# Leadership attributes in lean production context: analysis of production managers and CEOs

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## Abstract

Empirical works have analysed many different soft aspects of lean management. Recently lean leadership has gained specific interest. Our empirical work studies how lean production techniques mediates the relationship between leadership attributes and performance measures. Statistical analyses of two different organisational roles (CEO and production manager) from two cross-sectional datasets revealed that bossy and consultative leadership behaviours have impact in both years. Our findings clearly underline that the relationships among behaviours, lean and performance are not stable over the time.

**Keywords:** lean production, leadership, management

**Introduction**

Several quality and production paradigms have emerged in the last few decades with the promise of improving competitiveness of manufacturing companies. In the 1980s and 1990s the Total Quality movement had the largest impact on practice. From the 1990s on the lean production concept has been the most powerful approach (Holweg, 2007) (Womack & Jones, 1996).

However, the interest of academic community and even of professionals and companies (Netland, 2013) (Kovács & Rendesi, 2015) has remained tool-oriented. In accordance with this tool or technical oriented approach of lean the efforts have been focused on the definition of specific practices, on the description of toolset or the lean system (Liker, 2004) (Shah & Ward, 2007) (Shah & Ward, 2003) (Womack & Jones, 1996). A further crucial point of interest is related to study of the link between lean tools/system and operational and business performance measures (Demeter & Matyusz, 2011) (Demeter & Losonci, 2013).

While there are still many efforts devoted to the depiction of the system and its performance impact, a relatively recent and widely shared common sense is that only the better understanding of soft aspects of lean management like culture, HR or leadership could enable sustainable lean transition of companies. These soft topics are especially important in those industries (eg., automotive, electronics) in which the adoption of lean has become a "qualifier criteria". Since these industries have built considerable capacities in Hungary, more specifically in counties of Western-Transdanubia and Middle-Transdanubia Regions, the exploitation of these capacities can be enhanced by more proper management of lean transition.

Our empirical paper studies leadership attributes in lean context. **We analyse how the level of use of lean production techniques mediates the relationship between leadership attributes and performance measures**. We test our hypotheses on two different cross-sectional datasets and on two different hierarchical levels (ie., CEO and production managers), respectively.

The paper is organized as follows. First, we introduce some basic concepts of leadership. Then, we turn to the review of previous empirical findings about leadership and management in lean context. Based on these findings we elaborate two hypotheses. Before testing the hypotheses, we give a short overview on the survey and datasets and data analysis methods. The conclusion also summarizes managerial implications and future research questions.

## Leadership in GLOBE project

This work adapts Global Leadership and Organisational Behaviour Effectiveness (GLOBE) project's approach of leadership. The GLOBE project proposes 112 leadership attributes to grasp leadership. Based on these 112 variables Hanges and Dickson (2004) defined 21 primary and 6 secondary leadership factors (in our terms leadership behaviours). The secondary factors cover behaviours like charismatic, group-oriented, self-centred, participative, human-oriented and autonomous. GLOBE studies in Hungarian context show different results both at the level of attributes and at the level of factors. Several attributes that were not significant at international level were significant at domestic level, and these attributes give specific characteristics to the revealed primary and secondary factors. Bakacsi and Takács (1998) differentiated six factors like majesty, confident-participative, change manager, hermit and bureaucrat. In a later study, Karácsonyi (2006) found 7 factors, namely visionary-rousing, dictator, trustworthy-developer, reliable, protester, outsider and arm's length controller. Bakacsi and Sarkadi-Nagy (2003) have highlighted some specific characteristics of Hungarian leadership, however, they pointed out that in international context the Hungarian leadership is close to the patterns of Latin-European countries' leadership (eg., Spanish, Portuguese, Italian).

## Literature review on lean leadership

The growing interest towards soft issues in lean context is best presented by the evolution of the topics studied by Jeffrey K. Liker, a bestseller author. In 2004, he wrote about the building blocks of lean system and described the principles of Toyota's production system (Liker, 2004). In 2008, he turned to lean culture (Liker & Hoseus, 2008) that glues the principles elaborated previously. Finally, in 2012 he co-authored a book about lean leadership claiming that Toyota has established both a production and a leadership system at the same time (Liker & Convis, 2012), however, the latter has gained little interest until recently.

