The role of managerial perceptions and behaviors across hierarchical levels during lean implementation

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Abstract

Purpose – Do managers at different hierarchical levels in a firm perceive the effectiveness of a lean program differently, and does it matter for their commitment to it and the resulting lean implementation? This study answers these questions by analyzing the perceptions and behaviors of top and middle managers in a manufacturer deploying a global lean program.
Design/methodology/approach – The authors hypothesize that managers at different levels perceive lean programs differently, which, in turn, should affect their commitment to lean and the resulting implementation. To test these relationships empirically, the authors collect survey data from a global manufacturer in the process industry and analyze them using hierarchical linear regression and structural equation modeling.
Findings – The findings show that middle managers perceive lean programs as more effective than top managers do. They further show that higher commitment from the top and middle managers to the lean program is positively related to building the organizational infrastructure needed for lean implementation.
Research limitations/implications – This research is conducted in one global company. Although the research setting implicitly controls for many possible confounding variables, such as the product and process complexity or organizational culture, future research can explore and test the findings in other organizational contexts.
Originality/value – This study is the first to empirically study the relations between perceptions of and commitment to lean programs across different hierarchical levels and what it means for program implementation. The paper contributes new plausible explanations for why many lean programs slow down.

Keywords Lean, Management commitment, Strategic alignment, Behavioral operations
Paper type Research paper

1. Introduction

In search of productivity improvement, manufacturing organizations often launch lean programs. However, many organizations struggle to manage such programs, obtaining disappointing results and losing momentum in their implementation efforts (Sadun *et al.*, 2017). Although the technical aspects of lean and their link to operational performance have been widely understood (Shah and Ward, 2003; Womack *et al.*, 1990), there is still little knowledge about the social factors surrounding lean implementation. It has been suggested that a lack of understanding of the human factors that go into lean is one of the main reasons for the failure of lean programs (Losonci *et al.*, 2017; Wiengarten *et al.*, 2015). Scholars have recently started to address this gap by studying organizational infrastructure and behaviors during lean implementations (Bortolotti *et al.*, 2015; Cadden *et al.*, 2020; Camuffo and Gerli, 2018; Fenner *et al.*, 2022; Galeazzo *et al.*, 2017; Januszek *et al.*, 2022; Netland *et al.*, 2015, 2021; Nielsen *et al.*, 2018; Seidel *et al.*, 2019; Tortorella *et al.*, 2018; van Dun *et al.*, 2017).

Inspired by the celebrated Toyota Production System, lean programs can be conceptualized as systems of interrelated organizational practices (Furlan *et al.*, 2011;

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Galeazzo and Furlan, 2018; Shah and Ward, 2003). Their implementation is a complex socio-technical undertaking that involves people at all hierarchical levels. Managers' disagreement regarding the need or type of change can lead to conflict, undermining the implementation efforts (Floyd and Lane, 2000). One reason for disagreement can be different perceptions of the value of lean. For example, Wemmerlöv (2021) documents limited evidence that such programs can improve firms' financial performance, whereas operational improvements have been widely recognized (e.g. Netland *et al.*, 2015; Shah and Ward, 2003). However, strategic alignment is essential for an organization to develop continuous improvement capabilities (Galeazzo *et al.*, 2017).

Despite its importance, only a few studies have investigated organizational alignment in lean organizations. In one of these studies, Lodgaard *et al.* (2016) find that different groups of employees at different hierarchical levels experience varying barriers to lean implementation. For example, frontline workers may point to a lack of management commitment and leadership challenges, while top managers blame the ineffectiveness of lean tools and practices for improving financial performance; hence, their misaligned perceptions may inhibit a lean program initiative.

Besides perception, managerial behaviors have been recognized as another crucial success factor of lean programs. For example, Netland *et al.* (2015) and Camuffo and Gerli (2018) analyze various management practices, such as developing focused performance reports or collaboration within teams, establishing positive links between these practices and lean maturity. In another study, van Dun *et al.* (2017) investigate the behavior of effective lean managers and characterize it as attentive, appreciative and oriented toward human relations at work. Nevertheless, research on the behavior of middle managers and their teams when implementing lean remains scarce. Furthermore, research examining the cognitive underpinnings leading to such behaviors is in its infancy (e.g. Arellano *et al.*, 2021).

Most of the literature on the behavioral aspects of lean implementation programs rests on two assumptions. First, scholars have assumed that management behaviors (or commitment) result from their beliefs and perceptions. We follow recent studies (Arellano *et al.*, 2021) and distinguish between management perceptions about lean programs and their commitment toward these programs. What one *thinks* about lean effectiveness and how much one is involved in lean implementation can be different. Second, consistent with the *upper-echelon theory* (Hambrick, 2007; Hambrick and Mason, 1984), most studies assume that top managers' commitment trickles down to the shop floor. If top managers are involved in lean programs, this should directly affect the program's implementation. We propose that, especially in large and complex organizations, one should consider how top managers' perceptions affect middle managers' perceptions and commitment before reaching the shop floor.

In the present study, we address these gaps by analyzing how managerial perceptions differ across the various layers of the organizational hierarchy, along with how these differences manifest themselves in managerial behaviors. We draw on survey data from a company that has been implementing a lean program in its global production network consisting of 37 manufacturing facilities in 23 countries. Our empirical approach is two-staged. First, we test whether there are any differences in how top and middle managers perceive the program's effectiveness. Second, we test whether the perception of top managers affects their commitment to implementing the program and to what extent top management commitment permeates throughout the organization. This is done by studying the effects on middle managers' perceptions of the lean program's effectiveness, their commitment to lean program implementation and, ultimately, the actual degree of lean program implementation.

