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Measurement of Innovation Performance

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***Abstract*—**Time full of changes which is associated with globalization, tougher competition, changes in the structures of markets and economic downturn, that all force companies to think about their competitive advantages. These changes can bring the company a competitive advantage and that can help improve competitive position in the market. Policy of the European Union is focused on the fast growing innovative companies which quickly respond to market demands and consequently increase its competitiveness. To meet those objectives companies need the right conditions and support of their state.

***Keywords*—**Innovation, performance, measurements metrics, indices.

I. Introduction

THE primary aim is introduced innovative metrics which are available in European Union and available in the Czech Republic. The secondary aim of the paper is to evaluate innovation performance of small and middle companies in the Czech Republic on the basis of primary and secondary research. This paper was supported by the project "Innovation of Educational Programs at Silesian University, School of Business Administration in Karvina" CZ.1.07/2.2.00/28.0017.

Innovation as an intuitive and creative process is a difficult process to measure. Innovation, which is considered an art, is measured historically in terms of financials or counts. Financial measurements include new product- or service-specific sales or revenue growth, and count-type measurements include items like the number of patents, trademarks, articles, and product or service versions produced. However, experience shows these measurements do not correlate to the innovation activity; therefore they do not appear to be sufficient measures of innovation performance for a business.

The paper also indicates areas which are important to monitor and evaluate need in the context of the current time.

In the OECD countries, SMEs account for 95% of companies and 60 to 70 % of employment. Given the significant role of SMEs in the national economy in terms of their sizeable contribution to GDP, employment generation, export performance, and achieving sustainable national economic development, all national governments in the OECD consciously seek to facilitate the creation and development of the national SMEs sector. Over the past two decades, government policies have consistently sought to encourage innovation among SMEs, on the understanding that the development of a vibrant and dynamic SMEs sector, requires constant creativity and innovation to adapt to fast-changing market conditions, short product cycles and intense market competition.

SMEs, however, are an extremely heterogeneous group. Their innovative capacity an ability to develop new and innovative products, processes and services varies significantly depending on their sector, size, focus, resources and the business environment in which they operate. In certain high-technology sectors, such as semiconductors and biotechnology, innovative SMEs have been a key to the growth and dynamism of these sectors. In such sectors, patenting activity is comparatively much higher than in other sectors and small firms rely heavily on patents to signal expertise, either to attract research partners or investment [6].

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II. Business and Measurement of Innovation Performance

Most of the broad empirical studies on the relation between innovation and performance provide evidence that this relation is positive. However, as point out, innovation is an expensive and risky activity, with positive outcomes on firm performances but also with negative outcomes, such as increased exposure to market risk, increased costs, employee dissatisfaction or unwarranted changes. In addition, some studies arrive at conflicting conclusions. For instance, using a sample of small businesses, find that product innovation does not affect performance in benign environments, but has a positive effect on performance in hostile environments [4].

Literature attests of researches in the field of innovation capacity evaluation (for a company or a country). These approaches are generally based on the evaluation of the innovation process outcomes and of the resources devoted to it. All these statements may be considered through three analytical levels (setting aside the individual and collective cognitive level):

Level A: The permanent and global innovation management of the company. This level integrates all the strategic tasks, the organization of new projects launching and the improvement of innovation management practices.

Level B: The outcomes or inputs of a particular project. This level is characterized by a limited period and is concerned with the transformation of an idea up until an innovative product.

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Level C: The material characteristics of the innovative product resulting from the new product development process. This level represents the artefact of Level B. This approach suits our special interest in establishing links between evaluation and operational management tasks. The evaluation of Level C is very common in engineering through the definition of the future specifications of the innovative product and its relating performances [7].

Literature is mostly concerned with Level B evaluation. Many authors propose approaches to determine the balance between the outcomes and inputs of innovation. Generally, financial and commercial variables are taken into account. Financial evaluations are based on classical ratio including financial margins and returns on investment. Moreover, specific financial criteria dedicated to innovation resources are suggested: they generally measure time and cost development. Marketing variables include qualitative and quantitative aspects, such as new market shares and customer satisfaction (this last example is dedicated more to product's Level C than to the project's Level B). Strategic considerations, such as competitive advantage, are integrated to evaluate the balance between outcomes and inputs. Several authors (Archibugi and Pianta, 1996; Abraham and Moitra, 2001) add technological criteria, such as the number of patents, to conduct this evaluation [4].