The topic of leadership and management in lean context have attracted empirical interest after 2010. The available empirical studies show little overlap. The focal point of interest, the selected leadership concepts, the hierarchical levels analysed and even the applied methodologies are different. Considering regional focus, we can conclude that European works dominate. Further regions, like South America and Asia are also represented. There are two competing approaches how the authors define the selected leadership concepts in their studies. One stream derives the studied leadership/management concept from available lean related works. For example, van Dun and Hicks (2017) defined value set matching lean context in this manner. Cammuffo and Gerli (2012, 2018) and Seidel et al. (2017) also followed this approach when defining appropriate competences in lean environment. Authors in the other viable stream adapt leadership concepts with numerous and valid item sets from leadership literature and study them in a lean context. Values (van Dun and Wilderom, 2016), leadership attributes of GLOBE project (Gelei et al., 2015) and several leadership styles (Tortorella & Fogliatto, 2017) (Zarinah, et al., 2017) have been adapted successfully.

Due to the numerous leadership concepts studied, it is almost impossible to conclude with an integrated picture of leadership in lean context. There are items with positive and negative impacts as well. We can also identify several items with no impact, even if one would have awaited their positive impact previously. Pairwise selected studies emphasize the importance of participative (van Dun et al., 2017) (Zarinah et al., 2017) and relation-oriented (van Dun et al., 2017) (Tortorella et al., 2017) values. Furthermore, altruist and group-oriented (van Dun et al, 2017) (Seidel et al., 2017) behaviours were also highlighted. Several specific items have been emphasized by different works independently, eg., communicative behaviour (Gelei et al., 2015), democratic leadership style (Zarinah et al., 2017) or responsibility, candor and honesty values (van Dun et al., 2017).

Findings related to items with possible negative impacts are more contradicting. Zarinah et al. (2017) concluded that both autocratic and laissez-faire leadership styles have negative impact on lean production. They link non-participative behaviour to laissez-faire leadership style. Evidences presented by Gelei et al. (2015) suggest that autocratic behaviour with a similar content to Zarinah et al.’s autocratic and laizess-fair styles has no impact on the level of use of lean production techniques. Surprisingly, Gelei et al. (2015) found that micro-manager behaviour relying to a great extent on non-delegator attribute has a positive impact on lean adaption. van Dun and Wilderom (2016) have also found some values with negative impact (eg., humility, respect/honor, tradition), however, these values have not been analysed by other works. Finally, further efforts should be devoted to neutral items. Gelei et al.’s findings (2015) pointed out that motivational and performance-oriented behaviours, which in theory are in accordance with lean principles, have no impact at all on level of lean production.

Furthermore, while the study of the link between lean production (techniques) and performance is a major topic in general lean literature, there are only two related empirical works in lean leadership literature (Seidel, et al., 2017) (Zarinah, et al., 2017). Seidel et al. (2017) found positive relation between lean production and lean leadership competences. Zarinah et al (2017) concluded that lean production and democratic leadership style have a positive impact on business performance. Unfortunately, both papers have severe shortcomings. Zarinah et al. (2017) did not list any items, Seidel et al. (2017) have only considered correlation measures.

## Hypotheses

Instead of adapting a further leadership concept, we have decided, partially due to the availability of data, to rely on GLOBE project’s leadership attributes. Our aim is to analyse 1) how leadership attributes (behaviours) impact the level of use of lean production techniques (see eg., Gelei et al. 2015 and Tortorella et al., 2017) and 2) how leadership behaviours impact, even via lean production techniques, the performance measures of manufacturing firms (eg., Zarinah et al., 2017).

