Lean production and organisational performance: moderating roles of ability- and motivation-focused human resource management

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Abstract: Lean production (LP) is crucial for improving organisational performance. On the basis of ability-motivation-opportunity theory, this paper provides a new theoretical perspective to explain the interaction effect of human resource management (HRM) and LP on performance. Data from multiple informants from 212 manufacturing plants indicated that when organisations implement ability- and motivation-focused HRM to a high degree, LP is profitable. However, when organisations implement ability- and motivation-focused HRM to a low degree, LP is negatively associated with performance. Therefore, the synergy of LP and these two forms of HRM is critical for performance. Without HRM, LP could damage an organisation. Manufacturers in charge of LP must cooperate with HRM professionals because improving employees' abilities and motivation through HRM supports LP implementation.

Keywords: lean production; LP; ability-motivation-opportunity theory; human resource management; HRM.

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1 Introduction

The pressure of global competition continues to intensify. Traditional manufacturing systems are no longer suitable in current business environments (Shah and Ward, 2003). In the past two decades, numerous manufacturing approaches have been proposed, with lean production (LP) being particularly prominent (Arbós, 2002; Marodin and Saurin, 2013; Shah and Ward, 2007). LP enables producing products on the basis of minimal waste and removal of non-value-added activities (Sparrow and Otaye-Ebede, 2014). LP-induced process improvement leads to superior performance and competitive advantages (De Menezes et al., 2010; Shah and Ward, 2003, 2007; Wood et al., 2004).

After acknowledging the technical problems inherent in LP, several studies have recognised the importance of human resource management (HRM) in LP implementation. Various HRM practices are considered as aspects of LP (Marodin and Saurin, 2013; Olivella et al., 2008; Sparrow and Otaya-Ebede, 2014); for example, Olivella et al. (2008) identified ongoing training, teamwork, empowerment, compensation and rewards as LP aspects. De Menezes et al. (2010) incorporated three HRM practices, namely learning culture, empowerment and teamwork, into LP. Moreover, Martínez-Jurado et al. (2013) stated that LP contains the following five major HRM factors: training, communication, rewards, job design and work organisation. Marodin and Saurin (2013) asserted that no consensus exists regarding HRM practices in LP.

Although previous studies have recognised the influence of HRM on lean thinking, Thirkell and Ashman (2014) reported that professionals in human resources (HR) are excluded from participating in LP application. HRM is a professional system that is independent of manufacturing. Focusing on only some HRM practices in LP is

insufficient (Sparrow and Otaye-Ebede, 2014). A coherent HRM system yields a supportive context that enhances employees' abilities and stimulates employee motivation in LP (Kaufman, 2015; Bos-Nehles et al., 2013; Bonavia and Marin-Garcia, 2011; Shah and Ward, 2003; Sparrow and Otaye-Ebede, 2014).

On the basis of ability-motivation-opportunity (AMO) theory, the present study examined the moderating role of HRM in the relationship between LP and organisational performance (Bos-Nehles et al., 2013; Shah and Ward, 2003). AMO theory asserts that employees exhibit more favourable performance when they have the abilities, motivation and opportunities to perform their jobs (Paauwe, 2009; Boxall and Purcell, 2000; Becker and Huselid, 2006; Bos-Nehles et al., 2013). The adoption of LP implies the concept of 'work smarter, not harder', which represents a unique professional opportunity for employees (Sparrow and Otaya-Ebede, 2014). Sophisticated technology and innovative manufacturing techniques require multiskilled employees and critical changes in employee behaviour (Friel, 2005; Martínez-Jurado et al., 2013; Parker, 2003). LP implementation may be more beneficial in the context of favourable HR than in other contexts because of ability-focused HRM, which concentrates on enhancing ability and motivation-focused HRM, which focuses on motivation. Therefore, this study introduces AMO theory to investigate the moderating effects of ability- and motivation-focused HRM on the performance effects of LP.

