Accounting, Organizations and Society 38 (2013) 50–71

Contents lists available at SciVerse ScienceDirect

Accounting, Organizations and Society

journal homepage: www.elsevier.com/locate/aos

Management accounting and control practices in a lean manufacturing environment

Rosemary R. Fullerton [a,*], Frances A. Kennedy [b,1], Sally K. Widener [c,2]

[a] Jon M. Huntsman School of Business, Utah State University, Logan, UT 84322-3540, USA
[b] Clemson University, Clemson, SC 29634-1303, USA
[c] Jesse H. Jones Graduate School of Business, Rice University, Houston, TX 77005, USA

A B S T R A C T

A lean strategy is rapidly becoming the dominant paradigm in manufacturing. Kennedy and Widener (2008) use a case study to develop a theoretical framework of management accounting and control practices for firms following a lean manufacturing strategy. We build on Kennedy and Widener (2008) by examining a structural equation model that provides evidence on the extent to which a lean manufacturing implementation is related to five management accounting and control practices. Using survey data from 244 US companies with an interest in lean manufacturing, we find a direct positive relation between the extent of a lean manufacturing implementation and a simplified strategic reporting system, value stream costing, visual performance measurement information, and employee empowerment. We find a direct negative relation with inventory tracking; however, we find it is conditional on the extent of top management support for change in production strategies such that firms decrease reliance on inventory tracking in the presence of strong management support. We also conclude that the management accounting and control practices work together as a package in a lean manufacturing environment as evidenced by the many direct associations among the five management accounting and control practices.

Introduction

Lean manufacturing is often regarded as the most important strategy for manufacturing firms desiring to achieve world-class performance (Rinehart, Huxley, & Robertson, 1997). As firms progress in their implementation of lean manufacturing, many are recognizing the need for a supportive management accounting and control system (see Statements on Management Accounting (SMA), 2006). Yet, accounting research (and education) has been slow to recognize the importance of aligning management accounting and control practices with a lean manufacturing strategy (Castellano & Burrows, 2011; Haskin, 2010). This study addresses this limitation by investigating whether and how management accounting practices and controls are used in support of lean manufacturing.

Manufacturing firms have responded to the highly competitive market of the past two decades by implementing such practices as quality circles, statistical process control, theory of constraints, just-in-time inventory management (JIT), total quality management (TQM), six sigma, and total preventive maintenance (TPM). More recently, these practices are recognized as elements of a lean manufacturing strategy. The essence of the lean manufacturing strategy is that "all business processes and functions integrate into a unified, coherent system whose single purpose is to continue to provide better value to customers..." (Grasso, 2005, p. 19).

* Corresponding author. Tel.: +1 435 797 2332; fax: +1 435 797 1475.
E-mail addresses: Rosemary.Fullerton@usu.edu (R.R. Fullerton), fkenned@exchange.clemson.edu (F.A. Kennedy), widener@rice.edu (S.K. Widener).
[1] Tel.: +1 864 656 4712.
[2] Tel.: +1 713 348 3596.

0361-3682/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.aos.2012.10.001

Consistent with this notion of integration is the idea that accounting and control systems are aligned with strategy (Langfield-Smith, 1997); however, there is little empirical evidence that sheds insights on the integration of management accounting and control practices with a lean manufacturing strategy. Using a qualitative case study, Kennedy and Widener (2008) conclude that management accounting and control practices change in support of a lean manufacturing strategy. The aim of this study is to build on the Kennedy and Widener (2008) study and provide a deeper empirical understanding of the management accounting and control practices used by a cross-section of manufacturing firms to support their lean manufacturing strategy.

Specifically, our first purpose is to describe empirically the relations between a lean manufacturing strategy and five management accounting and control practices. Although several studies investigate various aspects of lean manufacturing practices, we know little about the use of management accounting and control practices in these environments. Therefore, we lack empirical understanding of such basic questions as whether firms alter their management accounting and control practices to support their lean manufacturing strategy. Our second purpose is to gain insight regarding how management accounting and control practices work together to support a lean manufacturing strategy. Although it is well-accepted that accounting and control practices are related and work as a "package" (Otley, 1980), information on what constitutes the package[3] used to support a lean manufacturing strategy is lacking.

Consistent with Kennedy and Widener (2008), we examine both management accounting and control practices. *Management accounting practices* refers to transaction processing that gathers and aggregates data in a meaningful manner. Drawing from Kennedy and Widener (2008), we examine the use of value stream costing (VSC), inventory tracking, and a simplified strategic reporting system. Most lean manufacturing firms will move from a functionally-oriented organization to one organized around value streams. "A value stream is the sequence of processes through which a product is transformed and delivered to the customer" (Haskin, 2010, p. 91). Value streams thus span functions from product design to sales to office support. VSC directly traces *actual* material and conversion (labor and overhead) costs to individual value streams. Inventory tracking is the monitoring and allocation of overhead and other inventoriable costs as raw materials move through production and are processed into final products. Finally, a simplified strategic reporting system is one that is efficient, minimizes transaction processing, and more generally supports the decision-making process of a lean manufacturing strategy.

Management accounting controls monitor and direct behavior in order to achieve goal congruence. Again drawing on Kennedy and Widener (2008), we examine employee empowerment and visual performance measurement information. The visual performance measurement information provides goals, targets, and feedback in a simplified way, making the information more powerful and easy for shop-floor workers to process (Galsworth, 1997). Empowered employees are able to effectively participate in quick and timely decision-making, which facilitates the achievement of goals inherent to lean manufacturing (see e.g., Fullerton & McWatters, 2002; Kennedy & Widener, 2008).

Using data from 244 US companies with an interest in lean manufacturing,[4] we test a structural equation model (SEM) that examines the relations between lean manufacturing and management accounting and control practices. We hypothesize and find that the extent of lean manufacturing implementation positively influences employee empowerment, visual performance measurement information, a simplified strategic reporting system, and VSC; and negatively influences inventory tracking. However, we find that the negative relation with inventory tracking is conditional on the level of top management support for change in production strategies. That is, top management support for change is necessary to reduce reliance on inventory tracking. These findings indicate that the form of four of the examined relationships are additive[5]; however, the form of the relationship between the extent of lean manufacturing implementation and inventory tracking is interactive, as it is a function of the level of top management support for change in production strategies.

We then examine the set of management accounting and control practices. After controlling for the extent of lean manufacturing implementation, we find many significant associations, which indicates these practices work together as a package. This finding shows that the relations between the extent of lean manufacturing implementation and each of the management accounting and control practices are not only additive, but also intervening. Thus, we find that the total effect of the extent of lean manufacturing implementation on each of the management accounting practices is greater than only the direct (additive) effect. Finally, we further examine the association between inventory tracking and VSC and find that firms run dual accounting systems in the group of firms that has implemented lean to a low extent; it is only when the extent of lean manufacturing implementation is high that firms substitute VSC for inventory tracking. This indicates that the form of the relation between VSC and inventory tracking is interactive as it depends on the extent of lean manufacturing.

[3] Malmi and Brown (2008) note that discussion of a *package* of controls dates back to Otley (1980) and state, "as a general conception, a management control system (MCS) package is a collection or set of controls and control systems." Although it has been discussed as such in the literature for over 30 years, Malmi and Brown (2008) note that there has been little theorizing or empirical testing of control packages. We use the term package to denote that significant associations exist among the set of practices (as opposed to each practice working in isolation). Note that we do not claim that this package necessarily includes all accounting practices and controls that could be used by the organization, and hence it could be an "incomplete" package.

[4] All but 17 of the respondent firms indicated they have adopted lean manufacturing.

[5] Luft and Shields (2003) identify various causal-model forms as: additive, intervening-variable, and interaction. We hypothesize and examine all three causal-model (linear) forms in this paper. For a more thorough discussion of these concepts, please see Luft and Shields (2003).

This study contributes to the literature in four ways. It responds to calls (e.g., Li, Sawhney, Arendt, & Ramasamy, 2012; van der Merwe & Thomson, 2007) to provide empirical research that clarifies our understanding of *whether or not* firms implement specific management accounting and control practices to support a lean manufacturing strategy. Other researchers have suggested that for management accounting research to be relevant, it must examine the "role of novel management accounting practices within contemporary settings" (Chenhall, 2003, p. 130; see also Balakrishnan, 2010). Second, we show that the relation between lean manufacturing and inventory tracking is not "universal," but rather conditional on top management support for change in production strategies (Luft & Shields, 2003, p. 185).

Third, we document several associations among the management accounting and control practices, suggesting that they work as a package in support of a lean manufacturing strategy. We also hypothesize and find that the association between inventory tracking and VSC is a function of the extent of lean manufacturing implementation. This responds to Malmi and Brown's (2008) request for more clarifying research on appropriate packages of management accounting practices for specific environments. They cite the Kennedy and Widener case study (2008) as a single example of providing an understanding of the configuration of management accounting controls for a lean environment. Finally, we use a database created by a strong survey response rate from an identified group of lean manufacturing users. This facilitates better measurement of the constructs, as there is common and clear understanding of the survey questions. Ultimately, this allows for more confidence in the reliability of the results.

The next section discusses and clarifies our representations of lean manufacturing strategy and management accounting and control practices; it also develops the hypotheses. The following section outlines the research methods, and then we discuss the results. The last section provides a summary of the study, research limitations, and future research suggestions.

Literature and hypotheses development

Lean manufacturing

A lean manufacturing strategy examines value from the customer's perspective and then redesigns the production processes to enhance that value (Womack & Jones, 2003). Systems are designed to minimize waste and produce quality products first-time through (Kennedy & Maskell, 2006; Shah & Ward, 2003). Lean manufacturing is a "pull" strategy, producing only to customer demand. Firms in this environment reorganize into cells and value streams (Womack & Jones, 2003) that allow them to focus on the value generated by products or product families across all functions.

Research shows that lean-related manufacturing practices such as JIT, TQM, and six-sigma are related to increased employee empowerment (Bowen & Lawler, 1992; Fullerton & McWatters, 2002) and visualization (Banker, Potter, & Schroeder, 1993; Zayko & Hancock, 1998), and with reduced inventory tracking (Banker et al., 1993). Shah and Ward (2003, 2007) expand these findings by determining the underlying constructs that define lean manufacturing. Kennedy and Widener (2008)[6] build on Shah and Ward (2003) and conclude that management accounting and control practices change in response to a lean manufacturing strategy.

To investigate the integration of a lean manufacturing strategy into and throughout the entire organization, we draw on contingency theory[7] (e.g., Gerdin & Greve, 2004, 2008). "The essence of contingency theory is that organizations must adapt their structure to contingencies such as the environment, organizational size, and business strategy if the organization is to perform well" (Gerdin & Greve, 2008, p. 996). It is important, although difficult, to identify the specific aspects of the environment and accounting system to study (Hartmann & Moers, 1999; Otley, 1980). To aid in the identification of appropriate variables for our study, we draw on the congruence model (Nadler & Tushman, 1980, 1997).

Congruence, defined as "the degree to which the needs, demands, goals, objectives, and/or structures of one component are consistent with those of the other" (Nadler & Tushman, 1997, p. 34), is the researcher's attempt to *understand* the laws of organizational relationships (Fry & Smith, 1987). The congruence model holds that internal consistency among components of "people, work, the formal environment, and the informal environment" is critical to achieving organizational fit.[8] The model assumes that the components must be in alignment; thus, changing one influences the other. The lack of congruence, or misfit, can lead to cognitive dissonance and organizational ineffectiveness (Beehr, Glazer, Fischer, Linton, & Hansen, 2009; Griffith & Myers, 2005; Myers, 2004; Roberts & Grover, 2012; Wright & Snell, 1998).

