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Innovation performance measurement: research into Czech business practice

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ABSTRACT

This article deals with innovation performance and its measurement. The objective is to present the measuring of innovation performance as it is implemented in today's Czech business environment. It begins with a comprehensive theory and the definition of essential terms. The theoretical part is followed by the analysis of the current state of the issue from the perspective of enterprises in the Czech Republic. The analysis consists of four own primary questionnaire surveys. The research outputs reveal weaknesses in current approaches to innovation effectiveness measurement. Our enterprises use all possible means to increase productivity and achieve operational excellence. However, they tend to neglect the important area of research and development. It has been proven, with help of questionnaire surveys, that many enterprises still do not measure innovation performance despite the importance of innovation as an engine of growth. Only a few organisations appear to have an effective system for measuring their overall innovation performance.

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1. Introduction

In the current economic situation enterprises face great challenges relating to competitiveness. They must react flexibly to the changing business environment and customers' demands. Meeting such changeable requirements brings constant pressure for innovation.

Innovation is the basis of sustainable growth in an enterprise. On the other hand, no matter how high the investment in innovation, there is no guarantee that it is being spent efficiently. Thus it is necessary to innovate wisely and with focus. Such activity requires that the enterprise is able to continuously evaluate ongoing innovation projects and use this data to make decisions on whether to continue.

Unfortunately, a large proportion of enterprises do not measure innovation performance, despite the enormous importance of innovation in driving enterprises' development (Skarzynski & Gibson, 2008). Experience and research show that top management must show long-term dedication to setting aside resources for innovation in order to establish a lasting organisational capacity to innovate (Davila, Epstein, & Shelton, 2013). Adams,

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Bessant, and Phelps (2006) point to the need for both practitioners and academics to measure innovation, and stress the absence of frameworks for innovation management measurement indicators as well as 'the relatively small number of empirical studies on measurement in practice'.

To assess the success of innovations, we need to choose the type of criteria used for the assessment. Hauschildt and Salomo (2007) recommend three types of criteria to measure innovation success: technical, economic and others. This article is intended to assess the economic performance of the innovation process (for a better understanding of the innovation process see Zizlavsky, 2013). Options for expressing innovation process effectiveness through economic indicators have also been investigated by the prominent Czech expert Valenta. In his latest publication Valenta (2001) concludes that improved economic performance of an enterprise is not only the result of innovative measures in manufacturing, but also of non-manufacturing innovations expressed in managing and servicing activities, and is also intensively influenced by the external environment.

In innovations, we want to find out what economic benefits have been generated by new products, or what savings have been made by the implemented process innovations, and what is the ratio between those benefits and their costs. In each stage of the innovation process, questions should be raised about whether it makes sense to continue working on the project, whether the parameters set will be achieved, and even whether the innovation stands a chance of succeeding in the market (Tidd, Bessant, & Pavith, 2009).

At the same time assessment of innovation process performance has a number of very specific features. Other authors (e.g., Erner & Presse, 2010; Gailly, 2011; Huang, Soutar, & Brown, 2004; Mensch, 2002; Patterson, 2009) also propose assessing investment performance using indicators analogous to those applied to assessing investment effectiveness (net present value, economic value added, profitability, payback period, etc.). We can also use a project management approach: we estimate future cash flows, create a cash-flow, calculate the rate of return on capital invested, compute financial indicators, and compare the values calculated with pre-determined criteria. Suitable financial indicators for evaluation of business success can be sound in a study by Karas and Reznakova (2013). The use of these indicators, however, is hampered by problems in determining costs incurred, and especially the quantification of future earnings on investment (Kislingerova, 2008).

How do Czech enterprises actually measure innovation performance? This was the aim of my own research. Its objective is to present the current measurement of innovation performance as implemented in the current Czech business environment. The research framework is based on four primary research projects carried out in Czech innovative enterprises under the auspices of the Faculty of Business and Management of Brno University of Technology and the Czech Science Foundation.

After a short introduction to the theory of innovation performance measurement the crucial terms are defined, the methods and process of research surveys are presented along with the results of the measurement and evaluation of implemented innovations, followed by a discussion on the current situation and an outline of future development trends. The discussion also 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.

2. Definitions

First, the terms 'innovation', 'innovative capability' and 'innovative performance' have to be defined, as well as their properties and dimensions.

There are numerous definitions of the concept of innovation in the economic and business literature. All the definitions have in common that innovation can be regarded as something new (Hauschildt & Salomo, 2007; Kotler & de Bes (2003); Littkemann & Holtrup, 2008; Porter, 1990; Rogers, 2003; Schumpeter, 1912; Valenta, 1969; Whitfield, 1975). The significance of innovation was already highlighted at the beginning of the twentieth century by Schumpeter. Based on Schumpeter's theory the Oslo Manual defines innovation as the implementation of a new or significantly improved product (goods or services), or a process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD, 2005).

Although other publications about innovation classification exist, the Oslo Manual is the foremost international source of guidelines for the collection and use of data on innovative activities in industry (Gault, 2013). Therefore, in this article the definition of innovation is taken from the Oslo Manual.

The Oslo Manual defines four types of innovation encompassing a wide range of changes in enterprises' activities:

- Product innovations involve significant changes in the capabilities of goods or services. Both entirely new goods and services and significant improvements to existing products are included.
- Process innovations represent significant changes in production and delivery methods.
- Organisational innovations refer to the implementation of new organisational methods. These can be changes in business practices, in workplace organisation or in the enterprise's external relations.
- Marketing innovations involve the implementation of new marketing methods. These can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services (OECD, 2005).