This study makes two main contributions. First, by incorporating AMO theory into LP implementation, we provide a consistent theoretical background for HRM in LP. No consensus on HRM practices in LP currently exists, which renders LP operation more difficult. Because various HRM practices exert similar effects, employers can follow the theoretical logic of AMO theory to select the most appropriate practices for their businesses (Shah and Ward, 2003). AMO theory offers a different perspective for understanding the synergy of LP and HRM. Second, the present study proposes HRM bundles rather than individual practices. Examining the effect of individual HR practices overlooks the synergy of various HRM bundles and thus yields misleading results (Shah and Ward, 2007). Considering the inability of firms to utilise one HRM practice at a time, the empirical findings of the present study reveal a phenomenon closer to reality.

In this paper, we first provide a brief review of the LP-related literature. We then introduce hypotheses developed on the basis of AMO theory, HRM and the performance effects of LP. Finally, we describe our research methods and results and provide a discussion and management implications.

2 Theory and hypotheses

2.1 Lean production

LP is employed worldwide (De Menezes et al., 2010) and emphasises removing waste to maximise value-added activities. Lean thinking has been used to design several manufacturing practices. McLachlin (1997) and Shah and Ward (2003) have listed 21 practices in 16 studies conducted from 1977 to 1999, which is reasonable given that manufacturing technology has advanced and LP continues to evolve (Hopp and Spearman, 2004; Spear and Bowen, 1999). On the basis of the basic value (Bonavia and Marin, 2006) and definitions (Birdie et al., 2008; De Menezes et al., 2010) of LP, we assert that LP comprises the following four critical practices.

2.2 Total quality management

The key feature of total quality management (TQM) is continual improvement for performance enhancement. TQM focuses on employee participation because all members of an organisation must contribute to quality goals to achieve organisational success (Bou and Beltran, 2005). To continually improve product quality, employees must continually analyse the difference between target and actual quality levels. If an employee detects a quality deficiency, the employee is responsible for its immediate correction (Nair, 2006; Ooi, 2012; Sila, 2007). Increased quality due to TQM implementation enables companies to issue premiums on the prices of their products and increases customer satisfaction and loyalty (Ali et al., 2010; Birdie et al., 2008; Yang, 2006).

2.3 Just-in-time system

In traditional manufacturing systems, stock is prepared to prevent a halt in the production line. However, buffers represent a commitment of resources that are not directly applied to production, which causes organisational slack and occasionally masks production problems (Macduffie, 1995). The just-in-time (JIT) system minimises resources tied up in buffers and stocks (Al-Matarneh, 2012). Producing products in direct response to customer demand is the core value of the JIT system. Each manufacturing process is completed just in time to begin the next one and the customer is guaranteed JIT delivery (Ahmad et al., 2003). The JIT system is advantageous because it shortens lead time, reduces stock costs, improves cash flow and enhances quality (Birdie et al., 2008; Alcaraz et al., 2014).

2.4 Advanced manufacturing technology

Advanced manufacturing technology (AMT) encompasses various computer-based practices such as computer-aided design, computer-aided manufacturing, automated material handling and computer-aided inspection. AMT primarily refers to computerised technologies applied to engineering, manufacturing processes and execution (Waldeck and Leffakis, 2007).

AMT automation can reduce labor costs, create higher output and enhance quality. A particular advantage of AMT over traditional automation is that when production lines change for different products, AMT can be used to easily install new software instead of physically resetting machines. Thus, AMT reduces nonproductive time while increasing production flexibility (Birdie et al., 2008; Cardoso et al., 2012).

2.5 Supply chain partnering

A supply chain involves three or more organisations that link a source to a customer. Supply chain partnering facilitates the development of sustained relationships in upstream and downstream product flows. A successful cooperative relationship facilitates the leveraging of information and materials (Boddy et al., 2000; Lengnick-Hall et al., 2013). Through cooperation with the JIT system and TQM, supply chain partnering can ensure the integrity of materials, prevent problems in advance and minimise the potential for shortfalls or delays in supply (Birdie et al., 2008; Menon, 2012).