2. Theoretical background and hypothesis development

Many of the organizational practices of lean management that companies use today were first developed at Toyota Motor Corporation (Monden, 1981, 1993). Later, lean was popularized through the best-selling *The Machine that Changed the World* by Womack *et al.* (1990). What followed has been a widespread adoption of lean practices by companies from various sectors and the development of an academic discipline (Åhlström *et al.*, 2021; Cusumano *et al.*, 2021; Holweg, 2007). However, despite various studies on its technical aspects, organizations have been struggling to become lean (Pay, 2008; Sadun *et al.*, 2017; Spear and Bowen, 1999).

Lean is a socio-technical system comprising technical and people-related elements (Bortolotti *et al.*, 2015; Samuel *et al.*, 2015; Shah and Ward, 2007). Accordingly, the role of managers—who are responsible for bridging the gap between lean tools and lean thinking (Mann, 2009)—has increasingly come into focus in recent lean studies (e.g. Arellano *et al.*, 2021; Galeazzo *et al.*, 2021; Januszek *et al.*, 2022; Netland *et al.*, 2019). While recognized in a few pioneering studies (Emiliani, 1998; Spear and Bowen, 1999), leadership has recently been rediscovered as one of lean's most important success factors.

In lean programs, different hierarchical positions require different types of leadership (Floyd and Lane, 2000; Netland *et al.*, 2019; Seidel *et al.*, 2017). Although top managers commit through indirect support, governance and monitoring, it is middle managers who translate organizational strategy into operational action (Mann, 2009; Marksberry, 2010; van Dun *et al.*, 2017). Hence, these managers engage directly with lean practices. In her study on the different roles of leaders in lean organizations, van Dun *et al.* (2017) find that higher-level managers express their leadership through verbal support and strategic guidance. In contrast, lower-level managers translate top managers' mandates into actions.

Because the roles among managers differ, so too can their *perceptions* of lean. Boyer and McDermott (1999), for example, find that there is substantial disagreement across different hierarchical levels of the manufacturing firm when rating investments in technology. Similarly, Lodgaard *et al.* (2016) show that leaders at different hierarchical levels perceive different barriers to lean implementation; this indicates a potential lack of alignment within organizations aspiring to become lean.

To achieve alignment in action across managers from different hierarchical levels, organizations must first break down overall objectives into individual goals and align them toward the same strategy. In lean organizations, this process is known as strategy deployment (Hoshin Kanri) and is generally achieved by cascading strategies and goals across the hierarchical levels (Netland *et al.*, 2019). Second, it requires a change of behavior and, arguably, more importantly, a change of mindset. The phenomenon of "strategic role conflict," in which managers have diverging expectations about the need to develop new competencies, can be a crucial problem here (Floyd and Lane, 2000). According to Emiliani (2003, p. 905), managers must "develop new beliefs" to implement lean. Many lean transformations fail because of mistaken beliefs about the actual purpose of the program (Mann, 2009).

The literature has studied the role of leadership in lean implementation. For example, Tortorella *et al.* (2018) study the effect of managerial seniority on lean implementation, and Seidel *et al.* (2017) collect and validate practical lean leadership competencies. Similarly, Camuffo and Gerli (2018) identify effective management behaviors for implementing lean. Besides these behavior-oriented studies, the research by van Dun *et al.* (2017) belongs to the few studies that consider the cognitive aspects because they—identify not only management behaviors—but also the values of effective lean managers. Similarly, Arellano *et al.* (2021) identify the different belief configurations that influence managerial behaviors. However, we do not find empirical studies considering different hierarchical levels when linking the cognitive aspects to managerial behaviors. Therefore, we ask the following research question: Are there significant differences in the perceptions of lean effectiveness between top and

middle managers? If so, how do they affect managerial behavior aimed at lean implementation and lean implementation outcomes?

2.1 Differences in managerial perceptions

Although lean research has increasingly focused on social factors, cognitive aspects such as beliefs and values have also come into focus. For example, van Dun *et al.* (2017) identify the different values and behaviors of effective lean managers, including self-transcendence and openness to change. Similarly, a recent study by Arellano *et al.* (2021) investigates managerial beliefs, finding different belief configurations that drive commitment to practice adoption. Social learning theory states that individuals observe, learn and adopt the values displayed by their role models (Bandura and Walters, 1977), but other factors also influence what individuals think of lean programs (Losonci *et al.*, 2011).

In strategic reorientation and organizational change, the roles of top-, middle- and operating-level managers differ along the dimensions of time, information and core values (cf. Mann, 2009). These differences can result in dissensus between managers, which has been labeled "strategic role conflict" (Floyd and Lane, 2000). Strategic role conflict is a common phenomenon in manufacturing organizations, and the literature provides evidence that managers from different hierarchical levels think differently about strategic initiatives and lean programs in particular (Boyer and McDermott, 1999; Floyd and Lane, 2000; Lodgaard *et al.*, 2016).

In an empirical study on strategic consensus, Boyer and McDermott (1999) find substantial disagreement between operators and managers. Operators tended to view investments in technology as significantly more important than managers. In a two-year in-depth case study, Lodgaard *et al.* (2016) explore the differences between the perceptions of middle and top managers in the context of lean implementation. The results show significant differences in perceived barriers. Furthermore, higher-level managers tend to emphasize tools and practices more than hierarchically lower-positioned managers.

The higher the manager's position, the more distant they are from the shop floor, thus, the fewer operational insights they may have. Although operational and middle managers are responsible for implementing the program, top managers might see the lean program as one initiative in a pool of many (Kellermanns *et al.*, 2005). As a result, top managers may be less exposed to the positive effects that lean programs can have on operational performance. Therefore, we hypothesize the following:

H1. Compared with middle managers, top managers perceive lean programs as less effective.