In accordance with the presented literature review, we expect that managers perceive that leadership behaviours impact lean production, so our 1st hypothesis is:

*Hypothesis 1: Leadership behaviours impact the level of use of lean production techniques.*

We expect that leadership behaviours have a direct and also an indirect impact via lean production techniques on performance measures. So, our 2nd hypothesis is:

*Hypothesis 2: Leadership behaviours have an impact on performance measures in lean context.*

## Database and variables

We test our hypotheses on specific subsamples of the Hungarian Competitiveness Research Centre's (HCRC) dataset. We only consider manufacturing firms with at least 50 employees. This means that out of the 300 respondent firms 89 firms are in our initial sample in 2009 and we have 78 firms in 2004. Both hypotheses are tested at two hierarchical levels, namely at the level of CEO and at the level of production manager. We also compare our results for the two different surveys.

There are 29 leadership attributes in the HCRC survey from the original 112 items of GLOBE project. We define leadership behaviour as a set of interrelated leadership attributes (see Gelei et al., 2015). Leadership attributes are evaluated by both hierarchical levels on a 1 to 7 Likert scale. There are five and six lean production techniques covering both the technical and the soft aspects of lean production. These items are evaluated by the production manager on a 1 to 5 Likert scale. Performance measures are different at the two hierarchical levels. In the case of production managers operational measures are selected. In the case of CEOs, the hypothesis is tested on financial and business oriented items. Items are assessed on a 1 to 5 Likert scale. The variables used in our analyses can be seen in Table 1.

*Table 1. - Variables from our datasets*

| Variable Group | Variable Name |
|---|---|
| | Improvement-oriented |
| | Bossy |
| | Inspirational |
| | Risk taking |
| | Ruthless |
| | Cooperative |
| | Autocratic |
| | Friendly |
| | Formal |
| | Encouraging |
| | Consultational |
| | Risk-averse |
| | Dictatorial |
| | Careful |
| | Complacent |
| | Provident |
| | Non-egalitarian |
| | Ability to foresight |
| | Motive arouser |
| | Communicative |
| | Excellence oriented |
| | Non-delegator |
| | Confidence-building |
| | Non-participative |
| | Elitist |
| | Performance oriented |

| | |
|---|---|
| | Motivational |
| | Micromanager |
| | Governing |
| | Empowerment |
| | **Continous improvement** |
| | Process focus |
| | Pull production |
| | Quality improvement and control |
| | Total profuctive maintenance |
| | Earnings per Revenue |
| | Return on Equity |
| | Market share (based on revenue) |
| | Technology level |
| | Management |
| | Product/Service quality |
| | **Production/Service quality** |
| | **Product/Service reliablility** |
| | Volume flexibility |
| | Order completion time |
| | Order completion accuarcy, reliablility |
| | Product/Service unit cost |
| | Production lead time |
| | Mix flexibility |
| | *Machine setup time* |

Note: Variables marked bold are not present in the 2004 dataset. Variables marked in italic are not present in the 2009 dataset

Our dataset is not without missing values. A general rule of thumb suggests that we should delete variables with 15% or more missing coordinates. All of our variables have missing values less than 15%, so no variable requires deletion. If our missing values are missing completely at random, then we could replace these with a simple statistical indicator according to the measurement level of the variable (mean, median or mode). Unfortunately, the production manager's dataset in 2009 and the CEO's dataset in 2004 do not meet these criteria at a 5% significance level according to the results of Little's MCAR test seen in Table 2.

*Table 2. – Results of Little's MCAR test for our four datasets*

| | CEO 2004 | CEO 2009 | Production Manager 2004 | Production Manager 2009 |
|---|---|---|---|---|
| $\chi^2$ | 2961,544 | 3740,718 | 4351,578 | 2491,521 |
| **degrees of freedom** | 2778 | 3537 | 4248 | 2334 |
| **p-value** | 0,00778018 | 0,227395 | 0,1309447 | 0,01174624 |

The cause of the patterns that disturbed the random property of the missing values in these two datasets is that missing values were concentrated to items dealing with lean techniques.

