“Development of the integrated quality management model for increasing the strategic performance of enterprises in the automotive industry”

AUTHORS	Lenka Štofova Petra Szaryszova Šarka Vilamova

ARTICLE INFO	Lenka Štofova, Petra Szaryszova and Šarka Vilamova (2017). Development of the integrated quality management model for increasing the strategic performance of enterprises in the automotive industry. *Problems and Perspectives in Management*, *15*(3), 4-15. doi:10.21511/ppm.15(3).2017.01
DOI	http://dx.doi.org/10.21511/ppm.15(3).2017.01
RELEASED ON	Monday, 18 September 2017
RECEIVED ON	Wednesday, 11 January 2017
ACCEPTED ON	Tuesday, 25 April 2017

LICENSE	This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License

JOURNAL	"Problems and Perspectives in Management"
ISSN PRINT	1727-7051
ISSN ONLINE	1810-5467
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
15	5	6

© The author(s) 2026. This publication is an open access article.

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10, Sumy, 40022, Ukraine

www.businessperspectives.org

Lenka Štofová (Slovak Republic), **Petra Szaryszová** (Slovak Republic), **Šárka Vilámová** (Czech Republic)

DEVELOPMENT OF THE INTEGRATED QUALITY MANAGEMENT MODEL FOR INCREASING THE STRATEGIC PERFORMANCE OF ENTERPRISES IN THE AUTOMOTIVE INDUSTRY

Received on: 11th of January 2017
Accepted on: 25th of April 2017

© Lenka Štofová, Petra Szaryszová, Šárka Vilámová, 2017

Lenka Štofová, PhD., Assistant Professor of Business Economics and Management, Faculty of Business Economics with seat in Košice, University of Economics in Bratislava, Slovak Republic.

Petra Szaryszová, PhD., Assistant Professor of Business Economics and Management, Faculty of Business Economics with seat in Košice, University of Economics in Bratislava, Slovak Republic.

Šárka Vilámová, Ph.D., Associate Professor, Faculty of Mining and Geology, VŠB- Technical University of Ostrava, Czech Republic.

This is an Open Access article, distributed under the terms of the Creative Commons Attribution-Non-Commercial 4.0 International license, which permits re-use, distribution, and reproduction, provided the materials aren't used for commercial purposes and the original work is properly cited.

Abstract

Objective pressures to create increasingly complex grouping of supply chain partners have next to their base priority of maintaining competitiveness and possible pitfalls. They are shown by the need to cope with a number of external risks that by participation in the chain inevitably penetrate to the enterprise and at the same time there is a duty to protect the partners from the negative effects of its own risks, as well as the enterprise itself, which threaten the common activities of the supply chain. In a review of the knowledge of the current state of the art the authors present models and progressive methodological approaches to integrated management and assessment of business performance. The results of our own research are presented, including verification of scientific hypotheses being explored importance of the automotive industry in Slovakia, both for production in the national economy, creation of employment and value added, as well as the effects on import or innovation. It is also defined in terms of international standards. Presented are the results of the empirical effects of the automotive industry in the total production, employment and value added in the national economy. The authors also deal prospects of development of the automotive industry in Slovakia, both in relation to the competitiveness of the industry itself, as well as in relation to the new industrial policy of Slovakia – Industry 4.0. Supporting part of the paper presents an application of multi-criteria methods for assessing the effectiveness of the research sample based on the DEA modelling, leading to the draft of assessment model of integrated quality management system on the principle of assessing the performance of the enterprise (BSC) and the draft of recommendations for business practice.

Keywords model, quality management, integration, strategic performance, efficiency

JEL Classification C51, C67, L10, L62, M11, O21, O32, L10

INTRODUCTION

Most Slovak suppliers in the automotive industry network of producers expect that in the future the industry's attention will focus mainly on materials (innovation, quality, costs, alternative materials, reducing the weight of vehicles) resulting from the highly competitive and strategic aims of the EU in the automotive industry. The growth of global competition affects the demand for new production methods and shorter life cycles of products while forcing the manufacturing enterprises to face complex problems in a rapidly changing business environment. The ability to use innovative processes, structures and systems is presented in the scientific works of Wördenweber, Eggert, Schmitt (2012); Friedli, Mundt, Thomas (2014) and Mahesh (2013) as a basic precondition for overcoming global competition.

To achieve a sustainable growth of competitive products within the new globalized markets that requires the development of those areas of the industry that have a specific status and are able to show a positive balance of foreign trade (in the case of the Slovak Republic it is its automotive industry) it is necessary to develop a range of tools and management techniques constantly changing over time in order to identify concrete solutions based on the priorities of the European strategies with the aim to improve decision-making processes at various levels of the industry. In the modern competitive business environment, the development and management of supply chains is one of the most important and critical issues faced by managers and multinational companies operating worldwide in the rapidly changing conditions, where flexibility, i.e., ability to adapt to changes in the system's environment is the most important strategic issue affecting a business success.