In the congruence model, work is what the organization is in business to do; that is, the activities employees perform on a daily basis (Nadler & Tushman, 1997). It describes the core business of the organization. "People" is the employees' skills, knowledge, and characteristics that they apply to their "work" (Wyman, 2003). The "formal

[6] An abbreviated description from Kennedy and Widener (2008) of the management accounting and control practices from both before and after the implementation of a lean strategy is shown in Appendix A. Due to the tractable nature of empirical cross-sectional research, we are limited in the management accounting and control practices that we examine. Since our survey development occurred before the publication of Kennedy and Widener (2008), we did not include measures that effectively captured either peer pressure or the use of standard operating procedures. However, with this exception, our examination of management accounting and control practices is consistent with those in Kennedy and Widener (2008). For more detail, see Kennedy and Widener (2008).

[7] Note that some (e.g., Chenhall, 2003) refer to this as "contingency-based research" while others (e.g., Chapman, 1997; Gerdin & Greve, 2004, 2008) refer to it as "contingency theory." Our purpose is not to enter into this debate; we will use the latter terminology.

[8] Gerdin and Greve (2004) specify that congruence fit assumes that the better-performing firms survive and are thus the firms that are observed. We assume that firms (e.g., managers) are acting rationally (although perhaps not optimally) as leaders in the area of lean by adopting management accounting and control practices that enhance performance (see discussion in Chenhall, 2003).

environment" includes an organization's structures, processes, methods, and procedures developed to help people achieve strategic alignment (Nadler & Tushman, 1980; Wyman, 2003), while the "informal environment" consists of unwritten and unformalized practices and processes that are embedded in the beliefs and values of the organization (Wyman, 2003). In sum, the congruence model suggests that in order to fully understand how firms perform, one must understand "the critical transformation process through which people, working within the context of both formal and informal arrangements, convert input into output" (Wyman, 2003, p. 5).

In our examination, we define "work" as lean manufacturing; it represents how the daily operations are performed. We view the characteristic of employee empowerment as "people." It is not the granting of decision rights, but rather the employee's belief that they have the skills and knowledge necessary to take proper actions and make appropriate decisions (Carroll, 1994). It is only when employees' knowledge and skills are congruent with the knowledge and skills required of their tasks that empowerment can flourish (Nadler & Tushman, 1980). The "formal environment" we define as visual performance information, inventory tracking, simplified strategic reporting, and VSC. These activities help set the structure and systems to direct the achievement of organizational goals. Finally, the "informal environment" is captured in the extent of top management support for change in production strategies. Nadler and Tushman (1980) point out that the behavior (rather than the position) of leaders is a critical component of the informal environment.

In the sub-sections that follow, we develop our hypotheses as depicted in Fig. 1. First, we predict an additive direct relation between the extent of lean manufacturing implementation and each of the management accounting and control practices. We then predict that the form of the relation between the extent of lean manufacturing implementation and management accounting and control practices is conditional on top management support for change in production strategies. Finally, we generally predict that the pairs of management accounting and control practices are directly related. We also predict, though, that the form of the relation between inventory tracking and VSC is conditional on the extent of lean manufacturing implementation.

Lean manufacturing and management accounting and control practices

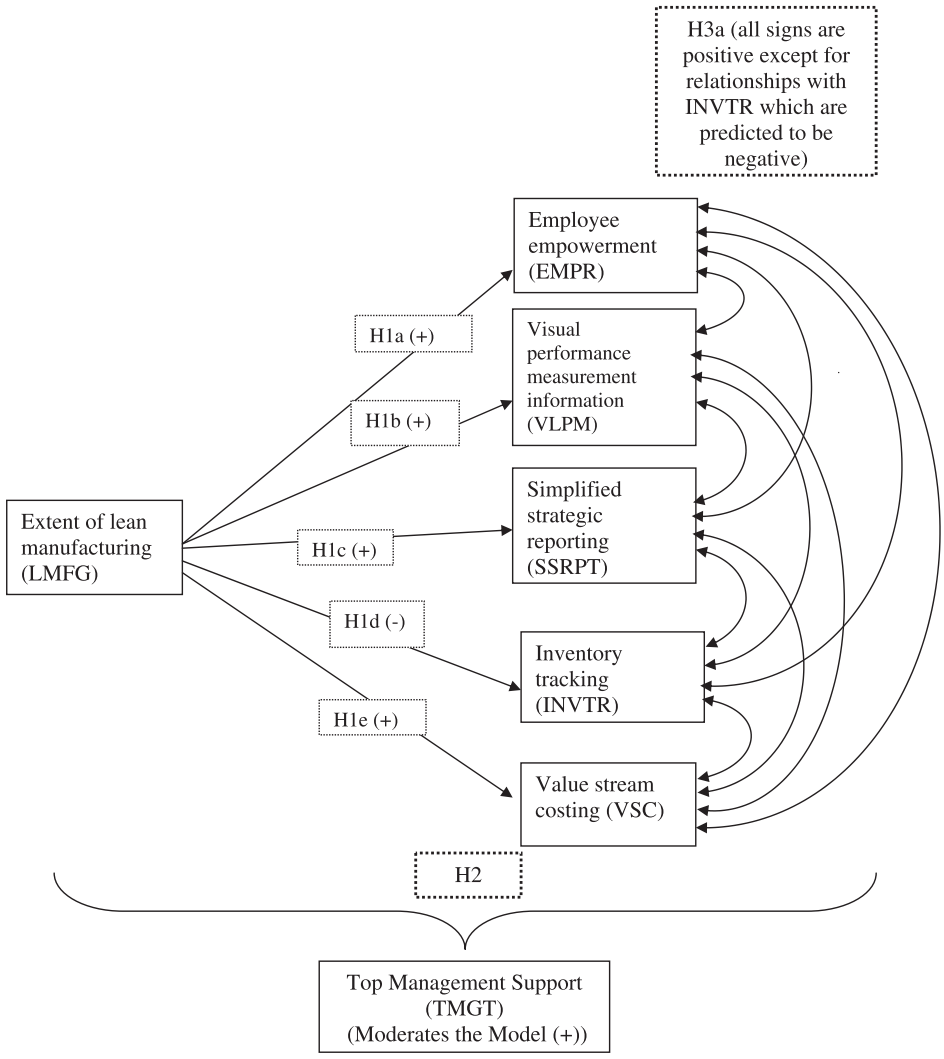
Our first hypothesis examines how the extent of lean manufacturing implementation ("work") influences empowerment ("people"). The congruence model argues that efficiencies result when the characteristics of the people are congruent with the work of the organization (Nadler & Tushman, 1980). Value stream managers and teams, responsible for the quality, cost, and delivery of the product as it flows through the processes, must be trained across functions and be able to make operating decisions and adjustments to their own work (Banker et al., 1993; Fullerton & McWatters, 2002). As employees acquire the characteristics necessary to make timely, effective decisions, they are more motivated to be empowered and achieve organizational goals (Herrenkohl, Thomas, & Heffner, 1999). This allows management to focus on developing strategic initiatives while employees focus on day-to-day activities necessary to execute the strategic vision (Shingo Prize for Operational Excellence, 2011). Prior research has shown that the implementation of TQM, JIT (Cua, McKone, & Schroeder, 2001; Ittner & Larcker, 1995) and world-class manufacturing (Lind, 2001) is related to empowered teams. Structural alignment and fit, and achievement of organizational goals (Herrenkohl et al., 1999) are much easier to accomplish when employees are empowered. In sum, employees who believe they have the necessary skills and knowledge to be empowered in their actions and decision-making will enable congruence between "people" and "work" in a lean "pull" environment. This leads to our first hypothesis:

H1a. The implementation of a lean manufacturing strategy is positively related to employee empowerment.

The congruence model argues that a firm's formal organization provides employees with a means to structure and coordinate their work activities in order to achieve the firm's strategic objectives (Wyman, 2003). In a lean manufacturing environment, visual controls are integral to facilitating effective work activities (Cunningham & Fiume, 2003; McGovern & Andrews, 1998; Zayko & Hancock, 1998). Visual transformations can make complex information simple by providing shop-floor workers with current, easy-to-use performance measurements (Cardinaels, 2008; Galsworth, 1997) that communicate real-time results. This helps ensure on-time delivery of quality products that meet customer specifications and demands (Maskell, Baggaley, & Grasso, 2012). Using qualitative data, Kennedy and Widener (2008) conclude that a lean manufacturing strategy is related to a visual performance measurement system comprised of operational measures critical to the achievement of lean strategic objectives. Thus, having a visible, timely measurement system linked to strategic objectives facilitates the congruency between work and the formal environment. This leads to our second hypothesis:

H1b. The implementation of a lean manufacturing strategy is positively related to the use of visual performance measurement information.

Consistent with the commonly accepted notion that management accounting practices support a firm's strategy (e.g., Langfield-Smith, 1997), the congruence model suggests that formal practices must be arranged in order to meet work demands (Nadler & Tushman, 1980). In a lean environment, accountants are encouraged to interact with shop-floor personnel to better understand their information needs and provide that information in a more simplified form (Cadez & Guilding, 2008; Cunningham & Fiume, 2003). Moreover, as firms progress in implementing a lean manufacturing strategy, the objectives of eliminating waste and inefficiencies will transfer from the shop floor to the support functions, resulting in simplified and streamlined processes throughout the organization (Maskell et al., 2012). Kennedy and Widener's (2008) case



Notes: We are only depicting the structural model.

H3b investigates how the relationship between INVTR and VSC is moderated by the extent of lean manufacturing implementation. This is not depicted above.

Fig. 1. Theoretical model.

study demonstrates how a lean manufacturing strategy influences the use of streamlined transaction processing, while Fullerton and McWatters (2001) empirically show that firms adopting higher levels of lean manufacturing are more likely to have simplified their accounting system. Thus, to achieve congruence between a firm's work and its formal accounting practices, we hypothesize the following:

H1c. The implementation of a lean manufacturing strategy is positively related to the use of a simplified strategic reporting system.

In a more flexible, flatter lean organization, congruence between work and formal practices is achieved by managing processes, rather than managing by accounting numbers (Johnson, 2006; Johnson & Bröms, 2000). Thus, many contend that detailed inventory tracking does not support a lean manufacturing strategy (e.g., Green, Amenkhienan, & Johnson, 1992; Howell & Soucy, 1987; Johnson, 1992; Kaplan, 1983, 1984). In fact, detailed inventory tracking can actually impede lean implementations (Solomon & Fullerton, 2007) by: (1) encouraging firms to build more inventory[9]; (2) focusing on the "accuracy" of product costs rather than customer value; (3) using volume and efficiency variances that discourage the creation of excess capacity; and (4) building a complex system of data collection and reporting that is difficult to understand (Maskell & Kennedy, 2007). This argument is supported by case studies such as

[9] Producing more inventory allows for a lower average product cost since fixed costs are spread over more units.

Brosnahan (2008), who explains that changing inventory valuation techniques to avoid allocations better supports lean manufacturing, and Åhlström and Karlsson (1996), who discuss how a management accounting system (MAS) focused on labor tracking almost derailed an otherwise successful lean implementation strategy.

In sum, the tracking of accumulated inventory costs through the manufacturing process will encourage firms to "over-produce, creating excess inventories and reducing the flow of production—exactly opposite the intent of lean manufacturing" (Maskell et al., 2012, p. 5). Thus, the reliance on inventory tracking should be reduced to achieve congruence between work and the formal environment for lean operations. We propose the following:

H1d. The implementation of a lean manufacturing strategy is negatively related to the use of detailed inventory tracking.

The congruence model asks whether "organizational arrangements are adequate to meet the demands of the task" (Nadler & Tushman, 1980, p. 43). One major objective of lean manufacturing is to increase the contribution of the value streams. VSC sheds insight on managing production bottlenecks and capacity, which are critical issues to the flow and pull so vital to lean production. Capacity information provided by VSC also allows value stream managers to better understand the relevant costs that affect future work related to whether or not to expand production, take on special orders, or in-source rather than out-source. Based on personal experiences, Solomon and Fullerton (2007) and Brosnahan (2008) argue that VSC improves the communication and decision-making process in lean organizations and saves money through significantly reduced transaction tracking. In their longitudinal case study, Åhlström and Karlsson (1996) demonstrate that refocusing the MAS on value streams is beneficial to a lean manufacturing strategy.