We regarded LP production as a configuration model that combines the aforementioned four practices that support one another and create synergy (MacDuffie, 1995; Shah and Ward, 2003, 2007). The JIT system requires that each production stage finishes at precisely the same time that the subsequent stage begins. The entire production process must be completed for JIT manufacturing to meet a customer's delivery date. In the JIT manufacturing process, TQM is responsible for monitoring and correcting flaws in the first production line. The reduction process variance of TQM simplifies the JIT manufacturing process. In addition, the JIT system facilitates TQM by eliminating potential waste and reworking. Supply chain partnering ensures the qualitative and quantitative delivery of materials. AMT facilitates the manufacturing process by minimising setup and changeover times. In summary, these four practices reinforce one another. The integrated LP system reduces manufacturing costs and increases product quality. The system is perceived as an ambiguous cause-and-effect model that is difficult for competitors to imitate (Birdie et al., 2008; McKone et al., 2001; Shah and Ward, 2003). Numerous empirical studies have shown the positive performance effects of LP (Chandler and McEvoy, 2000; Dennis, 2002; De Menezes et al., 2010; Wood et al., 2004). Accordingly, this study proposed Hypothesis 1:

Hypothesis 1 LP is positively associated with organisational performance.

2.6 AMO theory and HRM

AMO theory strongly asserts that HRM practices affect employees' abilities, motivation and opportunities to perform and thus influence their behaviours and performance (Appelbaum et al., 2001; Bos-Nehles et al., 2013; Gerhart, 2005). Therefore, AMO theory is often employed to explain the performance effects and guide the development of HRM (Paauwe, 2009).

On the basis of previous studies, we divided HRM practices into two bundles, namely ability-focused and motivation-focused HRM. Ability-focused HRM consists of rigorous selection, training and developmental performance appraisal and motivation-focused HRM consists of performance-based pay systems and employee stock ownership (Purcell, 2003; Almutawa et al., 2015; Innocenti et al., 2011). In accordance with the research objective, opportunities to perform in this study were defined as the implementation of LP.

The hypothesis related to the moderating effect of ability-focused HRM was based on the resource-based view (RBV). HR is widely acknowledged as a crucial source of competitive advantages because the characteristics of employees being valuable, rare, inimitable and irreplaceable are based on the RBV (Barney, 1991; Kang and Snell, 2009; Ployhart and Moliterno, 2011). Ability-focused HRM is one of the most common methods of cultivating HR to improve organisational performance. Enhancing employees' knowledge, skills and ability through ability-focused HRM produces higher-quality products and services and increases the value of employee contributions (Fey et al., 2009; Bulut and Culha, 2010; Hitt et al., 2001; Knies and Leisink, 2014; Ployhart et al., 2011).

LP is more complicated than traditional manufacturing methods. The high skill demands of the four LP practices reveal the critical role of HR (Friel, 2005; Martínez-Jurado et al., 2013; Parker, 2003); for example, TQM emphasises the need for employee involvement in order to improve quality, which considerably changes the

manners in which employees behave at work (Ali et al., 2010). When firms implement TQM, they usually adopt ability-focused HRM to train employees in management aspects such as new quality concepts, customer satisfaction systems, statistical quality control methods and problem-solving techniques (Yang, 2006; Jiménez-Jiménez and Martínez-Costa, 2009). Implementing the JIT system increases employees' ability requirements (Al-Matarneh, 2012). Firms must train workers to rapidly prepare machines without error in order to deliver the correct product to the correct location at the precise time. Erroneous operations disrupt the production process and are detrimental to the JIT goal. Ability-focused HRM must equip employees with the knowledge, skills and abilities required for the JIT system (Ahmad et al., 2003; Alcaraz et al., 2014; Johnson and Manoochehri, 1990). The successful implementation of AMT requires the support of new, advanced computer and technical skills. Previous studies have found that ability-focused HRM, which can facilitate workforce development, directly influences AMT outcomes (Waldeck and Leffakis, 2007). Regarding supply chain partnering, Lengnick-Hall et al. (2013) revealed that ability-focused HRM can transmit values, beliefs and norms that improve employees' behaviours in relation to supply chain partnering. When firms focus on improving their employees' abilities, they foster appropriate skills and behaviours that positively contribute to establishing supply chain partnering (Hohenstein et al., 2014; Kam et al., 2010).