We can define three levels of decision-making in the supply chain of the industry: strategic, tactical and operational. Simon, Karapetrovič, Casadesús (2012), Kohl et al. (2016) also define these levels of decision-making as the basic concepts of quality management concerning various elements and aspects such as resource planning, operation, control and review by using the definition of quality management within the supply chain management offered by Campbell, Sankaran (2005) as "the integration of key business processes in an integrated quality management from end user through original suppliers that provide products, services and information, providing value added for customers and other stakeholders".

1. INTEGRATIED MODELS OF BUSINESS MANAGEMENT SYSTEMS

The quality management model is defined on the basis of scientific literature by Olara et al. (2014) (the Integrated Management System (IMS)) as a "management system, which connects all components of the enterprise into one coherent system so as to achieve its purpose and mission". IMS is the only mechanism used by businesses to manage their processes or activities transforming inputs of resources into a product or service to meet business aims and equitably satisfy the stakeholders in terms of quality, environmental, technical, safety, ethical or other identified requirements.

The analysis of models and standards of different management systems is the integration of management systems in order to create a view regarding the opportunities and barriers towards reconciliation of the requirements of these systems. Management systems, in general, contribute to the professionalization of organizational management, including formalization, systematization and integration. They are often referred to as management or trading systems and are consciously anchored in the structure of organization. They are generally associated with the planning and control as the important roles of organizations.

1.1. Progressive approaches to the integration of management systems

In the current difficult situation, it is understandable that automotive companies in Slovakia try to implement integrated management systems that are based on the process management principles on the basis of the permanent management of changes. The Quality Management System, although it plays a major role in the production of automobiles and related components, is not enough. According to Dick, Heras, and Casadesús (2008), in order to achieve a full success, it is necessary at the same time to introduce additional management systems including quality management, environment management, risk management, industrial safety, occupational safety, management of technical systems, human resources management in combination with financial instruments of enterprises providing a framework for the assessment of integrated quality management – it is called "multidisciplinary approach".

A gradual implementation of integrated management systems has an impact on the participation of foreign investors in enterprises, customer requirements on the international markets and international standards, which have been successfully implemented by prosperous enterprises, especially in the countries of the European Union. In the current economic environment in which the shifting of business activities

and outsourcing have become the key strategic element of the global supply chains, a certain uniformity of management systems is created. A management system, however, is a tool of an enterprise ensuring the communication and interaction of stakeholders and processes, which makes it possible to make decisions for the improvement of the long-term sustainability of an enterprise and maximization of its value.

The emerging new challenges for successful business management make it necessary to review the integrated management system, which will prompt individual businesses to change their strategies, as well as to redefine their missions changing their approaches and visions regarding the management of an enterprise. The relevance of the integrated management system is defined by the growing number of organizations that have successfully implemented and are continuously improving their quality management systems. The academic interest in this topic, expert opinions and market trends suggest that integrated management systems are perceived as "management systems of the future" outlining the idea of their transformation into organizational concepts. From an operational perspective, the integration of management systems is understood as a combination and harmonization of all internal management processes into a unified system (SRAC, 2015).

Therefore, strategic management provides for the integration of different management systems with considerable benefits for different levels of an enterprise, which can be translated into effective business activities and, consequently, the related increase of business performance. This subject is further studied by Dragomir (2010) and Boire (2011) who confirm the statistical significance of hypotheses concerning the international standards and their management principles and techniques. The research and practice have shown that management tasks can be reproduced if the necessary standards are introduced along with the integrated management systems.

1.2. Integrated quality management as a tool of strategic management

An essential goal of sustainable growth and overcoming of the challenges of the single European market is the innovativeness of the industry. The evaluation system is focused on the multiperspectival approach that includes the internal and external environment by using a combination of assessment tools, including Key Performance Indicators (KPI), evaluation methods and audit procedures, as well as the monitoring and reporting of these instruments. The main outcomes of evaluation systems are concrete action plans for the improvement of the current situation and plans that can actively respond to potential problems. The decision-making processes are influenced by strategic management systems, but in many cases they lack long term perspectives and holistic solutions in enterprises leading to a higher risk of failure especially during the initial phase of innovative initiatives that should lead to innovative solutions (https://hbr.org/2015/06/you-need-an-innovation-strategy).

The development of strategic management approaches highlights the need to integrate isolated solutions in various industries to sustainable development and innovation within the single management system. According to Taticchi and Balachandran (2008) the measurement of management systems is still an essential issue, since enterprises must develop their strategies and goals based on the factors for achieving their economic and managerial success. Based on the discrepancy of the knowledge, the authors used the results of the integration of financial indicators such as ROI, ROE and ROCE in the performance management of management systems.

Perrini and Tencati (2008) typified significant aspects of sustainability that integrated new external perspectives with the aims of environmental perspective, which precedes the integration of Triple Bottom Line (TBL, 3BL) of sustainability as well as the concept of BSC method. This approach simultaneously combines financial and non-financial performance indicators to support the planning, implementation and control of activities. Asif et al. (2010) examined the issue of the extent to which sustainability tools can be implemented into integrated management systems. They understand corporate sustainability not only as an environmental problem, but rather as a holistic approach in terms of the broad vision within the concept of TBL for the long-term economic and social impacts of their actions. Kohl et al. (2016) adapted

the integrated assessment of key innovation initiatives in the automotive industry further addressing the mentioned weaknesses in the current approaches. In this context, innovative initiatives are defined in all management areas, which seek to create processes, structures and management systems leading to innovative solutions particularly in terms of the automotive industry.