2.2 Links between managerial perceptions and behaviors

Because roles and responsibilities differ depending on a manager's position, we conceptualize managerial behaviors in two ways. Top managers' behaviors aimed at lean implementation are characterized by their individual actions. We bundle these behaviors into "top management commitment," which, for example, can be expressed through "gemba walks," direct communication with employees, or dedication of resources to the program (van Dun *et al.*, 2017).

Because middle managers work more often in teams, their commitment to lean program implementation is expressed as collective behaviors by the organization compared to top managers' more individual behaviors. Examples include training of shop floor employees, regular team meetings to discuss the implementation, or the development, distribution, and use of guidelines. Therefore, we bundle middle managers' commitment to lean program implementation as collective organizational efforts to develop a lean-supportive "organizational infrastructure" (cf. Anand *et al.*, 2009; Galeazzo *et al.*, 2017).

Top managers are responsible for the firm's performance and are incentivized by performance achievement (Kerr and Slocum, 2005). They need to allocate resources and develop organizational infrastructures for implementing performance improvement initiatives (Mann, 2009). Therefore, we hypothesize that top managers will be more committed to lean programs when they perceive these programs to be effective in improving firm performance. Hence, we suggest the following hypothesis:

H2. Top managers' perceptions of lean program effectiveness are positively associated with top managers' commitment to lean program implementation.

Individuals who believe in the effectiveness of a specific practice will be more committed to adopting that practice (Arellano *et al.*, 2021). Correspondingly, Lozeau *et al.* (2002) argue that managers will "corrupt" the adoption of new practices when they do not perceive a fit with their organizational context. Hence, middle managers will assess the value of adopting certain practices based on the benefits that the organization as a whole, or they as individuals, can obtain from it. Therefore, we hypothesize that middle managers who perceive the lean program as effective will engage in more organizational efforts supporting the program than middle managers who do not perceive lean to be effective. Hence, we suggest the following hypothesis:

H3a. Middle managers' perceptions of lean program effectiveness are positively associated with more organizational infrastructure for lean program implementation.

We also hypothesize that besides middle managers' commitment in the form of organizational infrastructure, top managers' commitment will also affect the setup of a lean-oriented organizational infrastructure. Top managers' commitment provides employees with focus, helping them coordinate their efforts (Sull, 2003). Additionally, through the active participation of more senior managers, the rest of the organization can be coached, encouraged to think critically and challenged to implement lean (Dombrowski and Mielke, 2014; Liker and Convis, 2012; Rother, 2010). Employees also become aware of critical issues that unlock further improvement potential (Hirzel *et al.*, 2017). Hence, we suggest the following hypothesis:

H3b. Top management commitment to lean program implementation is positively associated with organizational infrastructure for lean program implementation.

Thus far, we have only hypothesized that managerial perceptions will influence managerial behaviors, but the relation can also be the opposite (Shook, 2010). Specifically, top management signaling can affect the *perceptions* of middle managers, particularly at the beginning of the implementation when results are unknown (cf. Losonci *et al.*, 2011). Commitment by top managers makes the program look more credible to hierarchically lower managers (cf. Emiliani and Stec, 2005; Liden *et al.*, 2008). Therefore, we hypothesize that, as middle managers recognize that top managers spend time and resources on implementing the lean program, they will perceive the lean program to be more effective. Hence, we suggest the following hypothesis:

H4. Top management commitment to lean program implementation is positively associated with middle managers' perceptions of lean program effectiveness.

The organizational infrastructure for lean implementation includes, among others, the definition of a team dedicated to leading and supporting lean implementation, training employees in lean, holding regular meetings to discuss the implementation and developing implementation guidelines. These measures facilitate the organization in implementing the lean program (Furlan *et al.*, 2019; Netland, 2016; Wiengarten *et al.*, 2015). A supportive

organizational infrastructure aids in the adoption of lean programs (Furlan and Vinelli, 2018; Galeazzo *et al.*, 2017). Without a supportive organizational infrastructure, a firm can implement lean, but this implementation is not likely to be sustainable or remain effective over time. Consequently, we hypothesize the following:

H5. Organizational infrastructure for lean program implementation is positively associated with lean program implementation.

The theoretical model in Figure 1 summarizes the hypotheses.

3. Research design

We collect our data from a global manufacturer in the process industry producing variants of the same chemical product: a resin-based liquid or powder product. The company has been implementing a global production improvement program in nearly 40 globally dispersed factories over the past five years. The company is approximately 100 years old, operates in all inhabited continents of the world, employs about 10,000 employees and generates a seven-digit annual revenue in US dollars.

The process industry has been relatively under-researched in the field of lean research, which is primarily because of the specific prevailing circumstances. Still, many lean principles and practices can be effectively implemented in this industry (Abdulmalek *et al.*, 2006; King, 2009; Lyons *et al.*, 2013). The improvement program that has been studied has been conceptualized by our case company and tailored to the needs of its specific industrial context. Our survey is, therefore, built on the practices that the studied organization has defined as its lean program.

3.1 Sample and survey design

To test our hypotheses, we use survey data that we collected in the global production network of our partnering company in the fall of 2017. We emailed the questionnaire to 325 preselected managers. We asked the managers from different organizational units and hierarchical levels to assess the strategic priority of lean, the current level of implementation of the lean program (2017) and the implementation level they were at two years before (2015). We also asked what organizational practices had been employed in the past two years, along with the perceived effectiveness of the program on operational performance.

We used close-ended questions on a 5-point or 7-point Likert scale to operationalize the application of organizational practices (from 1 = never to 5 = very frequently), the implementation level of the program on different dimensions (from 1 = low to 5 = high) and the perceived effect of the program on various performance measures (from 1 = significant negative impact to 7 = significant positive impact).

