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Controlling as a tool for SME management with an emphasis on innovations in the context of Industry 4.0

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Keywords: *industry 4.0; controlling; SME; innovation; audit*

Abstract
Research background: Small and medium-sized businesses are significant economic power and employer in the European Union. The modern globalized world, new technologies, and advanced connectivity bring SMEs a wide range of opportunities, but also threats. Increasing the stability and competitiveness of SMEs is one of the main goals of national governments and the EU. The research is based on personal research in SMEs, its experiences and backward testing of reached results.
Purpose of the article: The aim of the paper is to analyze the possibilities the potential of using controlling as a managing tool of SMEs for increased competitiveness in the context of Industry 4.0 with an emphasis on innovations.
Methods: The study is based on a detailed analysis of 341 SMEs from the Czech Republic obtained in the years 2017–2019. The data were analyzed using statistical methods such Pearson correlation, stepwise regression for the purpose of determining the relationship between the controlling management system of a company, its innovation potential, level of process maturity, number of employees, internal audit, financial stability and strategic plan. Statistical analysis confirmed the close relationship of the analyzed variables and backwards experimental testing of the statistical analysis conclusions defined critical factors in the area of people in an organization, usage of advanced information systems and Industry 4.0 technologies implementation.
Findings & Value added: Those important areas were determined as essential for the successful development of SMEs, as well as the most significant threats in the Industry 4.0 environment. The information obtained is useful in practice and can be applied to a more in-depth analysis of the

issues. The research findings are showing possible opportunities and treads for SMEs long term stability and development as well as ways to increase enterprise performance based on controlling management system.

Introduction

The contemporary hypercompetitive environment, the advent of Industry 4.0 technology, and intense competition from large and multinational companies are profoundly impacting the SME sector. At the same time, SMEs are the cornerstone of economies and are essential for their stability and competitiveness. This study seeks to determine the options for using controlling as a managing tool of SMEs to increase their competitiveness in the Industry 4.0 environment. Its originality is based in the search for a solution for increasing the competitiveness of SMEs within the company by in-depth personal research focused on management, experimental backward testing of statistical analyses results, its application in companies and innovation potential changes in time evaluation (0.5–1 year). The conclusions of the study offer a solution whose application needs not be involved or demanding of resources. The research findings are showing possible opportunities and treads for SMEs long term stability and development as well as ways how to increase enterprise performance based on controlling management system. The key areas and factors of the competitiveness and stability of SMEs in Industry 4.0 are defined. An in-depth analysis by using such Pearson correlation for linear dependency, stepwise regression for designing of the model were used on the sample of 341 Czech SMEs.

The study took place in several phases. In the first phase, statistical data obtained in the study sample of companies was used for the purpose of defining significant variables for further analysis. The outcome of these analyses was a model of the issues examined. In subsequent phases, the conclusions of statistical analyses were verified with backwards experimental testing. The outcome of this study is the definition of critical factors for increasing the competitiveness of SMEs in the Industry 4.0 environment with an emphasis on innovations and the opening of additional research questions.

Literature review

Controlling management in its developed form can initiate increased process maturity, can more precisely predict future trends, and can identify threats and opportunities in a timely fashion and thereby provide a compa-

ny with a competitive advantage. Controlling management of a company must be perceived as a set of overarching processes that integrate the individual areas of SMEs and are focused on the future. According to Draheim (2010), a business is based on processes and also enterprises should strive for the highest possible level of process maturity. In the context of this study, controlling management is viewed primarily according to Weske (2012, p. 5), who sees processes as an essential part of any business to achieve its goals. The applicability of this theory is confirmed by de Salas *et al.* (2017), who emphasizes the role in processes of logical sequence and regular evaluation in relation to established goals. This issue has been verified for SMEs by Belás *et al.* (2018), who confirm the role of controlling in achieving goals by companies from that sector. Also, according to Babikova and Bucek, controlling can be used as a modern managerial tool oriented for the future (2019). These theses are also verified by Bartok (2018) and Li and Huang (2019).

Innovation is an important factor necessary for the growth of SMEs and its increasing importance for commercial success and competitiveness in a "sustainable" economy is no accident, as shown by Vitezić and Vitezić (2015). According to Goller and Bessant (2017), the only processes and innovations cannot ensure competitiveness and stability, but must be part of business management. These conclusions are further developed by Goffin and Mitchell (2017), who perceive innovation as part of business activities that cut across disciplines and create exciting new ideas. Particularly in Industry 4.0, the requirements for a company's flexibility and innovativeness are continually growing. Other authors reference the need to focus concurrently on the innovation activities of a company, as well as its human capital, not only at the level of a team or company, but from a particular macro perspective, i.e. on a global scale Bae and Chang (2012). A specific barrier to the full use of innovation potential, of course, is the fact that companies perform the majority of their decision-making in uncertainty Belás *et al.* (2018) whereas this uncertainty can be perceived as a quantified risk and can be managed as such. This position is expressed by the work of Fetisová (2012). It is, therefore, essential to seek a tool with which SMEs can be an innovative and competitive economic power. Controlling may be such a solution.