A firm organizing into value streams needs a MAS designed for that type of formal organization (Brosnahan, 2008). In accordance with the congruence model, work efforts centered on value stream objectives leads to our next hypothesis.

H1e. The implementation of a lean manufacturing strategy is positively related to the use of value stream costing.

In this section, we have argued that congruence will be achieved through an additive causal model that links the "work" of the organization (i.e., extent of lean manufacturing implementation) to "people" (i.e., empowerment) and to "formal practices" (i.e., visual performance measurement information; simplified, strategic reporting; inventory tracking; and VSC). In sum, we have hypothesized that the extent of implementation of a lean manufacturing strategy is *directly* related to five management accounting and control practices. In the next sub-section, we turn our attention to how these direct relations are moderated by top management support for change in production strategies (i.e., the "informal" organization).

Moderating effects of top management support for change in production strategies

Nadler and Tushman (1980) point out that the behavior of management is a critical component of the "informal" environment because it significantly influences the transformation process of the congruence model (Nadler & Tushman, 1980, 1989). In a dynamic environment, top leadership must be an enthusiastic and active agent of change to motivate and reassure workers of the appropriateness of new techniques (Garcia-Morales, Jimenez-Barrionuevo, & Gutierrez-Gutierrez, 2012; Nadler & Tushman, 1989). Studies investigating TQM (e.g., Powell, 1995; Ugboro & Obeng, 2000) and JIT (e.g., Fullerton & McWatters, 2004; Wafa & Yasin, 1998) affirm the importance of top management commitment for achieving success in implementing advanced manufacturing technologies. Kaynak (2003, p. 425) summarizes this argument by stating: "It is management that provides the resources necessary for training employees in the use of new principles and tools, and creates a work environment conducive to employee involvement in the process of change." Wyman (2003) further explains that even though companies may have the correct strategy and vision in place, if managers cling to practices that are out of sync with visionary transformations, congruence will be inhibited and progress limited. Thus, in the presence (absence) of top management support for change in production strategies, the effects of a lean manufacturing initiative on the firm's management accounting and control practices are likely to be larger (smaller). This leads to the following hypothesis[10]:

H2. The effect of the extent of lean manufacturing implementation on management accounting and control practices, as hypothesized in H1a–H1e, will be greater with high top management support for change in production strategies than with low top management support for change in production strategies.

In the next sub-section, we turn our attention to how these management accounting and control practices form a package of controls that enhances congruency.

Relations among management accounting and control practices

Consistent with Nadler and Tushman (1980), we argue that congruence requires "people" to be aligned with the "formal" practices, and further, that the "formal" practices must be congruent with one another. Thus, we expect there to be relations among empowerment, visual performance measurement information, simplified strategic reporting, inventory tracking, and VSC. This argument is consistent with literature contending that accounting and control practices are related (e.g., Widener, 2007).

VSC, a simplified strategic reporting system, and visual performance measurement information articulate a firm's commitment to lean strategies and create a formal system

[10] Note that we are predicting a difference in the "form" of the association; that is, the regression lines or slope will differ between groups (Hartmann & Moers, 1999).

that provides the information to help achieve those lean objectives. VSC is a more straightforward accounting system that conveys the continuous improvement and reduction of waste principles embodied in lean. It attempts to capture actual costs with minimal allocations (Kennedy & Widener, 2008; Solomon & Fullerton, 2007), consistent with a simplified MAS that provides strategic information. Strategic operating measures are portrayed visually for the value streams, simplifying shop-floor information and aiding in the empowerment of employees to make decisions and take actions congruent with a lean strategy. Together, these practices serve to motivate creative innovation congruent with the firm's strategy of lean manufacturing.

Conversely, detailed tracking of inventory may encourage employees to take actions in a direction that is inconsistent with the lean manufacturing strategies supported by VSC, simplified strategic reporting, visual performance measurement information, and empowerment. Tracking of inventory costs can encourage firms to build inventory and fully utilize capacity regardless of demand, which is at odds with the objectives embedded in VSC. This may frustrate employees who feel conflicted about whether to fully utilize resources in building inventories, or to maintain a smooth, efficient flow that responds only to customer demand. Conversion cost allocations, contrary to the objectives of a simplified strategic reporting system, can distort product costs. Focusing on inventory levels and costs impairs employees' empowerment and detracts from the operational information embedded in the visual performance measurement information that provides strategic information on lean objectives.

We make no hypothesis about causation between the pairs of accounting and control practices due to the lack of underlying theory. However, consistent with this discussion, we expect that visual performance measurement information, simplified strategic reporting, VSC, and empowerment will be positively related to one another and negatively related to inventory tracking. These expected relations will facilitate congruence among the "formal" practices and "people." Although there are limited research findings in this area, Kennedy and Widener (2008) conclude in their case study that visual performance measures, employee empowerment, VSC, and simplified strategic reporting are related. We hypothesize the following:

H3a. Employee empowerment, visual performance measurement information, simplified strategic reporting, and VSC are positively related to each other and negatively related to inventory tracking.

Interestingly, while firms may understand their MAS deficiencies, Haskin (2010) notes that they are often reluctant to make changes in familiar, long-used methods. Decreasing the emphasis placed on the tracking of inventory is particularly challenging, since inventory tracking is critical for maintaining control of manufacturing processes designed to maximize production and *push* inventory through the facility (see Åhlström & Karlsson, 1996). Thus, although firms organized around value streams will begin to recognize the importance of VSC for achieving their lean goals, the continuation of inventory tracking initially may be necessary. In discussing the "maturity path" of lean accounting, Maskell et al. (2012) explain that companies in the earlier stages of lean implementations will often continue using their old reporting system to help maintain stability and achieve congruence among people, work, and the formal system. For example, to support lean operations at Wiremold, it was necessary to maintain a dual MAS for almost a year before transactions related to inventory tracking could be eliminated (Emiliani, 2007).

The tracking of inventories can be minimized when an organization transitions to a *pull* system with short production cycles and low inventories. Costs can be controlled through VSC, creating an efficient, simple, strategically-aligned reporting system. To maintain stability, we expect that in the early stages of a lean implementation, firms will run dual costing systems consisting of VSC and inventory tracking. However, firms in the later stages of a lean implementation and further along the "lean accounting maturity path" will place less reliance on inventory tracking. Thus, we formally hypothesize[11]:

H3b. Inventory tracking and VSC are positively (negatively) related when the extent of lean manufacturing implementation is low (high).

Methods

Data and sample

We developed a questionnaire and then pretested it with several academic colleagues, as well as four manufacturing managers working in firms implementing lean. We made changes in response to their feedback. We drew our sample from the 1389 participants who registered for at least one of the annual Lean Accounting Summits from 2005 to 2008. The first annual Lean Accounting Summit (i.e., a conference focused on how accounting could better support lean operations) was held in 2005 attracting approximately 250 attendees. By 2008, it had grown to just over 500 attendees.[12] We eliminated over one-third of the registrants who had either attended more than one Summit or were from the same plant.[13] We also eliminated potential

[11] Note that we are predicting a difference in the "form" of the association; that is, the regression line or slope will differ between groups (Hartmann & Moers, 1999). However, unlike H2, which predicted an ordinal interaction (i.e., the magnitude of the coefficient changes), here we are predicting a disordinal interaction (i.e., the sign of the coefficient changes) (Luft & Shields, 2003).

[12] Lean accounting is generally defined as a simplified accounting system that provides accurate, timely, and understandable information to support a lean transformation and improve decision making. It uses visual measures and value stream practices to help maintain financial control (see Maskell & Kennedy, 2007). Note that while lean accounting may not be "common knowledge" in the general populace, it would be a commonly understood term among the attendees at the Lean Accounting Summit.

[13] It would be helpful to have multiple responses from the same plant; however, it is not practical and may even be detrimental to obtaining responses. In fact, when this occurred accidentally, we received complaints that either they or a colleague had already responded.

respondents with incorrect contact information or who were employees of non-manufacturing entities or international firms. This resulted in a sample of 476. We contacted respondents a maximum of four times (three were by e-mail and the last contact was by mail) and received 265 responses. Six responses were incomplete and eliminated from the testing, leaving a response rate of 54%. We averaged the 15 responses received from duplicate plants, leaving a test sample of 244. The large majority of the respondents had accounting and finance backgrounds, with titles of controller, CFO, and VP of finance.

We investigated non-response bias by comparing early to late respondents, based on response return date. We defined early respondents ($n = 134$) as those who responded following the first contact. We defined late respondents ($n = 110$) as those who answered following the second or third contact. We found no statistically significant differences between groups for any of the variables examined in our model or for firm size.[14] Overall, the results support the absence of significant non-response bias.

Measures

Only a portion of the 125 survey questions are applicable to the relations examined in this project. The majority of the questions were either categorical or semantic differential scales (see Appendix B). While we used general concepts from previous studies to construct the instrument used for this research, the majority of the constructs were purpose developed. Appendix C contains criterion variables that we correlate with our constructs to demonstrate plausibility. We based the scale for extent of lean manufacturing on the Shingo Prize 2006 guidelines.[15] The nine elements representing lean manufacturing—standardization, manufacturing cells, reduced setup times, kanban system, one-piece flow, reduced lot sizes, reduced buffer inventories, 5S, and Kaizen—are consistent with extant literature (e.g., Fullerton & McWatters, 2002; Fullerton, McWatters, & Fawson, 2003; Shah & Ward, 2003, 2007).

We adapted the measures for empowerment and visual performance measurement information from the Shingo Prize Guidelines, the 14 principles described in the *Toyota Way* (Liker, 2004, pp. 38–39), and Kennedy and Widener (2008). The seven items that measure empowerment include employee involvement and training in problem solving and improvement initiatives. The eight-item scale that measures visual performance measurement information includes making the information visual, readily available, and aligned with strategic goals.

We drew on Kennedy and Widener (2008), Maskell et al. (2012), and Cunningham and Fiume (2003) to develop measures for inventory tracking and a simplified strategic reporting system. The three-item inventory tracking measure captures the importance of inventory tracking in terms of product cost accuracy and extent of cost allocations. The four-item measure for the simplified strategic reporting system variable represents the use of streamlined accounting processes designed to provide relevant strategic information.

Reliability and validity tests

Exploratory factor analysis

In order to develop a parsimonious representation for the various constructs in the survey, we initially conducted a principal-components-based exploratory factor analysis for each set of questions from the individual sections of the survey instrument.[16] We eliminated the few elements that had a cross-loading greater than 0.50 or that loaded onto a factor that did not make logical (or theoretical) sense. After all of the constructs were defined, we performed a second factor analysis to verify the initial results. We included only those elements from the results of the initial factor analysis related to the six constructs used in this study. Using the principal components method, the same six constructs emerged with eigenvalues greater than 1.0, accounting for 62% of the total variance in the data. These factors were in general alignment with *a priori* expectations. The oblique[17] rotation resulted in the following factors:

Lean Manufacturing Strategy (LMFG): The extent to which the facility has implemented various lean manufacturing tools such as cells, a *Kanban* system, one-piece flow, 5S, and *Kaizen*.
Employee Empowerment (EMPR): A participative organizational culture where employees are cross-trained and responsible for improvement suggestions, decision making, and quality output.
Visual Performance Measurement Information (VLPM): The availability and visibility of strategically-aligned performance measurement information on the shop floor.
Inventory Tracking (INVTR): The importance of inventory tracking both in accuracy of product costs and extent of cost allocations.
Simplified Strategic Reporting System (SSRPT): A simplified and streamlined accounting system aligned with strategic initiatives.
Top Management Support for Change in Production Strategies (TMGT): The extent to which top management is supportive of change and lean production strategies.