Nowadays, successful enterprises achieve or maintain success by continuous changes in the industry where they compete with the help of systemic innovation. Their competitive success comes from 'running differently', by reinventing themselves through innovative capability (Fiorentino, 2010). Innovative capability is currently considered the key condition of enterprises' competitiveness (Andergassen, Nardini, & Ricottilli, 2009) and performance. This relates particularly to small- and medium-sized enterprises (SMEs), which, thanks to their less structured organisational and administrative systems, are able to react faster to customers' requirements and trends in development (Audretsch, 2003; Zeng, Xie, & Tam, 2010). An increasing number of studies underline the existing correlation between innovative capability and innovation market success (Baden Fuller & Pitt, 1995; Barker III & Duhaime, 1997; Christensen & Raynor, 2003; Drucker, 1999; Epstein, Davila, & Matusik, 2004; Markides, 1997; Nicolescu & Nicolescu, 2012; Tushman & Anderson, 2004).

Hence innovation performance can be understood as the ability to transform innovation inputs into outputs, and thus the ability to transform innovation capability and effort into market implementation. The result of innovative performance is innovation market success.

Innovative performance overarches the measurement of all stages from R&D to patenting and new product introduction. In other words, this definition of innovative performance in the broad sense focuses on both the technical aspects of innovation and the introduction of new products onto the market, but it excludes the possible economic success of innovations (Ernst, 2001; Stuart, 2000).

3. Material and methods

With regard to the identified objective of the research projects – to learn about and study the current state of issues of management of innovative activities and their performance measurement as these areas are currently being dealt with in the Czech Republic, as well as foreign academic literature and practice in Czech enterprises – and the method of their fulfilment, when processing the research, the system approach and the following scientific work methods were utilised.

Research projects rely mainly on a systemic approach, applied for its ability to consider the situation in the context of external and internal circumstances. It employs a combination of different methods and techniques from various scientific disciplines (see below):

- Analysis is used as a method of acquiring and interpreting new knowledge. When processing secondary data secondary analysis was utilised. A source of secondary data was the academic literature – books, journals, articles from scientific and academic databases (Web of Science, Scopus, Emerald, EBSCO, etc.), with respect to their professional level and relevance.
- Questionnaire: In order to ascertain the real situation in innovation performance measurement in Czech enterprises, a questionnaire survey was conducted in our SMEs. At that stage, we endeavoured to contact as many as possible to obtain sufficient data.
- Comparison was utilised for the results of the questionnaire inquiry of individual enterprises. This basic benchmarking approach selected more innovative businesses for further personal interviews with their management (research 2009, 2010 and 2013–2015).
- An inquiry with the objective of acquiring particular data and following discussion of results acquired and verification of their implementation and realisation in practice was carried out in the form of personal interviews with enterprises' management, i.e., especially with members of the top management, executive agents, or owners of production facilities (research 2009, 2010 and 2013–2015).
- Content analysis was applied to the study of texts processed and acquired in the course of interviews with managers of selected enterprises (interview transcriptions and personal supporting documents acquired from respondents).
- Synthesis is used especially when results are announced.
- Induction (generalisation) was utilised especially when generalising the findings of the questionnaire inquiry. Verification of dependencies found was verified by the application of deduction.
- The feedback method allowed reconsideration of every step in research to make sure the research does not deviate from its original goal and its starting points.
- Statistical methods were utilised when analysing primary data and their results are presented in tables and charts in this paper. Minitab 15 statistical software was utilised for hypotheses tests and verification.

Concerning the methodological approach, following recent examples (Baird, Harrison, & Reeve, 2004; Carenzo & Turolla, 2010; CZSO, 2010, 2012, 2014; OECD, 2009; Sulaiman & Mitchell, 2005) a questionnaire-based survey was implemented to gather information and determine the true state of issues resolved in the management control of innovative activities. The survey method is often used to collect systematic data since it is time and cost-efficient and allows the carrying out of a statistical analysis (Groves et al., 2009). In addition, the replication of questions is possible and thus constitutes a comparison of results and pattern analysis.

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

This choice is related to the fact that managerial tools primarily originated and were subsequently developed in manufacturing enterprises. The second feature was the fact that manufacturing industry (according to CZ-NACE rev. 2, division C, section 10–33) is considered the most significant industry for development of the Czech economy since it is the largest sector. This allows a sufficient number of enterprises to be contacted to participate in the study. We estimate that the target population consists over 11,000 manufacturing enterprises.

According to the Czech Statistical Office and its survey in Czech Statistical Office, 2012, 51% of 5449 innovative enterprises are from manufacturing industry. Moreover, these enterprises had a 45.4% share in total revenues in 2012 in this part of the Czech economy (Czech Statistical Office, 2014, p. 15).

The key was to approach as many respondents as possible and so acquire a sufficiently large data scale factor for the evaluation of primary research. The inquiry itself provided quantitative as well as semi-qualitative data on the current state of the issue in question. The simplicity and 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 were open.

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: (1) macro level (distinguishing national and sector levels); (2) meso level (the level of the enterprise's product family); and (3) 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, in Europe, the Innovation Union Scoreboard (European Commission, 2014a) and the Regional Innovation Scoreboard (European Commission, 2014b); in the Czech Republic, innovation surveys are regularly performed by the Czech Statistical Office (www.czso.cz), 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 past decades (e.g., Archibugi & Pianta,

1994; Brusoni, Cefis, & Orsenigo, 2006; Casper & van Waarden, 2005; Cefis & Ciccarelli, 2005; Gourlay & Seaton, 2004; Malerba & Orsenigo, 1999; Meadow Consortium, 2010; OECD, 2007, 2010a, 2010b; Patel & Pavitt, 1994; Zumbusch & Scherer, 2013); therefore the present thesis does not study this level and bases its considerations on the findings of the aforementioned studies.

Innovation is considered to be one of the main drivers of productivity growth and economists have investigated both its determinants and its contribution to enterprise performance, measured as productivity; growth and/or market value. There are several reasons for analysing the link between innovation and productivity at the enterprise micro-level. First, it is enterprises that innovate, not countries or industries. Second, aggregate analysis hides much heterogeneity. Enterprises' 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 enterprises' behaviour; and they 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 enterprises' knowledge assets or specific knowledge channels can have an impact on these enterprises' productivity and therefore shed light on the role that innovation inputs, outputs and policies play in economic performance (OECD, 2009).