The process management of a company and the maturity of its processes must be continuously developed. According to Řepa (2012, p. 15), processes must be regularly evaluated and streamlined. Controlling management, which can be understood as a suite of overarching processes, can be an impetus for increased process maturity in a company. A report by McKinsey and Company (2017, p. 16) also points to the importance of regular

auditing and development of business processes. The report references the requirement for the digitization of processes, and their effectiveness is not reflected in the issue of costs, but also in accruals and deferrals. Following Draheim and his "Business process technology" (2010), the company should primarily focus on developing processes that are crucial for SMEs and ensure performance. The process management of the company and its innovation activities are the fundamental driving forces of an SME. Goller and Bessant (2017) state that although there are many explanations for the nature of innovation, it is clear that the innovation process is based on new approaches and ideas. Based on these conclusions, it is necessary to identify the need for continuous innovation of processes in SMEs, which is verified by Agostini *et al.* (2013). At present, modern management has to focus only on one thing — innovation. This is a significant part of the company's success, as mentioned (Zacharias, 2011). However, the innovation activities of a company do not suffice in and of themselves and must be part of a new process that only subsequently fulfils Goller and Bessant's (2017, p. 3) "Business process and value creation" theory. According to Goffin and Mitchell (2017), innovation is an exciting area that goes from (R&D) through marketing to CRM. These conclusions are also verified in a business cross-disciplinary consequents by Vitezić and Vitezić (2015).

Modern controlling is available to SMEs as a useful managerial tool that consists of analyzing historical and current data, in particular for the purpose of creating a more precise prognosis of future development and achievement of the established business goals. The concept of modern controlling in Industry 4.0 is for example described by Kamps (2013), who explained the modern controlling as a master process for achieving enterprise goals and noticed that at this consequences, controlling should be seen as an ideal tool for SME innovative potential development. Kamps also mentioned that the modern controlling managerial system is identifying, planning and focusing for SME goals achievement. Laval (2018) verified and developed this theory and also adds that controlling is an essential tool for SME stability and competitiveness. The focus of new controlling future, goals achieving and planning are also visible in Svensson and Edström (2016), who seen modern controlling as a new approach, which is focused on adapting in a hypercompetitive environment, to more stable in new circumstances, to support healthy enterprise which ready for new challenges. These conclusions were expanded by Písař and Havlíček (2018), who seen controlling as an opportunity for SMEs stable development and based on that also as a tool for EU cohesion and competitiveness. They also mentioned the importance of implementing new technologies and advanced

information system to SMEs as an essential support for controlling managerial system and its performance.

Modern controlling must meet the conditions formed by the Industry 4.0 environment and direct the company toward achieving a flexible organizational structure. On this subject, Safar *et al.* (2018) stated that the process of globalization and the 4th Industrial Revolution force researchers to look for new flexible business-organizational structures. The Industry 4.0 environment can be divided into two fundamental areas, according to Jo *et al.* (2017). The first area is created by the combination of developing technological environments such as IoT, Internet of services, (IoS), cyber-physical systems (CPS), smart objects and Big Data. The second area is characterized by companies operating in areas with high production costs that are motivated to search for innovative processes and the use of technologies for maintaining and developing the competitiveness of the company. It is not enough to have only a flexible organizational structure and technologies. It is also essential to have an overview of the business and the ability to predict future trends as accurately as possible. According to Cao *et al.* (2017), the importance of forecasting and controlling is fundamental to the successful growth of a company. According to their thesis, modern controlling supported by the performance of technologies in Industry 4.0 cannot only fill the function of a tool for company management, but can also be helpful in the area of evaluating commercial information and more effective costs and risks management.

The modern controlling management approach should be seen as a tool for SME future, primarily if powered by an advanced information system, technologies of Industry 4.0, and if it is regularly developed in time. Controlling essential function such as continuously evaluating and comparing if SME is achieving its goals is crucial for innovative potential and its possible failure. Controlling is working not only as an innovation management tool, but also as a business and investments safety fuse. Eliminating possible failure is supporting SME stability and long-term development.

Research aim, methodology and data

The study of SMEs is a fundamental issue for the development of the national and European economies, as SMEs are the crucial building blocks of such economies, as stated by Belás *et al.* (2018, p. 81). Antoniuk *et al.* (2017) see this situation in a similar way.

The aim of the paper is to analyze the possibilities the potential of using controlling as a managing tool of SMEs for increased competitiveness in the context of Industry 4.0 with an emphasis on innovations.

Based on that, the areas of relationships between an SME's variables such as technical level, innovation activities, and process maturity were defined. Effective SME management should then influence the overall health and performance (secondary variable). The capability to be flexible and innovative can be decisive for a business. An essential task of controlling is the active collection and evaluation of data at the lowest possible cost. Indeed, in the Industry 4.0 environment, companies have a wide range of technologies available that allow them to take advantage of active management through controlling.

Fundamental to this study is to define the connection between SME controlling management, the technological level of the company, its process maturity level, innovation activities and their impact on the company stability and competitiveness. If a relationship is proved between the study variables and SME controlling management, conclusions may be used to the cooperation of business and academic spheres.