[14] Due to missing observations on the sales variables, the total sample size for both comparison groups was 163.

[15] The Shingo Prize is an annual award that recognizes operational excellence. It is based on the lean management approach and model taught by Dr. Shigeo Shingo, and is awarded to companies per their effectiveness in transforming their organizations through the application of specific lean principles, systems, and tools. Those principles, systems, and tools are carefully outlined in a set of guidelines used to determine the selection of Shingo Prize recipients. The website for the Shingo Prize is www.shingoprize.org.

[16] Since the majority of the constructs in this study were new constructs designed by the authors, it was determined that an exploratory factor analysis should be performed initially to clarify the elements of the constructs. The scales resulting from the exploratory factor analysis were then used in the SEM confirmatory factor analysis. This is similar to the approach used in Fullerton and Wempe (2009).

[17] An oblique rather than a varimax rotation was used since we expect our factors to be related.

Table 1
Exploratory factor analysis: factor loadings for explanatory variables.

	Factor 1 LMFG	Factor 2 EMPR	Factor 3 TMGT	Factor 4 SSRPT	Factor 5 VLPM	Factor 6 INVTR
LMFG-standardization	−0.636					
LMFG-cells	−0.746					
LMFG-reduced setup	−0.681					
LMFG-Kanban	−0.729					
LMFG-one-piece flow	−0.772					
LMFG-reduced lot size	−0.785					
LMFG-reduced inventory	−0.641					
LMFG-5S	−0.722					
LMFG-Kaizen	−0.620					
EMPR-cross-train		0.664				
EMPR-quality decisions		0.786				
EMPR-quality training		0.698				
EMPR-training resources		0.657				
EMPR-emply suggestions		0.749				
EMPR-quality recognition		0.685				
EMPR-involvement		0.749				
TMGT-change			0.838			
TMGT-lean support			0.798			
TMGT-new strategies			0.775			
SSRPT-MAS simplified				0.772		
SSRPT-close streamlined				0.746		
SSRPT-support strategies				0.789		
SSRPT-decision making				0.778		
VLPM-collect shop floor					0.609	
VLPM-aligned measures					0.592	
VLPM-visual boards					0.687	
VLPM-quality info					0.653	
VLPM-defect charts					0.790	
VLPM-visual organization					0.532	
VLPM-productivity info					0.699	
VLPM-data work stations					0.721	
INVTR-track inventories						0.708
INVTR-assign OH						0.794
INVTR-assign labor						0.810

Notes: $n = 244$; all loadings in excess of 0.40 are shown; Kaiser–Meyer–Olkin measure of sampling adequacy is very good (0.90) and the Bartlett test of Sphericity is highly significant ($p = 0.000$).

These factors along with VSC represent the variables used in testing the path model. The results of the factor analysis are shown in Table 1.[18]

VSC is a single five-point semantic differential scaled question that asked respondents to assess the extent to which they used VSC from 1 "not at all" to 5 a "great deal." While most variables used in SEM are latent variables, it is also acceptable to use observed variables (Kline, 2005, p. 12). In concurrence with Sackett and Lawson (1990), Wanous, Reichers, and Hudy (1997, p. 247) state that "if the construct being measured is sufficiently narrow or is unambiguous to the respondents, a single-item measure may suffice." Their study demonstrates that single-item measures can be more robust than scale measures in certain circumstances. In our situation, the respondents were all attendees of the Lean Accounting Summit, who would be familiar with the meaning of VSC.

[18] Note that the positive anchor of the 5-point Likert scaled survey questions for LMFG is "5," and for EMPR, VLPM, INVTR, and SSRPT, the positive anchor is "1." To make the interpretation of the results more intuitive, we subtracted the responses to the questions representing EMPR, VLPM, INVTR, and SSRPT from 6 so the higher the value of each construct, the more empowered is the employee, the more usage of visual performance measurement information, the greater usage of inventory tracking, and the more simplified is the strategic reporting system.

The factor solutions support the construct validity of the survey instrument. Multiple-question loadings for each factor in excess of 0.50 demonstrate convergent validity (see Bagozzi & Yi, 1988). In addition, discriminant validity is supported, since none of the questions in the factor analyses have loadings in excess of 0.40 on more than one factor. Table 2 shows the correlation coefficients for the factors and the alpha coefficients, which all exceed the acceptable standard of 0.70 (Nunnally & Bernstein, 1994). All of the correlation coefficients shown in Table 2 are less than the reliability coefficients, providing evidence of discriminant validity (Bagozzi, Yi, & Phillips, 1991; Crocker & Algina, 1986). None of the variance inflation factors exceeded 2.0 and the tolerance statistics were all under 1.0 (not reported), indicating multicollinearity is likely not an issue.

Self-reported data are used exclusively in this study. The exploratory factor analysis helps determine the extent of common method bias (Campbell & Fiske, 1959; Podsakoff & Organ, 1986). Only 16.1% of the variance is explained by the first factor and the balance of the variance is explained by the remaining variables (12.6%, 12.3%, 7.8%, 7.2%, 5.9%). Overall, these tests support the validity of the measures representing the constructs used in this study.

Table 2
Pearson correlation table for independent variables.

	# of measures	1	2	3	4	5	6	7	Mean[a]	SD.	Cr. A
1. LMFG	9	1.00							3.758	0.89	0.91
2. EMPR	7	.44**	1.00						2.474	0.70	0.87
3. VLPM	8	.51**	.48**	1.00					2.589	0.74	0.86
4. SSRPT	4	.37*	.31**	.36**	1.00				2.806	0.93	0.71
5.INVTR	3	−.32**	−.09	−.08	−.14*	1.00			3.033	0.90	0.82
6. VSC	1	.34**	.17*	.39**	.18**	−.35**	1.00		2.440	1.21	N/A
7. TMGT	3	.48**	.50**	.42**	.32**	−.12	.22**	1.00	3.959	0.95	0.90

Notes: $n = 244$.
LMFG = implementation of lean manufacturing practices.
EMPR = a culture where employees are cross-trained and empowered.
VLPM = the visibility and strategic alignment of performance measurement information.
SSRPT = the simplification and strategic alignment of the accounting system.
INVTR = tracking inventories and assigning labor and overhead costs.
VSC = the extent of use of value stream costing.
TMGT = top management support in lean and change initiatives.
* Significant at the .05 level (2-tailed).
** Significant at the .01 level.
[a] All measures are a Likert scale from 1 to 5.

Confirmatory factor analysis

We evaluated the measurement model with a confirmatory factor analysis (CFA) (Gerbing & Anderson, 1988).[19] Schumacker and Lomax (1996, p. 72) recommend a two-step modeling approach that first evaluates the measurement model to assure its fit and then examines the full structural model. We use maximum likelihood (ML) estimation in AMOS 18 for both the measurement model and full structural model.[20] Among the 244 responses, most measures have a full response, with no more than four responses missing for any single measure. AMOS does not evaluate missing data, but provides a theoretical approach to random missing data that are "efficient and consistent, and asymptotically unbiased" (Byrne, 2001, p. 292). Where suggested by AMOS and justified theoretically, we included covariances between error terms of the same construct (see e.g., Baines & Langfield-Smith, 2003; Shields, Deng, & Kato, 2000).

We evaluated the measurement model using X^2 and the ratio of X^2 to degrees of freedom; Root Mean Square Error of Approximation (RMSEA); incremental fit index (IFI) (Bollen, 1989); Tucker–Lewis Index (TLI) (Tucker & Lewis, 1973); Comparative Fit Index (CFI) (Bentler, 1990), and Akaike information criterion (AIC) (Akaike, 1987). The measurement model has good fit indices, as shown in Table 3. We used the fitted residual matrix and the standardized coefficients of the construct indicators to evaluate convergent validity. None of the standardized residuals in the fitted residual matrix were large enough (>|2.58|) to demonstrate potential areas of model misfit (Jöreskog & Sörbom, 1988). In addition, as indicated in Table 3, all of the standardized coefficients are highly significant at $p < 0.001$.

[19] With the exception of top management support for change in production strategies, which is a moderating variable, we used the scales that resulted from the exploratory factor analysis.

[20] Our empirical method uses SEM because it accounts for the measurement error in the latent variables and allows for the examination of relationships among multiple dependent variables (Kline, 2005).

Results

Descriptive statistics

The survey respondents were asked to indicate whether or not ("yes or no") they had formally implemented lean accounting practices, lean manufacturing, and other manufacturing practices such as JIT. The results show that 119 of the 244 plants have some form of lean accounting in place. Not surprisingly, all of the 119 lean accounting adopters indicated that they have formally implemented lean manufacturing.[21] Fig. 2 depicts the distributions for the implementations of lean practices (lean manufacturing, lean accounting, JIT, TQM, and TPM) for all respondent firms.

Table 4 shows the results of splitting the sample at the median value of the extent of lean manufacturing implementation to examine how the levels of accounting and control practices vary across firms. The means are all in the directions expected; that is, high lean manufacturing firms place a higher emphasis on EMPR, VLPM, SSRPT, and VSC relative to low lean manufacturing firms. In contrast low lean manufacturing firms place a higher emphasis on INVTR relative to high lean manufacturing firms. The ANOVAs show that the means for all of the variables are significantly different ($p < 0.01$).

Structural equation model results

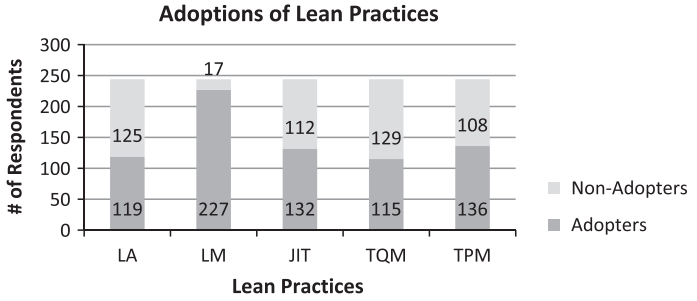
Before assessing the path coefficients, we evaluate the structural model fit. As shown in Table 5, the goodness-of-fit statistics generally indicate a good fit to the data. Although the X^2 is significant, the X^2 ratio is less than two, indicating an acceptable fit (Kline, 2005). Each of the remaining model fit indices shown in Table 5 (IFI, TLI,

[21] Note that this sample does not approximate a representation of the percentage of lean accounting adopters in the general population. The sample was taken from attendees at Lean Accounting Summits, where the interest in lean accounting and percentage of adoption would be much higher.

Table 3
Results from confirmatory factor analysis: Summary data for individual construct indicators.

Construct indicators	Standardized coefficients (loadings)	*t*-Values (all significant to $p < 0.000$)
Lean manufacturing strategy		
LMFG1	0.656	–[a]
LMFG2	0.739	9.927
LMFG3	0.698	9.469
LMFG4	0.692	8.532
LMFG5	0.730	9.798
LMFG6	0.785	10.326
LMFG7	0.671	9.090
LMFG8	0.650	8.876
LMFG9	0.712	9.534
Employee empowerment		
EMPR1	0.632	–[a]
EMPR2	0.689	9.952
EMPR3	0.711	9.070
EMPR4	0.696	8.949
EMPR5	0.743	9.368
EMPR6	0.595	7.902
EMPR7	0.816	10.003
Visual performance measurement information		
VLPM1	0.522	–[a]
VLPM2	0.606	6.909
VLPM3	0.637	7.780
VLPM4	0.701	7.418
VLPM5	0.695	7.451
VLPM6	0.722	7.538
VLPM7	0.713	7.570
VLPM8	0.651	7.184
Simplified strategic reporting system		
SSRPT1	0.639	–[a]
SSRPT2	0.512	8.103
SSRPT3	0.879	9.992
SSRPT4	0.791	9.775
Inventory tracking		
INVTR1	0.490	
INVTR2	0.723	6.140
INVTR3	0.785	5.955

Notes: $n = 244$ measurement models are estimated using maximum likelihood.
See Appendix B for definition of individual indicators from survey data.
Model fit indices: Chi-square, 566.455; degrees of freedom, 438; *p*, 0.000; Chi-square ratio, 1.293; IFI, 0.961; TLI, 0.955; CFI, 0.961; RMSEA, 0.035; AIC, 810.455 (saturated model, 1120.00).
[a] Indicates a parameter that was fixed at 1.0.