After deleting the records that are responsible for the patterns in missing values we have a sample of 62 companies in 2004 and of 73 companies in 2009. Unfortunately, there still remains some patterns in the missing values for the CEO's dataset in 2004 (MCAR: $\chi^2$= 2396.082, df= 915, p-value= 0,000). So, we needed to delete the Performance-oriented and Confidence-building variables, which were the causes for the remaining patterns in missing values. This way, we have values missing completely at random in each dataset at 5% significance level according to Table 3. So, we can now replace each missing value with the variable mode, as our variables measured at an ordinal level. Of course, this is a risky attempt in the case of the CEO's dataset in 2003 as we still have a rather low p-value.

*Table 3. - Results of Little's MCAR test for our four datasets after data cleaning*

| | CEO 2004 | CEO 2009 | Production Manager 2004 | Production Manager 2009 |
|---|---|---|---|---|
| $\square^2$ | 274,9395 | 681,0001 | 310,1649 | 893,746 |
| **degrees of freedom** | 239 | 671 | 307 | 863 |
| **p-value** | 0,05500787 | 0,3859802 | 0,4387361 | 0,227395 |

Because of outlier analysis based on interquartile ranges of each variable in each dataset, we deleted 7 observations from the 2009 datasets. Our sample size in 2009 therefore shrinks to 66 companies.

Of course, generalisation based on the research is not possible. Beside the small sample sizes and the not random sampling methods we also know that the sample is not representative. So, our following models only describe the relationship between leadership attributes, lean techniques and performance measures in the sample of the examined companies.

## Results

### *Factors – leadership behaviours, lean and performance*

The premise of our empirical research is the identification of leadership factors from leadership attributes, representing leadership behaviour. By using the constructed leadership behaviour factors, we can examine the effects of leadership on lean techniques and on performance by SEM models.

For the following methods to be applied we need to interpret the mean, standard deviation and correlation on our datasets. For this, we need to quantify our ordinally measured data. The quantification algorithm is based on Multiple Correspondence Analysis, following the guidelines of (Leeuw & Mair, 2009), (Abdi & Valentin, 2007) and (Linting, et al., 2007). After quantifying our variables, we can create leadership factors from our leadership attributes, using principal component analysis (PCA). PCA is a useful tool for extrapolating factors as the eigenvalues represent the variance of each created factor's variance, which can be used to determine the number factors. The variance of the standardized original variables is 1, so factors with variance greater than 1 are successful in representing more than one original variable.

To build leadership factors, we followed a heuristic search algorithm. From the 29 leadership variables we selected a random subset of 20 variables 5 times and we also consider the complete 29 variables. Altogether, we had 6 sets of variables. On each variable set we performed PCA with Varimax rotation and eliminated variables that were not evidently represented by one of the components with eigenvalues greater than one based on the variable's loadings. On the restricted set, we performed this kind of PCA again and eliminated other variables if it was necessary. We stopped the algorithm when all variables were evidently represented by the components (one variable only has one loading greater than 0.3). Next, we compared the 6 variable sets and selected the set in which the PCs from the set retained the most variance from the original variables in the set. We arrived at the leadership factors in Table 4 represented by the PCs of the selected set on each database. By applying this simple stochastic search, we could retain more of the selected variables variances than if we simply applied this elimination process only on the 29 variables. Leadership factors for each dataset are named in a way that factors constructed from similar variables receive the same name across the datasets.