In order to fulfill the objectives of this study, the following hypotheses were formulated:

H1: *A controlling management system supports SME activities in the area of innovation activities and thereby gives a company a competitive advantage.*

H2: *Development of strategic planning in an SME leads to an increase in the innovation activities of the company.*

H3: *Innovation activities are decisive for the economic performance of SMEs in the Czech Republic.*

H4: *Increasing the level of an SME's process maturity and internal auditing stimulate its innovation activities.*

Data

The study sample was generated by random sampling from The University of Finance and Administration SME research database (n=3780), where 714 SMEs were addressed. The research was performed on companies who cooperated and provided complete research data. The final re-

search is based on a sample (*n*=341) of SMEs from the Czech Republic. The study took place using data from the period 2017–2019.

The data studied was obtained on the basis of a questionnaire issued to SMEs, which for the purposes of this study are defined according to EU recommendation no. 2003/361. The first phase of the study used a questionnaire whose reliability has been validated. The questionnaire used the principle of a Likert scale and variables scaling by given parameters, which is presented in next subsection. The Likert scale (5 points) was primarily used for critical determinate factors and their and their properties connected with the human factor. The study included structured interviews with the employees and management with the importance of the areas of controlling, technology, process maturity, and innovation planning. For the reliability of research data, the Cronbach's alpha calculation was used. This indicator offers values in scale from 0 to 1, whereas a value of 0.7 and higher proves a high level of reliability and consistency of the data. The results of the statistical analysis will be tested by backwards experimental testing on randomized chosen individual SMEs.

Variables

Controlling management system: 0 = missing or inadequate, 1 = low level, 2 = moderate level, 3 = exceptional level, including automatic drivers for innovative approach.

A company's ability to make use of analysis of historical and current data was considered a fundamental factor for making more accurate prognoses and setting and achieving goals. Therefore, this is not to be confused with the older concept of controlling as a function of reporting or managerial accounting.

Process maturity level: CMMI model — assessment scale: 1 — Initial, 2 — Managed, 3 — Defined, 4 — Quantitatively Managed, 5 — Optimizing.

Employees: assessment scale by number of employees: 1=(0-5), 2=(6-15), 3=(16-30), 4=(31-50), 5=(51-100), 6=(101-250), 7=(>250).

Innovation plan: assessment scale: 0 = none or inadequate, 1 = low level, initial stages, random innovations, without feedback, 2 = moderate level, innovations are managed in a fundamental manner, control mechanisms for innovation failures are lacking, 3 = high level — the company has an innovation plan with a high standard and a process exists by which the company continually stimulates innovation activities, 4 = optimal level — the company has an innovation plan with a high standard and a process exists by which the company continually stimulates innovation activities.

Strategic plan — assessment scale: 0 = lacking or inadequate, 1 = low level, 2 = moderate level, targeted planning, 3 = advanced level, regular targeted planning and evaluation of goal achievement, 4 = exceptional level, advanced communication technologies, production, data collection, and a system of continuous improvement.

Return on Equity (ROE):

$$ROE = \frac{\text{Net Income}}{\text{Shareholder's Equity}} \tag{1}$$

Data analysis, model

The data obtained by the study will be analyzed using the method of regression and correlation analysis for the purpose of demonstrating the mutual dependence of the variables and the definition of the model.

We will consider a dependency model for the explained variable *y* for *m* explanatory variables $x_1, x_2, x_3, \ldots, x_m$. We will assume that each value of the explained variable *y* can be divided into two components, the deterministic component$\eta_{i=}$ $\eta(x_{1i}, x_{2i}, x_{3i}, \ldots, x_{mi})$, which is a function of the values $x_{1i}, x_{2i}, x_{3i}, \ldots, x_{mi}$, and a random component (disruptive component, random interference) ε_i, which is the outcome of the effects of other influences. The purpose is to define explanatory variables that influence the explained variable with statistical significance, defining the influence of individual sample explanatory variables on the explained variable under the condition that the other explanatory variables do not change, and defining the direction and intensity of the dependence. If the deterministic and random components are compiled by summation, we will then obtain an additive model.

$$y_i = \eta_i + \varepsilon_i, \quad i = 1, 2, 3, ..., n, \tag{2}$$

where the regression function η can be subsequently recorded:

$$\eta = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_m x_m = \beta_0 + \sum_{i=1}^{m} \beta_i x_i, \tag{3}$$

where $\beta_0, \beta_1, \beta_2, \ldots, \beta_m$ are regression parameters and$x_1, x_2, x_3, \ldots, x_m$ are explanatory variables. An estimate of this regression function is a sample (empirical) regression function in the format.