In summary, multiskilled employees are required for TQM, JIT, AMT and supply chain partnering. Firms that use ability-focused HRM can make HR fit LP operations more closely than can those lacking this approach. The relationship between LP and performance is strengthened by ability-focused HRM because more favourable HR ensures the development of reliable knowledge, abilities and work behaviours among employees for the successful implementation of LP (De Treville and Antonakis, 2006; Shah and Ward, 2003). On the basis of this rationale, this study proposed Hypothesis 2:

Hypothesis 2 The interaction effect of ability-focused HRM and LP is positively associated with organisational performance.

The premise of the moderating effect of motivation-focused HRM is supported by social exchange theory (Blau, 1964), which is based on reciprocity. When employees perceive that the firm they work for is concerned about their well-being and respects their contributions, they are more willing to perform well and offer feedback (Barrick et al., 2015).

Implementing LP is a complex task and a radical innovation strategy that requires major changes in employee behaviour (Martínez-Jurado et al., 2013). Multiple tasks and responsibilities are transferred to employees, who must ensure smooth operation and discipline colleagues who do not correctly execute the tasks in question (Treville and Antonakis, 2006; Shah and Ward, 2003). Such heavy work leads to an increase in employees' workloads and stress levels, which could result in resistance to LP participation (Bos-Nehles et al., 2013; Harris et al., 2002).

Previous studies have revealed that the obstacles to each LP practice are related to employee motivation (Bateman, 2005); for example, some studies have found that the outcomes of motivation in relation to TQM success, such as employee commitment and shared vision, are more favourable than the outcomes of other technical elements (Dow wt al., 1999; Jiménez-Jiménez and Martínez-Costa, 2009). The greater task variety and responsibility of the JIT system require highly dedicated and committed employees (Johnson and Manoochehri, 1990). Alcaraz et al. (2014) reported several critical success

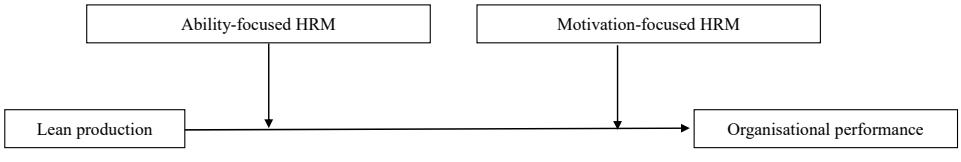
factors of the JIT system and supported the influence of motivation on JIT implementation. Waldeck and Leffakis (2007) emphasised that although employees are required to learn new skills for AMT, they cannot be passive recipients. Firms must establish specific HRM practices to motivate employees to use these advanced skills. Furthermore, because supply chain partnering requires firm-wide cooperation, incentives with broad goals are more effective than those with narrow functional goals (Menon, 2012). Employees with appropriate abilities must be motivated to apply those abilities to the productive process of supply chain partnering (Kam et al., 2010). Therefore, previous studies have supported the crucial role of employee motivation in LP implementation.

Employees' abilities are of little use unless the employees believe that their individual interests align with the company's interests. Motivation-focused HRM encourages employees to participate in LP by offering performance-based pay systems and employee stock ownership, both of which are common incentives to motivate employees because they consistently convey that the organisation acknowledges employees' contributions and is willing to share benefits with them. Strong incentives motivate employees to participate in LP (Bergmann and Scarpello, 2001; Bos-Nehles et al., 2013; MacDuffie, 1995; Macky and Boxall, 2007). On the basis of this rationale, this study proposed Hypothesis 3:

Hypothesis 3 The interaction effect of *motivation-focused HRM and LP* is positively associated with organisational performance.

According to AMO theory, employees exhibit more favourable performance when they have the abilities, motivation and opportunities to perform their jobs. The two HRM bundles in this study can be applied by organisations to improve employees' abilities and motivation to participate in the professional working opportunities offered by LP, which can strengthen the relationship between LP and performance. Figure 1 presents the full conceptual model.

Figure 1 Conceptual model



3 Research methodology

3.1 Sample

The unit of analysis for this study was the manufacturing plant. The sample consisted of 212 randomly selected plants, of which 12% were from the petrochemical industry, 21% were from the steel industry, 41% were from the electronics industry and 26% were from other industries. The diversity of the industries in our sample renders the research results generalisable. The average age of the sample plants was 21 years and the average number of employees was 606.