Integrated assessment leads to innovative initiatives helping enterprises achieve higher levels of maturity, developing high-quality and competitive products in a systematic manner. At the same time, the procedure of transparent monitoring for the implementation and ongoing monitoring of operational performance serves as a basis for the strengthening of the existing innovation initiatives. In addition, the integrated assessment leads to the suggestions for individual improvement, creating action plans that respond to the current and potential challenges of the competitive market. The main aim is the creation of favourable environment for innovation by replacing the traditional patterns for the adoption of innovative global challenges over the long term.

2. ASSUMPTION OF INTEGRATION OF THE BALANCED SCORECARD AND DATA ENVELOPMENT ANALYSIS

BSC is one of the modern quality tools that meet the criteria of a strategic business performance assessment. Its quality, flexibility and the general application of the method in the business practice took place within four generations.

The basis for the current fourth generation of BSC is the organization itself rather than the management of processes in the context of business performance. It is the learning of the enterprise's own strategy. The organization is consequently more accessible to changes and better able to respond to the necessary changes. This makes it possible to study the strategy and its impact on business performance. The fourth generation approach explicitly describes the role played by performance management. Furthermore, it is important to focus on the performance culture of employees in order to get the best results out of them just by creating mutually beneficial working conditions towards improving the potential of their enterprise. It is should also increase their understanding of independent decision-making and develop the adequate skills (http://www.excitant.co.uk/resources/white-papers/the-fourth-generation-balanced-scorecard-approach/).

Business success depends not only on the so called "hard" (quantitative) factors such as state of assets, market share and degree of utilization or lead times. For the enterprises also important are "Soft" (qualitative) factors such as image, employee satisfaction, benefits, computing techniques and quality management systems. On the other hand, there is a risk that many soft aims will not be measured convincingly. When working with standard measuring instruments there are no universally accepted parameters of BSC. Each BSC method is designed for an individual enterprise with specific strategy and focus. On the basis of three ideal and typical strategies Table 1 shows significant variations in the characteristics of the perspectives of the BSC depending on the selected strategy (Horváth & Partners, 2002).

Performance assessment plays an important role in detecting faults and problems of each enterprise. DEA model is a relatively new nonparametric approach to assessing the effectiveness of decision-making, which uses technically effective resources to minimize inputs for a given level of outputs, respectively to maximize outputs for a given level of inputs. It is used to measure technical efficiency. The efficiency in economic terms is defined as the ratio of input to output. Measuring the efficiency of production units and identification of the sources of their inefficiency is an assumption for improving the performance of any enterprise in competitive environment. It is a method based on the use of linear programming, which was originally developed to measure the effectiveness of non-profit organizations such as schools, hospitals, government and public administration. Later, its use was spread to various businesses, services, bank sector, and to measure the performance of national economies. To differentiate effective and ineffective organizational units, there are many different models of the DEA.

Table 1. Different strategies requiring differentiated performance measurement

Source: Horváth and Partners (2002).

Area of measuring	Lowest costs	Innovation	Customer relationship
	ROA	ROI	ROS
Financial activity	Profit per employee Productivity	Profit from new products Return on investment in research and development	Market share Share of business cases Earnings per customer
Customers	% of sales gained Market share perceived price	Perceived value Acceptance of new products The rate of change of suppliers	The perceived value compared to the competition Maintaining of customer loyalty
Quality of products	Features of prices e.g.: Maintenance costs Warranty costs	Features of prices e.g.: Innovation Sustainability	Features of prices e.g.: Reliability Availability Responsibility
Employees	Contentment towards: Fluctuation Absence Productivity	Contentment towards: Development Independence Information exchange	Contentment towards: Training courses Increasing the powers
Environment	Economic and policy tools	Green growth	Environmental quality of life

Based on the realized analysis it can be concluded that the BSC method as a tool for performance assessment of an enterprise, combining the strategy with Key Performance Indicators, but regarding the measurement of efficiency and management it has certain weaknesses. The identified weaknesses could be mitigated if the integration of the BSC method and the model of DEA could create a relative efficiency value for each process. The BSC method combined with the economic-mathematical model DEA creates an integrated model, which uses the BSC as a complex framework for setting assessment criteria and DEA as a method for ranking the efficiency of business processes, based on the input and output parameters (values of the key quantitative-qualitative indicators). The process and the use of the model of integration of BSC with DEA is shown in Figure 1, which can improve the overall explanatory power of the both methods.

In light of the results of the conducted analysis it is possible to formulate a research problem: the existence of standardized management systems in enterprises of automotive industry without available information about the depth of their mutual integration and the absence of a comprehensive assessment of their performance for decision-making about the transition to smart industrial policy by quantitative-qualitative indicators. The main reason is the fact that in Slovakia there is no study to comprehensively evaluate the importance of automotive suppliers and provide stakeholders a basis for deciding of a new intelligent industrial policy (Industry 4.0).

Source: own processing.