Considering the main research aim, Czech manufacturing industry and the level of measurement, the following research hypotheses were defined:

Hypothesis 1: Innovations are mainly performed by medium and large enterprises in the Czech business environment with a sufficiency of resources.

Hypothesis 2: Direct expression of the effects of innovative activities strongly depends on market development prognoses, and marketing information systems have to help with their predictions.

Hypothesis 3: In enterprises that have introduced a system of evaluation of innovative activities, this system contributes to faster decision-making.

Enterprises for surveys were selected from the Technological Profile of the Czech Republic, Kompass and the European Amadeus databases. The real return rates can be considered very good because return rates of mail-back questionnaires are usually under 10%. The detailed statistics of the questionnaire inquiries are shown in Table 1.

It is important to note that reminders were sent to non-responding enterprises, and in many cases the respondents answered that they would not fill the questionnaire due to poor experience from analogous surveys, a lack of time or the existence of internal policies relating to non-participation in academic research. This could evidence the difficulties created by this kind of research and the fact that innovation is a strategic issue for those enterprises.

Table 1. Overall statistics of the questionnaire surveys.

	Research 2009	Research 2010	Research 2011	Research 2013–2015
Target population	Manufacturing enterprises in the Czech Republic			
Research sample	Innovative manufacturing enterprises in the Czech Republic			
Number of enterprises addressed	250	800	650	2,877
By e-mail	230	750	650	2,807
By personal visit	30	50	0	70
Number of undelivered e-mails	13	35	27	98
Number of partially-completed questionnaires	4	9	13	153
Number of completed questionnaires	53	139	212	354
Real return	21.2%	17.4%	34.1%	12.30%

Source: Author's research.

Within three consecutive research projects carried out from 2009 to 2011 under the sponsorship of the Internal Grant Agency of the Faculty of Business and Management of Brno University of Technology, various approaches to management of the innovation process and its performance measurement were examined. A total of 53 mostly production enterprises participated in the first project called Research into the Level of Development of Innovation Potential, Creation and Evaluation of the Innovation Strategy of Medium-sized and Large Machine-industry Companies in the South Moravian Region in the Czech Republic (Reg. No. AD 179001M5). This project made several unfavourable findings on the state of management of innovative activities. Therefore, this area was examined in detail in the second and third related research projects called Development of Knowledge for Improvement of Information Support of the Economic Management of Company Development, in Accordance with Development of the Business Environment (Reg. No. FP-S-10-17) undertaken in 2010 and Development of Knowledge for Improvement of Information Support of the Economic Management of a Company (Reg. No. FP-S-11-1) in 2011. Future research has been advised to collect where possible objective quantitative and also semi-qualitative data on the current state of the issue. Therefore, these projects have become the bases for in-depth research within postdoc project of the Czech Science Foundation No. 13-20123P in the field of innovation performance measurement. The substance of this project was to design and verify measures and achieve higher credibility of future benefits prediction from innovation processes.

4. Research results

4.1. General characteristics

Questions from the first part of the questionnaire were related to the basic characteristic data of the enterprise, such as the enterprise's size, origin, market, etc. Enterprise size is a traditional contingency factor in economic research. Specifically, this section studies the impact of one factor linked to enterprise size: number of employees (although the turnover data were collected with help of questionnaire as well. However only the number of employees is concerned in most parameters). In fact, this factor is usually the basis of enterprise classification. The distribution of enterprises by size is based on EU law and the Recommendation of the European Commission, 2003; /361/EC of 6 May 2003 (European Commission, 2003, p. 36). This standard is divided into four groups: micro, small, medium and large enterprises. Table 2 shows the percentages obtained using the number of employees and turnover indicators.

The first empirical evidence of the survey emerged by way of descriptive statistics. We noted through the analysis of questionnaires that the results of research surveys carried out between 2009 and 2015 contradict each other. In 2009 the results suggested that innovations are mostly performed by medium enterprises (45% of respondents) followed by large enterprises (30% of respondents) with small and micro enterprises at the tail. This confirms the Hypothesis 1 that innovative activities are pursued predominantly by medium and large enterprises that have sufficient resources.

However, in 2010 the most innovative of the polled enterprises were micro and small enterprises (75% respondents in total) followed by medium enterprises (13% of respondents) with large enterprises being last (12% of respondents).

Table 2. Distribution of enterprises engaged in research surveys.

	Research 2009	Research 2010	Research 2011	Research 2013–2015
Category/year	*n* = 53	*n* = 139	*n* = 212	*n* = 354
Employees				
Micro	16%	43%	24%	7%
Small	9%	32%	36%	29%
Medium	45%	13%	24%	46%
Large	30%	12%	16%	18%
Turnover				
Micro	15%	67%	44%	21%
Small	26%	15%	24%	23%
Medium	38%	11%	17%	41%
Large	21%	7%	11%	15%

Source: Author's research.

The factor that may be behind this result is the economic crisis of that period. It can be assumed that enterprises were aware of the threat of losing their competitiveness which could potentially lead to their demise. While medium and large enterprises focused on operational efficiency and cost saving, small enterprises could react to changes in the environment through innovation. The bigger the enterprise the more organisationally demanding are any innovative changes, which is why mainly smaller businesses with a flexible organisational structure innovate in these times. Large enterprises naturally strive to support innovation as well but due to their more complicated organisation these activities may manifest themselves later. The importance of small and medium enterprises for the development of the Czech economy is therefore increasing. This is highlighted also by the Concept for the Support of Small and Medium Entrepreneurs for the period of 2014–2020 by the Ministry of Industry and Trade of the Czech Republic (for more information see Ministry of Industry & Trade of the Czech Republic, 2012).