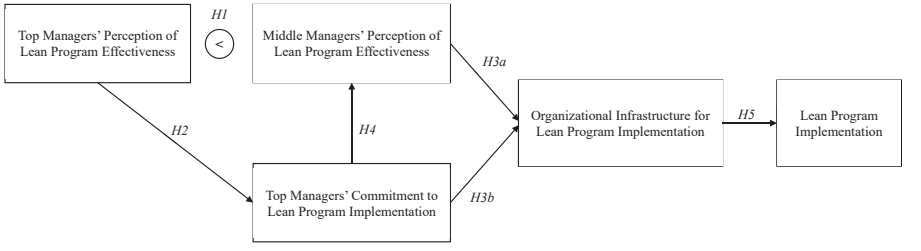


Figure 1.
Theoretical model

Source(s): Created by authors

In total, we obtained 280 responses, corresponding to a response rate of 86%. On average, we received eight responses per plant. We have viewed each manufacturing plant as a separate organizational entity, where each plant manager is considered a top manager. This is justified because the plants have a significant degree of autonomy, for example, serving a local or regional market. The distribution of the respondents and other sample characteristics are shown in Table 1.

To reduce the risk of common method bias, we have followed the recommendations of Podsakoff *et al.* (2003). We consider only key respondents who were actively involved in implementing the improvement program. Moreover, we review the survey format and wording multiple times to avoid misunderstandings. We have also performed Harman's single-factor test to estimate the effect of common method bias. Following the idea of principal component analysis, we load all the items of this study into an exploratory factor analysis as a post hoc marker variable analysis (Malhotra *et al.*, 2006). Potential bias exists if a single factor can explain most of the variance. Our test shows that the first factor accounts for only 31.5% of the variance, indicating low concerns for common method bias in the sample.

3.2 Data analysis

To test our hypotheses, we employ two different methods of statistical analysis. We test our first hypothesis by running a hierarchical linear model on the full sample ($n = 280$) to identify the differences between top managers ($n = 34$, with one top manager per plant; e.g. plant managers, managing directors, heads of production, etc.) and middle managers ($n = 246$; e.g. warehouse managers, quality controllers, production planners, etc.) regarding their perceptions of how effectively the improvement program has affected operational performance (H1). Instead of just comparing the averages of these two groups, the regression model allows us to control for various variables, such as plant age or manager experience.

Second, we create a structural equation model to operationalize our conceptualizations of middle and top managers' perceptions of lean effectiveness, top management commitment, organizational infrastructure for program implementation and program implementation. We perform maximum likelihood estimation using Stata 16 to analyze the direct and indirect effects (H2–H5). In this way, we can capture managerial commitment and the plant's involvement in program implementation as latent variables while simultaneously analyzing

Sample characteristic	Number of responses	Classifications	Totals	Percent
Respondent's position	280	Top management	34	12.1
		Middle management	246	87.9
Unionized	260	Majority unionized	130	50
		Not unionized at all	130	50
Respondent's years of experience within firm	279	<5 years	60	21.5
		5–10 years	85	30.5
		10–15 years	57	20.4
		>15 years	77	27.6
Plant start-up year	267	<1980	15	5.6
		1980–1999	114	42.7
		2000–2009	77	28.8
		>2010	61	22.8

Source(s): Created by authors

Table 1.
Sample characteristics

their effects on program implementation (Gefen *et al.*, 2000). We run a robustness check by calculating the same model but replacing program implementation, which was measured in 2017, with the difference in program implementation measured in 2015 and 2017.

In our analyses, we control for managers' experience (measured in years in the company), plant age (measured in years since start-up), product type (dummy variable distinguishing powder-based and liquid-based products) and unionization (dummy variable distinguishing unionized vs non-unionized plants). Using data from one single firm, we implicitly control for industry, organizational culture, and process and product complexity.

3.3 Measures

In the structural equation model, we use five primary constructs that we measure as reflective constructs, each of which is composed of multiple independent survey items: perceived effectiveness of the lean program by top managers and by middle managers, top management commitment, organizational infrastructure and lean program implementation.

Given the multidimensionality of production improvement programs, we need to capture the perceived effectiveness of the lean program on several dimensions. Hence, we operationalize the perceived effectiveness of the improvement program using four different performance dimensions: on-time delivery (MP01 for middle managers, TP01 for top managers, respectively), throughput time (MP02, TP02), productivity of machines and labor (MP03, TP03), and percentage of right-first-time products (MP04, TP04). We asked both top and middle managers to assess the effect of program implementation on these performance dimensions over the past two years. Based on this conceptualization, we measure perceived performance effects separately for the top and middle managers in our model.

We operationalize *top management commitment* using three behavioral items: hands-on involvement in program implementation (TC01), gemba walks (TC02) and mandating the implementation (TC03). The first item measures the extent top managers have been involved in driving the program implementation. The second item, gemba walks, measures how frequently top managers visit the shop floor to follow up on the program implementation; this includes observing the processes and communicating with employees, indicating top managers' explicit interest in program implementation. The third item measures the extent top managers have communicated the implementation as a critical objective in the plant's long-term strategy. These measures comprise what prior studies have identified as critical top management behaviors for lean implementation (van Dun and Wilderom, 2012; Worley and Doolen, 2006).

We measure the organizational infrastructure for the program's implementation as teams dedicated to leading and actively supporting the implementation of lean (OI01), formal program training of shop floor workers (OI02), regular meetings to discuss the implementation (OI03), and the development and use of implementation guidelines (OI04). According to Anand *et al.* (2009), a continuous improvement infrastructure provides an organizational context that enables the coordination and sustainability of organizational learning and systematic improvement efforts. In this sense, a team dedicated to implementing an improvement program, that has formal training, holds regular meetings and follows implementation guidelines will create an organizational infrastructure that supports implementing a lean program.