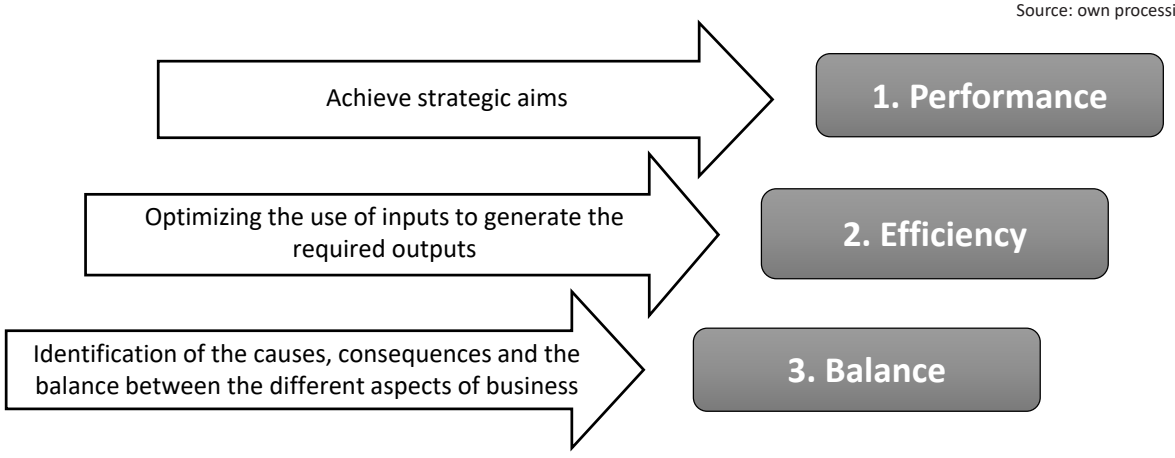

Figure 1. Aims of the integration model BSC-DEA

2.1. Characteristic of the object of research

In defining the automotive industry we are based on statistical classification of economic activities used by EUROSTAT NACE Rev. 2, which has been since 2008. Under the automotive industry we understand the production of motor vehicles, trailers and semi-trailers, i.e., the sector indicated by the number 29.10.0 Motor Vehicle Production with concrete subclasses. When selecting the survey sample we used the criteria that caused differences in the research sample:

- Failure to disclose financial statements,
- Inactivity of enterprise and activity characterized by zero sales, respectively, negative results of the economy for the year, followed by negative profitability of indicators, etc.
- The leading phase of the enterprise or termination of business (not taking all year)
- Regime of the enterprise in liquidation, tender or restructuring.

The initial core set was in this way reduced to the research sample of 102 suppliers of the automotive industry network that make up the research sample representing 36.96 % of the enterprises from the original core set.

For data processing we used descriptive statistical methods (calculation of absolute and relative frequency) distribution of the research sample in terms of enterprises by NUTS 3 (Table 2).

Most enterprises of the sample are allocated in the Bratislava Region and in the Banská Bystrica Region (6.9%). The Bratislava Region had 20 enterprises of the sample, which represents almost 20%. The Trnava Region is the site of business activities of 13 enterprises, 17 in Trenčín Region, 8 in Nitra Region, 10 in Prešov Region, 19 in Žilina Region and in Košice Region, 8 enterprises.

2.2. Research methodology and interpretation of the results

When processing the results we used standard methods of scientific work and mathematical-statistical methods, methods for quantification and verification of the relevant data to draw conclusions and make recommendations, as well as empirical methods based on theoretical knowledge.

In forecasting the development of enterprises or industries it is necessary to know both the global trends and the internal structure and relations in various economic and managerial areas. The assessment of effective forecasting of trends in the automotive industry can create dependencies between different economic variables, such as sales, number of employees, productivity, assets, total costs, indebtedness, value added and others. This section examines selected linearly dependent variables (multiple linear regression of least square method), and also the relationships between the levels of significant differences and appropriateness of these variables in mathematical modelling. The chapter will consider the further evaluation of business efficiency in the network of automotive suppliers through a set of quantitative-qualitative indicators, as reflected in the various strat-

Table 2. Frequency by region

Source: own processing.

NUTS 3 (Region)	Absolute frequency	Cumulative frequency	Relative frequency (%)	Cumulative relative frequency (%)
Banská Bystrica	7	7	6.86275	6.8627
Bratislava	20	27	19.60784	26.4706
Košice	8	35	7.84314	34.3137
Nitra	8	43	7.84314	42.1569
Prešov	10	53	9.80392	51.9608
Trenčín	17	70	16.66667	68.6275
Trnava	13	83	12.74510	81.3725
Žilina	19	102	18.62745	100.0000
Missing data	0	102	0.00000	100.0000

Source: own processing.

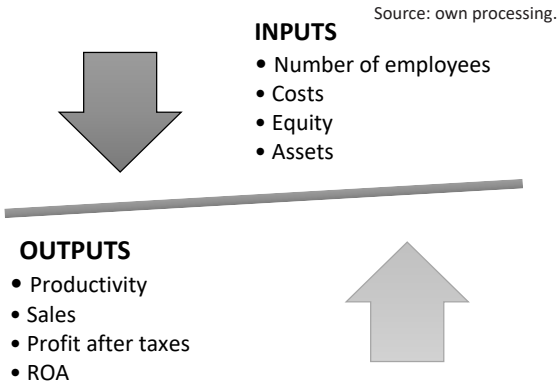

Figure 2. Model 1. Strategy "lowest costs"

Source: own processing.

