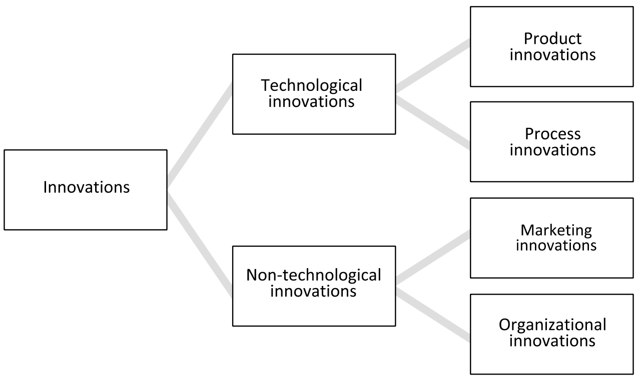

Figure 5 Chart of the classification of innovation activities by type according to the Oslo Manual (OECD, 2005)

Technological innovations create new products, processes and important technical changes in products and processes. Innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Technological innovations can be classified by products or processes, as well as by the degree of importance of the changes achieved in each case.

Non-technological innovations include particularly organisational, entrepreneurial and social innovations. According to the methodology of the Czech Statistical Office, we can also place environmental innovations in this category, i.e. the introduction of new or significantly improved products (goods or services), production processes, marketing or organisational methods which create benefits for the environment (CZSO, 2008).

Product innovations can utilise new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies. In this book, the term "product" covers both products and services. Product innovations can include:

- The introduction of new goods and services.
- Significantly improved functional or user characteristics of existing goods and services (through changes in materials, components and other performance--improving characteristics).
- Innovation in services:
  - Significant improvements in the way they are provided (for example, in terms of effectiveness or speed).
  - Adding new features or characteristics to existing services.
  - Introduction of entirely new services.

Process innovations represent the introduction of new or significantly improved production and/or delivery methods. This includes:

- Significant changes in techniques, equipment and/or software.
- Reducing environmental impacts and safety risks.
- New or significantly improved methods for the creation and provision of services.
- Significant changes in the equipment and software used in service-oriented companies.
- Procedures and techniques that are employed to deliver services.
- New or significantly improved techniques, equipment and software in ancillary support activities, such as purchasing, accounting, computing and maintenance.

Marketing innovations are aimed at:

- Better addressing customer needs.
- Opening up new markets.
- Newly positioning a company's product on the market, with the objective of increasing the company's sales.

The distinguishing feature of a marketing innovation is the implementation of a marketing method not previously used by the company, regardless of whether it has been developed by the innovating company or adopted from other companies or organisations. New marketing methods can be implemented for both new and existing products.

Marketing innovations include:

- Significant changes in product design that are changes in product form and appearance without altering the product's functional or user characteristics. They also include changes in the packaging of products such as foods, beverages and detergents, where packaging is the main determinant of the product's appearance.
- New marketing methods in product placement primarily involve the introduction of new sales channels (and not logistics methods such as transport, storing and handling of products).
- New marketing methods in product promotion.

Organisational innovations in business practices include:

- Implementation of new methods for organising standard routines and procedures for the conduct of work (for example, the implementation of new practices to improve learning and knowledge sharing within the company).
- Innovations in workplace organisation, i.e. the implementation of new methods for distributing responsibilities and decision making, division of work within and between company activities (and organisational units).
- Implementation of new ways of organising relations with other companies or public institutions, such as the establishment of new types of collaborations with suppliers, and the outsourcing or subcontracting for of business activities in production, procuring, distribution, recruiting and ancillary services.

Changes in business practices, workplace organisation or external relations that are based on organisational methods already in use in the company are not organisational innovations. Nor is the formulation of managerial strategies in itself an innovation. Mergers with, or the acquisition of, other companies are not considered organisational innovations, even if a firm merges with or acquires other companies for the first time.

The Frascati Manual mentions only technological innovation. Technological innovation activities are all of the scientific, technological, organisational, financial and commercial steps, including investments in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products and processes. R&D is only one of these activities and may be carried out at different phases of the innovation process. It may act not only as the original source of inventive ideas but also as a means of problem solving which can be called upon at any point up to implementation (OECD, 2002).

Besides R&D, other forms of innovative activities may be distinguished in the innovation process. These are, for example, acquisition of disembodied technology and know-how, acquisition of embodied technology, tooling up and industrial engineering, industrial design n.e.c., other capital acquisition, production start-up and marketing for new or improved products.

It follows from these definitions that there are various kinds of innovation and various paths to achieving them. Innovation today represents a process which starts with an idea followed by various stages of development resulting in actual implementation. Without introducing an innovation on the market, the innovation process would be incomplete and the innovation itself unimplemented.

3.2 Innovation versus Invention

Furthermore, invention, already mentioned at the beginning of this chapter, must be distinguished from innovation. Invention is only the first step in a long process during which a good idea is transformed into a widely applicable, effective product. Invention and innovation can be closely linked and occur in a swift succession but they often take place separately and it may take a number of years before an invention can be applied in practice (and many inventions never reach this stage). Invention is the first emergence of an idea for a new product while innovation occurs only when it is actually introduced on the market. The ability to apply scientific inventions as innovations on the market is one of the pillars of high innovation performance. Unlike inventions, innovations generate economic value and are accessible to numerous recipients.