A. Historical Development of Innovation Metrics

Historical a development we can divide to four generations.

The first generation of metrics reflected a linear conception of innovation focusing on inputs such as R&D investment, education expenditure, capital expenditure, research personnel, university graduates, technological intensity, and the like.

The second generation complemented input indicators by accounting for the intermediate outputs of S&T activities. Typical examples include patent counts, scientific publications counts of new products and processes, high-tech trade.

The third generation is focused on a richer set of innovation indicators and indexes based on surveys and integration of publicly available data. The primary focus is on benchmarking and rank ordering a nation´s capacity to innovate. A man difficulty at the moment is the validity of international data companies incorporating service sector innovations into the surveys.

Relevant fourth generation metrics currently at an embryonic stage include knowledge, networks, risk and others [2].

TABLE I
EVOLUTION OF INNOVATION METRICS BY GENERATION

First generation Input indicators (1950s-60s)	Second Generation Output Indicators (1970s-80s)	Third generation Innovation Indicators (1990s)	Fourth generation process indicators (2000s plus emerging focus)
• R&D expenditures • S&T personnel • Capital • Tech intensity	• Patents • Publications • Products • Quality change	• Innovation surveys • Indexing • Benchmarking innovation capacity	• Knowledge • Intangibles • Networks • Demand • Clusters • Management techniques • Risk/return • System dynamics

Source:[2]

B. Framework for Innovation Metrics

Innovative capabilities are crucial for maintaining, respectively increasing the competitiveness of companies. Innovative capabilities are the property of companies but they do not define the innovative activities of the companies. These can be identified only by comparing two or more companies in a specific market context.

Innovative capabilities are a kind of background for the emergence of innovations. Measuring innovation capacity can then be done by measuring the assumption that means inputs (factors of production) in the innovation process (associated with finding and collecting innovative ideas and ending with investment in worker education and in research and development). It is obvious that some conditions are relatively easily measurable (quantity), others very heavily (quality).

Innovation as an intuitive and creative process is a difficult process to measure. Innovation, which is considered an art, is measured historically in terms of financials or counts. Financial measurements include new product- or service-specific sales or revenue growth, and count-type measurements include items like the number of patents, trademarks, articles, and product or service versions produced. However, experience shows these measurements do not correlate to the innovation activity; therefore they do not appear to be sufficient measures of innovation performance for a business.

In order to establish a set of working measures of innovation, one must identify common characteristics of the innovation process, their inter-relationships and well-defined deliverables. In order for an innovation process to be standardized, its inputs, in-process activities and outputs must be identified. An innovation process includes many process steps and dozens of possible metrics. The challenge is that people want to devise magical measures that can tell the whole story and serve as predictors of innovation. Immediately establishing an adequate and accurate measurement system is unlikely to succeed; starting with an initial set of measures is a better approach [3].

III. EFFECTIVE MEASURES OF INNOVATION

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Innovation performance follows the innovative activities of the company but as innovation activity it is not the property of the company. It is again the result of the innovation process and arises from interactions among competing firms in a given market situation. Innovation performance is generally considered as a crucial component of long-term competitiveness of countries and regions.

Innovation performance (implementation of innovation) stands up to the very end of the innovation process. For measurement it is necessary to understand and describe the whole innovation process and to identify factors that may affect the ultimate realization of innovation. Measuring output includes for example number of newly listed products, changes in market share, growth in sales and profit growth from sales of innovative products.

An organization before to begin measurements of innovation initially must clearly state its objectives.

- Define the purpose of innovation in the organization.
- Establish expected innovation deliverables (basic and specific) and their contribution to business performance, including growth and profitability.
- Determine the measures of success of key innovation deliverables.