$$Y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots + b_m x_m = b_0 + \sum_{i=1}^{m} b_i x_i \tag{4}$$

or in a more accessible format for interpretation

$$Y = b_0 + b_{yx_1 \cdot x_2 x_3 x_4 \ldots x_m} \cdot x_1 + b_{yx_2 \cdot x_1 x_3 x_4 \ldots x_m} \cdot x_2 + b_{yx_3 \cdot x_1 x_2 x_4 \ldots x_m} \cdot x_3 + \ldots$$

$$\ldots + b_{yx_m \cdot x_1 x_2 x_3 \ldots x_{m-1}} \cdot x_m , \tag{5}$$

where $b_{yx1 \cdot x2\, x3\, x4 \ldots xm}$, $b_{yx2 \cdot x1\, x3\, x4 \ldots xm}$, $b_{yx3 \cdot x1\, x2\, x4 \ldots xm}$, …, $b_{yxm \cdot x1\, x2\, x3 \ldots xm-1}$ are sample individual (partial) regression coefficients, that indicate how on average the value of the explained variable y changes if the value of the explanatory variable increases before the tangent by one unit, under the condition that the values of all explanatory variables until that point remain unchanged. The estimate b_0 is the sample regression constant.

Because the linear regression hyperplane (2) is linear in terms of the parameters (and is also linear in terms of the explanatory variables), we can use the least-squares method for an estimate of the regression parameters $\beta_0, \beta_1, \beta_2, \ldots, \beta_m$

$$Q = \sum_{i=1}^{n} \varepsilon_i^2 = \sum_{i=1}^{n} (y_i - \eta_i)^2 =$$

$$= \sum_{i=1}^{n} (y_i - \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \ldots + \beta_m x_{mi})^2 \rightarrow \min . \tag{6}$$

If we replace the regression parameters $\beta_0, \beta_1, \beta_2, \ldots, \beta_m$ with their estimates $b_0, b_1, b_2, \ldots, b_m$, or b_0,$b_{yx1 \cdot x2\, x3\, x4 \ldots xm}$, $b_{yx2 \cdot x1\, x3\, x4 \ldots xm}$, $b_{yx3 \cdot x1\, x2\, x4 \ldots xm}$, …, $b_{yxm \cdot x1\, x2\, x3 \ldots xm-1}$, meeting condition (5), we obtain

$$S_R = \sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (y_i - Y_i)^2 =$$

$$= \sum_{i=1}^{n} (y_i - b_0 - b_{yx_1 \cdot x_2 x_3 x_4 \ldots x_m} \cdot x_{1i} - b_{yx_2 \cdot x_1 x_3 x_4 \ldots x_m} \cdot x_{2i} - b_{yx_3 \cdot x_1 x_2 x_4 \ldots x_m} \cdot x_{3i} - \ldots - b_{yx_m \cdot x_1 x_2 x_3 \ldots x_{m-1}} \cdot x_{mi})^2 \rightarrow \min. \tag{7}$$

We look for such values b_0, $b_{yx1 \cdot x2\, x3\, x4 \ldots xm}$, $b_{yx2 \cdot x1\, x3\, x4 \ldots xm}$, $b_{yx3 \cdot x1\, x2\, x4 \ldots xm}$, …, $b_{yxm \cdot x1\, x2\, x3 \ldots xm-1}$ that the residual sum of squares S_R may be minimal. We look for the minimum function, therefore the first partial derivative of the residual sum of squares S_R according to the individual b_0, $b_{yx1 \cdot x2\, x3\, x4 \ldots xm}$, $b_{yx2 \cdot x1\, x3\, x4 \ldots xm}$, $b_{yx3 \cdot x1\, x2\, x4 \ldots xm}$, …, $b_{yxm \cdot x1\, x2\, x3 \ldots xm-1}$ we set as equal to zero. By modifying the set of equations we receive, we can obtain a set of normal equations for the linear regression hyperplane (7), which we can solve to obtain the desired estimates of regression parameters b_0, $b_{yx1 \cdot x2\, x3\, x4 \ldots xm}$, $b_{yx2 \cdot x1\, x3\, x4 \ldots xm}$, $b_{yx3 \cdot x1\, x2\, x4 \ldots xm}$, …, $b_{yxm \cdot x1\, x2\, x3 \ldots xm-1}$.

In the event that we capture a dependence between the explained variable y for m explanatory variables $x_1, x_2, x_3, \ldots, x_m$ using the regression hyperplane (2), we will use sample individual (partial) correlation coefficients (the coefficients of the individual correlations) and the sample multiple correlation coefficient (the coefficient of the multiple correlation). The sample partial correlation coefficients $R_{yx1 \cdot x2\ x3\ x4\ \ldots\ xm}$, $R_{yx2 \cdot x1\ x3\ x4\ \ldots\ xm}$, $R_{x3 \cdot x1\ x2\ x4\ \ldots\ xm}$, …, $R_{xm \cdot x1\ x2\ x3\ \ldots\ xm-1}$ measure the closeness (strength, intensity) of the linear dependence between the explained variable y and the explanatory variable prior to that point under the condition that all explanatory variables prior to that point are constant. This finding is one of the key findings for understanding how the analyzed variables mutually impact each other. A more precise method for analyzing the data obtained conforms to the methods of Darlington and Hayes (2017).

Experimental testing

Assuming it is possible to compile a model of the sample regression hyperplane of the tested variables in relation to the innovation activities of a company, and if the mutual influence of the variables is evident from this model, a random sample of SMEs will be generated and the validity of the correlation analysis obtained will be tested against this sample with an emphasis on fulfilling the objectives of the study.