Thus, for better understanding the same area was examined in the 2013–2015 research. Based on these data we can state that innovations are mostly performed by SMEs (82% in total), resp. by medium enterprises (46% of respondents) followed by small (29% of respondents), large (18% of respondents) and micro enterprises (7% of respondents).

However, these results contrast with studies by the Czech Statistical Office (Czech Statistical Office, 2010, 2012, 2014) that consider large enterprises as innovation leaders in the Czech Republic (see Figure 1). On the one hand, given a certain level of innovation inputs, larger enterprises might have a higher innovative sales intensity because they can appropriate innovation benefits more easily than SMEs and/or because of economies of scale. However, SMEs might use innovation inputs more efficiently because of entrepreneurial abilities or greater flexibility in production processes. Previous evidence has indicated that although larger enterprises are more likely to sell innovative products this probability increases less than proportionately with size and that among innovative enterprises, the share of innovative products in total sales tends to be higher in smaller enterprises (e.g., Brouwer & Kleinknecht, 1996).

Moreover, the OECD study (2009) also provides mixed results: size is positively correlated, negatively correlated or not correlated with turnover. Economies of scope and scale and knowledge flows within enterprises seem to play a role in commercialisation.

It is very difficult to confirm or invalidate Hypothesis 1 based on these contrary results. Anyway, what is most important from a managerial point of view is the finding that

enterprises perform innovation, but differ in form of innovation (see Table 3). The essential question is not whether to innovate or not, but how to innovate.

The majority of Czech manufacturing enterprises (77% in 2014) carry out innovation irregularly and randomly, i.e., as a consequence of intuitive and immediate decisions, or to counter a negative development. Only a quarter of enterprises (23% in 2014) executes innovation regularly, i.e., as a standard part of their businesses and systematically managed.

Respondents answered the question about what innovations had been implemented by the enterprise during the last three years while what importance they carry for the enterprise represented another part of the research. They could select from four predefined types of innovation (see innovation classification according to Oslo Manual 2005). The questionnaire includes a list of examples for each type of innovation. Since respondents were able to select more answers for this question, a recalculation had to be carried out where relative frequency was determined as a percentage of the number of selected answers out of the total number of respondents in the group. Some of the key research findings are summarised in Table 3.

These balanced results highlight the fact that product innovations often require process innovations, e.g., in the form of acquiring new production technology, and in order for these product innovations to be successful on the market and bring the enterprise higher value, it is often necessary to seek new distribution channels via marketing innovations.

The measurement instrument used in the questionnaire to estimate the importance of innovation was a 5-item Likert scale: 1 = very important, 2 = important, 3 = neutral, 4 = not important, 5 = completely unimportant. In the summary of the percentage ratio of

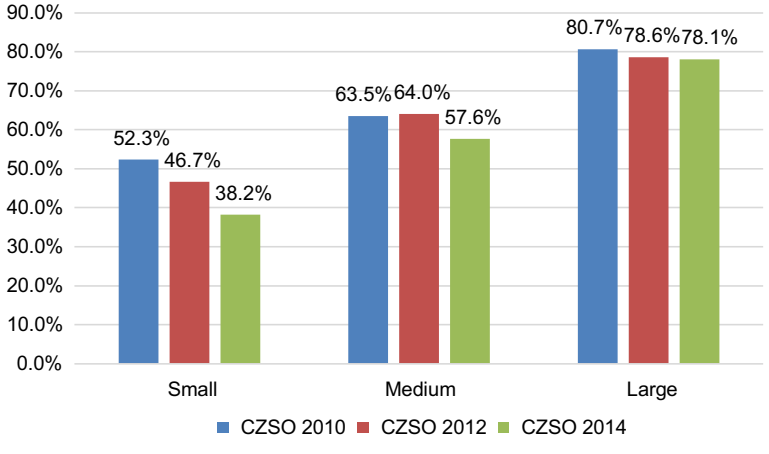

Figure 1. The ratio of innovative enterprises in the total number of enterprises engaged in CZSO surveys by size (CZSO, 2010, 2012, 2014) (Source: Data are retrieved from Czech Statistical Office).

Table 3. Implemented innovations.

	Research 2009	Research 2010	Research 2011	Research 2013–2015
Innovation/Frequency	*n* = 53	*n* = 139	*n* = 212	*n* = 354
Product innovation	32%	28%	33%	38%
Process innovation	30%	25%	27%	29%
Organisation innovation	17%	22%	19%	12%
Marketing innovation	20%	23%	21%	21%
None	1%	2%	0%	0%

Source: Author's research.

positive answers, i.e., values 1 (very important) and 2 (important), the order of individual possibilities was determined. Evaluation of the importance of individual types of innovation for enterprises is shown in Table 4.

The main motives leading to the commencement of such innovative activities are growth of revenues/profits, reaction to demand, increased quality, increased market share, and last but not least, inspiration by competitors. Motives of innovative activities represent a starting point for innovation strategies. Strategic marketing and research, with a nomination by top management, participates in strategy proposal and formulation. The objective of every innovation strategy is achieving a competitive advantage leading to the enterprise's improved position on the market, while other objectives are derived from this (Czech Statistical Office, 2014; Žižlavský & Šmakalová, 2011).

Innovation expenditures include all expenses for both in-house and externally purchased activities that aim at the development and introduction of innovations, regardless of whether these have yet been introduced. They comprise current (e.g., labour costs, externally purchased goods or services, etc.) and capital expenditures (e.g., on machinery, instruments, intangible assets, etc.).

Innovation expenditures are an important metric to determine the amount of resources that enterprise provided for carrying out innovative activities. To overcome the unwillingness of respondents to transmit confidential information four categories were predefined; innovation expenditures based on actual needs, up to 5% of the annual budget, 5–10% of the annual budget and more than 10% of the annual budget.