The implementation level of the lean program is based on four items: process improvement (PI01), competence development (PI02), performance management (PI03) and stable processes (PI04). These items correspond to the main principles of the company's lean program. Table 2 lists the four principles, providing examples of key lean practices and tools. Hence, we operationalize lean as the company does, which aligns with other studies

Lean principle	Key lean practices included	Example of tools
Continuous improvement	Problem-solving	A3, 5 whys, VSM
	Standard operating procedures	One point lessons
	5S	Shadow boards
Competence development	Training	Safety induction
	People empowerment	Skill matrix
	Leadership	Gemba walks
Performance management	Daily layered accountability meetings	Daily meetings
	Visual management	Team boards
	Use of key performance indicators	SMART goals
Stable processes	Right first time	Process capability metrics
	Flow efficiency	Supermarket, Kanban, SMED
	Product cycle time	Cycle time reduction

Source(s): Created by authors

Table 2. Lean principles, practices and tools in the company's lean program

(e.g. Distelhorst *et al.*, 2017; Netland and Ferdows, 2016). An advantage is that the respondents interpret the items similarly and are aware of the company's definitions of them. These principles are also aligned with studies on lean for process industries (King, 2009). We use the program implementation in 2017 as the dependent variable. As a robustness check, we also run a model employing the difference in program implementation between 2017 and 2015 as the dependent variable to capture not only absolute values of lean implementation but also relative values, i.e. the actual change in the degree of lean implementation.

4. Results

4.1 Hierarchical linear modeling

We run a hierarchical regression to test our first hypothesis. We used a dummy variable to distinguish middle managers from top managers. Table 3 shows the results, including the control variables of plant age, experience and unionization as the independent variables in Model 1. Model 2 adds an independent dummy variable representing middle management to compare middle managers' perceptions against top managers' perceptions (set as the baseline). The statistically significant results show that middle managers perceive the performance effect of the improvement program as higher than what top managers do. We also find a statistically significant effect for the control variable *experience*.

	Model 1		Model 2	
	Coefficients	std. error	Coefficients	std. error
(Constant)	−0.475***	0.269	−0.913***	0.321
Plant age	0.0839	0.057	0.08	0.057
Experience	0.0158*	0.008	0.0192**	0.008
Unionization	−0.04	0.133	−0.067	0.132
Top management			reference	
Middle management			0.489**	0.199

Note(s): Dependent variable: Perceived effect of program implementation on operational performance
**$p < 0.05$, ***$p < 0.01$
Source(s): Created by authors

Table 3. Hierarchical linear modeling results

4.2 Measurement model

The measurement model describes the conception of the latent variables based on the observable items. In our model, we have five latent variables that use 19 items. We test the measurement model regarding individual item reliability, internal consistency and convergent validity (see Tables 4 and 5). Starting with a confirmatory factor analysis, we

Table 4. Confirmatory factor analysis, composite reliability and Cronbach α

Item code		Standardized loadings	t value (all $p < 0.001$)	CR	α
	Perceived Performance Effects by Middle Managers			0.913	0.914
MP01	On-time delivery to customers	0.8	24.79		
MP02	Throughput time	0.89	41.1		
MP03	Productivity of machines and labor	0.91	46.24		
MP04	Percentage of Right-First-Time products	0.8	25.22		
	Perceived Performance Effects by Top Managers			0.94	0.93
TP01	On-time delivery to customers	0.8	8.73		
TP02	Throughput time	0.96	33.9		
TP03	Productivity of machines and labor	0.95	36.36		
TP04	Percentage of Right-First-Time products	0.85	14.12		
	Top Management Commitment			0.839	0.847
TC01	Hands-on involvement	0.78	22.05		
TC02	Gemba walks	0.81	20.56		
TC03	Implementation mandates	0.8	25.33		
	Organizational Infrastructure			0.883	0.866
OI01	Dedicated implementation team	0.78	24.17		
OI02	Shop-floor training	0.87	37.14		
OI03	Regular meetings	0.85	32		
OI04	Implementation guidelines	0.73	18.74		
	Program Implementation			0.867	0.868
PI01	Continuous improvement	0.81	25.75		
PI02	Competence development	0.76	20.44		
PI03	Performance management	0.81	26.44		
PI04	Stable processes	0.77	21.88		

Source(s): Created by authors

Table 5. Tests of convergent validity

Latent variables	Average variance extracted (AVE)	Correlations between latent variables (square root of AVE in the diagonal) (1)	(2)	(3)	(4)	(5)
(1) Mid. Managers' perception	0.725	*0.851*				
(2) Top Managers' perception	0.797	−0.05	*0.893*			
(3) Top Management Commitment	0.635	0.558***	0.02	*0.797*		
(4) Organizational Infrastructure	0.655	0.262***	0.024	0.621***	*0.809*	
(5) Program Impl	0.621	0.454***	−0.016	0.574***	0.409***	*0.788*

Note(s): *** Significant at the 0.01 level

Source(s): Created by authors

find that all measurement items load on their corresponding factors at statistically significant levels ($p < 0.001$), thus indicating good item reliability.

We use three different methods to test the internal consistency for each latent variable. First, we calculate Cronbach's alpha reliability coefficients, comparing them to Nunally's (1978) minimally acceptable reliability level of 0.7. The alpha coefficients are greater than the recommended threshold for each construct.

Second, we calculate composite reliability (CR) scores for each latent variable by dividing the squared sum of the individual standardized loadings by the sum of the squared sum of the individual standardized loadings and the variance of the corresponding error terms (Fornell and Larcker, 1981). The calculated values exceed the threshold of 0.7 for each latent variable (Nunnally, 1978), thereby suggesting adequate internal consistency for our measurement model (see Table 4).

