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OPPORTUNITIES OF LEAN THINKING IN IMPROVING THE COMPETITIVENESS OF THE HUNGARIAN SME SECTOR

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Abstract
One of the key factors of a competitive economy is creating a strong, internationally competitive SME sector. This essay is based on the fact that management tools used in the SME sector are insufficient. With the development of these tools, the competitiveness of companies could improve. According to the literature, using lean thinking has a positive influence on the company's effectiveness, and also proved that lean approach can be successfully extended out of the car industry, into the limitedly resourced SME sector, too. Even though the topic of lean manufacturing is analysed by many studies, there is a lack of papers dealing with its usage in the SME sector.
The originality of this paper lies in analysing the current status of using lean manufacturing practices among the Hungarian SMEs operating in the manufacturing industry. The paper includes an examination about how deeply the elements of lean thinking are present in the Hungarian SME sector, how large the development reserves are, and whether there is a difference between the usage of lean practices.
A structured questionnaire was used for data collection. SMEs' representatives, mostly CEOs and managers from the Hungarian manufacturing industry participated in the survey. The sample contained 128 observations. The study has two control variables, which are the size of the company and the relation to the lean management.
The survey brought the following results. First of all, it shows that the level of using lean is low among the Hungarian SMEs. Furthermore, customer orientation is a key factor in the sector, however, there are considerable possibilities for progress by the inner processes and the handling and involvement of the suppliers. Firstly, a good basis to increase the effectiveness could be the creation of thinking in processes influencing the supply chain. Secondly, the development of the leadership and the involvement of the employees at some level are also significant. Key findings is that without state incitement and the involvement of outside experts, progress cannot be expected to spread on a broad scope.
The background of the research method was created to fit the available literature and to capable to be used in other countries, too. Moreover, this way the available information can be expanded with a regional dimension, in case further studies are going to be made.

Keywords
SMEs, lean implementation, lean manufacturing, lean thinking, Hungarian SMEs.

Introduction

While 99.8% of the Hungarian companies belong to SME sector, 70% of the employees are working at these corporations, which give about the 53% of the GDP and one third of the export. 94% of SME's micro companies, providing half of the sector's employees and one third of the GDP generated by the sector. SMEs are the basis of national economy with mostly domestically owned businesses, whose more eminent enter to the international circulation determining the potential of the long term competitiveness.

If we look at the German example, there is a strong layer of medium enterprises owned by one person or one family, who ensure the trustworthi-

ness of the company with their name and wealth. The companies of the so called 'Mittelstand' (middle level) are independently able to export and they also have a great R&D potential. These provide the crucial part of the German economy's efficiency. The establishment of a similar corporation background in Hungary would be the key element to catch up. This is included in the government's future plans as well. There have been several government programs to encourage this process, but none of them brought breakthrough results yet.

Based on the 2016 report of the European Small Business Act [1] Fig. 1, the comparison of the results in the Middle-European region and in some reference countries was completed. Out of the 9 fundamental principles analysed in the SBA-profile, the greatest leeway can be experienced on the field of 'second chances' and 'skills & innovation'. Assisting the new start after promiscuous failings could be important in the increase of undertaking entrepreneurship and extending the strata of entrepreneurs.

The "skills & innovation" creates the future competitiveness, so it has a key importance. The principle measures the achieved innovation, the cooperation in innovations, the part-taking in the e-commerce, the availability of the ICT specialist skills and the related training of the employees in the SME sector. In the current European Union budget period, the R&D&I based subsidies became an advantaged factor. At the same time, supporting goods and process innovation seems to be a preferred area compared to organizational innovation appearing in the [2] as well.

According to the author, the management toolkit applied in the SME sector is frequently insufficient, influencing negatively the competitiveness of companies. The author assumes that efficiency reserves – so called organisational innovation options – are exist in the sector. Improving them, the competitiveness of the company could also increase. There are reserves in the management and in other levels of the company, in the organizational culture and also in the use of complex management views that are not in need of excessive apparatus. Since the quality of management influences the market placement of the company's extant technical innovation, the organizational innovation can be the basis of constant renewal skill and the establishment of innovation focused, too. It means that a progress in the organizational innovation could induce the increase of competitiveness.