3.2 Procedure

A list of plants provided by the Taiwanese Ministry of Economic Affairs served as the sampling frame of the present study. Previous studies have asserted that smaller companies generally make less use of professional HRM systems (De Kok et al., 2006). Therefore, the present study focused on plants with more than 100 staff members.

After plants with incomplete information had been removed, 2,000 plants remained, of which 1,000 were selected through random sampling. We initially contacted the manufacturing and personnel managers of the surveyed plants by telephone. After confirming the managers' names and job titles, we sent two sections of the study questionnaire separately. The LP section was sent to the plant chiefs and the HRM section was sent to the HR managers. A total of 2,000 questionnaires were distributed.

The return rate for the LP section was 27.2% and that for the HRM section was 26.3%. A total of 212 plants returned both sections of the questionnaire, thereby yielding a final effective return rate of 21.2%. To assess non-response bias, we conducted a chi-square test to measure firm size. No significant differences were detected (chi-square = 50.825; $p > 0.05$).

3.3 Measures

3.3.1 Lean production

Following the definition of Birdie et al. (2008), we assessed TQM, JIT, AMT and supply chain partnering to define LP. The measuring instrument was adapted from Snell and Dean (1992) and used to separately measure the four LP practices. In addition, we adopted the additive index to represent LP (MacDuffie, 1995; Shah and Ward, 2003).

The complete questionnaire items are presented in the appendix. A sample item is outlined as follows: "To what extent does your plant implement quality control circles?" The respondents answered the question by using a 5-point Likert scale (1 = 'not at all'; 5 = 'fully'). The Cronbach's alpha was 0.87.

3.3.2 Human resource management

We identified five core HR practices to measure the two HRM bundles. Ability-focused HRM was measured through rigorous selection, training and developmental performance appraisal. Motivation-focused HRM was measured through performance-based pay systems and employee stock ownership. We referred to Snell and Dean (1992) in developing the questionnaire items. A sample item is outlined as follows: "At what resource level does your factory pay for selection?" The respondents provided their responses by using a 7-point Likert scale (1 = 'very low'; 7 = 'very high'). The Cronbach's alpha was 0.93. The final question was about employee stock ownership. We asked, "Does your plant offer annual bonuses?" The response options were 'Yes = 1' and 'No = 0.' The additive index was adopted to represent the two HRM bundles (Lepak and Snell, 2002; Shah and Ward, 2003).

3.3.3 Organisational performance

Because of the lack of objective data on factory-level performance in Taiwan, we adopted a subjective measurement method. Data were reported by factory chiefs and a sample

item is outlined as follows: "What is the level of performance at your plant compared with other plants in the same industry?" The performance indicators comprised product quality, employee morale and employee productivity (Oczkowski and Farrell, 1998; Powell and Dent-Micallef, 1997). An overall additive index was used to represent organisational performance. Exploratory factor analysis was performed to confirm whether only one construct was present. Data were extracted for only one factor, for which the eigenvalue was greater than 1. All factor loadings were above 0.7 (Jöreskog and Sörbom, 1993). The Cronbach's alpha was 0.92.

3.3.4 Control variables

This study contained several control variables. Because business environments may differ by industry, we included three industry dummies and industry competition to control for industrial heterogeneity (Datta et al., 2005; Ng and Dastmalchian, 2011). Plant age was measured by an open question and plant size was measured by the natural logarithm of the number of employees. These two variables could affect the establishment of HRM and manufacturing systems in an organisation (Bonavia and Marin, 2006).

4 Analysis and results

Table 1 presents the descriptive statistics and correlation coefficients for all variables, revealing LP and ability- and motivation-focused HRM to be positively correlated with organisational performance ($r = 0.38$, 0.62 and 0.61, respectively; $p < 0.01$). The findings revealing significant correlations are consistent with those of previous studies.