Third, we measure the amount of variance captured by a construct regarding the amount of variance because of measurement errors, which is done by calculating the average variance extracted (AVE) for each latent variable. To do this, we divide the sum of the squared item standardized loadings by the sum of the squared item standardized loadings and sum of the variance of the error terms. According to Fornell and Larcker (1981), convergent validity is given when the AVE is above the threshold of 0.50. For each latent variable, the AVE returns an acceptable value (see Table 5).

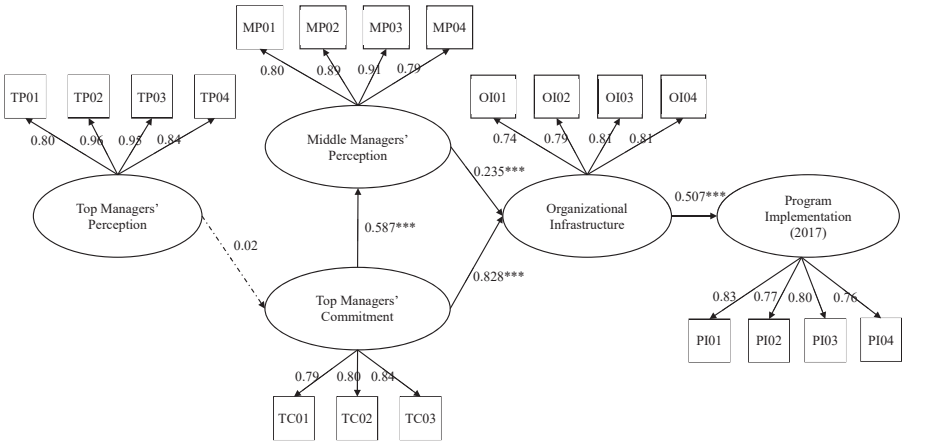
4.3 Structural model

Our structural equation model indicates good model fit, considering χ^2 (354.927, df = 213, $p < 0.001$) with $\chi^2/\text{df} = 1.67$ being below the threshold of 3. Statistical significance suggests that the model might be inadequately specified. However, it is also well-recognized that this measure is sensitive to sample size (Arbuckle, 1999). For this reason, for the overall model fit, we also take other structural diagnostics that are not affected by sample size into consideration (Bentler and Bonett, 1980). The root mean square error of approximation (RMSEA) (Steiger and Lind, 1980) is one of the most widely used estimates of misfit/fit of structural equation models. It describes the discrepancy between the proposed model and the original covariance matrix of the sample (Byrne, 1998). The RMSEA is 0.056, which is below the recommended cut-off value of 0.08 (Cudeck and Browne, 1983).

Equally, the Tucker–Lewis index (TLI) of 0.937 (Tucker and Lewis, 1973) and comparative fit index (CFI) of 0.946 (Bentler, 1990) exceed the cut-off value of 0.90 (Mulaik *et al.*, 1989). Overall, these fit indices suggest that the model has a good fit, which is further supported by comparing them to fit indices of prior structural equation models from the field of operations management (cf. Shah and Goldstein, 2006).

Figure 2 illustrates all hypothesized relationships and corresponding standardized regression coefficients. Interestingly, we do not find support for Hypothesis 2. However, we find support for our remaining hypotheses. Both middle managers' perceptions and top managers' commitment to the lean program show a statistically significant, positive effect on the development of a lean-supportive organizational infrastructure (H3a: $\beta = 0.235, p < 0.001$; H3b: $\beta = 0.828$, $p < 0.001$). In other words, a one standard deviation increment in middle managers' perceptions of the lean program's effectiveness leads to a 0.235 standard deviation increase in organizational infrastructure. Further, top managers' commitment positively influences middle managers' perceptions (H4: $\beta = 0.587$, $p < 0.001$). Finally, we find a statistically significant effect of organizational infrastructure on lean program implementation (H5: $\beta = 0.507, p < 0.001$).

Regarding control variables, only a few show statistical significance in their relationships with the latent variables. For example, we find that the experience of middle managers has a positive effect on their perceived effectiveness of the program ($\beta = 0.022$, $p < 0.05$). Top



Note(s): *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source(s): Created by authors

Figure 2.
Structural equation model with parameter estimates and factor loadings

managers' perceptions are, in turn, positively affected by the unionization of the plant ($\beta = 0.199$, $p < 0.01$) but negatively associated with plant age ($\beta = -0.147$, $p < 0.05$).

In addition, we run a robustness check by replacing the lean program implementation level in 2017 with the difference in program implementation between 2015 and 2017. Overall, the results are almost the same, showing very similar coefficients at the same significance levels with one marginal exception: the effect of organizational infrastructure on the relative lean program implementation measure being significant only at the 5% level.

Regarding our model, we have identified the possibility of a mediating effect, namely, middle managers' perceptions mediating top managers' commitment effect on organizational infrastructure. Traditionally, causal step methods have been employed to test the mediation effects, such as Baron and Kenny's (1986) stepwise approach. According to this approach, a mediation effect exists if (1) the independent variable significantly predicts the mediating variable, (2) the independent variable significantly predicts the dependent variable and (3) the mediating variable significantly predicts the dependent variable while controlling for the effect of the independent variable. As shown in Table 6, the results confirm a mediation effect. To ensure the robustness of our findings, we employ another parametric (Sobel, 1982) and nonparametric test (bootstrap). For our nonparametric test, we follow the bootstrap approach that Preacher and Hayes (2004) develop using a 95% confidence interval. Both tests confirm what the stepwise approach has shown, hence supporting the mediation effect.