Experimental testing and definition of critical factors

The next step of the research was focused out on the SMEs randomly generated a sample by a local investigation, structured interviews with cross management-employees sample. The importance of this step was based on statistical analyses results, their implementation and in time progress evaluation (0.5–1 year). The areas for experimental testing were: controlling, process management, innovation activities of the company and the technical maturity of the SME.

Results

Statistical testing was carried out using the program IBM SPSS ver. 25.

Validating the consistency and reliability of analyzed data

The research sample n = 341 in the first step was tested in terms of the completeness of the tested variables and passed the test of completeness at 100%. The next step tested the reliability of the tested data. The tested sample of variables in question achieved a Cronbach's alpha variable of 0.846, which confirms the high reliability of the tested data and thereby the conclusions of this analysis as well.

Statistical analysis

The purpose of the statistical analysis was to define the variables that are decisive for the innovation activities of a company. Because of detected variables damaging multicollinearity (Pearson correlation coefficient higher than 0.8), some of them were excluded from model computing. The variables were then included in the model according to Table 1. The calculation of the output model — sample regression hyperplane was then carried out, see Table 2

Output model — sample regression hyperplane:

Innovation plan = -0.089 + 0.473*Controlling management system + 0.312*Internal audit + 0.111*Employees + 0.107*Process maturity level -0.157*Strategic plan + 0.069*ROE Scale. (8)

Apart from the explanatory variable Strategic plan, all explanatory variables positively influence the explained variable. The sample regression coefficient b_5 = -0.157 indicates that if the value of the explanatory variable Strategic plan grows by one degree (one unit), then provided that the values of all other explanatory variables do not change, this change will invoke a decrease in the value of the explained variable Innovation plan averaging 0.157 (in units of the explained variable). All individual t-tests are at a 5% significance level, statistically significant (the P-values in the last column are less than 0.05). From Table 3 it is clear that the overall F-test of the model is also significant with the six explanatory variables at a 5% significance level.

Table 4 indicates how the value of the multiple coefficients of determination (R-squared) grows with the gradual inclusion of variables in the model. A strong dependence can subsequently be seen from the model.

Interpretation of results and use of output model

The above model (8) can be used to validate or refute the formulated hypotheses:

- H1: Based on the compiled model for the explained variable Innovative plan, it is clear that the variable Controlling management system influences the innovation activities of a company at a statistically significant 5% significance level. It can, therefore, be seen that increasing the level of controlling management-oriented in particular on the future results of the company with significantly increase the innovation potential of the business. This can be considered a rather important finding. The implementation of such modern controlling is feasible for SMEs and can substantially increase their stability and competitiveness. Hypothesis H1 may be considered validated.
- H2: One exciting finding of the model compiled is that an increase in activities in the area of strategic planning leads to a not particularly significant but nonetheless discernible decrease in innovation activities. One of the assumptions of this study was that strategic planning would be a crucial factor in the innovation activity of a business. While this study is processing data from a sample of 341 SMEs, it is nonetheless clear that SMEs with a higher level of strategic planning has a lower level of activity in the area of innovation. A potential interpretation of this finding could be such that SMEs with a higher level of strategic planning are more resilient to unfavourable influences and therefore, less motivated to engage in innovation activities. Nevertheless, this would represent the formulation of additional research questions for a future study. On the basis of the above findings, hypothesis H2 cannot be validated.
- H3: From the above model, it can be seen that while the variable of ROE reflects value for the Innovation plan explained variable of + 0.069, this value is not particularly fundamental for the innovation activities of an SME. ROE thus has a positive impact on the development of innovation activities, and nonetheless, in this context, it is merely one of several factors. Hypothesis H3 may be considered validated.
- H4: In the above model, the sample partial regression coefficient of process management achieves a value of + 0.107 and the internal audit variable a value of + 0.312. It is essential to recognize that internal audit

often tends to be an impetus for process innovation in an SME. It is clear that increasing each individual variable and but ideally increasing them simultaneously invokes a response in the form of increased SME innovation activities. The values of the study variables Process Management and Internal Audit in the above model are statistically significant for innovation activity. Hypothesis H4 may be considered validated.

SME Controlling in Industry 4.0 — the main principle

Experimental testing of the statistical conclusions confirmed that companies with higher use of controlling have higher economic activity and stability. On the basis of the findings from this experimental testing, a process of controlling management for SME companies has been proposed. Controlling management for these companies can be described as a set of overarching processes whose goal is to coordinate the entire entity, as well as a set of processes whose task is to analyze historical and current data with an eye to more accurate prognosis and achievement of company goals. For example, the thesis of Moeller (2011) on these issues states that controlling is methodically changing from an audit approach focused on the past into a tool oriented on the future through support of a company's process management. The process of controlling management is explained by Figure. 1.

Discussion

Based on experimental testing of the conclusions of the statistical analysis, the results of the testing were validated, and other findings related to the study questions were discovered.