LA = lean accounting
LM = lean manufacturing
JIT = just-in-time
TQM = total quality management
TPM = total productive maintenance

Fig. 2. Description of sample.

Table 4
Descriptive statistics for comparison of variable means between high and low lean manufacturing plants.

Variable	High lean manufacturing	Low lean manufacturing	Significance
EMPR	2.757	2.295	***
VLPM	2.681	2.086	***
SSRPT	2.375	2.010	***
INVTR	2.846	3.222	***
VSC	2.750	2.130	***

Notes: We use a median split to divide firms into low and high lean manufacturing implementation.
EMPR = a culture where employees are cross-trained and empowered.
VLPM = the visibility and strategic alignment of performance measurement information.
SSRPT = the simplification and strategic alignment of the accounting system.
INVTR = tracking inventories and assigning labor and overhead costs.
VSC = the extent of use of value stream costing.
*** $p < 0.01$.

Table 5
Base results.

Relationships	Hypothesis	Expected sign	Coefficient	*t*-Values
Panel A: Test results of the trimmed structural equation model				
LMFG → EMPR	H1a	+	0.310	3.602***
LMFG → VLPM	H1b	+	0.449	4.746***
LMFG → SSRPT	H1c	+	0.292	2.601***
LMFG → INVTR	H1d	−	−0.129	−1.529*
LMFG → VSC	H1e	+	0.700	5.005***
EMPR ↔ VLPM	H3a	+	0.191	4.776***
INVTR ↔ VSC	H3a	−	−0.065	−2.123**
VSC ↔ SSRPT	H3a	+	0.148	4.523***
VLPM ↔ VSC	H3a	+	0.036	1.405*
VLPM ↔ SSRPT	H3a	+	0.112	3.038***
EMPR ↔ SSRPT	H3a	+	0.082	2.257**

Hypothesis	Independent variable	Dependent variable	Direct effects	Indirect effects	Total effects
Panel B: Standardized direct, indirect, and total effects					
H3a	LMFG	EMPR	0.310***	0.162***	0.472***
H3a	LMFG	VLPM	0.449***	0.178***	0.627***
H3a	LMFG	SSRPT	0.292***	0.228***	0.520***
H3a	LMFG	INVTR	−0.129*	−0.053**	−0.182**
H3a	LMFG	VSC	0.700***	0.111***	0.811***

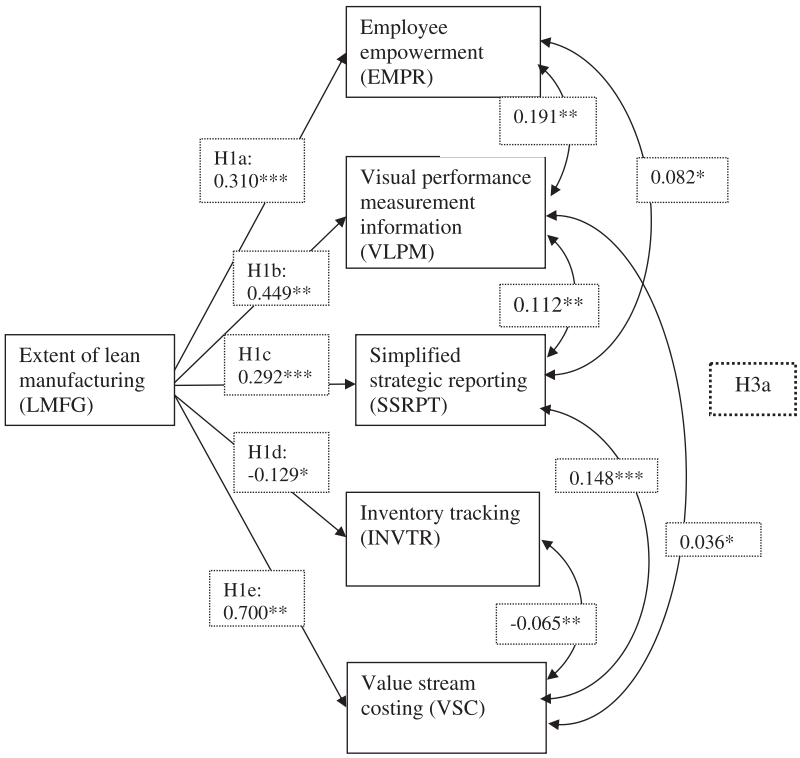
Notes: $n = 244$ measurement models are estimated using maximum likelihood.
Model fit indices: Chi-square, 568.671; degrees of freedom, 442; *p*, 0.000; Chi-square ratio, 1.287; IFI, 0.962; TLI, 0.956; CFI, 0.961; RMSEA, 0.034; AIC, 804.671 (saturated model, 1120.00).
LMFG = implementation of lean manufacturing practices.
EMPR = a culture where employees are cross-trained and empowered.
VLPM = the visibility and strategic alignment of performance measurement information.
SSRPT = the simplification and strategic alignment of the accounting system.
INVTR = tracking inventories and assigning labor and overhead costs.
VSC = the extent of use of value stream costing.
* Significance of the *p*-value at <0.10. We report one-tailed *p*-values.
** Significance of the *p*-value at <0.05. We report one-tailed *p*-values.
*** Significance of the *p*-value at <0.01. We report one-tailed *p*-values.

and CFI) exceed the acceptable fit level of 0.90, and the RMSEA is considerably lower than the acceptable fit measure of 0.08 (Browne & Cudeck, 1993). Further, parsimony is demonstrated by an AIC that is lower than that for the saturated model.

Our theoretical model, as shown in Fig. 1, captures the direct relations of the extent of lean manufacturing implementation with the management accounting and control practices. We also model relationships, restricted to equivalence, between the dependent variables. This allows the accounting practices to work together as a package; yet this does not require us to specify causal directions. It also captures any indirect relations that lean manufacturing has with the management accounting and control practices. We trim the original model by eliminating four non-significant paired associations, leaving six significant associations among the dependent variables.[22] The results from this trimmed model are shown in Table 5, Panel A, and depicted in Fig. 3.[23]

[22] The statistical inferences of the full and trimmed models are qualitatively similar. Trimming the paths facilitates interpretation and presents a simpler model.

[23] As an additional robustness test, the model was analyzed utilizing summed factor scores instead of the full latent model. This allows for a more efficient model as it has a reduced number of parameters to estimate. The results are qualitatively similar.



Notes:
***,**,* indicates the significance of the p-value at <0.01, 0.05, and 0.10, respectively. We report one-tailed p-values.

We are only depicting the results of the structural model.

Fig. 3. Results.

All five of the hypothesized structural paths (H1a–H1e) are supported and are in the expected direction. The results show that as the extent of lean manufacturing strategy increases, so does EMPR (H1a; $p < 0.01$), VLPM (H1b; $p < 0.01$), SSRPT (H1c; $p < 0.01$), and VSC (H1e; $p < 0.01$). In this environment, firms minimize conversion cost allocations and the intense tracking of inventory (H1d; $p < 0.10$). Consistent with existing literature (e.g., Baines & Langfield-Smith, 2003; Langfield-Smith, 1997), our sample firms have adapted their management accounting and control practices to align with their strategic initiatives, suggesting that they have achieved congruence among their work practices (i.e., lean manufacturing), people (i.e., empowerment), and formal practices (e.g., value stream costing). As firms become more focused on a lean manufacturing strategy, they are more apt to manage with readily available, visual, strategically-aligned performance measures and provide employees with broader training and responsibilities.

In H2, we investigate whether the relations hypothesized in H1a–H1e are moderated by the extent of top management support for change in production strategies. To provide evidence on H2, we split the sample at the median of top management support to derive groups that have either "low" or "high" levels of support. To test the joint significance of whether top management is a moderator, we compare a restricted model, where the parameters are restricted to be equal across sub-groups, to a model that allows these parameters to vary freely (Hu & Bentler, 1999). We use the X^2 difference as a test of the null hypothesis that the moderator variable (i.e., top management support) has no effect on the group of paths. We find that the model does differ between low and high levels of top management support for change in production strategies ($p < 0.05$).

To provide direct evidence on H2, we run individual model comparisons, and in each, we allow one of the parameters of interest to vary freely, while comparing it to a fully restricted model. The results reveal that only one of the relations between the extent of lean manufacturing implementation and the five management accounting and control practices is moderated by top management support. We find that top management's support for change in production strategies is necessary to reduce reliance on inventory tracking as the extent of lean manufacturing implementation increases (low coef. = 0.036, p = n.s.; high coef. = −0.291, $p < 0.10$).

While H2 has only limited support, the results do reveal an important insight. If the firm is to achieve congruency between work and the formal reporting system by reduc-

Table 6
Moderating analysis: Top management support for change in production strategies.

Partition Variable	Hypotheses	Top management support		Significant paths unrestricted and restricted models
		Low Mn = 3.199 *N* = 124	High Mn = 4.744 *N* = 120	
LMFG → EMPR	H2	0.175**	0.304**	n/s
LMFG → VLPM	H2	0.413***	0.358***	n/s
LMFG → SSRPT	H2	0.315**	0.196	n/s
LMFG → INVTR	H2	0.036	−0.291*	*
LMFG → VSC	H2	0.676***	0.803***	n/s
INVTR ↔ EMPR		0.019	-0.024	n/s
INVTR ↔ VLPM		−0.132**	0.076	***
INVTR ↔ SSRPT		0.066	−0.017	n/s
INVTR ↔ VSC		−0.024	−0.084*	n/s
SSRPT ↔ EMPR		0.002	0.175***	**
SSRPT ↔ VLPM		0.138***	0.057	n/s
SSRPT ↔ VSC		0.099*	0.197***	*
VSC ↔ EMPR		0.002	−0.044	n/s
VSC ↔ VLPM		0.054	0.044	n/s
VLPM ↔ EMPR		0.144**	0.271***	*

Model comparison statistics	
X^2 restricted MM, unrestricted SM (fully restricted MM/SM)	1152.670 (1177.881)
X^2 difference tests	*p* = .017
DF	876 (890)
CMINDF	1.316 (1.323)
CFI	.907 (.904)
RMSEA	.036 (.037)

Notes: *n* = 244.
The reported coefficients are from a model in which groups are constrained to have a common measurement model but the path coefficients are allowed to freely vary between groups.
We report one-tailed *p*-values for all predicted relations (i.e., the relations between LMFG and each of EMPR, VLPM, SSRPT, INVTR, and VSC), and two-tailed *p*-values for all other associations.
LMFG = implementation of lean manufacturing practices.
EMPR = a culture where employees are cross-trained and empowered.
VLPM = the visibility and strategic alignment of performance measurement information.
SSRPT = the simplification and strategic alignment of the accounting system.
INVTR = tracking inventories and assigning labor and overhead costs.
VSC = the extent of use of value stream costing.
* Significance of the *p*-value at <0.10, for the unstandardized coefficients.
** Significance of the *p*-value at <0.05, for the unstandardized coefficients.
*** Significance of the *p*-value at <0.01, for the unstandardized coefficients.

ing its reliance on inventory tracking, it is necessary to have top management that is supportive of change in production strategies. Since virtually all of the sample firms had adopted some level of lean manufacturing, the respondents may have felt that top management had previously demonstrated support for general change initiatives and training provisions by implementing lean. Thus, it could be that because they are relatively easier and more straight-forward practices to change, the other three "formal" accounting practices and empowerment do not show a significant difference in their relationships with "work" conditional on top management support. In contrast, eliminating inventory tracking may be considered the most challenging of the management accounting practices examined to change since it involves the elimination of a much-used standard practice. Unfortunately, we do not have the data to examine these relationships further and must leave this for future research. The results are presented in Table 6.