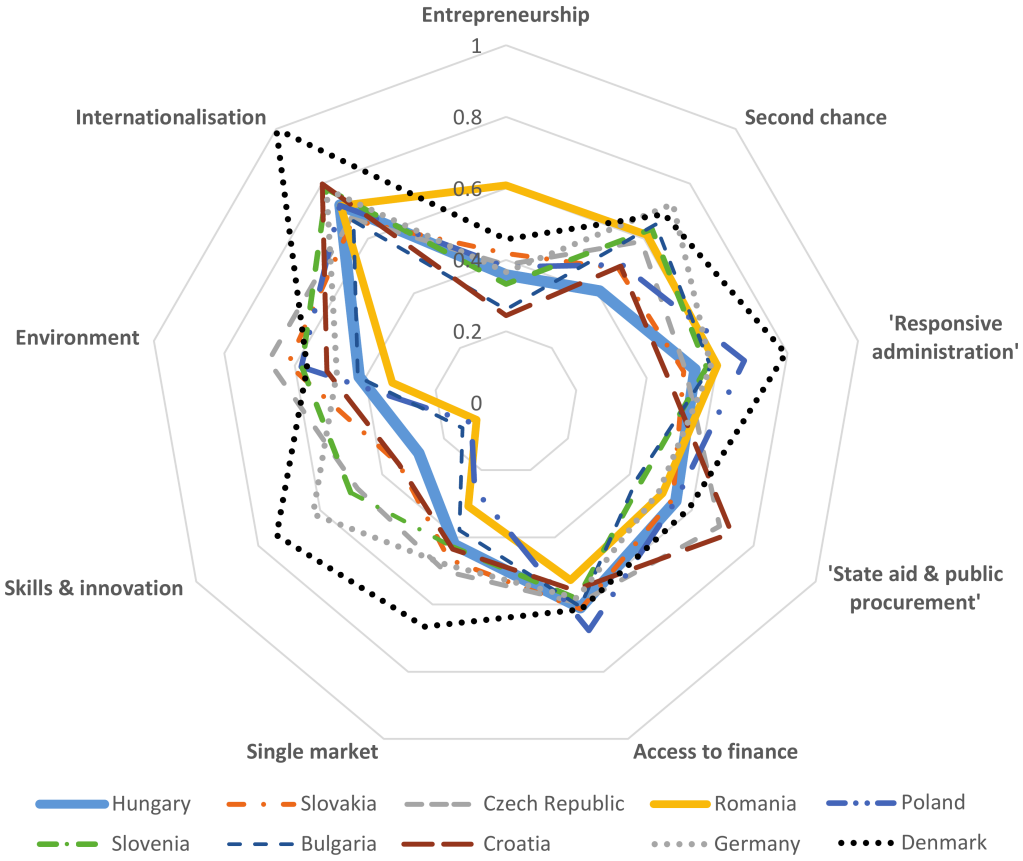

Fig. 1. The SBA profiles of the Central European region, based on [1].

The speciality of the SME sector is the limited size of available resources arisen from its size, what determines the possibilities of improving the management toolkit. The toolkits of the lean manufacturing, which were spreading widely the previous years, can be reached by SMEs. This way of organization development is easily completed and it is also an alternative to develop efficiency. The author brings this into the study. [3] shows a positive effect between the use of lean manufacturing practices and the company's operational performance among the small and medium sized manufacturing enterprises.

This essay analyses how deeply the elements of lean thinking are present in the Hungarian SME sector working in the processing industry and it deals with the question how large the development reserves are. It is also part of the analysis, which aims to evaluate the possible differences between the usage of lean practices and revealing the tools, which would be the best to focus on first.

Literature review

Lean production

The roots of the lean production system [4] go back to the production system of the Toyota (TPS) [5]. The increasing efficiency of the Far Eastern corporation occupied the Western researchers as well. It took long time before these production methods could have been implemented fully and operationally into practice. The two basic concepts, that the system is built on, are the elimination of waste and the respect for people. The latter one has a completely different basis in the Japanese culture, so the view itself needs to be implemented. The toolkit relies on the success of this implementation.

The power within people is one of the driving forces of lean. It builds on the employees and their ideas, and this is from where one of its critical points derives. How do we reach it in a society where coming up with new ideas is not usual on an operational level? How could employees on operational level motivated? [6].

The book called "The Machine That Changed the World" by [7] was the turning point, after which this approach started to get more and more naturalized in the Western culture. The lean shows how to acquire the ability of constant development, how to configure the processes to match real costumer demands, and how to create a quality-oriented and flexible organization, which involving the members of the supply chain, focuses on producing real (consumer) value. The lean system, using fewer resources, produces an output with the same or better quality, providing a higher costumer value.

The lean manufacturing can be referred as an idea, philosophy, as a strategy and also as a set of methods and tools which may lead to terminological conflicts [8]. Out of the definitions of the lean literature [9, 10] definition stands the closest to the author:

"Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability."

This definition greatly emphasizes that the organizational culture and the lean toolkit are the two pillars. Building on the cooperation of these, the efficiency of business activity can be improved considering the processes outreaching the company. The main principals of lean fit this definition perfectly. These are the followings: (customer) value, value stream, flow, pull, continuous improvement [11].

The lean based company leadership became popular last two decades, though according to certain researches the effectiveness can vary in different sectors and organizations. For instants big and inflexible machines, long setup time, small series and complex resource-system are typical in the processing industry. Beside organizational factors, such as the size of the organization, the types of suppliers and customers, the intension of automatization, also the types of products and the requirements of quality control are crucial. Similarly, at SMEs and big corporations, the structure, the decision making process, the exploitation of resources, the culture and the subsidies are influencing the introduction of lean-minded company leadership [12].

[13] showed, that companies that follow cost leadership and differentiation strategies also use the lean production system is also used by companies that follow cost leadership and differentiation strategies. He pointed out that the quality- and flexibility oriented lean companies apply the lean techniques more intensely. These companies achieve greater improvement on most of the efficiency indicators. At the same time, he did not find connection between the two strategical production orientation and practices of the high performance work system's (HPWS) extended enforcement, furthermore he could not prove the positive effect of the HPWS practices on the effectiveness. This, however can be explained so, that there is a minimum level of factors connected to high performance work system which is higher than the similar level at companies using the traditional production system. Meeting this minimum level is necessary to reach the positive effect of lean production.

The lean management is becoming more popular among SMEs last decade, at the same time there is still a vast potential in this sector. The implementation and usage of lean methods primarily spread through the consultative sphere and the requirements of multinational corporations towards their suppliers, while the introduction demand of company leadership who experiences the positive changes at the neighbours is also getting more considerable.

Lean management in the SME sector

The small and medium enterprises have less resources and capital. The missing management knowledge is often a disadvantage. The management knowledge of growing micro companies based on the excellent technical knowledge is not developing, they do not learn modern management methods. It is common that the owner is the head of the company so he has to be convinced of the benefits of new management perspective. He also has to realize that introducing this perspective is not cost- and time-wasting 'alchemy', but it has real results and advantages, because the management commitment is a significant principle in organizational development projects. As barrier of introducing the lean management is when the lean perspective stops at the door of the factory. The management of the company does not trust their business partners, they do not involve them in the development, which becomes the barrier of the integrated lean approach. In the SME sector, introducing lean management is often not an individual initiation, but the dominant customer is insisting on it, for example as part of its development program concerning the value chain [14]. At the same time, being more flexible than the big companies can be an advantage for them. It is easier to introduce lean practices because of having more informal inner relationships, shorter communication chains, less bureaucracy and traditional requirements [14].

The literature that deals with the connection between the lean production and the SME sector typically analyses three areas. The critical success factors connected to the implementation of the lean production is profoundly disclosed, and several literatures deal with the possibilities of implementing lean production system. As shown below, only a few literatures deal with the analysis of the operational lean tools that can be used in the SME sector.