Box 1 Invention versus innovation

Some of the most famous inventions of the nineteenth century came from men whose names are forgotten; the names which we associate with them are of the entrepreneurs who brought them into commercial use. For example, the vacuum cleaner was invented by J. Murray Spengler and originally called an "electric suction sweeper". He approached a leather goods maker in the town who knew nothing about vacuum cleaners but had a good idea of how to market and sell them – a certain W.H. Hoover. Today, the name Hoover is inseparable from the onset of vacuum cleaners in the United States.

Similarly, a Boston man called Elias Howe produced the world's first sewing machine in 1846. Unable to sell his ideas despite travelling to England and trying there, he returned to the USA to find Isaac Singer who had stolen the patent and built a successful business from it. Although Singer was eventually forced to pay Howe a royalty on all machines made, the name which most people now associate with sewing machines is Singer not Howe.

(Bryson, 1996; Tidd et al., 2005)

3.3 Degree of Innovation

Another distinguishing element is the degree of innovation. In Schumpeter's definition of innovation, novelty for the relevant sector is repeatedly emphasised and radical innovations play a key role in economic development in his theory. This view is related to the classification of innovations by degree of novelty into:

- Radical, which represent the introduction of revolutionary new technologies, but also considerable uncertainty for the business model and the whole company (e.g., Kock, 2007). This type of innovations has risks. You may not be able to determine when the breakthrough will be made and the accompanying costs (Kerzner, 2013).
- Incremental, i.e. gradual improving of existing technology, which have generally quantifiable impacts on business (e.g., Garcia & Calantone, 2002). This type of innovation may be able to be accomplished quickly and with the existing resources in the company. The intent is to solve a problem and add incremental value to the end result.

- Rationalisation, which involves the prevention and elimination of production losses while using existing business elements optimally.
- Disruptive, which disrupt the existing market or create entirely new markets (e.g., Christensen, 1997).

The element of novelty appears, for example, in the definition by Witfield (1975), according to whom innovation represents a set of complex processes occurring in addressing problems, as a result of which a processed novelty is created. In his definition, Kotler and Trias de Bes (2003) also uses the element of innovation, placing the term into context with every novelty which generates benefits for society.

The Oslo Manual (OECD, 2005) distinguishes three relevant concepts: (i) new to the company, (ii) new to the market and (iii) new to the world. The first concept covers the diffusion of an existing innovation to a company (the innovation may have already been implemented by other companies). Companies that first developed innovations (new to the market or new to the world) can be considered as drivers of the process of innovation. Many new ideas and knowledge originate from these companies, but the economic impact of the innovations will depend on their adoptions by other companies. Information on the degree of novelty can be used to identify the developers and adopters of innovation, to examine patterns of diffusion and to identify market leaders and followers.

Valenta (2001) defines novelty levels as dimensions characterising innovation, or different distances travelled by new products, or other factors of production or some other activity, from the original condition preceding innovation. In total, Valenta (2001) distinguishes 11 innovation levels, of which one is negative (degeneration) and ten are positive. The latter can be further divided into the 3 aforementioned groups, radical, incremental and rationalisation innovations (for more detail, see Vlček, 2011, p. 14-19).

Radical innovations:

- **Level 9** innovation: New stem, constituting a wholly new element of a business unit, which has been created in a manner entirely different from the existing approach to nature. This includes, for example, the application of micro--technologies and nano-technologies producing entirely new stems of products. Existing technological principles belong to the same stem of macro-technologies that are based on direct human intervention in the external characteristics of nature. Through micro- and nanotechnologies, the productive acts of humans have entered the very internal structure of non-living and living material.

- **Level 8** innovation: New kind, representing a change in the concept of an element of a business unit subject to innovation, which is designed on a previously known stem of technologies.
- **Level 7** innovation: New species, bringing a change in the concept of an element of a business unit subject to innovation while preserving the original concept of its solution.

Incremental innovations:

- **Level 6** innovation: New generation, involving a change in all decisive functions of an element of a business unit subject to innovation while preserving the original concept of its solution.
- **Level 5** innovation: New variant, representing a change in one or several functions of an element of a business unit subject to innovation.
- **Level 4** innovation: Qualitative adaptation, involving qualitative adaptation of the element subject to innovation to the quality, but also quantity parameters of other elements of a business unit. This includes, for example, adapting the shape of the components of a future product to the technical parameters of the machine on which they are produced. This means increasing the manufacturability of a design.
- **Level 3** innovation: Change in quantity, involving only a change in the quantity of the elements of a business unit which are otherwise unchangeable in terms of quality.

Rationalization innovations:

- **Level 2** innovation: Reorganisation in the sense of specific organisational arrangements of production, such as transfers of operations among worksites or different placement of material in the warehouse, etc.
- **Level 1** innovation: Intensity, taking the form of an increase or some other change in the intensity of use of the individual elements of a business unit (for example, intensity in the performance of individual operations).
- **Level 0** innovation: Regeneration, meaning simple renewal of the elements of a business unit subject to innovation. This simple renewal results from the most elementary creative activity of the controlling and controlled entities in a business unit aimed at overcoming the tendency to degenerate present in the elements of the business unit if they act merely as lower organisms. For example, a machine of metal tends to corrode; workforces lose their original qualifications if they do not renew their knowledge and skills, etc. Therefore, things such as ensuring punctuality, observance of technological discipline