We applied hierarchical regression to test the hypotheses. Table 2 indicates that the research findings support Hypothesis 1 in Model 2. The relationship between LP and organisational performance was observed to be positive ($\beta = 0.295$, $p < 0.01$; ΔR-square = 0.13; $p < 0.05$). Furthermore, following previous studies, we included all related variables to create interaction terms, thereby avoiding multicollinearity (Aiken and West, 1991; Jaccard et al., 1990). The results are evident in Models 3 and 4. We observed a positive and statistically significant coefficient ($\beta = 0.23$, $p < 0.01$; ΔR-square = 0.40; $p < 0.01$) for the interaction effect of ability-focused HRM and LP empirically; hence, Hypothesis 2 was supported. Moreover, we noted a significant regression coefficient of the interaction term in Model 4 ($\beta = 0.22$, $p < .01$; ΔR-square = 0.43; $p < 0.01$); therefore, Hypothesis 3 was supported. The interaction effect of motivation-focused HRM and LP was positively associated with organisational performance.

To clarify the form of interaction, we followed the method of Aiken and West (1991) to produce a figure for the interaction effect. As expected, Figures 1 and 2 display consistent results. When ability- and motivation-focused HRM were relatively high (i.e., high ability-focused HRM in Figure 1 and high motivation-focused HRM in Figure 2), LP was positively associated with performance. By contrast, when both HRM bundles were relatively low (i.e., low ability-focused HRM in Figure 1 and low motivation-focused HRM in Figure 2), LP was negatively associated with performance. Therefore, Hypotheses 2 and 3 were further supported.

Table 1 Descriptive statistics and correlation

		Mean	*S.D.*	*1*	*2*	*3*	*4*
1	Petrochemical industry (dummy)	0.12	0.33				
2	Steel industry (dummy)	0.21	0.41	–.20**			
3	Electronic industry (dummy)	0.41	0.49	–.31**	–.43**		
4	Plant size (log)	2.47	0.44	–.05	–.00	–.02	
5	Plant age	21.18	19.96	.02	.03	–.09	–.02
6	Industry competition	5.76	0.80	.07	.01	–.00	.01
7	Lean production	2.96	0.77	.01	.01	.04	.40**
8	Ability-focused HRM	4.19	0.82	.10	–.02	.05	.29**
9	Motivation-focused HRM	4.29	0.83	.00	–.02	.02	.16*
10	Organisational performance	4.73	0.89	.06	–.05	.06	.23**

		5	*6*	*7*	*8*	*9*
1	Petrochemical industry (dummy)					
2	Steel industry (dummy)					
3	Electronic industry (dummy)					
4	Plant size (log)					
5	Plant age					
6	Industry competition	.06				
7	Lean production	.05	–.10			
8	Ability-focused HRM	–.07	–.09	.53**		
9	Motivation-focused HRM	–.06	–.07	.33**	.65**	
10	Organisational performance	–.04	–.11	.38**	.62**	.61**

Note: *p < .05; **p < .01.

Figure 2 Interaction effect of ability-focused HRM and LP (see online version for colours)