Table II shows variety of measures that can guide thinking in the right thinking in the right direction and facilitate development of appropriate measures of innovation. Good measures of innovation, being specific, measurable, and actionable, catapult the innovation process and produce significantly more innovative outcomes.

TABLE II
ADDITIONAL MEASURES OF INNOVATION

Elements of innovation process	**Business Innovation Measures**	**Process Innovation Measures**
Inputs	• Funding • Culture of risk taking • Rewards • Tools	• Excellence in research • Innovation management • Time allocation (%)
In - process	• Targets for innovation • Process of innovation • Extant of institutionalization • Idea management • Internal a external • Recognition	• New idea deployment • Extent of improvement or change • Degree of differentiation • Disruption or innovativeness • Time to innovate
Outputs	• Patents • New products, services or solutions • Sales growth • Market position or ranking • Customer perceptions	• Rate of innovation • Savings • Opportunities

Source: [3]

TABLE III
MEASUREMENT OF INNOVATION PERFORMANCE

Individual indicator	• Measure
Realized innovation	• Number of implemented innovations during a period
Success of innovation	• Number of successful projects to the total number of initiated innovative projects
Time of innovation	• Average time implementation of innovate projects
Acquired patents	• Number of patents for a certain period
Economic indicators	• Return on Innovation • Total expenditure on innovation as a % of sales • Real contribution of the project to the overall cost of the project

According to Košturiak, Chal' (2008), it is useful to use the following indicators of innovation performance: [5]

- Success of innovations: the number of successful projects to the total number of initiated innovative projects.
- Effectiveness of innovations: the real contribution of
- Time of innovation: the average time implementation of innovative projects.
- Return on Innovation: the period during which benefits from an innovative project reach the project costs.
- Return on Innovation: return on investment in innovation.
- Total expenditure on innovation as a percentage of sales.

From our own knowledge, it is possible the indicators of innovation performance summarize in Table III.

IV. INNOVATIVE COMPANIES IN THE CZECH REPUBLIC

A. Own Research

Department of Management and Business of School of Business Administration in Karvina, Silesian University in Opava conducted survey under the title "Adaptability of SMEs in the current economic conditions in the crisis years 2010 -

2012. The research took place in the summer semester of the year 2011 with the help of full-time and distance students. Interpreted sample characterizes the state in 206 companies in the Czech Republic. The questionnaire was completed by the student on a personal meeting with a manager of company. The questionnaire survey included the following categories: A. Identification of the company (11 questions), B. Strategic and Project Management (9 questions), C. Risk and crisis management (11 questions), D. Personnel Policy (7 questions), E. Production, services and innovative activities (9 questions), F. Use of grants and subsidies (8 questions), G. Energy savings and renewable energy (6 questions), H. Identification and intermediate student opinion survey (6 questions)[9].

In order to evaluate the survey there was used SPSS 11.5 program. Outputs were achieved with using several methods, for the purposes of this study there were selected three methods: Rotated Component Matrix (factor loadings after rotation, arranged by size), Communalities (part of variability explained by variables common factors) Correlation Matrix (mutual dependence of two questions).

One of the objectives of the research carried out by the department was to analyze and evaluate whether firms innovated in the years 2010 - 2012, and what types of innovations where the most frequently. As for the questionnaire survey there was formulated hypothesis (H): Innovation activities in this period are concentrated primarily on product - product or service.

The results showed that 70.1% of enterprises (206 companies) didn´t innovate, 29.9% of firms innovated. Only 12 companies innovated something different and the rest truly innovated the product.

From the questionnaire survey conducted by the Department of Management and Entrepreneurship there was possible to point out areas that can have a high impact on the success of the organization.

Using SPSS program 11.5 there was found this structure of questions which attract the most links with other questions and are most responsible for the results that came out after the evaluation of specified number (sample) of questionnaires. Questions correlation coefficient higher than 0.5 was found 36, but in order to remained the contribution clear and concise, the table number 20 involved only 12 of the most important issues with a correlation coefficient higher than 0.7.

From the results in the Table IV it may be inferred that the areas can have the greatest impact on the speed of adaptability of companies to changes and development. Innovation, performance measurement and strategic planning are factors that specifically help companies to survive.