The critical success factors of implementing lean in the SME sector

[15] identified the following critical factors during the implementation of lean management into the SME sector. During the first phase of the implementation, the commitment and support of the management, and the training done by the lean expert are the most important. Aside from those, fitting to the strategy, the long-term perspective, the proper methods, the proper scope, and the proper planning are also highlighted as determining aspects. This resonates with other fields, for example the experiences in connection to the success of an IT implementation project [16]. According to [15] the most important factor in the execution phase is the implementation based on pilot projects. One of the basic principles of the agile project management is based on the fact that you can eat a big elephant also just in small bites [16].

The proper time- and resource allocation, the proper budget for training and for outer consultants, the early change of culture and the involvement of employees are also significant factors. The standardization of the best exercises and the elaboration of measuring the achievement are inevitable for the long-term sustainment [15].

[12, 17] and [18] reach similar conclusions. A research done among the Polish SMEs showed the shortcoming of management as the critical factor. Having problems with information flow, being uninformed about the effects of the to-be-carried-out assignments, and identifying lean as a process surely followed by lay-offs that force employees to stand against the change. Setting short-term financial goals is also a regular mistake [19].

Examining SMEs in the food industry, [12] reached the conclusion that trained employees and in-house competence are more crucial factors than the commitment and support of the management. [20] also emphasizes that the main priority of the sustainable execution of becoming a lean is the cultural change. [21] also highlights the organizational and cultural factors, such as commitment, strategy, adaptation, and the role of leadership, as the under-the-surface basement of the lean iceberg model, upon which the sustainable development can be built.

[22] distinguish the challenges of the SMEs at the different stages of lean implementation (based on the time since the beginning of the introduction). [23] investigates in the correlations (strengths and conflicts) between the principles of lean manufacturing, [33] and the characteristics of SMEs via literature review. The results emphasize that the notions of leadership, expertise and decision-making are crucial.

[24] analysed the critical factors in contingency theory perspective (depending on the organization, the size of the company, the lean maturity and the national culture). He did not find essential differences between the SMEs and the big enterprises, howev-

er, he showed that on a lower level of lean maturity the using of rewards and recognition, the finding and sharing of best practices, and the use of external experts are more important than on higher levels of maturity. This is specially accented in the successful implementation of lean manufacturing at companies of the SME sector.

Lean implementation is a project, in which most of the critical factors overlap with the critical factors of the success of a general project. The important element provided by them highlights the critical role of human resources. The base of long-term success can be the development based on the involvement and commitment. According to the author the results of [24] can be used especially well. The contingency theory suggests that distinct environments require different approaches, so CSFs are the most effective when they are tailored to different environments. The above-mentioned results mentioned point out the especial significance of involving an outer expert in the beginning stages of implementing lean at SMEs. This involvement can be the basis of creating the inner experts in the future. Furthermore, to uncover good practices and to develop a system of rewards and recognition that inspire to use them are also essential in lean introduction.

How to introduce lean into the SME sector

There are two different directions of the implementation. The approach of full implementation keeps the long-term goal in sight, thinks in a system and moves on with small steps on long-term toward becoming lean. The concept of rapid improvement (kaizen blitz) mainly aims to reform the problematic areas and to have quick wins [25]. The resource need of full implementation is a risk factor for SMEs, while in kaizen blitz, skipping long-term fundamentals is touch-and-go. Quick wins but long-term perspective – this is how you can define the goals of lean introduction in the case of SMEs. The quick wins help the commitment of management and employees. However, it has to be taken into account that the organizational and cultural background needs to be built up step by step at the same time., It has a constant need for development creating the milieu of sustainable development [26].

[27] confirmed, that out of corporations which are using process control practices on the same level, the ones which highlights the priority of sustainability will generate bigger performance improvements, than those who focus less on sustainability.

Several researches try to create an implementation model for the SMEs [14], [28]. [29] shows a successful way of lean implementation facilitated with a systematic use of business process change approach. Boehm's software development spiral model is the basis of [20]'s lean incipience spiral model, in which the corporation steps onto the next level of maturity in an iterative way, relying on the previous stages. This way result in quickly noticeable results with less resource investment while also it keeps the risks low and makes the management's task easier. This is a useable approach for SMEs that have not had any experience yet about the first steps.

[30] try to measure the leanness of an organisation, how deeply the lean thinking is adopted. [31] defines a framework to align operational indicators with strategic objectives using lean management. [32] proposes the use of production lead time for measuring the level of leanness of production.

The lean production itself started in the SME era, when Sakichi Toyoda established his automatic loom factory [33]. The lean can be understood as a perspective that influences the view of the business and the processes [34]. With the help of lean thinking and approach the toolkits which previously focused on the production companies can be used with a growing success by companies in the service sector. The success factors mentioned above show that primarily the change of the organizational and cultural factors is the key. Other tools can be built on this. This does not mean partial implementation [25], but step-by-step development fitted to the level of maturity by [20], which is based on the creation of commitment and on supporting culture. So culture is not just result but also a base of a sustainable and successful lean implementation [9, 35].

Not all the elements of lean are suitable for every SME. For example, not every product type is suitable with pull system. Otherwise, there are relevant tools and also the organizational culture based on constant development which are able to ensure efficiency at any companies. From this point of view, lean management is an attitude, a perspective, which organizes and manages business processes keeping some main organizing principles in focus.

Upon this ground, we can overview what lean tools are capable to use in the SME sector.

Lean tools in the SME sector

There are relatively few literature, that makes suggestion for lean tools for the SME sector. [14], and [15] suggest the following lean tools for the companies in the SME sector: FIFO; 5S; Benchmarking; Kaizen; Idea management; Job rotation; Autonomous and varied teams, empowerment; Visual management; Just in Time; Pull system and Kanban; Zero Defect through process-integrated failure control, poka-yoke; Value Stream Mapping (VSM); Decreasing the setup time; Low cost (intelligent) au-

tomation; Cellular manufacturing; Standardization; Scoreboards (lean KPI) and Knowledge management.

[36]'s research studying the companies in food industry leads to the conclusion that the small- and medium-sized enterprises mostly use customer-related practices and total productive maintenance (TPM). [37] investigates the connections between lean manufacturing and manufacturing flexibility in SMEs using a single case study.