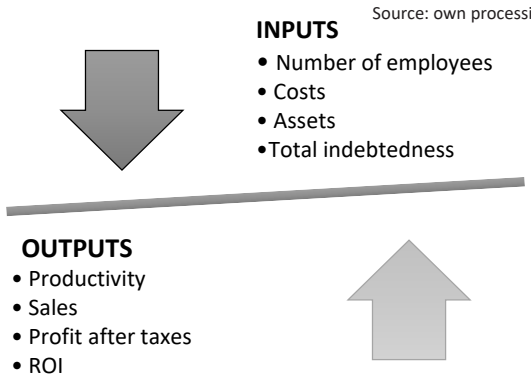

Figure 3. Model 2. Strategy "innovation"

Source: own processing.

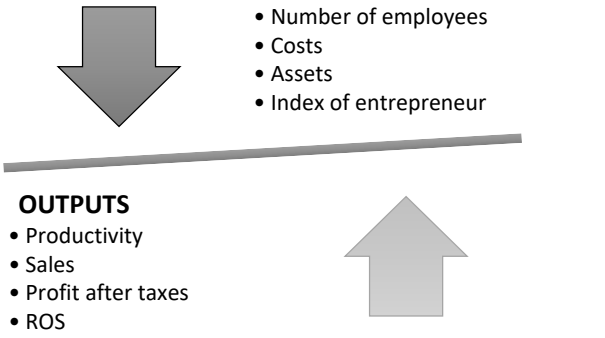

Figure 4. Model 3. Strategy "customer relationships"

egies of assessment model of integrated quality Management based on the principle of BSC DEA.

Regarding the business efficiency of automotive suppliers, we have classified them according to the empirical study by Horvath and Partners (2002) using the following strategies: lowest costs, innovation and customer relationships. The selected quantitative-qualitative indicators of the DEA modelling of efficiency can be divided into the monitored inputs and outputs acc strategies.

The necessary condition of usability of the indicator is to obtain its value using an appropriate measurement procedure. The concept of measurement can be characterized as a set of operations to determine the value of a quantity in certain units.

In the next section, we present the necessary data for decision-making regarding the use of quantitative-qualitative indicators in each DEA model in the summary tables.

In estimating the parameters by using the least square method we created a table of important indicators to determine the suitability of the selected model's variables – coefficient of determination R^2 (Table 3).

Table 3. Summary results of the regression analysis of the variables of each model

Source: own processing.

Model 1		Model 2		Model 3	
Variables	**Modified R^2**	**Variables**	**Modified R^2**	**Variables**	**Modified R^2**
ROA	–0.0324630767	ROI	–0.0341379586	ROS	0.0210645908
Profit after taxes	0.840881774	Profit after taxes	0.653297738	Profit after taxes	0.659012321
Sales	0.87811401	Sales	0.877530632	Sales	0.659012321
Labor productivity	0.282776458	Labor productivity	0.285794716	Labor productivity	0.297500958

Table 4. Summary results of Fisher test variables of each model

Source: own processing.

Model 1		Model 2		Model 3	
Variables	F	**Variables**	F	**Variables**	F
ROA	0.206080387	ROI	0.166471507	ROS	1.54332585
Profit after taxes	134.437038	Profit after taxes	48.5790605	Profit after taxes	49.7995963
Sales	182.910806	Sales	181.924005	Sales	181.579975
Labor productivity	10.9552025	Labor productivity	11.103981	Labor productivity	11.6931095

The value of modified R2 provides information on the model's ability to capture a significant dependence on the given output variable from four input variables. The variables ROA, ROI, ROS, which are included in the Models 1-3, are statistically significant due to their complexity.

The coefficient of determination of the linear regression function 84.08% explains the variability of output variable, for example, of Profit after taxes. The proposed Model 1 shows on what basis a parameter is considered justified. The same principle can be applied to other variables of other models.

In order to determine the significance (significance of differences between two dispersions) of the Models 1-3, we used the parametric Fisher test (Table 4).

The results of this test lead to the conclusion that all three models are significant for the purpose of further modelling.

To verify the statistical significance of Models 1-3 by ANOVA we used a Fisher-Snedecor test criterion (Table 5).

We chose the correct variables to express the values such as Profit after taxes (Model 1). The variables ROA, ROI and ROS have the values, which are statistically insignificant $(p > \alpha)$. Subsequently, for testing the regression coefficients we used nonparametric t-test of all output variables of each of Models 1-3. By using this test we obtained the results that, in most cases, were statistically significant, which means that at least one of the correlation coefficients was different from zero.

Financial indicators have no direct connection to the corporate strategy. These are so called delayed indicators. They do not have an impact on the current and future progress of activities of an enterprise. A strategy identifies goals that must be achieved while financial indicators provide only a one-dimensional view of an enterprise making it possible to monitor only the financial aims.