We noted that the most frequent innovation expenditures are up to 5% of the annual budget, especially in small and medium enterprises. SMEs invest into innovative activities according actual needs. The largest contribution to this figure is made by micro enterprises (65% of respondents) followed by small (38% of respondents) and medium enterprises (36% of respondents). In contrast, the inverse pattern is observed for expenditures from 5% to 10%, from 11% for micro enterprises to 34% for large enterprises. Large enterprises (23% of respondents) devote more than 10% of their annual budget to innovation, while micro enterprises invest into innovation according actual needs (65% of respondents). In other

Table 4. Importance of particular innovation types for enterprises.

	Average	Standard deviation	Modus	Evaluation 1–5 (%)					Σ 1 + 2 (%)
				1	2	3	4	5	
2010 (n = 139)									
Product innovation	2.2857	1.0302	2	18	29	14	12	27	47
Process innovation	2.2419	0.9619	2	18	28	16	10	28	46
Organisational innovation	2.3485	0.9127	2	15	28	26	8	23	43
Marketing innovation	2.3226	0.9801	2	16	27	19	10	28	43
No innovation	2.3125	0.8455	3	4	7	7	1	81	11
2011 (n = 212)									
Product innovation	2.1845	1.2101	1	37	33	16	7	7	70
Process innovation	2.2000	0.8623	2	22	43	27	6	2	65
Organisational innovation	2.4379	1.1762	2	25	34	21	14	6	59
Marketing innovation	2.4426	1.0167	2	18	35	30	12	5	53
2013–2015 (n = 354)									
Product innovation	2.5426	1.4769	2	32	33	21	11	3	65
Process innovation	2.4442	0.9926	2	33	27	19	15	6	60
Marketing innovation	2.5077	0.9024	2	24	25	31	14	6	49
Organisational innovation	2.6220	0.9256	2	19	28	26	17	10	47

Source: Author's research.

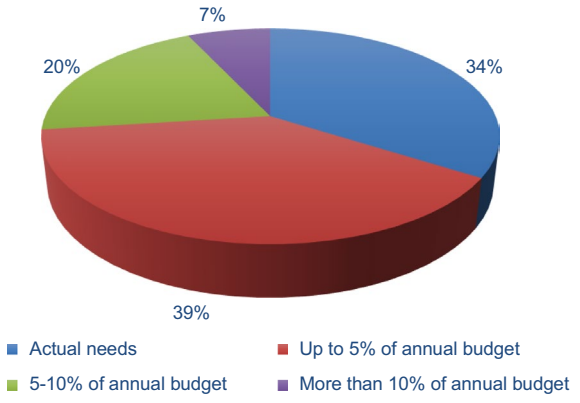

Figure 2. Innovation expenditures ($n = 354$, Source: Research 2013–2015).

words, the larger the enterprise the higher the expenditures, regularly planned and spent annually on innovation (see Figure 2).

4.2. Measurement of innovation

Well-managed innovations successfully commercialised in the market are a tool that enterprises can use to win competitive advantages allowing them to prosper even in a recession. It is a modern trend to innovate, but innovations must be implemented prudently and in a targeted manner. Moreover, innovative activities are very costly and they tie up a substantial part of an enterprise's available resources for a significant period. Effort and resources expended must be recouped if it is to stand a chance of surviving in a strongly competitive environment. The need for a management control system is crucial in innovations.

Therefore, a key area of these surveys was the question of evaluation and responsibility for innovative projects – where the key decisions are made and where it is decided whether the innovation is viable. When asked whether the enterprises had evaluated implemented innovative projects, the vast majority answered affirmatively in all periods under consideration, with 79%, 64% and 79% of respondents, respectively (see Figure 3). On the other hand, what is disquieting is that this area is neglected by 36% of respondents even though they implement innovations.

In the area of responsibility for innovative activities, it is characteristic of the surveyed enterprises that in the final stage the management always has the main say. Moreover, in SMEs the owner usually directly manages the whole enterprise. This phenomenon was particularly observed in small family enterprises. Logically, this is due to the fact that the management bears the greatest responsibility for the implemented innovative projects and assumes the risks arising from the possible failure of a particular action, which is reflected in all the activities of the enterprise (see Figure 4).

Within the 2013–2015 research survey respondents who said they evaluate innovative activities, i.e., 281 in total, were asked to indicate the evaluation techniques they use within innovative activities to provide information for decision-making and control. The questionnaire focused on the 16 core project level evaluation metrics of innovation performance. This set of metrics was formed after the literature review of the most frequently innovation

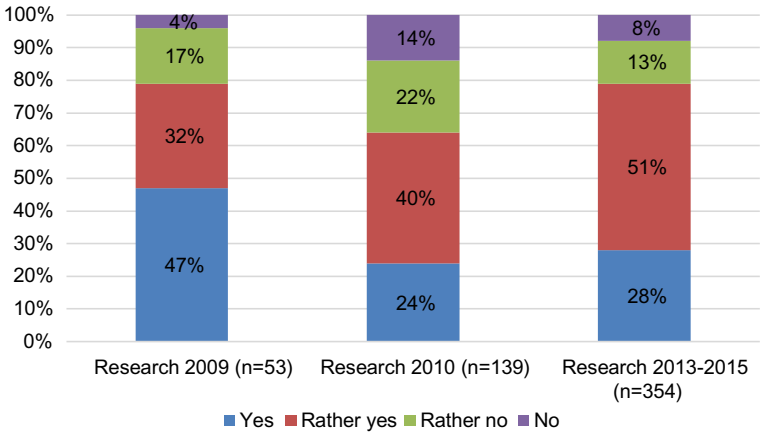

Figure 3. Evaluation of innovative projects (Source: Research 2009, 2010, 2013–2015).