From the very broad list above it is visible, that there is no specific toolkit developed for SMEs. However, that certain basic principle of contingency theory is true which suggests that different environments requires different approaches. It has to be stated, that the use of lean tools is not determined by the size of the company but the goal aimed to be achieved by the company. The customization of lean tools based on lean principles can play the key role in comprehensive success.

The usability of lean tools for SMEs, the possibilities and the limitation factors of the implementation of these tools in the SME sector was overviewed in [38].

Research methods

Qualitative and quantitative methods were used for the research. During the first phase five interviews were carried out – three managers, one consultant and a person from the academic sphere was questioned. The answers helped to set the questionnaire.

The survey ran on LimeSurvey open source survey software on the university's server. The author filtered the invited corporations with the help of the Bisnode PartnerRadar database's service to fill out the survey. The members of the target group are working actively under the NACE 20–33 (except '18 Printing and reproduction of recorded media' and '33 Repair and installation of machinery and equipment') code (manufacturing industry) and employ between 20 and 249 people. All of the requests were sent out individually. The author also contacted directly companies with which he is acquainted. The survey was completed during the spring of 2017.

Approximately 2600 invitation was sent out, out of which there was 585 (22.5%) started survey along with 149 finished one. The 5.73% response rate unfortunately fell under the referenced rate of about 10% that was observed in the literature. Based on the latest data from the Hungarian Central Statistical Office [39] for the year 2015, under the NACE codes 10–17 and 19–32, with 20–249 people employed, there were 3805 acting companies, which means that approximately 68% of them were contacted.

Assuming a directly proportional connection between the number of employees and the complexity of the company's operation processes, the author set the staff headcount's lower limit at 20 employees. In the case of smaller companies (under 20 employees), the complexity of the process management, the possibilities in it and the benefit generated by the lean is significantly lower compared to the chosen small and medium-sized enterprises. The medium-sized companies' category of 50–249 people was divided into two approximately similar parts above and under 110 people. With the help of these categories, the dependence on size can be even more accurately analysed.

In fear of distortions, companies were not forced to provide the turnover and the balance sheet. In the case of lean manufacturing, the number of employees is more decisive, than the revenue and the balance sheet total which are dependent on the type of product (for example the material cost, machine requirements built in the product). The classification according to the number of employment suits the previous international statistical practices, as well. 80% of those, who filled the survey gave these data, all of them being under the EU SME-classification limit [40]. This study considers small and medium-sized enterprises as it was defined above under the concept of SMEs.

Despite the careful invites, some companies which answered the questionnaire turned out to be too small (9 companies) or too big (4 companies) based on the number of employees, thus the author disqualified them. 8 companies were also disqualified, because they checked the service activity by the monitoring questions. (When the questionnaire was created, the author planned to involve companies with service activities, too. By these companies, more categories cannot be defined, but the author supposed that the practices of lean office could be analysed. During the first round of questionnaire survey, experiences required to exclude companies with service activities. The questionnaire has to be customised to this sector, so this survey is not dealing with SMEs with service profile.) The sample containing 128 cases is certainly acceptable based on the studies in the examinable field. For example, [41] compared 3 countries, used a sample consisting 35 observations and refers to other similarly-sized studies as justification.

Answers came from all 19 counties, however, their distribution does not follow any patterns. In the sample there are 56 companies with staff headcount up until 49, 35 companies employ between 50–110 peo-

ple and 37 companies have between 111–249 employees. The questionnaire was typically filled out by CEOs, head managers, logistic managers, financial managers or other managers.

The questionnaire found in *Appendix* included two sections. The first one covered the company's profile and asked about the usage of lean concept. The second section was m eant to map out the connection with the lean practices. There were statements drafted here. The implementation of these had to be evaluated on a seven point Likert scale (from 1 – strongly disagree/no implementation, to 7 – strongly agree/full implementation) in connection with the plant.

Formulating the statements was based on the study of [10]. This holistic study included both the external and the internal, and both the social and the technical factors, which was confirmed by statistical procedures. Furthermore, it is also an advantage, that the already existing examinational framework gives the possibility to compare the results with the results of former researches. This was also a strong reason for using the existing framework. However, according to the interviews the author modified and extended the framework, while paying attention not to harm the core statements' comparability. While translating the statements to Hungarian, the author intended to avoid lean technical terms, to receive clear answers from companies that are not qualified in lean manufacturing. The model for the research is shown in Fig. 2.

[10] based the definition of the lean manufacturing on ten detached lean elements, which are classified into three categories: supplier related, customer related and internally related elements. The ten elements are the followings: supplier feedback, JIT delivery, developing suppliers, involved customers, pull (developing JIT and Kanban), flow, low setup, (statistically) controlled processes (SCP), TPM and involved employees. The range of internal elements was extended with the poka-yoke, 5S, visual management, genba, autonomous team, in-process quality and leadership & atmosphere dimensions. The lowest level indicates the number of the statements in connection to the operational constructs.

The author created an index number from the average of the observations to the statements given to the different dimensions. This way the operational construct level was analysed with 17 index score, the underlying construct level with 3 index score and the main concept level with a fully contracted index score.

At the evaluation of the statements there were a 'not explainable by the given company' and a 'no answer' option provided. Because of the number statements (53), it was absolutely necessary to avoid anamorphosis. Aside the 57 fully filled questionnaire, the others had missing data, mostly from the Pull, Flow, Setup and SCP dimensions.

If the answer rate of operational measures belong to a given operational construct was under 41% in a respond, on the higher level 'missing value' was written instead of index points. Taking this rule into account by the main concept index score, the ratio of the missing value is 2.3%, while in the case of the underlying construct index scores 6.7% the maximum and finally by the 17 index scores of the operational construct level the highest missing value is 14.8%. All of them are under the previously determined expectation of maximum 15%.

On the level of the underlying construct the Cronbach's alpha is 80.4%, which indicates an appropriate reliability. On the level of the operational construct the Cronbach's alpha score is 90.4%, which strengthens the internal consistency. The value is on the verge of redundancy [42]. If we examine the original ten dimensions of [10], the score is 86.8%, which means that the dimensions' expansions have an explanatory effect.