Other key factors of the use of controlling for managing SMEs in Industry 4.0

We can divide other critical factors into a first category — internal or closely related factors and a second category — external factors. The second category of external factors will not be addressed by this study, and yet it is essential to mention that it is specifically governmental digital strategy, support of the development of communication networks (presently 5G networks), legislative changes, institutions and locations for support of digital development, and many other items rank among the necessary con-

ditions for development of SMEs in Industry 4.0. A new guide for further research into these factors may include, for example, the Innovation Strategy of the Czech Republic 2019–2030 (Government of the Czech Republic, 2019). Nonetheless, this study seeks to find solutions within the business, and for this reason, we will not further examine external factors.

Internal key factors

There are a number of internal factors critical to the use of controlling management. The most important of these factors is described below.

The people in the business

- Management – it was determined that 83% of the companies study identify a lack of democratic leadership of the business as their most significant obstacle. In 47% of the companies studied, the leadership methodology is even described as autocratic/dictatorial and identified as a barrier to development and innovation. Mostly, this consisted of businesses that were managed by founders who were unable to accept that someone else could lead their business at least as well as they had.
- Change aversion – over 2/3 of respondents (68%) of the studied companies identify the need for development and innovation as essential for the growth and competitiveness of their companies, and yet upon closer review, 76% do not look to make changes and 41% of the respondents block change as a matter of principle. A simple explanation for this could be “why to change what works?" This finding is dangerous because it essentially suggests that the innovativeness and competitiveness of a SMEs are influenced in no small extent by each individual in the business. The area of changes and innovations in the company is addressed by Jespersen *et al.* (2017, p. 879).
- Degradation of shared information – an experimental validation of degradation of information communicated in oral form demonstrated that over 2/3 of information transmitted between 5 respondents degraded within a single day. 64% of respondents considered effective communication to be essential for employee satisfaction and performance. Experimental testing determined that businesses with innovative communication methods demonstrated higher performance, employee satisfaction, and employee engagement in company activities. Open information platforms with a positive impact on the quality of communication within the company include various chat applications, shared repositories, or work communities on social media. What is interesting is the significant

difference in employee satisfaction discovered at companies using solely oral and non-digital forms of communication (36%) versus (71%) of respondents also using digital forms of communication.

Internal audit, processes and their development

Following on the previous category — people in the company — another critical factor identified was regular internal process auditing. Processes often do not evolve along with the company, and the issue is often adherence to processes that have lost their meaning, effectiveness, etc. Kupec (2018) considers the role of process auditing and modern management of SMEs in the digital environment to be fundamental. Řepa (2012, p. 15) states that business processes must be regularly assessed and streamlined, which confirms, for example, the modern concept of controlling as a tool of SME management related to the innovation activities of the company, which is further validated by Laval (2018, p. 13). Svensson and Edström (2016) also recommends a similar approach to process management, identifying controlling and auditing as a tool for facing new challenges — that is, a tool focused on future results. These theses are verified and developed also by Říhová *et al.* (2019) who close interaction between processes maturity level and teams potential performance.

Advanced information systems

- ERP – Enterprises Resources Planning for systems and their use present a sizeable competitive advantage for SMEs. 79% of the studied companies do not conduct tests of information system functionality at least 1x every three years. During the study, it was determined that even prospective companies often use outdated information systems intended in particular for basic needs such as managing accounting or tax records. These outdated systems often do not allow for efficient managerial accounting and are often marked by higher costs for data collection and evaluation, and the outcomes often tend not to be current. The implementation of modern ERP systems enables active data collection and evaluation – sometimes even in real-time.
- Cloud, connectivity, automated data sharing – for the time being, this represents an underused area. It was determined that 42% of the studied companies take advantage in some way, at least to a necessary extent, of shared surfaces, data repositories, etc. More advanced use of technologies — such as automated management of remote worksites, automated data exchange between various subjects, and others —– were used by

only 7% of the subjects in the studied companies, whereas it is these solutions that can offer substantial reductions in production costs and thereby increase competitiveness.

– Digitization and controlling – to digitize and manage in a modern way does not mean only converting an old system (processes, organizational structure, logistics, etc.) into digital form. To digitize means to modernize processes, increase their efficiency, and ultimately transform an entire business. Only 34% of the studied businesses had experience implementing modern controlling management, and only 1/3 of the studied businesses identified their implementation of modern controlling management to be without issues. An interesting perspective on the implementation of controlling and process auditing in innovation processes is emphasized primarily by Karjalainen *et al.* (2018, p. 450); this issue is also addressed by Vitezić and Vitezić (2015, p. 176). The authors agree regarding the essence of the symbiosis of controlling and process auditing and state that these fields will have great importance for SME and their competitiveness. Modern controlling has a visible impact on the functioning of process auditing, as stated by Mahdavi and Abbas (2017).

Technology, 3D printing, IoT, Big Data, AI and others — while it seems that these are terms we often encounter, the reality in the studied companies is such that practical examples of their use in SMEs appear only rarely. There is a wide range of factors preventing mass uptake of new technologies. In the study sample, 64% of companies lack complete or adequate strategic development of the company with regard to the implementation of the above technologies. The remaining companies are considering implementation, yet 83% do not consider execution within five years to be realistic. In the complete study sample of 341 companies, there were only 21 that used these technologies in any way. This fact may be considered significant for the competitiveness of SMEs in the next ten years.