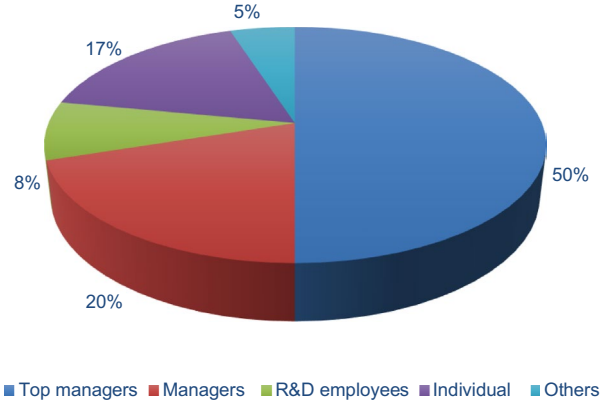

Figure 4. Responsibility for innovative projects ($n = 53$; Source: Research 2009).

management control tools (Carenzo & Turolla, 2010; Cokins, 2009; Davila et al., 2013; Griffin & Page, 1993, 1996; Niven, 2014; Skarzynski & Gibson, 2008; Tzokas, Hultink, & Hart, 2004).

Hultink and Robben (1995) drew a distinction between measuring innovation performance in the short term and in the long term after launch. They found that the importance attached by managers to indicators of innovation performance depended strongly on this time perspective. Therefore, the research team decided to include short-term as well as long-term performance assessment. Respondents were asked to indicate the performance measurement tools they used within innovation projects in the previous three years.

Here again respondents were able to select more answers to this question, a recalculation had to be carried out where the relative frequency was determined as a percentage of the number of selected answers out of the total number of respondents in the group. The measurement tools were divided into two groups; financial and non-financial. The results are shown in Table 5.

Table 5. Performance measurement methods ($n = 281$).

Category (Number of employees)	Micro (1–9)	Small (10–49)	Medium (50–249)	Large (>250)
Balanced Scorecard	0.00%	2.38%	10.95%	33.91%
Budget	67.45%	72.46%	84.27%	100.00%
Cost accounting (with cost centres)	11.33%	19.31%	35.13%	42.67%
Cost accounting (without cost centres)	20.38%	25.19%	22.54%	14.17%
EBITDA, EBIT	28.16%	30.45%	36.19%	34.85%
Economic value added EVA	0.00%	2.14%	17.50%	20.15%
Payback period	3.15%	17.23%	24.49%	36.84%
Profitability (ROI, ROE, ROA, ROS)	23.70%	20.13%	13.52%	7.92%
Revenues from innovation	59.19%	74.28%	83.45%	100.00%
Cannibalisation of existing products by innovation	4.12%	5.26%	6.43%	16.24%
Customer satisfaction indicators	23.45%	17.33%	22.50%	26.67%
Growth of market share	8.69%	13.17%	18.36%	36.13%
Innovativeness	2.70%	2.56%	7.12%	13.41%
Number of new customers	34.33%	32.73%	47.20%	52.48%
Patents	7.81%	10.47%	28.49%	36.96%
Productivity and quality indicators (lead time, etc.)	3.43%	6.81%	15.70%	32.76%

Source: Research 2013–2015.

5. Discussion

Focusing on enterprises adopting measurement and management control systems, the following analysis investigates the application of management control techniques. Table 5 shows that budget, revenues from innovation and EBITDA are the most frequently applied managerial tools in Czech innovative enterprises. Based on these results we can claim that the prevailing approach is the monitoring of financial indicators. On the other hand, economic value added, Balanced Scorecard and innovativeness are implemented least. In other words, the Czech enterprises analysed and adopted rather traditional measurement tools less 'innovative' techniques. Here, a gap between global and Czech enterprises has been discovered (cf. Belás, Bilan, Demjan, & Sipko, 2015; Davila, Foster, & Li, 2009; Chiesa & Frattini, 2009; Hendricks, Hora, Menor, & Wiedman, 2012; Rigby, 2007).

The first reason that could explain the gap between Czech and foreign enterprises might stem from a lack of knowledge. Small Czech enterprises especially are usually not familiar with these managerial instruments. A second reason is the fact that the owner is in management of the vast majority of these, preferring his own experience to management control tools. A third reason concerns cost aspects. Valuable information does not come free of charge. Hence adopting such 'innovative' measurement and management control system involves heavy costs. A fourth reason could lie in the characteristics of the management control tools. They are primarily designed to solve domestic enterprise issues (such as the Balanced Scorecard from the US, which is a robust management control system). Therefore, it is difficult to adapt these to different contexts without making adjustments. Besides, their high level of uncertainty avoidance does not allow Czech enterprises to try out new management control instruments. A similar situation has been discovered in Italian SMEs (cf. Carenzo & Turolla, 2010).

In addition, Table 5 demonstrates that financial indicators are more frequently adopted than non-financial indicators. Since we are studying the Czech manufacturing business environment, i.e., the for-profit sector, innovation evaluation must always be based on a group of logically-interrelated financial indicators. However, the majority of managers in

Czech enterprises feel that non-financial indicators should also be used to monitor the innovative efforts and projects undertaken. Managers should rely more on non-financial indicators than on the financial ones, because these indicators provide a better assessment of progress in real time and of the probability of success.

In fact, profitability metrics, cash-flow, etc. typical short-term indicators, are the most significant measures adopted by enterprises to evaluate their innovation performance. These financial metrics are connected with short-term aims and based on historical accounting data. This suggests that a short-term view, a typical European cultural feature, influences enterprises in the choice and structure of innovation performance measurement systems.

Financial metrics are also known as delayed indicators, because they are used to measure past results. But innovations are more oriented to the future and are connected with long-term aims. Innovation has to be understood as the long-term creation of value and for enterprises future financial performance has to be a stronger motivating force than the short-term cycle. Hence focusing only on financial metrics is not correct. A well-designed management control system of innovation should therefore include an appropriate mix of financial and non-financial indicators, which should be subsequently compared using benchmarking with competitors or with models of excellence.