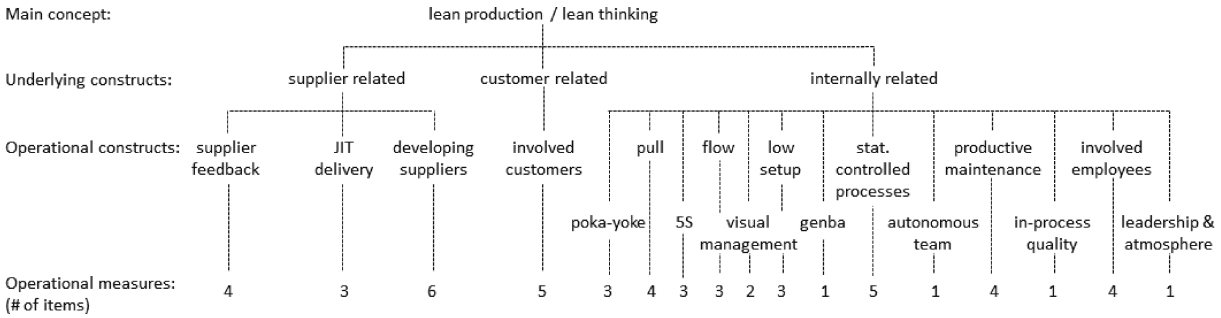

Fig. 2. The research model based on [10], modified and extended.

A wide range of the literature proves the positive effect of the lean manufacturing on the company's effectiveness (several cases are determined for example by [3, 34, 43], and [44]). [41] established, that the examined corporations in the food industry primarily have reached results in reducing cost, improving profitability, increasing productivity and reducing customer complaints. [45] analysed the lean practices' effect on inventory turnover. [27] also showed the positive effects of the process control practices on operational performance in the dimensions of costs, quality, flexibility and dependability dimensions.

Based on that the questions of the research are the followings:

RQ1 On what levels do the lean practices show up among the Hungarian SMEs? How big are the efficiency development reserves on this field?

RQ2 Are there notable differences between the implementation levels of the different practices? Which dimensions' development would be worth focusing on?

The study used descriptive statistics, Chi-Square Test, ANOVA and a non-parametric test (Friedman's, Wilcoxon and Kruskal-Wallis H tests) for analysing the data, because the assumption of normal distribution of the variables based on the done Shapiro-Wilk test could not be guaranteed in every single case. Both descriptive and exploratory statistical analyses were conducted to check the association between exploration variables (plant size, relation to lean) and the research questions. To the methodically proper way of using the statistical methods [46] was the basis. The following section explains the results.

Results

As shown in Table 1, the average of the lean total score (4,514) is moderate, there is room for improvement. On the underlying constructs' level the normality of 'Customer related' score was not confirmed by the Shapiro-Wilk test, thus Friedman's non-parametric test was run to determine the existence of differences in the underlying constructs scores. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. The scores were statistically significantly different, $\chi^2(2) = 74.801$, $p < .0005$. Post hoc (Wilcoxon) analysis revealed statistically significant differences between 'Customer related' score and 'Internally related' score ($p < .0005$) and 'Customer related' score and 'Supplier related' score ($p = .0005$), but not between 'Supplier related' score and 'Internally related' score. It can be stated, that customer orientation is significantly more present, than the relationships with the supplier.

Table 1
Use of lean among the Hungarian SMEs.

	N	Mean	SD
Main concept:			
lean total score	125	4.514	0.896
Underlying constructs:			
'internally related' score	125	4.484	0.975
'customer related' score	126	5.306	1.203
'supplier related' score	120	4.212	1.015
Operational constructs:			
in-process quality score	119	5.529	1.437
genba score	125	5.512	1.479
poka-yoke score	123	5.440	1.231
customer involvement score	126	5.306	1.203
supplier feedback score	124	5.271	1.099
leadership & atmosphere score	126	5.198	1.585
flow score	109	5.069	1.572
5S score	124	4.765	1.455
pull score	114	4.673	1.448
TPM score	127	4.599	1.437
low setup score	111	4.480	1.351
Employee involvement score	125	4.341	1.352
autonomous team score	122	4.287	1.718
(Supplier) JIT delivery score	115	4.242	1.441
supplier development score	117	3.438	1.119
stat. controlled processes score	116	3.238	1.647
visual management score	125	3.060	1.703

On the operational constructs level also the Friedman's non-parametric test was conducted and pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. The scores were statistically significantly different, $\chi^2(16) = 423.771$, $p < .0005$. Post hoc analysis revealed statistically significant differences. Altogether 73 significant ($p < .05$) deviation was shown out of the possible 136. The last three elements of the order based on the average (Table 1) is significantly different from all of the elements above. This means that the visual management, the statistically controlled processes and the supplier development require development the most. The easier implemented practices with fewer resources required (for example in-process quality, genba, poka-yoke), significantly bigger scores. This proves that the lean toolset in the SME sector accompanied with limited resources is also an available possibility.

Depending on the fulfilment of a normal assumption, the Kruskal-Wallis H test or the ANOVA as an exploratory statistical analyses were also conducted to check the association between exploration vari-

ables (plant size, relation to lean manufacturing) and the use of lean practices.

In case of the variables of lean total score and the underlying constructs level, the difference based on the company's size cannot be shown. On the operational constructs level two statistically significant difference can be proved, in the case of genba ($\chi^2(2) = 8.29$, $p = .016$) and the statistically controlled processes ($\chi^2(2) = 16.566$, $p < .0005$). Consequently, pairwise comparisons were performed using Dunn's procedure with a Bonferroni correction for multiple comparisons, and adjusted p-values are presented. This post hoc analysis revealed statistically significant differences in genba scores between the small companies that employ up until 49 people and the companies with 110-249 employees ($p = .015$). The score of small companies is significantly higher, thanks to the fact, that the local observation and decision making is not necessarily a conscious tool, but the result of the subconscious usage of this practice. This can be a consequence of the bigger informality and the simpler processes of small companies. The post hoc analysis also revealed statistically significant differences in statistically controlled processes scores between the small companies that employ up until 49 people and the companies with 110–249 employees ($p = .015$). The tool with a special resource requirement appears significantly more strongly by bigger sized companies.

