INNOVATION SCORECARD

Ondřej Žižlavský

Innovation Scorecard

Conceptual Performance Measurement and Management Framework for Innovation Process

by
Ondřej Žižlavský

BRNO UNIVERSITY OF TECHNOLOGY
VUTIUM PRESS

Reviewers

Prof Eddie JP Fisher, Ph.D., M.Sc., Hon FAPM
Universidad de Oriente, Faculty of Social Sciences, Santiago de Cuba, Cuba
Palacky University, Olomouc, Czech Republic

Prof Ashok Shom
ESSEC Business School, Paris, France

ISBN 978-80-214-5316-6

CONTENTS

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my great appreciation to everyone who contributed his or her time, energy, or expertise to make this book done.

My greatest appreciation belongs to my wife Šárka who suffered from consequences of my creative work. Without her patience and tolerance this book would never be written.

Thanks are due to Mária Režňáková for her encouragement, constructive and valuable comments during the writing period.

My sincere thanks to Veronika Novotná and Michal Karas who provided help with statistical analysis of data.

A special thanks to Pavol Babinčák for working background in his apartment.

I am also grateful for graphical and editing work provided by Jana Frýbortová and Karolína Křížová.

Last but not least, my thanks go to all participants in the research survey.

This book and the whole research project No. 13-20123P Innovation Process Performance Assessment: a Management Control System Approach in the Czech Small and Medium-sized Enterprises was financially supported by the Czech Science Foundation.

ABOUT AUTHOR

Ondrej Zizlavsky is a Assistant Professor in the Institute of finances at Faculty of Business and Management, Brno University of Technology, where he specialised in innovation, R&D management control systems and finances. He received his master degree in mechanical engineering in 2006 from Faculty of Mechanical Engineering, Brno University of Technology and his PhD in Economics from Faculty of Business and Management, Brno University of Technology in 2009.

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.

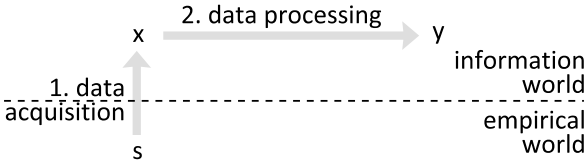

Figure 1 Measurement as data acquisition and possibly data processing (Lazzarotti et al., 2011, p. 213)

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.

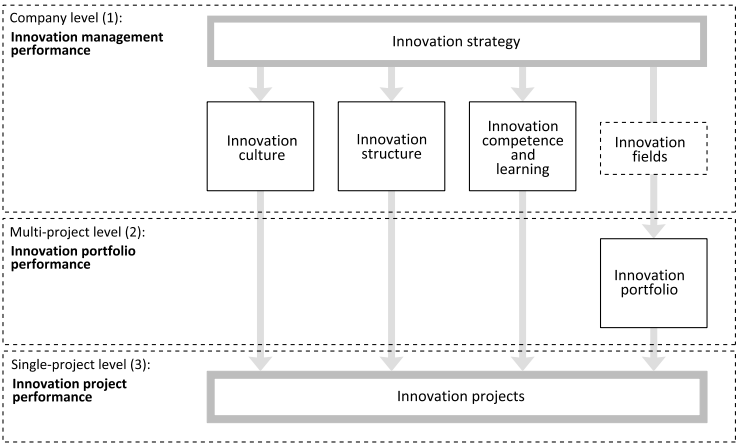

Figure 2 Levels and dimension of an IPMS (Schentler et al., 2010, p. 306)

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).

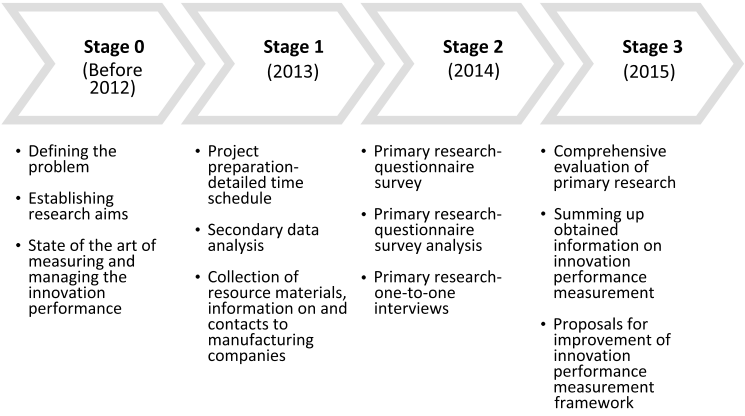

Figure 3 Progress chart of the research project

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