After defining the input and output parameters and the verification of compliance with the conditions for the use of radial DEA we measured a relative technical efficiency in the selected set of automotive suppliers – the Decision Making Units (DMU). This relative efficiency was assessed through the model assuming constant and variable return to scale (CCR DEA and BCC DEA model).

Table 6. Summary results of Fisher-Snedecor test criteria of the variables of each model

Source: Own processing

Model 1		Model 2		Model 3	
Variables	p	**Variables**	p	**Variables**	p
ROA	0.934484005	ROI	0.954926789	ROS	0.195747644
Profit after taxes	0	Profit after taxes	2.29007028E-22	Profit after taxes	1.03092956E-22
Sales	0	Sales	0	Sales	0
Labor productivity	0.000000226311016	Labor productivity	0.000000186061484	Labor productivity	0.0000000862789378

3. SUMMARY CHARACTERISTICS OF RADIAL DEA MODELS

In this case, it was important to determine whether the effectiveness of the research sample of enterprises related to our chosen strategies based on lower costs, innovation or customer relationships that would help clarify the efficiency of selected enterprises, taking into account the constant return to scale. As part of the research we also tested CCR DEA models focused on outcomes. The results of other models were studied only marginally. Effective enterprises have proven their efficiency in all tested models. With inefficient enterprises there were some minor deviations of efficiency and these deviations had no relevant effect on the results of the further analysis of enterprises. We will present the results of technical efficiency on the basis of BCC DEA models.

Based on the tested Models 1-3 we calculated the rates of technical efficiency of each DMU from the research sample, taking into account variable returns to scale. The rates of technical efficiency of DMUs from the research sample calculated by BCC DEA model are presented in Table 6.

On the basis of the lowest standard of deviation (0.308844) and the highest average we assess the BCC model No 1 as the most effective. It is followed by the BCC No 2 Model. The BCC No 3 Model is the least-efficient with regard to the monitoring of the degree of technical efficiency.

The explanatory power of the model BCC DEA is considered more accurate because of the lower standard deviations for achieving values that can be interpreted as a credible outcome of modelling. Model 1 (BCC1) uses a strategy of the lowest costs in the pursuit of the ROA as an explaining variable achieving an average rate of technical efficiency of DMUs (26.73%). It is followed by the characteristics of the model BCC 2 (23.76%) and BCC 3 (21.78%). Testing inputs and outputs by using statistical methods, we concluded that the appropriate model in the application of the quantitative-qualitative indicators is Model 1 (BCC 1) considering the variable of return to scale based on the results of testing of input variables by using t-test. The above findings make it possible to carry out more effective forecasting, creating an extrapolation based on the mapping of strategic corporate behavior.

3.1. Strategic decision-making in conditions of qualitative competition

The new economy has begun to show a causal relationship between changes in economic growth, inflation and unemployment, while flattening and lengthening the programme cycle. Unlike the "old economy", it contributes to the mainstreaming of quantitative-qualitative indicators of "higher economic growth accompanied by falling respectively low unemployment and wage growth at a sufficiently high productivity that ensures constant respectively low labor unit costs and thus low inflation". The question is where they come from and what the drivers of these changes are. Unlike most diverse theories and concepts that study the new economy and various aspects of accelerating scientific and technological progress, we consider that the reason is more complex and has a more fundamental character. The introduction of this concept is especially important because it makes it possible to overcome the narrow techno-econom-

Table 6. Characteristics of technical efficiency rates of the observations sets for the BCC DEA model

Source: own processing.

Variable	Descriptive statistics (BCC)									
	N valid	Average	Median	Min	Max	Lower quartile	Upper quartile	STDEV	CV	Share of enterpr.
BCC 1	102	0.600470	0.526035	0.116355	1.000000	0.308199	1.000000	0.308844	51.43376	26.73%
BCC 2	102	0.590382	0.536073	0.087775	1.000000	0.278562	0.964998	0.312232	52.88642	23.76%
BCC 3	102	0.543110	0.454373	0.065558	1.000000	0.214682	0.970947	0.349644	64.37806	21.78%

ic understanding of the new economy and globalization and organically integrate it into new interpretations of the environmental, socio-economic and socio-political relations.

The study of integrated performance assessment has led us to the conclusion that the performance level of the sector can be assessed by the ability of the industry to create added value and profits on the basis of efficiency of business inputs and outputs. The development of an enterprise is conditioned by efficiency gains. It can be ensured in different ways. The assessment of integrated quality management is also a modern way of assessing the performance of an enterprise, which is based on the fact that the classification of non-financial indicators helps determine the relationship to strategic planning.

From the perspective of DEA, the assessment model generalizes the integrated quality management standards regarding the classification of inputs and outputs into subgroups (BSC perspectives). From the perspective of the BSC, the integrated assessment model of quality management of automotive suppliers offers a new approach to performance assessment by using quantitative analysis that combines various perspectives into a single value that can be considered a holistic financial, non-financial, short-term or long-term view of an enterprise.

The results of the BSC DEA model as an integrated assessment model of quality management will create mutual dependence between machines, manufactured parts and production environment.