*Table 4. – The constructed leadership factors and their retained variances*

**Production Manager** **CEO**

| Variable Name | 2004 | 2009 | 2004 | 2009 |
|---|---|---|---|---|
| Improvement-oriented | x | Consultative | x | Consultative |
| Bossy | Bossy | Bossy | Bossy | Bossy |
| Inspirational | x | x | x | x |
| Risk-taking | x | x | x | x |
| Ruthless | x | Bossy | Bossy | Bossy |
| Cooperative | x | x | x | Consultative |
| Autocratic | x | Bossy | x | Bossy |
| Friendly | x | x | x | x |
| Formal | x | Formal | x | Formal |
| Encouraging | Motivational | x | Consultative | Consultative |
| Consultative | Consultative | Consultative | Consultative | Consultative |
| Risk-averse | x | x | x | x |
| Dictatorial | x | Bossy | Bossy | Bossy |
| Careful | x | x | x | x |
| Complacent | Bossy | x | x | Bossy |
| Provident | Consultative | Motivational | x | Motivational |
| Non-egalitarian | x | x | x | x |
| Ability to foresight | x | x | x | x |
| Motive arouser | x | x | x | x |
| Communicative | x | x | x | x |
| Excellence oriented | x | x | x | x |
| Non-delegator | x | x | MicroMan | MicroMan |
| Confidence-building | x | x | x | x |
| Non-participative | x | x | x | x |
| Elitist | x | x | x | x |
| Performance oriented | Motivational | x | x | Motivational |
| Motivational | x | Motivational | x | Motivational |
| Micromanager | MicroMan | MicroMan | MicroMan | MicroMan |
| Governing | x | x | x | x |
| **Variance Retained** | 93.00% | 85.90% | 81.36% | 77.28% |

In all the datasets, we have KMO>1/2 (smallest is 0.611) and we can reject the null hypothesis of sphericity via the Bartlett test at 5% significance level for the selected leadership variables (highest p-value is still 0.000).

The further evaluation of our leadership factors is based on 4 aspects according to (Hair, et al., 2014) and (Peng & Lai, 2012).

Aspect 1 is the internal consistency of our factors. This can be measured via Cronbach's alpha. According to (DeVellis, 2016) an alpha value below 0.5 means an inconsistent factor, while alpha above 0.8 means a highly consistent factor. In our case, we have alphas in the range of 0.556-0.801. This means that none of our factor is inconsistent, but only a few are highly consistent. So, based on Cronbach's alpha, usually we have a moderate level of consistency. We also have some factors constructed from a single variable with alphas trivially 1, which can bear certain risks (Fuchs & Adamantios, 2009), mainly redundancy between factors. However, we use these factors mainly in order to be able to compare the different datasets and our factors are already selected in a way to ensure that a variable is evidently attached to a factor. So, overestimation of factor homogeneity is not so serious of a threat. Furthermore, our aim is not the description of the factors. The factors are used as simplification tools while describing the relationship of leadership attributes, lean techniques and performance. In this case, (Fuchs & Adamantios, 2009) is not against using single variable factors.

Aspect 2 reliability of the manifest variables: variable reliability is the amount of variation explained by the LV of the variable. Its value can range between 0 and 1; regarding standardization of the variables, this value equals the squared loading of the variable. The minimum acceptable value is 0.4. In the CEO 2009 dataset Cooperative and Dictatorial and in the Production Manager 2004 dataset Bossy variables do not make the 0.4 threshold, so these variables are left out from the empirically tested SEM models.

Aspect 3 is convergence validity, which can be evaluated by the average variance extracted (AVE). The interpretation of AVE is similar to the communality in factor analysis. The AVE measures the extent that the factor explains the variance of its own manifest variables (practically, it shows an average variable reliability). Its value ranges between 0 and 1, and the minimum accepted value is 0.5. A lower value indicates that another factor explains the variance of the manifest variables rather than their own factor. In our case, the lowest AVE value is 53.3%, in the case of the Micromanager variable in the CEO 2009 dataset, so our factors fit this criterion.

Aspect 4 is discriminant validity, which can be measured via the cross-loadings. The condition states that the weight of a variable related to its own factor should be higher than the weight of a variable related to all other factors. This condition is satisfied as the termination criteria for the selection process for the variables used in the PCA was that the final result must satisfy this discriminant validity condition.

In the case of the lean and CEO performance variables, we have no problem constructing a single, consistent factor for the PLS model. In the case of the lean variables, the single lean factor created by the selected variables have a high consistency with Cronbach's alpha of 0.886 and 0.879 in 2004 and 2009 respectively. The CEO performance factor also has alpha values higher than 0.8: 0.820 and 0.802 in the examined two years.