The evidence depicted in Fig. 3 and Table 5 provides some support for H3a. After controlling for the effect of lean manufacturing implementation on the management accounting and control practices, EMPR, VLPM, SSRPT, and VSC have positive associations with each other and negative associations with INVTR. Six of the 10 paired associations are significant in the direction expected: EMPR with VLPM (coef. = 0.191, $p < 0.01$) and with SSRPT (coef. = 0.082, $p < 0.05$); VLPM with SSRPT (coef. = 0.112, $p < 0.01$); and VSC with SSRPT (coef. = 0.148, $p < 0.01$), with VLPM (coef. = 0.036, $p < 0.10$), and with INVTR (coef. = −0.065, $p < 0.05$). The results suggest that not only do companies that operate with a lean manufacturing strategy individually adopt these management accounting and control practices, but these management accounting and control practices work together as well.

Table 5, Panel B, depicts the total effects the extent of lean manufacturing implementation has on the management accounting and control practices. It shows that the extent of lean manufacturing implementation has the largest total effect on VSC (0.811, $p < 0.01$), followed by VLPM (0.627, $p < 0.01$), SSRPT (0.520, $p < 0.01$), EMPR (0.472, $p < 0.01$), and INVTR (−0.182, $p < 0.05$). Interestingly, the

Table 7
Package of management accounting and control practices as moderated by lean manufacturing.

Partition variable	Hypothesis	Lean manufacturing practices		Significant paths unrestricted and restricted models
		Low Mn = 2.998 *N* = 122	High Mn = 4.278 *N* = 122	
INVTR ↔ EMPR		−0.864	0.050	***
INVTR ↔ VLPM		−0.960**	−0.074*	***
INVTR ↔ SSRPT		0.347	−0.012	***
INVTR ↔ VSC	H3b	0.356***	−0.078*	***
SSRPT ↔ EMPR		0.339	0.101**	***
SSRPT ↔ VLPM		0.663	0.164***	***
SSRPT ↔ VSC		−0.036	0.175***	**
VSC ↔ EMPR		−0.330	−0.020	***
VSC ↔ VLPM		−0.387*	0.047	***
VLPM ↔ EMPR		1.291	0.286***	***
Model comparison statistics				
X^2 restricted MM, unrestricted SM (fully restricted MM/SM)				600.290 (627.715)
X^2 difference tests				***
DF				430 (440)
CMINDF				1.396 (1.427)
CFI				0.911(0.902)
RMSEA				0.052(0.042)

Notes: *n* = 244.
The reported coefficients are from a model in which groups are constrained to have a common measurement model but the path coefficients are allowed to freely vary between groups.
We report one-tailed *p*-values for all predicted relations (i.e., the relation between INVTR and VSC) and two-tailed *p*-values for all other associations.
LMFG = implementation of lean manufacturing practices.
EMPR = a culture where employees are cross-trained and empowered.
VLPM = the visibility and strategic alignment of performance measurement information.
SSRPT = the simplification and strategic alignment of the accounting system.
INVTR = tracking inventories and assigning labor and overhead costs.
VSC = the extent of use of value stream costing.
* Significance of the *p*-value at <0.10, for the unstandardized coefficients.
** Significance of the *p*-value at <0.05, for the unstandardized coefficients.
*** Significance of the *p*-value at <0.01, for the unstandardized coefficients.

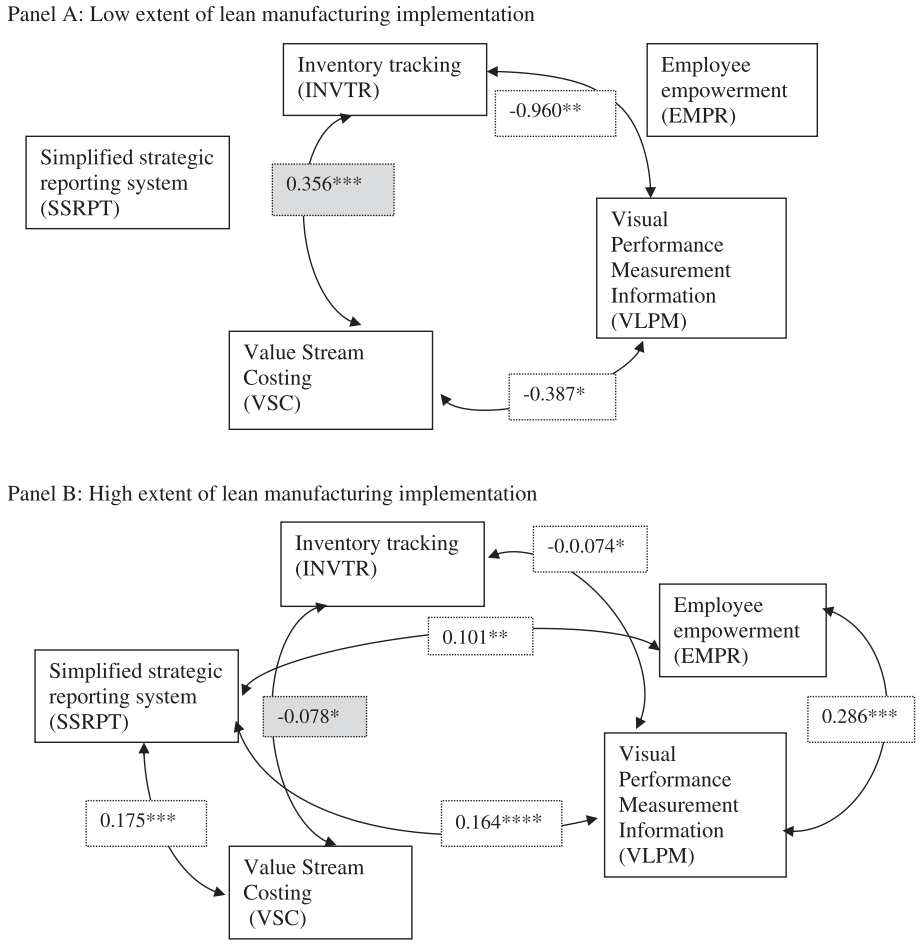
indirect effect of the extent of lean manufacturing implementation through the other management accounting and control practices has almost as large of an effect on SSRPT (0.228, $p < 0.01$) as does its direct effect (0.292, $p < 0.01$). Examination of the indirect effects reveal that the extent of lean manufacturing implementation on each of the management accounting and control practices through the set of remaining practices is strongly significant for all five of the accounting and control practices. In sum, the total effects of the extent of lean manufacturing implementation on each of the five management accounting and control practices is greater relative to only the direct effect. This indicates that the form of these relationships is not only additive, but also intervening.[24]

The results indicate that our cross-section of sample firms use all five of the management accounting and control practices in combination and not in isolation. It also appears that the effect of management accounting and control practices in support of lean manufacturing strategies is greater than the effect of reducing the use of the more traditional inventory tracking (i.e., it has the lowest total effect). This implication is not surprising, since several studies indicate organizations resist changes to such traditional management accounting practices as the tracking of inventory (Fullerton & Wempe, 2009; Haskin, 2010), even when it appears the information does not facilitate decision making for a lean environment.

To provide evidence on H3b we split the sample at the median of the extent of lean manufacturing implementation to derive groups that have either a "low" or "high" extent of lean manufacturing implementation. The results are shown in Table 7 and illustrated in Fig. 4. To test joint significance of the entire model, we compare a restricted model, where the parameters are restricted to be equal across sub-groups, to a model that allows these parameters to vary freely (Hu & Bentler, 1999). We use the X^2 difference as a test of the null hypothesis that the extent of lean manufacturing implementation moderator variable has no effect on the group of paths.[25] We find that the *package* of management accounting controls and practices used to sup-

[24] Luft and Shields (2003) state that this finding is not contradictory since the paths are not restricted to be only additive or only intervening. Instead we allow for both relationships. For example, the extent of lean manufacturing implementation not only directly affects simplified strategic reporting, but also indirectly affects it through employee empowerment.

[25] We know from H1a–H1e that the relations between the extent of lean manufacturing implementation and each of the five accounting and control practices behave as expected. A null finding on H3a would indicate that although the means of the accounting and control practices varied across groups as revealed in H1a–H1e, the structure of the "package" itself (i.e., the manner in which the accounting and control practices are related) does not differ between groups.



Notes: All associations shown are significantly different between groups.

***,**,* indicates the significance of the *p*-value at <0.01, 0.05, and 0.10, respectively. We report one-tailed *p*-values for all predicted associations and two-tailed p-values for all other associations.

We are only depicting the results of the structural model.

The shaded boxes provide evidence on H3b.

Fig. 4. The package of management accounting and control practices in firms with low or high extent of lean manufacturing implementation.

port a low extent of lean manufacturing implementation is significantly different compared to the package used to support a high extent of lean manufacturing implementation (X^2 difference = 27.425, $p < 0.01$).

To provide direct evidence on H3b we run an individual model comparison where we allow only the parameter of interest to vary freely, while comparing it to a fully restricted model. In the low (high) implementation group, the reliance on INVTR is higher (lower) (relative to the other group, as shown in Table 4) and positively (negatively) associated with VSC (low: coef. = 0.356, $p < 0.01$; high: coef. = −0.078, $p < 0.10$). The X^2 difference test is significant ($p < 0.01$). This result provides evidence on H3b, and shows that firms in the low group employ dual costing modes, while in the high group they substitute INVTR for VSC.

Although not hypothesized, we also find that each of the remaining *individual* paths is significantly different across the groups. The results reveal important insights. In the high group, all five accounting controls and practices are associated, while only three practices have associations in the low group. That is, EMPR and SSRPT are not associated with the remaining three elements of the accounting and control package in the low lean implementation group. It is also interesting to note that "people" and "formal" practices are not related in the low lean implementation group, whereas in the high implementation group, "people" (e.g., EMPR) is associated with the "formal" environment (e.g., SSRPT and VLPM). Wyman (2003) suggests that congruence is present if each of the four components of the congruence model is aligned with one another. While these relationships were not hypothesized, the

presence of congruence is more apparent in the high lean implementation group relative to the low group.

Robustness tests

We run a series of models that controls for the implementation of TQM, TPM, and JIT (yes/no), unionization (yes/no), size (as proxied for by sales), management experience (in years), the extent of balanced scorecard (BSC) and ABC implementation, and the perceived level of world-class manufacturing. We implement these controls by modeling paths between each of the control variables and each of the five management accounting and control practices. In untabulated results, we find that our statistical inferences are quite robust across the various tests.[26] A chi-square difference test comparing the fit for each of the control variable models to our base model demonstrated that our base model is the best-fitting model. Due to the consistency of our results and lack of a significant chi-square difference, we conclude that our base results are robust.

Conclusion

This research provides some of the first empirical evidence of the use of management accounting and control practices in a lean manufacturing environment. It appears that as the implementation of a lean manufacturing strategy intensifies, the organization simplifies its internal accounting reporting system, eliminates inventory tracking and overhead allocations, and increases its use of VSC. We also find that the presence of top management support for change in production strategies motivates firms to reduce their emphasis on inventory tracking as the extent of lean manufacturing increases.