However, it is statistically not significant, more factors outside of genba receive higher average by smaller companies. These factors are autonomous team, leadership & atmosphere, TPM, 5S, poka-yoke, in-process quality, supplier feedback. The small enterprises' easier processes can explain these differences. For instants, the 5S can be implemented to one desk. Even if the small enterprise is not using it, they can feel having no mess and less loss caused by being unstructured. For this reason, the small enterprise is less sensible to the problem. It is also true for managing the processes or the informal inner and external relationships. With the increase of size, this kind of flexibility has to become more structured. The lean thinking and practices can help to develop this effectively.

The inner association also got analysed in context of the current relation to lean manufacturing. There were five groups separated in relation to lean manufacturing. The (1) consistent users, the (2) those who only use it in some of their activities; and out of those who do not use lean, (3) those who have short-term plans to implement it, (4) those who know lean (but do not plan on using it), and (5) those who do not know lean manufacturing.

A one-way ANOVA was conducted to determine if the lean total score was different for groups with relation to lean manufacturing. Data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$). There was homogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p = .262$). The differences between groups was statistically significant, $F(4,\ 120) = 4.084$, $p = .004$, $\omega^2 = 0.09$. Tukey post hoc analysis revealed that the mean increase from "We do not use it and have no such short-term plans" ($M = 4.227$, $SD = 0.959$) group to "Yes, we consistently apply this approach, and do our development in sight of it" ($M = 5.479$, $SD = 0.605$) group (1.253, 95% CI [0.336, 2.170]) was statistically significant ($p = .002$). Also the increase from "We do not use it, but we have a plan to implement it" ($M = 4.328$, $SD = 0.712$) group to "Yes, we consistently apply this approach, and do our development in sight of it" group (1.152, 95% CI [0.876, 2.216], $p = .027$) was significant. However, no other group differences were statistically significant.

The analyses of the current relation to lean manufacturing on the underlying constructs level is concluded in Table 2.

The score of the customer processes is high in every category. Though there are differences, they are not significant statistically.

The analysis of the relations to lean manufacturing on operational constructs level is concluded in Table 3. All the elements which show statistically significant differences are added to this table.

Though the number of the statistically significant differences is relatively low, there are only two factors where the biggest average is not by the "Yes, we consistently apply this approach, and do our development in sight of it" group. One of them is the in-process quality, which questions the exploration of defects inside the processes; the other one is leadership & atmosphere, which is in connection to the participation of the management. In the latter case it has to be pointed out, that thought this factor received very high scores in other groups, by employee involvement they reached considerably lower scores. The fact that the questionnaire was mostly filled out by managers, so the questions in connection to the leadership shows the perspective of the managers can explain the controversy.

Table 2
The associations of the current relations to lean manufacturing on the underlying constructs level.

'Internally related' score	one-way ANOVA; Levene's test ($p = .124$); $F(4,\ 120) = 3.757$, $p = .006$, $\omega 2 = 0.08$ Tukey post hoc test: statistically significant mean increase between "We do not use it and have no such short-term plans" ($M = 5.485$, $SD = 0.617$) group and "Yes, we consistently apply this approach, and do our development in sight of it" ($M = 4.216$, $SD = 1.029$) group (1.269, 95% CI [0.265, 2.273], $p = .006$) and between "We do not use it, but we have a plan to implement it" ($M = 4.156$, $SD = 0.725$) group and "Yes, we consistently apply this approach, and do our development in sight of it" group (1.329, 95% CI [1.821, 2.476], $p = .014$).
'Supplier related' score	one-way ANOVA; Levene's test ($p = .878$); $F(4,\ 115) = 4.061$, $p = .004$, $\omega 2 = 0.09$ Tukey post hoc test: statistically significant mean increase between "We do not use it and have no such short-term plans" ($M = 3.857$, $SD = 0.994$) group and "Yes, we consistently apply this approach, and do our development in sight of it" ($M = 5.326$, $SD = 0.868$) group (1.470, 95% CI [0.425, 2.514], $p = .002$) and between "We do not use it, but we have heard of it" ($M = 4.242$, $SD = 0.818$) group "Yes, we consistently apply this approach, and do our development in sight of it" group (1.085, 95% CI [0.148, 2.155], $p = .045$).
'Customer related' score	Kruskal-Wallis H test; $\chi 2(4) = 4.710$, $p = .318$ no statistically significant difference

Table 3
The associations of the current relations to lean manufacturing on the operational constructs level.

'Internally related'	Employee involvement score	one-way ANOVA; Levene's test ($p = .473$); $F(4,\ 120) = 2.717$, $p = .033$, $\omega 2 = 0.05$ Tukey post hoc test: statistically significant mean increase between "We do not use it and have no such short-term plans" ($M = 3.880$, $SD = 1.44$) group and "Yes, we consistently apply this approach, and do our development in sight of it" ($M = 5.333$, $SD = 0.875$) group (1.453, 95% CI [0.105, 2.801], $p = .028$).
	visual management score	Kruskal-Wallis H test; $\chi 2(4) = 14.534$, $p = .006$ Dunn's procedure with a Bonferroni correction for multiple comparisons post hoc test: statistically significant between "We do not use it and have no such short-term plans" and "Yes, we consistently apply this approach, and do our development in sight of it" group ($p = .003$).
	5S score	Kruskal-Wallis H test; $\chi 2(4) = 10.145$, $p = .038$ Dunn's procedure with a Bonferroni correction for multiple comparisons post hoc test: statistically significant "We do not use it, but we have a plan to implement it" group and "Yes, we consistently apply this approach, and do our development in sight of it" group ($p = .02$).
	stat. controlled processes score	Kruskal-Wallis H test; $\chi 2(4) = 26.445$, $p < .0005$ Dunn's procedure with a Bonferroni correction for multiple comparisons post hoc test: statistically significant between "We do not use it and have no such short-term plans" group and "Yes, we consistently apply this approach, and do our development in sight of it" group ($p = .003$).
'Supplier related'	(Supplier) JIT delivery score	Kruskal-Wallis H test; $\chi 2(4) = 11.431$, $p < .022$ Dunn's procedure with a Bonferroni correction for multiple comparisons post hoc test: statistically significant between "We do not use and have no such short-term plans" group and "We do not use it, but we have heard of it" group ($p = .045$) and the "Yes, we apply it to some of our activities" ($p < .0005$) as well "Yes, we consistently apply this approach, and do our development in sight of it" group ($p = .001$).
	supplier development score	one-way ANOVA; Levene's test ($p = .509$); $F(4,\ 112) = 3.466$, $p = .01$, $\omega 2 = 0.08$ Tukey post hoc test: statistically significant mean increase between "We do not use and have no such short-term plans" ($M = 3.087$, $SD = 1.10$) group and "Yes, we consistently apply this approach, and do our development in sight of it" ($M = 4.619$, $SD = 1.14$) group (1.532, 95% CI [0.367, 2.696], $p = .004$).