Source: own processing.

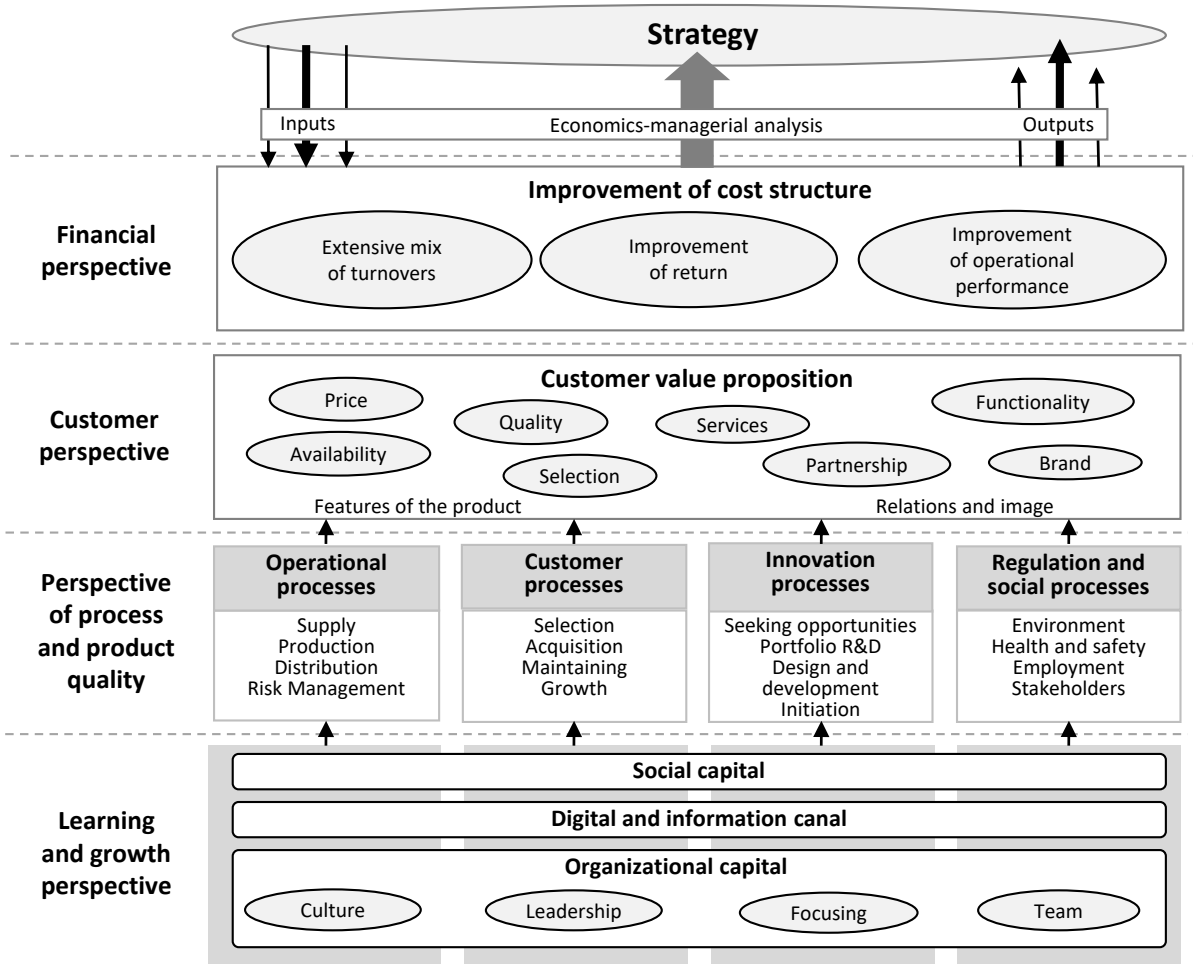

Figure 5. Strategies for enterprises in the network of suppliers in the automotive industry

Involved in these relationships are also the suppliers, partners and even customers. This will require new algorithms and applications that connect millions of things to ensure that everything functions smoothly. The final effect should be lower production costs of the product at greater flexibility for enterprises, product diversity and shortened innovation cycle.

The BSC DEA model has helped us develop an integrated system of performance assessment of DMUs of the research sample with a strategy that would help increase the efficiency of enterprises (Figure 5).

The concept of globalization and the new economy introduces a more universal type of competition referred to as a super or "mega competition", which increases the importance of comparative position both in terms of business and in terms of the national economy. The revolutionary information and knowledge are transformed into innovation and new "super technologies" creating the conditions for an efficient use of economic resources of an enterprise. Therefore, the impact of changes on the formation of the new economy and the globalization processes manifest themselves in the active or passive adaptation of enterprises.

Under conditions of unprecedented speed and differentiation of innovation processes and diversification of the needs and forms of satisfying them, the focus of strategic management shifts to the investigation and assessment of competitive environment in order to create comparative advantages for enterprises helping them gain competitive superiority.