Regular analysis and seeking opportunities for innovation — is one of the most critical defects of SMEs. These companies lack analysis of their external and internal environments for the purpose of seeking opportunities. This is one of the main functions of controlling, which regularly analyzes historical data for comparison to the current status obtained on the basis of analysis. According to these findings, it then specifies a more accurate prognosis, which is used as a basis for defining company goals. Modern controlling may then be viewed as an impetus for change and innovation. This article expands the study of modern controlling of the company in the broader multi-disciplinary context of management, human resource management, and the issues of competitiveness of SMEs in Industry 4.0. (Müller & Däschle, 2018, p. 1; also Petrů *et al.*, 2018). An essential part of regu-

lar analysis and seeking innovation opportunities is their continuity, as stated by Henttonen and Lehtimäki (2017).

Strategy for digitization and the Industry 4.0 environment is one of the present significant aspects for SMEs in the environment of Industry 4.0. Regular updates to the strategic plan of digital development with an emphasis on the innovation activities of the company are essential for an SME. In the concept of Marjański and Sułkowski (2019) process auditing is described as significantly contributing to the innovativeness of business processes and creation of the digitization strategy in SMEs. Benefits of strategic planning and digitization are reflected in the activities of SMEs that can make effective decisions, which also supports the theory of modern management, according to Draheim (2010, p. 11).

Conclusions

Using controlling as a tool for managing a company in Industry 4.0 is profiled by this study as an effective approach for SMEs, which enables to support their competitiveness. On the basis of statistical analysis conducted a relationship between controlling management, process maturity, innovation activities and the technological level of the company was confirmed. This finding indicates that increasing the activity and the level of one variable also increases the level of other variables and thereby their benefit. The study data also indicates that the level of controlling management of a company and its innovation activities are also important factors for its financial health and competitiveness. Statistical analysis and backwards experimental testing of its conclusions have validated these results and key factors for modern controlling management of a business and increasing its competitiveness have been defined on that basis. This has fulfilled the study objectives and has either validated or failed to substantiate study hypotheses.

However, this research also has some limitations. One of the important limits is the time factor. The process of data collecting based on depth personal research inside companies, data processing and backward testing is a time-consuming process. The other time factor is visible in the current hyper-competitive environment and its rapid development. If these research findings may be used in SME practices, then ot is important to deliver it in short time. These limitations are causing that the research sample must be revised in time and data older than 3 years couldn't be used. The way these limits should be crossed is to conduct the same or similar research by more teams in different places and compare the obtained results.

SMEs are the foundations of national and European economies and modern controlling may be used as a tool for their management and increased competitiveness. This reseach also raises interesting questions that can serve as the basis for future study and deepening knowledge in these issues and beyond. How to stimulate SMEs change management for higher innovative activities and also decrease innovation risk factors? How to develop and apply ERP systems ready for easy implementation and cross SMEs cooperation? How to motivate SMEs for implementation Industry 4.0 and its tool to be able to increase their competitiveness? These and many other questions arising and defining topics for future research and its objectives.

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Annex

Table 1. Dependent Variable Innovation plan, variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	Controlling management system	---	Stepwise*
2	Internal audit	---	Stepwise*
3	Employees	---	Stepwise*
4	Process maturity level	---	Stepwise*
5	Strategic plan	---	Stepwise*
6	ROE	---	Stepwise*

Criteria: Probability-of-F-to-enter <= 0.050, Probability-of-F-to-remove >= 0.100).

Table 2. Dependent Variable – calculation of the resulting model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.354	0.077		4.566	0.000
	Controlling management system	0.862	0.032	0.823	26.661	0.000
2	(Constant)	0.110	0.073		1.507	0.133
	Controlling management system	0.585	0.040	0.558	14.455	0.000
	Internal audit	0.374	0.039	0.374	9.685	0.000
3	(Constant)	0.012	0.076		0.163	0.870
	Controlling management system	0.538	0.041	0.514	13.045	0.000
	Internal audit	0.348	0.038	0.348	9.089	0.000
	Employees	0.100	0.025	0.126	4.024	0.000
4	(Constant)	0.019	0.075		0.249	0.804
	Controlling management system	0.475	0.048	0.454	10.005	0.000
	Internal audit	0.283	0.046	0.283	6.213	0.000
	Employees	0.089	0.025	0.113	3.594	0.000
	Process maturity level	0.106	0.041	0.141	2.608	0.010
5	(Constant)	0.041	0.074		0.553	0.581
	Controlling management system	0.498	0.048	0.475	10.474	0.000
	Internal audit	0.304	0.046	0.304	6.681	0.000
	Employees	0.106	0.025	0.133	4.195	0.000
	Process maturity level	0.123	0.041	0.164	3.027	0.003
	Strategic plan	-0.156	0.052	-0.108	-3.018	0.003