The results also show that all of the management accounting and control practices are either directly or indirectly related to one another. It is interesting to note that for some practices, the indirect effect of the lean manufacturing implementation rivals the direct effect, supporting the importance of the notion of a package of controls. In firms that have implemented a higher level of lean manufacturing, the package is comprised of all five management accounting and control practices bound together by six significant associations within the package, while in the low lean manufacturing group the package is comprised of only three of the accounting and control practices, which are bound together by three significant associations.

Understanding the relations among the variables and how elements of the firm's work, people, formal, and informal environment impact one another provides an important contribution to the existing literature. Congruence in the lean manufacturing environment takes on many forms. Congruence between "people" and "work" takes on an additive form. People who believe they have the necessary skills, knowledge, and authority to meet the demands of lean manufacturing are empowered. Congruence between the "formal" environment and "work" takes on an additive form, except for the association between "work" and the specific formal practice of inventory tracking, which is conditional on the "informal environment," proxied for by top management support for change in production strategies. Congruence between "people" and the "formal environment" and within the "formal environment" is demonstrated through associations. Moreover, the association between inventory tracking and VSC is conditional on the extent of lean manufacturing implementation. Our results suggest that the respondent firms in this study are recognizing the need to change their management accounting and control practices to better support their lean manufacturing strategy and achieve congruence among their work, people, and formal and informal practices.

In sum, our study contributes to the accounting literature by providing insights on the workings of the package of management accounting and control practices in a lean manufacturing environment, and what congruence in this environment looks like. These are important theory and practice insights that move our knowledge of management accounting forward and help keep our research relevant.

Limitations of the research

Our research sample is not random, which reduces the generalizability of the findings. It is difficult to find a sizable sample of firms that have adapted their management accounting practices to match their lean production, so we depended on a single venue for selecting our respondents. We assume that the respondents were interested in lean and particularly the principles of lean accounting by their attendance at Lean Accounting Summits. The sample respondents would also be more likely to have a better understanding of the survey questions and related issues than a random sample. This helps alleviate some of the usual concerns about data collection in survey research—that the respondents had sufficient knowledge to answer the items, and subsequently answered the questions conscientiously and objectively.

Future research

This study has taken a first step in examining the congruence among a firm's people, work, and its informal and formal environment by investigating various aspects of the manufacturing and management accounting environments. The results may encourage manufacturing firms to be willing to take steps to change their MAS in support of other change initiatives. Long-term analyses would be helpful to evaluate the sustainable success of these changes. A next logical research step would be to more fully flesh out the congruence framework (Nadler & Tushman, 1992, 1997) by including additional aspects of the informal organization: that is, beliefs and shared values. Furthermore, an examination of the contingency relationship—whether or not implementing VSC in a lean environ-

[26] We only find differences for the results of two paths. When controlling for JIT, size, ABC implementation, and classification as a world-class manufacturer, the marginal relation ($p < 0.10$) between the extent of lean manufacturing implementation and INVTR becomes insignificant, but when controlling for TQM, the relation is more significant ($p < 0.05$). The association between VLPM and VSC is marginal in our base results ($p < 0.10$) and is insignificant when controlling for TPM and BSC implementation.

ment leads to better operational and/or financial performance—would provide direct evidence on the assumption that congruence among aspects of people, work, and the formal and informal organization are key for high-performing organizations. Future research could also extend our results to include an examination of the use of standard operating procedures and peer pressure, two additional controls that Kennedy and Widener (2008) identified as important for a lean manufacturing strategy. It is critical that research continues to search for ways to improve MAS so they provide more useful information to the decision makers of world-class firms operating in the highly competitive global markets of today.

Acknowledgements

We would like to thank Shannon Anderson, Ramji Balakrishnan, Anne-Marie Kruis, and Kim Krumwiede for their feedback on earlier versions of this manuscript. We also appreciate the helpful comments from participants at the 2009 EIASM Conference in Muenster, Germany, the 2010 AAA conference in San Francisco, CA, and a 2010 research forum at Utah State University. Finally, we gratefully acknowledge the constructive comments of two anonymous reviewers and the editor, Mike Shields.

Appendix A. Description of management accounting and control practices prior to and following the implementation of lean manufacturing

(Adapted from Kennedy and Widener (2008))[a]

Before lean initiative	After lean initiatives
Manufacturing	
Manufacturing is characterized by a batch-and-queue process, production is to forecast, separate functional areas and ad hoc teams are used to increase quality, employees are single-tasked	Manufacturing is characterized by one piece flow, production is to customer order, bottlenecks are managed to optimize flow, production teams are formed, and quality is built into the process
Transactional processing	
Purchase orders are used to support material purchases, batch processing of payment to suppliers occurs on a cyclical routine such as weekly or bi-weekly, support personnel match invoice of purchase order to packing slip prior to payment, and reconcile differences, and detailed information is maintained by multiple labor categories	Purchase orders are converted to annual blanket purchase orders in order to reduce transaction processing, accounts payable are processed in accordance with lean "pull" principles so suppliers are paid when appropriate, invoices are no longer required since supplier is paid from the packing slip according to terms on the blanket purchase order, labor reporting is trimmed or not needed, and labor is considered a period cost and treated as more fixed than variable
Use of actual costs	
Full absorption costing is used to value inventory, standard costs are used and variances are calculated, bill of materials is used for inventory pricing and tracking (through mapping to perpetual), perpetual inventory is maintained to track resources throughout production cycle as well as individual inventory categories	Material only cost system, overhead may be allocated at the product family level, but not in any greater detail, value stream costing with the only allocation a facility charge by square footage; otherwise actual costs for the week are charged, perpetual inventories are not needed for inventory tracking due to low inventory levels, value stream orientation *is used* for reporting and managing. Value stream P&L is used to calculate average unit product cost
Performance measurement	
The performance measures include traditional variance and accounting measures tracked by the accounting group. The information is provided to managers and supervisors in numerical form	The performance measures are non-traditional operational measures and do not include manufacturing variances. They are generated from the bottom up, and posted throughout facility and shop floor
Social controls	
Supervisors and managers are empowered, there is no peer pressure as the employees are individual contributors, there is no visualization of information as there are only paper reports provided to managers and supervisors, and training is only on single process duties	Employees are empowered; they choose their own team, are responsible for vacation, work, and production schedules, ensure quality assurance, request training, and track their own performance measures. Cell members pressure one another to perform, and to gain additional training and skills, responsibilities are posted; visualization is evident on cell and value stream metric boards and on flip charts; training is emphasized, monitored

(*continued on next page*)

via a skills matrix, and employees have access to training modules via the company intranet

[a] Our measure of visual performance measures captures both visualization and non-traditional performance measures from Kennedy and Widener (2008), while our measure of empowerment captures both empowerment and training from Kennedy and Widener (2008). Our measure of VSC and inventory tracking corresponds to the use of actual costs in Kennedy and Widener (2008), while our measure of simplified strategic reporting corresponds to streamlined transaction processing (Kennedy & Widener, 2008).

Appendix B. Survey questions that support the variables used in this research

Lean Manufacturing Strategy (LMFG)[a]
To what extent has your facility implemented the following:
- Standardization
- Manufacturing cells
- Reduced setup times
- *Kanban* system
- One-piece flow
- Reduced lot sizes
- Reduced buffer inventories
- 5S
- *Kaizen* (continuous improvement)

Employee Empowerment (EMPR)[b]
Please indicate the level of agreement or disagreement to the following statements:
- Majority of shop-floor workers are cross trained
- Shop-floor workers participate in quality decisions
- Management is committed to quality-related training
- Resources for training are readily available
- All employees are encouraged to make suggestions for problem solving
- Employees are recognized for superior quality performance
- We have a great deal of employee involvement-type programs

Visual Performance Measurement Information (VLPM)[b]
Indicate your agreement to the following statements related to your management accounting system:
- Many performance measures are collected on the shop floor
- Performance metrics are aligned with operational goals
- Visual boards are used to share information
- Information on quality performance is readily available
- Charts showing defect rates are posted on the shop floor
- We have created a visual mode of organization
- Information on productivity is readily available
- Quality data are displayed at work stations

Inventory Tracking (INVTR)[b]
Indicate your agreement to the following statements related to your management accounting system:
- Tracking inventories is an important accounting function
- Assigning accurate overhead costs to product is critical
- Assigning labor costs to inventory is critical
- Simplified Strategic Reporting System (SSRPT)[b]
- Indicate your agreement to the following statements related to your management accounting system:
- Our accounting system has been simplified in the past 3 years
- Our accounting closing process has been streamlined
- Our management accounting system supports our strategic initiatives
- Our accounting information system facilitates strategic decision making

Value Stream Costing (VSC)[a]
Indicate the extent to which your facility uses value stream costing

Top Management Support for Change in Production Strategies (TMGT)[c]
How supportive is top management in:
- Initiating change programs?
- Implementing lean manufacturing practices?
- Providing training for new production strategies?

[a] Possible responses: Not at all = 1; little = 2; some = 3; considerable = 4; great deal = 5.
[b] Possible responses: Strongly agree = 1…2…3…4…Strongly disagree = 5.
[c] Possible responses: Indifferent = 1…2…Encouraging = 3…4…Highly Supportive = 5.

Appendix C. Criterion validity

To test the criterion validity of the model measures, alternate test variables expected to show a positive correlation with the measures are evaluated.

Measure	Test variable(s)	Explanation for proposed correlation	Properties of test variable[a]	Correlation
Lean manufacturing strategy	World class manufacturing	If a firm is implementing lean practices, it is likely to consider its operations as world-class, rather than traditional.	Single item	0.466***
Inventory tracking	Use of variance analyses and standard costs	If you are tracking inventories and assigning overhead costs to products, you are likely using a standard costing system with variance analysis.	4 items (0.900)	0.359***
Simplified strategic reporting system	Strategy of reduced processes	If a firm has extended lean thinking into its accounting processes, it has a strategy of streamlining its processes.	Single item	0.255***
Value stream costing	Level of lean accounting	The higher the use of VSC, the more the level of lean accounting adoption. Also, a firm will likely be reporting value stream performance more frequently.	Single item	0.431***
	Frequency of reporting value stream performance		Single item	0.417***
Employee empowerment	Use of self-directed teams	To have empowered employees, you would expect to have teams that work together in making operational decisions.	Single item	0.405***
Visual performance measurement information	Frequency of reporting cell performance and productivity	If you use visual performance measures to help control operations, you would expect firms to also more frequently report cell performance and productivity.	Single item	0.454***
			Single item	0.401***
Top management support for change in production strategies	Management style is participative	For top management to support lean strategies, it should be less autocratic (more participative) and more flexible.	Single item	0.470***
	management is flexible		Single item	0.277***

**, * Significant at p 0.05, 0.10, respectively, two-tailed, $N = 214$.
*** Significant at $p < 0.01$, respectively, two-tailed, $N = 214$.
[a] Properties of test variables: nr. of items (Cronbach's Alpha).

References

Åhlström, P., & Karlsson, C. (1996). Change processes towards lean production: The role of the management accounting system. *International Journal of Operations & Production Management, 16*(11), 42–56.

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika, 52*, 317–332.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*(1), 74–94.

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly, 36*(3), 421–458.

Baines, A., & Langfield-Smith, K. (2003). Antecedents to management accounting change: A structural equation approach. *Accounting, Organizations and Society, 28*, 675–698.

Balakrishnan, R. (2010). Planning: The step-sister in managerial accounting research. *Presentation at the 2010 GMARS conference*. Lansing, Michigan.

Banker, R., Potter, G., & Schroeder, R. (1993). Reporting manufacturing performance measures to workers: An empirical study. *Journal of Management Accounting Research, 5*, 33–53.

Beehr, T. A., Glazer, S., Fischer, R., Linton, L. L., & Hansen, C. P. (2009). Antecedents for achievement of alignment in organizations. *Journal of Occupational and organizational Psychology, 82*, 1–20.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238–246.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York: Wiley.