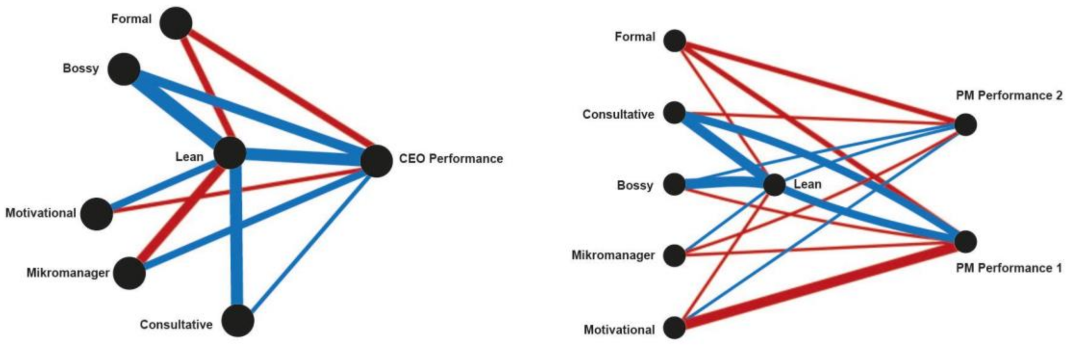
However, the variables chosen to measure the performance perceived by production manager were not forming a single measurement factor. They formed two factors and with the initial variable set the discriminant validity criterion was not satisfied. So, we omitted those variables that were represented by both factors based on their loadings. The final results are consistent based on the Cronbach's alpha measures in Table 5.

*Table 5. – Factor consistency measures for factors measuring the Production Manager's performance*

| **Factor** | **Variables** | | **Cronbach's α** | |
|---|---|---|---|---|
| | **2004** | **2009** | **2004** | **2009** |
| PM's performance measure 1. | Lead time, Order completion accuracy, reliability | Product/Service quality, Product/Service reliability | 0,804 | 0,872 |
| PM's performance measure 2. | Machine setup time | Order completion accuracy, reliability, Lead time | 1 | 0,886 |

*SEM models*

Once our factors are finalized, we can evaluate the estimated PLS models, where we assume that the effect of leadership behaviours on performance are mediated by the lean techniques. Two model graphs are visualised from the 2009 datasets for CEO and production manager in Figure 1.




*(a) CEO* *(b) Production Manager*

*Figure 1. – The graphs of two SEM-PLS models for 2009. Thickness of the edges is proportional to effect size and red edge means negative, while blue means positive effect*

During the evaluation of the PLS models we do not apply measures of generalizing ability because of the before mentioned small samples (62 and 66 companies for 2004 and 2009 respectively). We measure the model fit to our sample by the variance explained in the endogenous factors via the R-squared indicator.

According to Table 6, we have R-squared ranging from 10%-50%, which indicates moderate explaining power with the exception. We have two exceptions. In 2009 the second PM Performance measure is weakly explained by lean and leadership behaviours and in 2004 lean techniques are also weakly explained by the leadership behaviour of the production manager.

*Table 6. – Explanatory power pf the SEM-PLS models on the endogenous variables.*

| **Endogenous Factor** | **$R^2$** | | | |
|---|---|---|---|---|
| | **Production Manager** | | **CEO** | |
| | **2004** | **2009** | **2004** | **2009** |
| Lean | 7% | 21% | 14% | 29% |
| CEO Performance | x | x | 13% | 26% |
| PM Performance 1 | 15% | 19% | x | x |
| PM Performance 2 | 11% | 4% | x | x |

Our models are best at explaining lean techniques and CEO performance in 2009. They can be classified as moderately strong explaining powers.

The coefficients of our PLS models are standardized coefficients because of the setting of the applied semPLS R package (Monecke & Leisch, 2012). The absolute value and sign of these coefficients can be used as a direct measure for the effects of leadership behaviours on lean techniques and performance. Figure 1 is based on these coefficients. Because we constructed our factors representing leadership behaviours via PCA, these factors are uncorrelated by definition, so multicollinearity is not an issue in our models.