Table 2. Continued

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
6	(Constant)	-0.089	0.095		-0.936	0.040
	Controlling management system	0.473	0.049	0.451	9.726	0.000
	Internal audit	0.312	0.045	0.313	6.877	0.000
	Employees	0.111	0.025	0.140	4.404	0.000
	Process maturity level	0.107	0.041	0.143	2.616	0.009
	Strategic plan	-0.157	0.052	-0.108	-3.045	0.003
	ROE	0.069	0.032	0.066	2.196	0.029

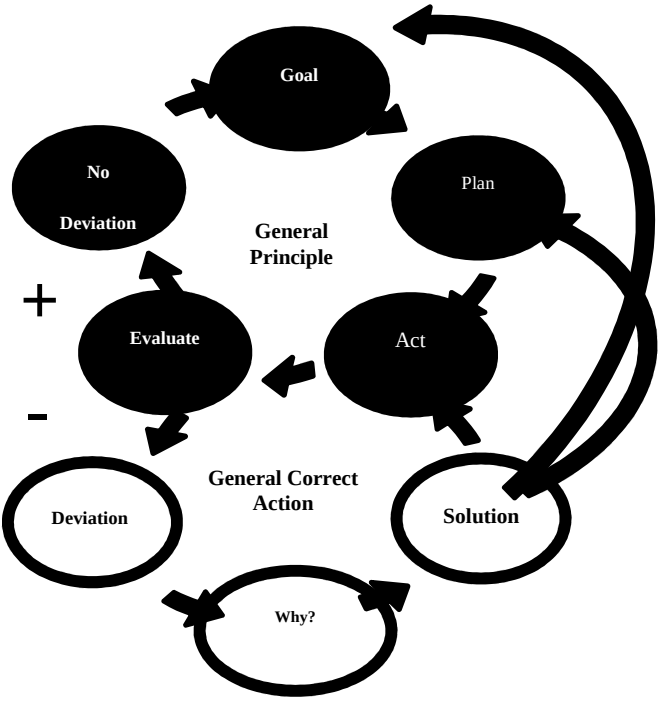
Table 3. Model F-test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	274.474	1	274.474	710.829	0.000[b]
	Residual	130.899	339	0.386		
	Total	405.372	340			
2	Regression	302.910	2	151.455	499.617	0.000[c]
	Residual	102.462	338	0.303		
	Total	405.372	340			
3	Regression	307.608	3	102.536	353.447	0.000[d]
	Residual	97.765	337	0.290		
	Total	405.372	340			
4	Regression	309.548	4	77.387	271.350	0.000[e]
	Residual	95.825	336	0.285		
	Total	405.372	340			
5	Regression	312.084	5	62.417	224.141	0.000[f]
	Residual	93.288	335	0.278		
	Total	405.372	340			
6	Regression	313.412	6	52.235	189.719	0.000[g]
	Residual	91.960	334	0.275		
	Total	405.372	340			

Table 4. Trend of determination coefficient values(R-squared)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.823[a]	0.677	0.676	0.621
2	0.864[b]	0.747	0.746	0.551
3	0.871[c]	0.759	0.757	0.539
4	0.874[d]	0.764	0.761	0.534
5	0.877[e]	0.770	0.766	0.528
6	0.879[f]	0.773	0.769	0.525

Figure 1. The process of controlling management



Goal – this can be a specific objective, innovation, market position, number of units sold, etc.
Plan – this describes the strategy for achieving the established goal, needed resources, budget, risk management, expected outputs, and other essential components.
Action – initiating the execution of the plan and continuing until the established goal is met; in the event of an unsuccessful innovation or significant deviations, stopping activities in order to protect the stability of the company, not wasting resources and orientation on other projects/goals.
Evaluation – at reasonable, regular intervals on a continuous basis until the goal is met.
No deviation found – the controlling process will continue until the goal is achieved.
Deviation identified – should be identified in positive or negative numbers. Is also necessary to define the possible evaluation results range, when, for example, 3 % deviation is not calculated as a deviation.
Negative deviation – the achievement of the goal is endangered. This may include, for example, a decrease in sales, a substantial increase in costs, an error in executing the plan, failure to meet customer expectations, etc. Negative deviations are influencing and visible in the financial stability of the business. An important step and task of controlling is any necessary termination or fundamental restructuring of the plan that is failing. In an SME, a repeated process error tends to be due to the controlling process following a random or nonexistent interval, or an interval that has been chosen inappropriately.
Positive deviation – the first meaning to a positive deviation may be positive. To sell over the plan, to complete a process more quickly, with lower costs, etc. is a positive outcome. In reality, however, a positive deviation proving an error or inaccurately planning, inefficient capital or resources using, or other issues which decrease profit. Negative deviation should be decreased or eliminated by more precise planning, by processes optimizing, by more accurate forecasting and by other ways.
Why? At the time of detecting the deviation, it is essential to immediately initiate an analysis of the origin of the deviation for the purpose of eliminating it.
Solution – measures are proposed based on the analysis of the deviation. In the event of a non-functioning solution, the company tries a different solution and continues until the deviation is eliminated or the pursuit of the goal is discontinued.