Integration of non-financial metrics into systems for measuring performance allows managers to better understand relations between various strategic innovation targets, communicate the linking of these targets with workers' activity and to formulate priorities and allocate resources based on the defined targets (Kaplan & Norton, 2000). The main contribution of non-financial indicators is the identification of key factors influencing the development of financial indicators. These indicators are also more sensitive to change, a crucial characteristic in the current turbulent environment. The results of the international study have confirmed that there is a strong association between the use of non-financial indicators and a strategy oriented toward innovation and quality (Said, HassabElnaby, & Wier, 2003).

There is also space for the measurement of other important factors that support innovation, such as creative climate, commitment to innovative activity, the number and quality of ideas, communication inside the enterprise, etc. (Humphreys, McAdam, & Leckey, 2005). Scientific research into measurement methods and indicator creation describing innovations and their effects on the social environment has only just started (Hipp & Grupp, 2005).

Empirical evidence highlights a growing group of enterprises adopting non-financial measures. In particular, the number of new customers and their satisfaction index are the most commonly used when compared to innovativeness and the cannibalisation of existing products by innovative ones, assessed by respondents as insignificant. Thus, the most significant effect of innovations was on the satisfaction of customer needs, which should subsequently be reflected in a growth in sales or, more precisely, operating profit.

Individual indicators for measuring innovation performance are insufficient on their own as they always view innovation from just one perspective. The problem of practically all available metrics is the fact that measuring of innovation should be performed efficiently, i.e., functionally (it must yield relevant information for management) and economically (at a reasonable cost). Individual indicators usually meet the condition of economy but rarely of functionality because they view innovation from too narrow a perspective.

To evaluate an ability or performance it is necessary to have a full perspective, which is why the author sees a solution in using a system with several individual indicators. However,

complex indicators clash with economy and sometimes also with functionality as they contain subjective or hard-to-forecast indicators. Despite these shortcomings the use of complex innovation indicators is probably the best option. Whether they measure innovation capability, performance or a combination of these, they always study the innovative process from more perspectives and from multiple angles. It strives to give a full picture of the studied area, which cannot be achieved with individual innovation indicators.

The Balanced Scorecard method seems most appropriate for introducing a complex system of measuring innovation performance for an entire enterprise (e.g., Horvath & Partners, 2007; Kaplan & Norton, 1996, 2000; Niven, 2005, 2014). It is one of the most popular and powerful concepts of enterprise performance measuring systems. Although its original idea focused on business strategy it can be applied to any process, including innovation. Nonetheless the introduction of a comprehensive Balanced Scorecard system, although its philosophy is simple and logical, is too challenging for Czech SMEs in terms of time, organisation and finance. The current situation of Czech SMEs requires them to concentrate more on operational efficiency thus taking them out of practical research and development, which kills the motivation of workers to take an active approach to increasing innovation performance. From contact with managers and owners of Czech enterprises it can be stated that they are interested in modern management methods but the implementation of Balanced Scorecards faces many challenges. In most small and medium enterprises successful implementation of the Balanced Scorecard is feasible only in co-operation with a specialised consulting company.

However, the empirical evidence demonstrates the low adoption rate of the Balanced Scorecard. Focusing on the advanced management control approach, the Balanced Scorecard, we found a gap between micro and small enterprises on one side and medium and large enterprises on the other. In the micro and small enterprises, the Balanced Scorecard is being implemented only by a minority. Less than 3% of respondents have adopted this method. However, this percentage increases in medium and large enterprises.

In particular, most Czech enterprises, especially medium and large ones, monitor the performance of innovative activities by using specific financial and non-financial measures, but without any logical link between them. In other words, only a small number of enterprises, especially large ones and those having different perspectives, actually understand the importance of the cause-and-effect relationship between metrics. In addition, after overcoming the barriers and reluctance of the managers to communicate more detailed information about their systems of innovation evaluation, these systems proved not to be very appropriate, while being biased in favour of financial indicators.

Finally, the author therefore recommends introducing selected features and indicators of the mentioned methods of innovation performance measuring and management and to creating one's own specific innovation scorecard that would best capture the factors and metrics of innovative activities of the individual enterprise. The selection of the relevant indicators must be customised for the enterprise as each innovation is unique and specific.

6. Hypotheses tests

Based on the research results, the hypotheses expressed prior to the start of the research projects will now be statistically tested.

Hypothesis 2: Direct expression of effects of innovative activities strongly depends on market development prognoses, and marketing information systems have to help with their predictions.

The first aim of the questionnaire research was to find out whether enterprises evaluate realised innovative activities and whether they utilise a marketing information system to evaluate predictions of future markets. For that purpose, the hypothesis H1 and the following questions from the 2010 questionnaire will be used: Does your enterprise evaluate the realised innovative projects? And is there a marketing information system implemented and utilised for future market modelling in your enterprise?

Independency statistical testing of two qualitative characters will be carried out for statistical dependency verification. The null fragmental hypothesis FH0 is going to be tested, that random values are not dependent, in comparison with the alternative fragmental hypothesis FH1 (see Table 6).

FH0: The expression of innovation effects and modelling future markets are not related to each other.

FH1: The expression of innovation effects and modelling future markets are related to each other.

Calculated test criterion: (see Figure 5) (χ^2=17.620; α=0.05;DF=1; P-Value=0,000). For selected significance level α = 0.05 is determined a quantile χ_0,95^2 (1) of Pearson distribution χ_0,95^2 (1)=3.841. Because the value of test criterion was realised in critical field (17.620 > 3.841 and P-Value = 0.000), fragmental null hypothesis FH0 is rejected on five

Table 6. Relations research of innovative activities evaluation and markets forecasts (n = 139).