Bowen, D. E., & Lawler, E. E. I. I. I. (1992). The empowerment of service workers: What, why, how, and when. *Sloan Management Review, 33*(3), 31–42.

Brosnahan, J. (2008). Unleash the power of lean accounting. *Journal of Accountancy, July*, 60–66.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Newbury Park, CA: Sage.

Byrne, B. M. (2001). *Structural equation modeling with amos: Basic concepts, applications, and programming*. Mahwah, NJ: Erlbaum.

Cadez, S., & Guilding, C. (2008). An exploratory investigation of an integrated contingency model of strategic management accounting. *Accounting, Organizations and Society, 33*, 836–863.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multi-trait–multi-method-matrix. *Psychological Bulletin, 56*, 81–105.

Cardinaels, E. (2008). The interplay between cost accounting knowledge and presentation formats in cost-based decision-making. *Accounting, Organizations and Society, 33*, 582–602.

Carroll, A. (1994). *What's behind the "E" word: Myths about empowerment and why you need it*. Belmont, MA: Interaction Design, Inc.

Castellano, J. F., & Burrows, R. (2011). Relevance lost: The practice/classroom gap. *Management Accounting Quarterly, 12*(2), 41–48.

Chapman, C. S. (1997). Reflections on a contingent view of accounting. *Accounting, Organizations and Society, 22*, 189–205.

Chenhall, R. H. (2003). Management control systems design within its organizational context: Findings from contingency-based research and directions for the future. *Accounting, Organizations and Society, 25*(4), 127–168.

Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory*. Fort Worth, TX: Harcourt, Brace, and Jovanovich.
Cua, K. O., McKone, K. E., & Schroeder, R. G. (2001). Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. *Journal of Operations Management, 19*(6), 675–694.
Cunningham, J. E., & Fiume, O. J. (2003). *Real numbers: Management accounting in a lean organization*. Durham, NC: Managing Times Press.
Emiliani, B. (2007). *Better thinking, better results*. Wethersfield, CT: The Center for Lean Business Management, LLC.
Fry, L. W., & Smith, D. A. (1987). Congruence, contingency, and theory building. *Academy of Management Review, 12*(1), 117–132.
Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. *Journal of Operations Management, 19*, 81–96.
Fullerton, R. R., & McWatters, C. S. (2002). The role of performance measures and incentive systems in relation to the degree of JIT implementation. *Accounting, Organizations and Society, 27*, 711–735.
Fullerton, R. R., & McWatters, C. S. (2004). An empirical examination of cost accounting practices. *Advances in Management Accounting, 12*(85), 85–113.
Fullerton, R. R., McWatters, C. S., & Fawson, C. (2003). An examination of the relationships between JIT and financial performance. *Journal of Operations Management, 21*, 383–404.
Fullerton, R. R., & Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Production Management, 29*(3), 214–240.
Galsworth, G. D. (1997). *Visual systems: Harnessing the power of the visual workplace*. New York: AMACOM.
Garcia-Morales, V. J., Jimenez-Barrionuevo, M. M., & Gutierrez-Gutierrez, L. (2012). Transformational leadership influence on organizational performance through organizational learning and innovation. *Journal of Business Research, 65*, 1040–1050.
Gerbing, D. W., & Anderson, J. C. (1988). An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research, 25*(2), 186–192.
Gerdin, J., & Greve, J. (2004). Forms of contingency fit in management accounting research—A critical review. *Accounting, Organizations and Society, 29*, 303–326.
Gerdin, J., & Greve, J. (2008). The appropriateness of statistical methods for testing contingency hypotheses in management accounting research. *Accounting, Organizations and Society, 33*, 995–1009.
Grasso, L. P. (2005). Are ABC and RCA accounting systems compatible with lean management? *Management Accounting Quarterly, 7*(1), 12–27.
Green, F. B., Amenkhienan, F., & Johnson, G. (1992). Performance measures and JIT. *Management Accounting* (October), 32–36.
Griffith, D. A., & Myers, M. B. (2005). The performance implications of strategic fit of relational norm governance strategies in global supply chain relationships. *Journal of International Business Studies, 36*, 254–269.
Hartmann, F. G. H., & Moers, F. (1999). Testing contingency hypotheses in budgetary research: An evaluation of the use of moderated regression analysis. *Accounting, Organizations and Society, 24*, 291–315.
Haskin, D. (2010). Teaching special decisions in a lean accounting environment. *American Journal of Business Education, 3*, 91–96.
Herrenkohl, R. C., Thomas, J. G., & Heffner, J. A. (1999). Defining and measuring employee empowerment. *Journal of Applied Behavioral Science, 35*(3), 373–390.
Howell, R. A., & Soucy, S. R. (1987). Cost accounting in the new manufacturing environment. *Management Accounting* (August), 42–48.
Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1–55.
Ittner, C. D., & Larcker, D. F. (1995). Total quality management and the choice of information and reward systems. *Journal of Accounting Research, 33*, 1–34.
Johnson, H. T. (1992). *Relevance regained: From top-down control to bottom-up empowerment*. New York: The Free Press.
Johnson, H. T. (2006). Lean accounting: To become lean, shed accounting. *Cost Management, 20*(1), 6–17.
Johnson, H. T., & Bröms, A. (2000). *Profit beyond measure*. New York, NY: The Free Press.
Jöreskog, K. G., & Sörbom, D. (1988). *LISREL 7: A guide to the program and applications*. Chicago, IL: SPSS, Inc.
Kaplan, R. S. (1983). Measuring manufacturing performance: A new challenge for managerial accounting research. *The Accounting Review*, 686–705.
Kaplan, R. S. (1984). Yesterday's accounting undermines production. *Harvard Business Review, 62*, 96–102.
Kaynak, H. (2003). The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management, 21*(4), 686–705.
Kennedy, F. A., & Maskell, B. (2006). *Lean enterprise fundamentals. Statement of management accounting*. Institute of Management Accountants, pp. 1–32.
Kennedy, F. A., & Widener, S. K. (2008). A control framework: Insights from evidence on lean accounting. *Management Accounting Research, 19*, 301–323.
Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford Press.
Langfield-Smith, K. (1997). Management control systems and strategy: A critical review. *Accounting, Organizations and Society, 22*(2), 207–232.
Li, X., Sawhney, R., Arendt, E. J., & Ramasamy, K. (2012). A comparative analysis of management accounting systems' impact on lean implementation. *International Journal of Technology Management, 12*(57), 33–48.
Liker, J. K. (2004). *The Toyota way*. New York: McGraw Hill.
Lind, J. (2001). Control in world class manufacturing—A longitudinal case study. *Management Accounting Research, 12*(1), 41–74.
Luft, J., & Shields, M. D. (2003). Mapping management accounting: Graphics and guidelines for theory-consistent empirical research. *Accounting, Organizations and Society, 28*, 169–249.
Malmi, T., & Brown, D. (2008). Management control systems as a package—Opportunities, challenges and research directions. *Management Accounting Research, 19*, 287–300.
Maskell, B. H., Baggaley, B., & Grasso, L. (2012). *Practical lean accounting* (2nd ed.). Boca Raton, FL: CRC Press.
Maskell, B. H., & Kennedy, F. A. (2007). Why do we need lean accounting and how does it work? *The Journal of Corporate Accounting and Finance*, 59–73.
McGovern, M. F., & Andrews, B. J. (1998). Operational excellence: A manufacturing metamorphosis at western geophysical exploration products. In J. K. Liker (Ed.), *Becoming lean: Inside stories of U.S. manufacturers* (pp. 388–406). Portland, OR: Productivity Press.
Myers, M. G. (2004). Implications of pricing strategy—Venture strategy congruence: An application using optimal models in an international context. *Journal of Business Research, 57*, 591–600.
Nadler, D. A., & Tushman, M. L. (1980). A model for diagnosing organizational behavior. *Organizational Dynamics*, 35–51.
Nadler, D. A., & Tushman, M. L. (1989). Organizational frame bending: Principles for managing reorientation. *The Academy of Management, 111*(3), 194–204.
Nadler, D. A., & Tushman, M. L. (1997). *Competing by design: The power of organizational architecture*. New York: Oxford University Press.
Nadler, D. A., & Tushman, M. L. (1992). Designing organizations that have good fit: A framework for understanding new architectures. In D. A. Nadler, M. Gerstein, & R. B. Shaw (Eds.), *Organizational architecture* (pp. 39–56). San Francisco: Jossey-Bass.
Nunnally, J., & Bernstein, I. (1994). *Psychometric theory* (3rd ed.). New York: McGraw-Hill.
Otley, D. T. (1980). The contingency theory of management accounting: Achievements and prognosis. *Accounting, Organizations and Society, 5*, 413–428.
Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management, 12*(4), 531–544.
Powell, T. C. (1995). Total quality management as competitive advantage: A review and empirical study. *Strategic Management Journal, 16*(1), 15–37.
Rinehart, J. W., Huxley, C. V., & Robertson, D. (1997). *Just another car factory? Lean production and its discontents*. Ithaca, NY: Cornell University Press.
Roberts, N., & Grover, V. (2012). Investigating firm's customer agility and firm performance: The importance of aligning sense and respond capabilities. *Journal of Business Research, 65*(5), 579–585.
Sackett, P. R., & Lawson, J. R., Jr. (1990). Research strategies and tactics in industrial and organizational psychology. In M.D. Dunnette & L.M. Hough (Eds.), *Handbook of industrial and organizational psychology* (2nd ed.), (Vol. 1, pp. 419–489). Palo Alto CA: Consulting Psychologists Press.
Schumacker, R. E., & Lomax, R. G. (1996). *A beginner's guide to structural equation effects in structural equation modeling*. Mahwah, NJ: Erlbaum.
Shah, R., & Ward, P. T. (2003). Lean manufacturing: Context, practice bundles, and performance. *Journal of Operations Management, 21*, 129–149.

Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management, 25*(4), 785–805.
Shields, M., Deng, F. J., & Kato, Y. (2000). The design and effects of control systems: Test of direct- and indirect-effects models. *Accounting, Organizations and Society, 25*(2), 185–202.
Shingo Prize for Operational Excellence (2011). *Model & Application guidelines*. Utah State University (Version 6), pp. 1–44.
Solomon, J. M., & Fullerton, R. (2007). *Accounting for world class operations*. Fort Wayne, IN: WCM Associates.
Statements on Management Accounting (SMA) (2006). *Accounting for the lean enterprise: Major changes to the accounting paradigm*. Institute of Management Accountants, pp. 1–35.
Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*, 1–10.
Ugboro, I. O., & Obeng, K. (2000). Top management leadership, employee empowerment, job satisfaction, and customer satisfaction in TQM organizations: An empirical study. *Journal of Quality Management, 5*, 247–272.
van der Merwe, A., & Thomson, J. (2007). The lowdown on lean accounting. *Strategic Finance* (February), 26–33.
Wafa, M. A., & Yasin, M. M. (1998). A conceptual framework for effective implementation of JIT. *International Journal of Operations & Production Management, 18*(11), 1111–1124.
Wanous, J. P., Reichers, A. E., & Hudy, M. J. (1997). Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology, 82*(2), 247–252.
Widener, S. K. (2007). An empirical investigation of the levers of control framework. *Accounting, Organizations and Society, 32*, 757–788.
Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation* (2nd ed.). New York: Free Press.
Wright, P. M., & Snell, S. A. (1998). Toward a unifying framework for exploring fit and flexibility in strategic human resource management. *Academy of Management Review, 23*(4), 756–772.
Wyman, O. (2003). The congruence model: A roadmap for understanding organizational performance. *Delta Organization & Leadership*, 1–15.
Zayko, M., & Hancock, W. M. (1998). Implementing lean manufacturing at Gelman Sciences, Inc. In J. K. Liker (Ed.), *Becoming lean: Inside stories of U.S. manufacturers* (pp. 246–301). Portland, OR: Productivity Press.