Chi-square test of independence was conducted between plant size and relation to lean manufacturing. One third of the expected cell frequencies was lower than five, so they do not meet the assumption. Because of this, the plant size of the changing middle enterprises was merged, so a small company and a merged medium company category remained in the test. 90% of expected cell frequencies were greater than five, which is higher than the minimally expected 80%, strengthening the validity of these results. There was a statistically significant association between plant size and relation to lean manufacturing, $\chi^2(4) = 33.079$, $p < .0005$. The association was moderately strong, Cramer's $V = .508$.

It can be stated that there is an obvious association between the size of the company and the current relation to lean manufacturing. The larger companies took more noteworthy steps to implement lean. For example, all the companies that consistently use lean are medium-sized enterprises, as also the ones that plans lean introduction are mainly from the medium-sized category.

Discussion

As shown in the results, the use of lean manufacturing among the Hungarian SMEs is low. The customer orientation is essential in the sector, but at the same time there are significant possibilities for development in the handling and involvement of the suppliers and the inner processes.

[41] analysed SMEs in the food industry in three countries (Belgium, Germany and Hungary) with similar method. In their study they stated, that these companies widely use the tools of total productive maintenance, employee and also customer involvement. The customer involvement in the Hungarian SME sector is also strongly present in comparison to other lean practices-. On the other hand, the TPM and the employee involvement are not showing prominent scores. The low use of the statistical process control is also similar.

The implementation of JIT, pull and flow components or the setup time reduction is often hard, and the type or demand of the products do not make the use of those instruments possible. The changes made on plant layout requires a big investment in a sector where companies face limited resources (true in an international sense as well, see [18]). At the same time, however, numerous practices could be generally used in this case. The basis of long-term development could be the newly perceived involvement of employees and the development of autonomous teams. The low implementation of the visual management is surprising, especially if we compare it with the result of the poka-yoke. It seems a one-sided solution to develop it without an effective visual background. The supplier' development is also an important element, which is currently not among the highlighted areas, just like it was not included in the previously referenced food industry study [41]. Thinking in processes influencing the supply chain out of the company could be a good base to increase the efficiency. But there is an efficiency reserve in the case of the universally usable 5S or in-process quality, genba and poka-yoke tools that are on the forefront of the list that introduces the implementation's depth in Table 1. It is also experienced when leaving out the point scores of companies, which are using lean toolkit consciously from the research.

By the inner processes and on the supplier side it is visible, that those companies that are consistently using the lean perspectives are significantly farther in usage. This, of course, could seem unambiguous. However, the results correspondingly with the literature [25] show that even though small, isolated steps can have benefits, the integrated and consistent implementation makes possible the process development overarching the entire company.

Relatively little statistically significant difference could be shown between the plant size and the use of the lean approach. Though the averages differ, these differences in most cases were not clear from a statistical point of view. This roughly overlaps with the results of [41]. It has to be added that in the recently mentioned study the difference between the micro and medium-sized companies were shown, while in this analysis micro companies were left out because of the interviews and the author's consideration. It can be highlighted, that the size dimension is truly important during the implementation of lean tools.

Limitation

However – as it was referenced in the research methods section – numerous studies with similar topics worked with lower sample number, the sample size is undeniably a limitation. Just like the low response rate. One of the reasons for that could be the length of the questionnaire, because it did not take a long time to fill, but it required a monotone task. Mainly some of the statements, required more consideration, understanding and seeing behind the processes especially from companies which were not applying lean. Moreover, some of the questions were not exactly features of the given company. This could be the reason behind the high rate of started, but not finished questionnaires. It is representative, that 87.5% of those

who consistently use lean manufacturing gave an appraisable answer to minimum of 95% of the statements, while this rate is 65% by those who do not even plan to use lean manufacturing.

Conclusion

Taking all the above-mentioned facts and findings into account, it can be settled that the study successfully measured the depth of the usage of lean manufacturing practices among the Hungarian SMEs in the manufacturing industry. Though the topic of lean manufacturing is exploited by many studies, these mostly analyse the introduction, the success factors and the boundaries and barriers of lean manufacturing. There are only a small number of studies about the exploration of its usage in a given sector. It means, that this analysis can provide a base for actions by the government, or for further analyses. If we accept the previously quoted, in many studies demonstrated result, that the lean manufacturing has a positive effect on the company's effectiveness it can be a starting point in the research. It also has to be accepted that lean as an approach can be extended outside of the car industry. In this case, based on the gotten results it would be practical to support individually the organizational innovation in the SME development proposals.

Based on [24], it is especially important to involve the support of outside experts, even the collaboration with consultant companies during the tender period. This overlaps with one of the main paths of lean manufacturing's expansion in sectors. It provides a convincing tool for the company to start the project. As it was previously mentioned several times, the management of the SMEs are sceptical and expect results instantly. The less chance a company has for that, the stronger the view is that defines it as waste of resources [18]. However, the change of perspective can make a ground for the need to renew, and for the increase of the company's innovation potential. The organizational development determines the competitiveness on long-term, but having an effect directly on people, it is an extremely hard project, which requires leadership, change management and project management competences as well. This is why it is worth stimulating the process, which would help the competitiveness of the SME sector in the long term, too.