In order to measure the stability of these coefficients, we applied bootstrap simulation with 500 repeats to get a sense of the empirical distribution of the coefficients and we can determine whether a coefficient is significant at a level of 5% or 10%. If a coefficient is significant in our setup, we cannot state that the effect captured by the coefficient is generalizable out of sample (because we are still not representative). But, the significance of a coefficient means that the coefficient value is stable against a small change in the sample's composition. These significant effects are collected in Table 7.

*Table 7. – Significant or strong effects in our SEM-PLS models.*

| CEO 2009 | Production Manager 2009 | CEO 2004 | Production Manager 2004 |
|---|---|---|---|
| Bossy->Lean | Consultative->Lean | MicroMan->Performance | Lean->Performance 2 |
| Consultative->Lean | Bossy->Lean | Consultative->Lean | Bossy->Performance 1 |
| Lean->Performance | Motivational->Performance 1 | Bossy->Lean | *Consultative->Lean* |
| MicroMan->Lean | Consultative->Performance 1 | | |
| | *Lean->Performance 1* | | |

Note: Red effects are negative, while Green effects are positive effects. Effects marked italic are not significant effects, but strong effects based on their standardized coefficients

Based on Table 7, we can state that in the case of our examined companies, lean techniques are boosted in both examined hierarchy levels in 2009 by two leadership behaviours: **Consultative and Bossy**. On the CEO level, leadership behaviours only have indirect effect on performance through lean techniques. However, on the level of production manager, the Motivational leadership behaviour usually results in the decay of Performance 1 (quality and reliability). On the other hand, Consultative behaviour has a positive direct effect on PM's performance 1 measure. The same measure is also greatly impacted in a positive way by lean techniques based on the standardized coefficient, however this effect is not stable (not significant at even 10%).

In 2004, the above-mentioned effects from 2009 are modified in the following ways. On the CEO level, Bossy leadership behaviour still has a positive effect on lean techniques. But the Consultative behaviour now has a significant negative effect on lean techniques. On the production manager level in 2004, Bossy behaviour has a negative effect on the Performance 2 measure that represents machine setup time. The same performance measure is positively impacted by lean techniques. Not a significant effect, but based on the standardized coefficient it is important to see that lean techniques are positively impacted by Consultative behaviour from the production manager.

It is a constant effect over the two periods that Micromanager behaviour in the case of the CEO significantly decreases CEO performance, either directly (2004) or indirectly through lean techniques (2009).

Altogether, the results are somewhat mixed, so both of our hypotheses can be accepted partially. If we compare the two years, then result in year 2009 are more clear.

## Conclusion

Our research has contributed to the recent debate on lean leadership in four dimensions: (1) it defines several long term leadership behaviours of CEOs and production managers; (2) it compares the revealed leadership behaviours at these different hierarchical levels both (3) in relation to lean production and (4) in relation to performance improvements.

Our empirical findings underline that leadership behaviours impact the adaption of lean techniques and we have also highlighted the direct and indirect impacts of behaviour on performance. However, the patterns of relationships are less clear than expected.

Bossy and Consultative behaviours have effects at both levels and in both years of study. While these behaviours have clear positive impact on lean in 2009, they show contradicting patterns in 2004. The possible positive impact of Bossy behaviour is rather unexpected since it was considered to have a negative (Zarinah, et al., 2017) or an item with no impact (Gelei, et al., 2015). While previous lean and mass production related works (Wilkinson, et al., 2001) (Lowe, 1993) described managers who preferred dictatorial or autocratic behaviours, these behaviours are usually overlooked in empirical works. Consultative behaviour matches lean thinking theoretically. According to our results, Micro-manager behaviour have direct negative impact, however this behaviour does not show a constant pattern over time – at the level of CEOs. The negative impact of Micro-manager behaviour is in accordance with Zarinah et al.' (2017) findings and does not match with the Gelei et al.'s (2015) results who found that in the case of production managers it has a slight positive impact on lean adaption.

It is without precedent that an empirical work on lean leadership present findings over a 5-year time period. Our two cross-sectional datasets bear the opportunity to compare the evolution of managerial perceptions. Our findings underline that causal links are rather unstable over time. However, we acknowledge and urge similar analyses on more up to date datasets.

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