Innovative activities evaluation/markets forecasts	No	Yes	n_i
No	26	8	34
Yes	37	68	105
n_j	63	76	139

Source: Author's research 2010.

```
           C1     C2  Total

    1      26      8     34

        15.41  18.59

        7.277  6.033


    2      37     68    105

        47.59  57.41

        2.357  1.953


Total      63     76    139


Chi-Sq = 17.620; DF = 1; P-Value = 0.000
```

Figure 5. Chi-Square test output from Minitab (n = 139; Source: Author's research 2010).

Table 7. Exploration of the relations between the introduction of a system of evaluation of innovative activities and faster decision-making ($n = 212$).

Innovative activities evaluation/faster decision-making	No	Yes	n_i
No	107	37	114
Yes	0	68	98
n_j	107	105	212

Source: Research 2011.

```
             No      Yes      All

1             0       68       68
           0.00   100.00   100,00
           0.00    64.76    32.08
           0.00    32.08    32.08

2           107       37      144
          74.31    25.69   100.00
         100.00    35.24    67.92
          50.47    17.45    67.92

All         107      105      212
          50.47    49.53   100.00
         100.00   100.00   100.00
          50.47    49.53   100.00

Cell Contents:      Count
                    % of Row
                    % of Column
                    % of Total
Fisher's exact test: P-Value =  0.0000000
```

Figure 6. Fisher's exact test output from Minitab ($n = 212$; Source: Author's research 2011).

percentage level significance and the alternative fragmental hypothesis FH1 is accepted. Random values are dependent and the relationship between direct expression of innovative activities effects and market progress forecasts by the marketing information system has been demonstrated.

Based on primary research results and the statistical independency test we can consider the research hypothesis H1 as confirmed.

Hypothesis 3: In enterprises that introduced a system of evaluation of innovative activities, this system contributes to faster decision-making.

In connection with the H1 hypothesis, the assumption is now being statistically tested that the introduction of a system of evaluation of innovative activities contributes to faster decision-making. For this purpose, the following questions from the 2011 questionnaire will be used: 'Is your enterprise using a system of evaluation of innovative activities?' and 'Does this system of evaluation of innovative activities contribute to faster decision-making?' The results of the answers to these two questions are shown in Table 7.

Fisher's exact test was conducted to verify statistical dependence. The FH0 partial null hypothesis stating that random quantities are independent was tested against the FH1 partial alternative hypothesis.

FH0: The introduction of a system of innovation evaluation does not contribute to faster decision-making (independent variables).

FH1: The introduction of a system of innovation evaluation contributes to faster decision-making (dependent variables).

The calculated P-Value is equal to 0.0000000 (P-Value < α) and we therefore reject the FH0 partial null hypothesis at a 5% level of significance and accept the FH1 partial alternative hypothesis. (see Figure 6) Random quantities are dependent and proof was provided that the introduction of a system of innovative activities evaluation contributes to faster decision-making. For that reason, all stakeholders are forced to ascertain in a timely fashion the respective parameters of innovation and respond to them. Hypothesis 2 can be considered confirmed.

7. Conclusion

At the end, let us ask a simple question: 'To measure or not to measure the effects of innovations?' Most readers now answer in the affirmative, but as shown by the results of primary research, many surveyed managers were not so quick to respond in this way.

The purpose of this study was to investigate enterprises' approaches to measuring their innovation performance. For this, the main literature in matters of innovation and performance measurement, as well as previous studies that have dealt with the problem of measuring this kind of activity have been reviewed. Based on this review and empirical findings from primary research, major implications relevant to academics and practitioners stem from this study.

First, the work has implications for the field of business performance measurement. Research has outlined a number of metrics; various methods and performance measurement frameworks for innovation process evaluation that exist in Czech manufacturing enterprises.

The second unique feature of the present study is the research methodology adopted. It is one of the few comprehensive studies to address the question of what methods of innovation performance measurement are being implemented in innovative Czech manufacturing enterprises. Moreover, the research takes into account the specifics of the investigated issue, such as measurement in soft systems, the core micro-level of measurement, and the specifics of the Czech business environment.

Third, the research can aid practitioners, since it provides organisations with new insights and findings which managers can translate into the context of their own businesses. Specifically, enterprises know that with a clear innovation strategy they can be more innovative, improve innovation processes and achieve better financial results.

On the other hand, the benefits need to be assessed in a purely realistic manner. As with any other research, the methods employed have inherent limitations, which lead to opportunities to improve future research in this area. Therefore, this study is intended to motivate researchers to conduct more large-scale studies in the area of innovation performance measurement system implementation in different business sectors and areas.

Firstly, the results of this study are limited to the analysis of a single case study, representing a starting point for further research in other industries and countries. In this sense, the findings may be extrapolated to other CEE countries, since economic and technological development in the Czech Republic is similar to that in other OECD member countries. An important gap in the adoption of innovation measurement and management control tools was identified between global and Czech enterprises. Hence more research is needed and a sampling framework that combines enterprises from different countries could be used in order to provide a more international perspective on the subject. Also, it may be interesting to analyse enterprises in different phases of the innovation process in order to observe their advances in innovation and the existence of innovation performance measurement system implementation.

Secondly, respondents were asked to answer questions in relation to a representative innovation they had developed and launched in the previous three years. This retrospective methodology has several limitations. For example, halo bias effects may be present because the performance of the innovations chosen was known prior to completion of the survey. There may also be differences between respondents' recalled and actual measurements. For example, selective recall, rationality bias and reconstruction bias may cause respondents to massage their responses upwards in order to make their firms look good.

Thirdly, this research is based on what managers have done. Thus the research is descriptive, providing an insight only into the number and nature of metrics used for the innovation process.

The last limitation to be noted is that the measurement of the performance of the innovative process was, is and always will be encumbered by a certain inaccuracy associated with the creative nature of this process. There is a fundamental resistance by creative workers to any form of measurement and standardisation of their work. However, it must be noted that, in view of the importance of the innovative process for the development of the enterprise and the amount of resources put into it, performance measurement in this area is necessary.

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