The first steps' results of the multiple-staged implementation process can be persuasive enough to continue. Based on the research's results, it is worthwhile to start from the leadership basing on the thinking elements that are already present in a low level fragmentally and begin to involve the employees. In the same time a pilot project can be carried out which drives to a quick win.

The methodological background of the research was created to fit the literature at hand, and that it could be used in other countries as well. With this the information on hand was expanded with a regional dimension in case of completing further studies with similar methods. When the international extension is increasing, the sample size could also grow. It could lead to a statistically even more significant result.

Appendix

Questionnaire

Please provide the number of employees by your company.

Please provide the company's turnover in 2016 (an around number, if the person who fill this out knows it, it is not mandatory).

Please provide the company's balance sheet total in 2016 (an around number, if the person who fill this out knows it, it is not mandatory).

Is the company active in manufacturing or service?

◯ manufacturing
◯ service

Please provide the industrial sector based on the company's main activity (for example, machine manufacturing, car industry, food industry, agriculture, etc.)

Please provide in which county is the company's plant.

Please provide your position (not mandatory).

Is the lean manufacturing approach applied when organizing the business?

◯ We do not use it and have no such short-term plans.
◯ We do not use it, but we have heard of it.

◯ We do not use it, but we have a plan to implement it.
◯ Yes, we apply it to some of our activities.
◯ Yes, we consistently apply this approach, and do our development in sight of it.

In the following I would like to ask you to evaluate the statements in connection to the inner processes, customers and the suppliers.

Please evaluate the statements below about the inner processes on a scale of 1 to 7:

1 – no implementation (strongly disagree)
7 – complete implementation (strongly agree)
NE – not explainable
NA – no answer

	1	2	3	4	5	6	7	NE	NA
Empinv01; Shop-floor employees are key to problem solving teams.									
Empinv02; Shop-floor employees drive suggestion programs.									
Empinv03; Shop-floor employees lead product/process improvement efforts.									
Empinv04; We strive to develop/train shop-floor employees to be capable of doing cross functional scope of activities.									
AutTeam01; Shop-floor employees are delegated some scope of authority and intervention decisions.									
Atmosphere01; The managers do not work above, but with the employees.									
Genba01; Decisions are always made based on the direct, local inspection of the problem.									
TPM01; We dedicate a portion of everyday to planned equipment maintenance related activities.									
TPM02; We maintain all our equipment regularly.									
TPM03; We maintain excellent records of all equipment maintenance related activities.									
TPM04; We post equipment maintenance records on shop floor for active sharing with employees.									
Visman01; The current process status is projected with easily observable, visual signs.									
Visman02; The current score of the key performance indicators are projected in an easily observable manner.									
5S01; During work there is a specifically marked place for every element, material (even file), the employee takes it from there and put it back there.									
5S02; During work, employees never need tools, materials (even files) to be searched, these are their accessible, properly marked place.									
5S03; Only what is necessary for their current job is in front of the operators.									
PokaY01; Recurrence of previous mistakes are excluded during the process planning.									
PokaY02; Possible mistakes during the execution are analysed during the process planning.									
PokaY03; It is known to the shop-floor employees, what to do by any arising problem. There is an assigned group, who provides immediate help.									
QualA01; Constant screening for possible mistakes on every process stage; the defected product does not go to the next station after the recognition point.									
Pull01; The pace of the production is determined by the pace of the delivery.									
Pull02; Production at a given station is determined by the current demand of the next station.									
Pull03; We use a „pull" production system.									
Pull04; We use Kanban, squares or containers of signal for production control.									
Flow01; Products are classified into groups with similar processing requirements.									
Flow02; Products are classified into groups with similar routing requirements.									
Flow0304; Equipment is grouped to produce a continuous flow of families of products, this determine our factory layout.									
Setup01; Our employees practice setups to reduce the time required.									
Setup02; We are continuously working to lower setup times in our plant.									
Setup03; We have low set up times of equipment in our plant.									
SPC01; Large number of equipment/processes on shop floor are currently under SPC.									
SPC02; Wide data collecting and extensive use of statistical techniques to help the process analysis.									
SPC03; Charts showing defect rates are used as tools on the shop floor.									
SPC04; We use fishbone type diagram to identify causes of quality problems.									
SPC05; We conduct process ability studies before product launch.									

Please evaluate the statements below about the customers on a scale of 1 to 7:

	1	2	3	4	5	6	7	NE	NA
Custinv01; We frequently are in close contact with our customers.									
Custinv02; Our customers frequently visit our plants.									
Custinv03; Our customers give us feedback on quality and delivery performance.									
Custinv0405; Our customers are actively and directly involved in current and future product offerings.									
Custinv06; Our customers frequently share current and future demand information with marketing department.									

Please evaluate the statements below about the suppliers on a scale of 1 to 7:

	1	2	3	4	5	6	7	NE	NA
Suppfeed01; We frequently are in close contact with our suppliers.									
Suppfeed03; We frequently visit our supplier's plants.									
Suppfeed04; We give our suppliers feedback on quality and delivery performance.									
Suppfeed05; We strive to establish long-term relationship with our suppliers.									
SuppJIT01; Suppliers are directly involved in the new development process.									
SuppJIT02; Our key supplier deliver to plant so there is no need to store anything (based on just in time).									
SuppJIT03; We have a formal supplier certification program.									
Suppdevt01; Our suppliers are contractually committed to annual cost reductions.									
Suppdevt02; Our key suppliers are located in close proximity to our plants.									
Suppdevt03; We have corporate level communication on important issues with key suppliers.									
Suppdevt04; We take active steps to reduce the number of suppliers in each category.									
Suppdevt05; Our key suppliers manage our inventory.									
Suppdevt06; We evaluate suppliers on the basis of total cost and not per unit price.									

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