B. The Score of Innovative Position of the Czech Republic

1) Summary Innovation Index (SII)

The Czech Republic is one of the moderate innovators with a below average performance. By international comparison of overall innovation performance of the Czech Republic remains below the EU-27. The main short comings of the innovation environment include low availability of financial resources for innovation (especially in venture capital) and small industrial use and legal protection. Fig. 1 shows the average annual change in the major indexes, which his calculated in dicator SII. The graph shows the average annual change in the CR compared with Switzerland and EU27.

TABLE IV
THE MOST IMPORTANT QUESTION –TOP 12 (COMMUNALITIES)

Initial		Extraction
1. Product and service innovation	(E1)	0,809
2. Written procuration (C8)		0,805
3. Changing the view on strategic planning (B5)		0,804
4. Areas of changes in products and services (E2)		0,779
5. Measures in practice (C10)		0,777
6. Renewable Energy (G3)		0,748
7. Written risk analyses (C7)		0,737
8. Types of innovation (E8)		0,731
9. Performance measurement (C9)		0,725
10.Return		0,721
11.Number of employees		0,715
12.Profit (C3)		0,708

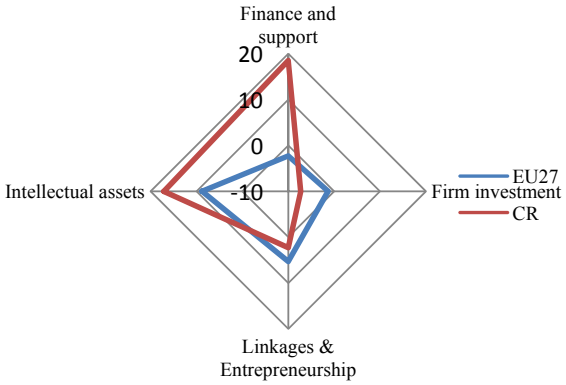

Fig. 1 Annual average growth per indicator and average country growth (2011)

The Czech Republic belonged according to rating dynamics of innovation performance (calculated on the basis of the development of the indicators making up the SII in the previous five years) with an average annual growth of 4.8% among well above average among countries (average annual growth rate of the EU-27 amounted to 1.8%) in the year 2009. In the year 2010, the average annual growth in innovation performance of Czech Republic was lower - only 2.6%, while the average annual growth rate of EU countries amounted only 0.85%. Thanks to economic growth in the year 2010 (mainly due to positive developments in the manufacturing and service industries), the current average annual growth rate of the innovation performance of the Czech Republic rose to 3.2%. While in the year 2010 the value for the EU-27 was 0.85% in the year 2011 average growth rate dropped to 0.33% due to the impact of the economic crisis. In both years, the resulting growth rate is positively influenced by the development of indicators in open, excellent and attractive research systems, the negative impact was observed in case of indicators of corporate investment, in usage of venture capital (there

decreased indicator - amount of funds designated as venture capital to HDP) and in innovators group (decrease of innovative small and medium sized enterprises) [1].

2) Global Competitiveness Index (GCI)

For more than three decades, the World Economic Forum's annual Global Competitiveness Reports have studied and benchmarked the many factors underpinning national competitiveness. From the onset, the goal has been to provide insight and stimulate the discussion among all stakeholders on the best strategies and policies to help countries to overcome the obstacles to improving competitiveness. The concept of competitiveness thus involves static and dynamic components. These components are grouped into 12 pillars.