CONCLUSION

Analyzing qualitative changes taking place in the global economy, it is possible to draw conclusions about the industrial policy with particular reference to Slovakia. Slovakia will actually be implementing the industrial policy of the EU. The latest official documents refer to the policy that supports enterprises (Enterprise Policy), which is clearly focused on increasing the competitiveness of European enterprises. The transition to a qualitatively new stage should become a new understanding of competitiveness and the competitiveness of outputs measured more broadly, not only through the national economic indicators.

We have proposed a new methodology to measure the overall performance of the automotive industry. The most effective model consists of indicators with selected input and output parameters for the implementation of the DEA analysis. One of the main reasons for the success of any organization is the correct application of the strategy that could be achieved by using the BSC DEA model. Performance indicators are grouped according to the strategies of organizations in order to monitor the effectiveness of organizations though DEA modelling of inputs and outputs. To avoid unnecessary inaccuracies it is necessary to identify the input and output variables for monitoring the behaviour of the chosen indicators.

The proposed integrated BSC DEA model could improve the overall quality of both models. They define indexes that are associated with the inputs and outputs applicable to the DEA model. The BSC DEA model is simple and effective in comparing business efficiency with a given set of measures of input and output variables. The results show that an enterprise can measure its efficiency in relation to other companies in the sector and to know the impact of their business operations and initiatives on the BSC. It is a method for evaluating a business plan on a qualitative basis. The integrated BSC DEA model takes advantage of both methods. The relative effectiveness of any financial or non-financial corporation has become an interesting topic among researchers in the world. Usually it focuses on the various components of organization, procedures and human factors adequately evaluating the systems for the company's development and stability in today's economic conditions. The results of evaluation makes it possible to identify deviations from the set aims and tasks.

REFERENCES

1. Asif, M., Bruijn, E.J.D., Fisscher, O.A.M., Searcy, C. (2010). Meta-management of integration of management systems. *The TQM Journal, 22*(6), 570-582. https://doi.org/10.1108/17542731011085285
2. Boiral, O., Gendron, Y. (2011). Managing with ISO systems: lessons from practice. *In Long Range Planning, 3,* 197-220. http://dx.doi.org/10.1002/bse.701
3. Campbell, J., Sankaran J. (2005). An inductive framework for enhancing supply chain integration, *International Journal of Production Research,* 43(16), 15 August. http://dx.doi:10.1080/00207540500095852
4. Dick, G.P.M., Heras, I., Casadesús, M. (2008). Shedding light on causation between ISO 9001 and improved business performance. In *International Journal of Operations & Production Management*, *28,* 687-708. https://doi.org/10.1108/01443570810881811
5. Dragomir, M. (2010). Cercetărişi contribuţii privind concepţia, dezvoltarea, implementare aşiîmbunătăţirea continuă a sistemelorde management integratal calităţii, mediului şisănătăţiişi securită ţiimunciiînîn treprinderile industriale, Universitatea Tehnică, ClujNapoca, 15-18.
6. Friedli, T., Mundt, A., Thomas, S. (2014). Strategic Management of Manufacturing Networks. Berlin, Heidelberg: Springer; 2014. https://doi.org/10.1007/978-3-642-34185-4
7. Horváth & Partners. (2002). Balanced Scorecard v praxi. 1. vyd. Praha : Profess Consulting, 386.
8. Kohl, H., Orth, R., Riebartschb, O., Hecklaub, F. (2016). Integrated Evaluation System for the Strategic Management of Innovation Initiatives in Manufacturing Industries. *13th Global Conference on Sustainable Manufacturing – Decoupling Growth from Resource Use*. https://doi.org/10.1016/j.procir.2016.01.057
9. Mahesh, N. (2013). Consumer's Perceived value, Attitude and Purchase Intention of Green Products. *Management Insight*, 9(1). https://www.inflibnet.ac.in/ojs/index.php/MI/article/view/1854/1585
10. Olaru, M., Pirnea, I. C., Hohan, A., Maftei, M. (2014). Performance indicators used by SMEs in Romania related to integrated management systems. *Procedia Social and Behavioral Sciences Journal, 109,* 949-953. https://doi.org/10.1016/j.sbspro.2013.12.570
11. Perrini, F., Tencati, A. (2008). Sustainability and Stakeholder Management: the Need for New Corporate Performance Evaluation and Reporting Systems. *Business Strategy and the Environment*, 15(5), 296-308. https://doi.org/10.1002/bse.538
12. Simon, A. – Karapetrovic, S. – Casadesús, M. (2012). Difficulties and Benefits of Integrated Management Systems. *Industrial Management & Data Systems*, 112(5), 828-846. https://doi.org/10.1108/02635571211232406
13. SRAC. (2015). Organismul de Certificare a Sistemelor de Management. Retrieved from www: http://www.srac.ro/srac.php?id=160&meniu=1 (accessed on 01.09.2015).
14. Taticchi, P., Balachandran, K. R. (2008). Forward performance measurement and management integrated frameworks. *International Journal of Accounting & Information Management,* 16(2), 140-154. Retrieved from http://dx.doi.org/10.1108/18347640810913807
15. The Excitant Fourth Generation Balanced Scoreacard Approach. (2016). Retrieved from http://www.excitant.co.uk/resources/white-papers/the-fourth-generationbalanced-scorecard-approach.