5. Discussion and implications

Despite the vast popularity of lean programs, many manufacturing organizations still face problems advancing and sustaining their implementation (Jasti and Kodali, 2015; Losonci *et al.*, 2017; Netland *et al.*, 2015). Prior studies have shown that leadership is a critical success factor, but it should differ across hierarchical levels (Mann, 2009; Netland *et al.*, 2019).

5.1 Hierarchical differences in lean program perception

Our results have shown that top managers are generally less convinced of the effectiveness of a lean program than middle managers, which may be due to different reasons. A top

Mediator	Baron and Kenny's stepwise approach Effect of X on M coef	T	*p*	Effect of X on Y coef	T	*p*	Effect of M on Y coef	T	*p*	
Middle Managers' Perception	0.604	7.37	0.000	1.02	27.94	0.000	0.513	12.34	0.000	*Mediation supported*
	Sobel test									
	z		***p***							
Middle Managers' Perception	3.07		0.002							*Mediation supported*
	Bootstrapped estimate Confidence Interval									
Middle Managers' Perception	0.049		0.258							*Mediation supported*

Source(s): Created by authors

Table 6. Testing mediation effects

manager's job description usually includes responsibility of many departments at a high level but with less in-depth insights into manufacturing operations (Floyd and Lane, 2000). Because of their physical detachment from everyday operations, top managers seek financial evidence for lean success, such as increased market share, margin expansion or revenue growth (Emiliani and Stec, 2005), and if they do not find it, they may quickly lose conviction in the program's effectiveness (Wemmerlöv, 2021). However, due to confounding variables, it is difficult for researchers and practitioners to observe a direct relationship between lean and financial indicators, both for the researchers and practitioners (Wemmerlöv, 2021). Moreover, lean programs should not only be valued financially; they bring additional benefits, such as improved safety and morale (Monden, 1993).

Middle managers, in turn, are closer to the shop floor. Thus, they directly observe the performance changes associated with implementing lean programs. Specifically, higher levels of program implementation manifest in realized process improvements (e.g. solved problems, eliminated waste), better-trained employees according to global program standards, more process stability in terms of quality, flow, and cycle time and better performance management (e.g. using visual boards, shift handover meetings and key performance indicators). For these reasons, middle managers may more quickly observe than top managers how these changes affect the productivity of their workforce or the quality of the processes and products.

This finding has important implications for organizations aspiring to implement lean programs. Top managers are usually the first to decide upon the launch and continuation of a lean program, so their convictions are essential for the program's sustainment. The fact that top managers could perceive lean programs as less effective than other parts of the organization is a risk to the program's success.

5.2 Independence of perception and behavior

The reasons why we do not find a significant link between top managers' perceptions and commitment can be manifold. Arellano *et al.* (2021) show that managers have individual, multidimensional belief configurations that drive their commitment to practice adoption. Besides the belief in the effectiveness of a specific practice or program, belief in one's own ability to perform a certain behavior or social pressure to perform a certain behavior can drive individual behavior (Ajzen, 1991).

The characteristics of top management jobs could explain the detachment of their perceptions from their behaviors. Admittedly, top managers are usually loaded with

numerous responsibilities, which quickly distracts them from being present on the shop floor and engaged in implementing improvement programs (cf. Kellermanns *et al.*, 2005). Furthermore, the higher managers climb the hierarchical ladder, the more they are exposed to other non-manufacturing-related work tasks or expectations from other stakeholders (Burgelman, 1994; Floyd and Lane, 2000). The more external forces influence an individual, the less their own beliefs and perceptions will drive their behaviors. Consequently, top managers' lack of commitment does not necessarily need to be because of a lack of belief.

5.3 Interdependence of perception and behavior

Notwithstanding the relationship between top managers' perceptions and behaviors, the latter can have important consequences for manufacturing firms because top management's commitment affects the organization in many ways. On the one hand, managerial commitment is seen by other employees, who will then recognize the resources spent by top management, be it money, time or anything else. If employees experience that senior managers care, they too will see a reason to care (Emiliani and Stec, 2005). Accordingly, our results show that the more committed top managers are, the higher the middle managers' estimate of the program's effectiveness will be. It follows that employees will be more motivated and, thus, more involved in implementation (Emiliani, 2008; Netland *et al.*, 2019).

On the other hand, our results show that top management commitment has an even more substantial direct effect on the efforts spent on the organizational infrastructure for program implementation than middle managers' perceptions. As prior studies have shown, this can be because of increased face-to-face support, which shows strong engagement and helps build a relationship between top managers and shop floor operators, leading to a motivating effect on both sides (Hirzel *et al.*, 2017; Sadun *et al.*, 2017; van Dun and Wilderom, 2021; Worley and Doolen, 2006). Top managers can promote the program, stress its importance, issue guidelines or coach employees (Dombrowski and Mielke, 2014; Liker and Convis, 2012; Rother, 2010).

At the same time, direct observations on the shop floor and exchanges with shop floor employees can help direct top managers' attention to potential improvements while demonstrating the effectiveness of the program. The lean literature stresses the importance of learning and knowledge creation for successful lean implementation (Danese *et al.*, 2017; Secchi and Camuffo, 2019; van Dun and Wilderom, 2021). Therefore, the learning and knowledge transfer process is bidirectional because top managers also learn from shop floor teams (van Dun and Wilderom, 2021), and successful lean implementation thrives under the combination and co-creation of knowledge, as well as collective problem-solving (Galeazzo *et al.*, 2017; Hirzel *et al.*, 2017).

5.4 Implications for effective lean implementation

Regarding the degree of lean implementation, a supportive organizational infrastructure that relies on team meetings, training sessions or guidelines appears to be an effective measure for channeling these efforts and effectively driving implementation. This is supported by Onofrei *et al.* (2019), who identify structural and social capital as significant factors for successful lean implementation. Our interpretation of organizational infrastructure provides a platform that enables codified knowledge (structural capital) and open communication (social capital).