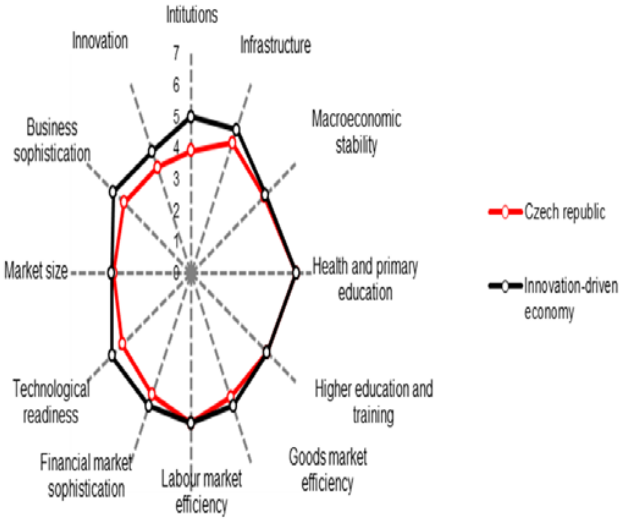

Fig. 2 Global Competitiveness Index (GCI) 2010-2011

In 2012, the Czech Republic (CR) was ranked in the GCI ranking score at the 39th site. In the 12th Pillar Innovations the CR is doing well as it is ranked at 32nd place out of 144 countries. According to this, the pillar significantly outperforms other new member states which conversely overtake the Czech Republic under the first pillar of the GCI - the quality of institutions. The table shows the results of the various factors in a pillar of innovation for the Czech Republic and Switzerland (CH). The values range from 1 to 7. From these areas the Czech Republic has the worst rating in the *Government procurement of advanced tech products* indicator which amounted 122nd position. On the other hand, The Czech republic was positioned 22nd place at the pointer *Capacity for innovation.* In the comparison of values between the Czech Republic and Switzerland, there is the biggest difference in the protection of intellectual and industrial property. GCI indicator assesses the Czech Republic in relatively better way than the index SII. It positive lye valuates the business and technological advancement, the quality of higher education, the ability to innovate and the availability of the research projects and training services. However, the negative aspects are also evaluated: these are the cooperation among private sector and universities, patent applications and procurement of advanced technology, the lack of transparency in government policy, the embezzlement of funds and confidence in the political situation. Czech Republic is behind its "innovative system" and should proceed to its reformation [8].

3) Pan-European Innovation Survey

Standardized metrics for measuring innovation in the EU and EFTA (European Free Trade Association) is a pan-European innovation survey (CIS), which is designed in order to be possible to compare the results obtained among businesses, industries and ultimately among states. Measuring innovation according to the CIS methodology the Czech Statistical Office conducts by using TI questionnaires. Current TI 2013 questionnaire is based on the Oslo Manual in 3rd revision and of the Eurostat harmonized guidelines for statistical surveys in the EU CIS 4 for the reference period 2010-2012. Due to revisions in the Oslo manual follows the questionnaire TI 2013 in the company four types of innovation - product, process, organizational and marketing. Questionnaire TI 2013 is a combined metric tracking innovation inputs and outputs. The areas are covering four types of innovations thematically, the size and scope of business, innovation activities, innovation funding, information resources, innovative collaboration, the results of innovative activities, limiting factors of innovation. From comparison of the collected information in an enterprise and from aggregate data for the Czech Republic it can be tracked according to various aspects track innovation capacity and performance. Comparisons in among companies in a field (summary data are classified according to the Classification of Economic Activities (NACE), company size, etc.) is due to the broad base of European data measured by a standardized metric of the biggest benefits of the metrics from a business perspective.

V. Conclusion

Before we move to look at examples of successful routines for innovation management, we should pause for a moment and define what we mean by "success". We have already seen that one aspects of this question is the need to measure the overall process rather than its constituent parts. Many successful inventions fail to become successful innovations, even when well planned [10].

We have already seen that one aspects of this question is the need to measure the overall process rather than its constituent parts. Many successful inventions fail to become successful innovations, even when well planned.

Equally, innovation alone may not always lead to business success. Although there is strong evidence to connect innovation with performance, success depend on others factors. If the fundamentals of the business are weak, then all the innovation in the world may not be sufficient to save it. This argues for strategically focused innovation as part of a "balanced scorecard" of results measurement.

This document deals with an evaluation of innovative activities in the Czech Republic using the composite indicator

Summary Innovative Index, the Global Innovative Index and IMD index. The final position of the Czech Republic in the field of innovative performance is still below the European average but there is a trend of gradual convergence to the average innovative performance of the EU-27. However, the innovative performance and competitiveness of the country slows down inefficient management of public funds, excessive bureaucracy and poor political environment.

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