Overall, our results show that top managers' commitment is important for keeping the program operational and supporting its implementation. Our model shows that top managers' commitment affects the organizational infrastructure more strongly than the middle managers' perceptions of lean effectiveness.

Another implication of our results is that the exclusive use of traditional communication structures where top managers are merely informed by direct subordinates can hamper the

build-up of the necessary organizational infrastructure for lean implementation. An increased exchange with top management fosters vertical communication among hierarchies, which is essential for creating an awareness of strategic priorities and aligning the organization (Ateş *et al.*, 2020; Biggs *et al.*, 2014), which is another driving force behind lean implementation (Galeazzo *et al.*, 2017).

Besides the importance of top managers when it comes to lean implementation, our study shows that organizations might rely on the involvement of the workforce to implement lean programs successfully (Emiliani, 2003). Top management commitment is an enabler for the whole organization in effectively implementing a lean program. In this way, our study empirically confirms the anecdotal evidence in the literature (e.g. Ballé *et al.*, 2016; Netland *et al.*, 2019; Rother, 2010).

5.5 Implications for research

Our paper has three main implications for future research. First, we show that top managers have lower perceptions of the usefulness of lean programs than middle managers. This result has important implications for the research on lean management and on operations management research in general. Our results resonate with those scholars arguing that the nature of the executives' jobs drives top managers away from shop floor practicalities (Emiliani and Stec, 2005). Executives are often more comfortable working in settings driven by financial and economic indicators, thus losing sight of what happens on the front. In this way, managers might fail to identify how operations improvement can help them learn how to steer the firm's strategy in a direction where they can gain a competitive advantage. The link between operations improvement and strategy can become blurred, weakening the contribution the operations can have on the firm's competitiveness (Hayes and Wheelright, 1984). We encourage scholars to study how top managers' perceptions of organizational change programs, such as lean, can be improved and what this can mean for firms' competitiveness.

Second, our results indicate a possible nonlinearity in the relationships between perceptions, commitment and behaviors at different hierarchical levels. On the one hand, increasing top managers' perceptions of lean effectiveness do not automatically increase their commitment to the program. For example, managers may believe in a range of concepts that they do not find time to prioritize. Other confounding effects, such as institutional pressures, may also explain top managers' commitment to lean programs. On the other hand, an increase in middle managers' perceptions of lean effectiveness directly translates into higher levels of lean organizational infrastructure. At the same time, top managers' commitment to lean programs, both directly and indirectly through middle managers' perceptions, also supports the establishment of a lean organizational infrastructure.

Third, the finding that the perceptions of middle managers are not independently formed but are affected by top managers' commitment has important theoretical implications. Middle managers' perceptions of lean effectiveness are not independent of the environment, as is often implicitly assumed by scholars. The extent to which top managers actively engage in lean implementation and strategically communicate the importance of lean implementation can positively influence middle managers' perceptions of lean programs. This shows that middle managers' perceptions—which, in turn, influence their actions toward creating a supportive organizational infrastructure—could be forged by context and shaped partly by top managers.

We encourage scholars to continue this line of research and deepen our community's understanding of the intricate relationships that link perceptions, commitment and behaviors at different hierarchical levels. This calls for future research exploring the behavioral and political aspects of leadership in lean program implementation.

5.6 Implications for managers

The findings imply some practical advice for managers. We confirm that top managers play an important role because of their strong influence on setting up, maintaining and supporting the organizational infrastructure, strategic alignment and dedication of resources to lean program implementation. Their active involvement in implementation is important because it can increase their perceptions of lean effectiveness, foster the transfer of knowledge and spark new ideas or discussions that employees can embark on and realize. Hence, top managers are advised not only to rely on direct communication with subordinates but also to supplement it with a direct exchange with frontline workers. Training, structured meetings and instilling dedicated teams and guidelines are effective means that manufacturers can employ to realize lean program implementation.

The finding that top managers' perceptions of lean effectiveness seem unrelated to their commitment to lean has important managerial implications, too. Increasing the likelihood of the success of a lean implementation from the top might require identifying the antecedents of top management's commitment toward the lean program. The institutional perspective (Di Maggio and Powell, 1991) argues that practices can be adopted for institutional factors, regardless of the effect these practices have on a firm's performance. Imitating the "best in class," for example, can represent a source of legitimacy for top managers striving to achieve recognition in their firms, regardless of their beliefs about the effectiveness of the practices adopted by the best in class. Understanding the institutional factors that drive top managers' commitment in each context is key to promoting and supporting lean program implementation.

6. Conclusions and limitations

Our study shows that perceptions of lean program effectiveness differ among middle managers and top managers. Middle managers perceive lean programs as more effective than top managers do. A plausible reason is that middle managers are much closer to the implementation and can quickly observe tangible and intangible results. In contrast, top managers are busy managing other aspects of the business and mostly see only aggregate financial results. Moreover, we show that top managers' commitment to the program relates positively to the perception of middle managers and supports building an effective organizational infrastructure for lean implementation, which ultimately drives more lean implementation. Our study also has limitations. First, we have collected data within the production network of a single firm. This research design effectively controls for industry effects, but it hurts the external validity of the results. Second, we conceptualize commitment and perceptions as latent constructs comprised of three to four items. A broader system of measures would be even better to capture these concepts more precisely. Third, our cross-sectional survey design has led to the measurement of all items simultaneously. A longitudinal study considering the longevity of lean implementation efforts would allow for even more robust insights. Fourth, because we study top managers, we implicitly face the issue of a small sample size regarding their responses, which limits the validity of our results. Fifth, studying lean as it is operationalized in the firm increases internal validity but limits our opportunities to generalize beyond our research context.

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