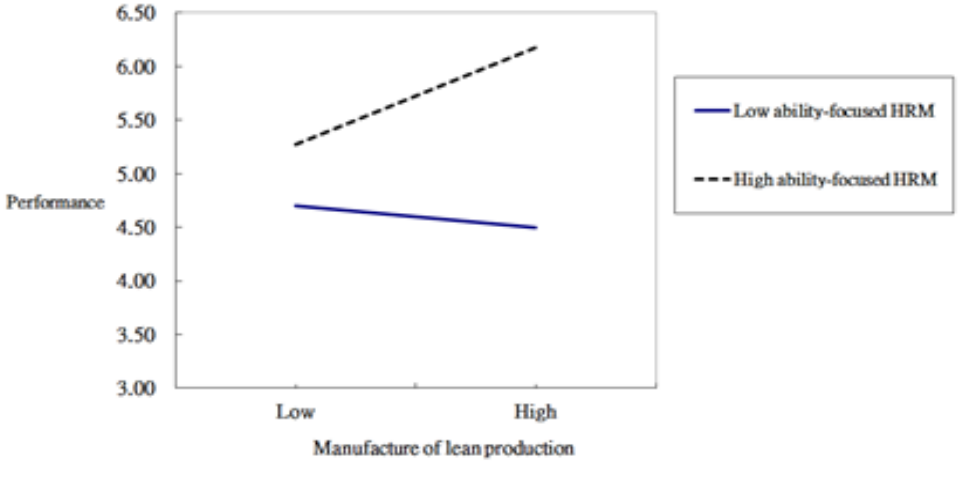


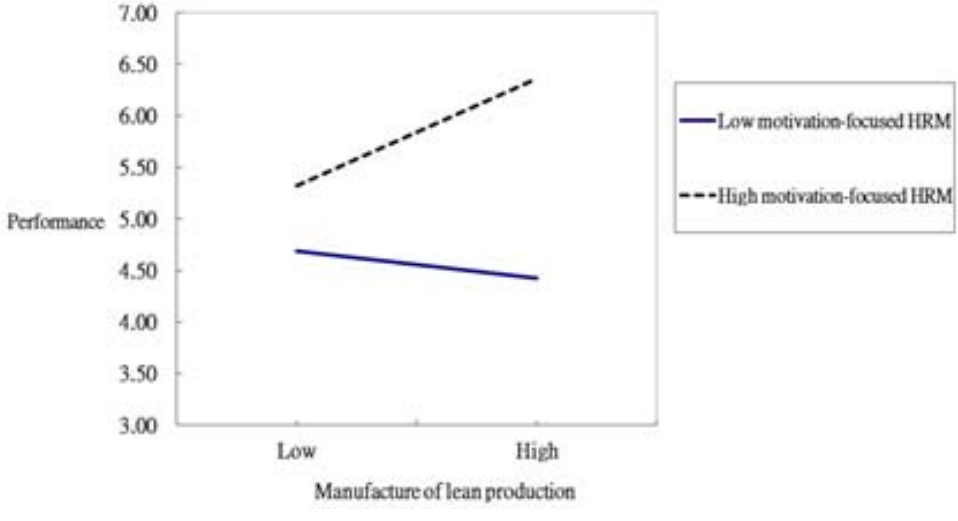
Table 2 Results of hierarchical regression analyses

	Model 1	*Model 2*	*Model 3*	*Model 4*
Control variable				
Petrochemical industry (dummy)	0.03	0.01	0.01	0.08
Steeindustry (dummy)	–0.06	–0.06	–0.05	–0.04
Electronic industry (dummy)	0.01	–0.01	0.01	0.06
plant size	0.19*	0.07	–0.02	0.01
plant age	–0.09	–0.12	–0.02	–0.08
Industry competition	–0.10	–0.08	–0.05	–0.07
Independent variable				
Lean production (LP)		0.295**	0.15	0.17
Ability-focused HRM			0.55**	
Motivation-focused HRM				0.58**
Interaction				
Ability-focused HRM × LP			0.23**	
Motivation-focused HRM × LP				0.22**
Adjusted R-Square	0.01	0.08	0.36	0.39
ΔR-Square	0.05	0.13*	0.40**	0.43**
Model F value	1.28	2.57*	8.81**	10.49**

Note: *p < .05; **p < .01.

The overall findings suggest that ability- and motivation-focused HRM can create supportive contexts, thereby yielding the positive performance effects of LP. If both HRM bundles are low, LP is negatively associated with performance.

Figure 3 Interaction effect of motivation-focused HRM and LP (see online version for colours)



5 Discussions

This study provides a new theoretical perspective to discuss the interrelationships between HRM, LP and performance. The findings demonstrate the importance of AMO theory and clarify the reasons for the joint implementation of HRM bundles and LP. Although the results revealing the positive performance effect of LP are similar to those of previous studies (MacDuffie and Pil, 1996; Shah and Ward, 2003), when ability- and motivation-focused HRM are considered, the relationship between LP and performance changes. As expected, when organisations implement ability- and motivation-focused HRM to a high degree, LP is profitable. However, in contrast to our expectations, when organisations implement ability- and motivation-focused HRM to a low degree, LP is revealed to be negatively related to performance. The synergy of LP and the two HRM bundles is the most critical reason for success, because without the HRM bundles, LP could damage an organisation.

The negative consequence of LP in the aforementioned condition is notable. Most previous studies have asserted that LP is positively associated with performance. Therefore, in firms that apply LP, the result is a change in performance (MacDuffie and Pil, 1996), possibly because of the implementation level of ability- and motivation-focused HRM. Some previous studies have cited sociotechnical systems theory, which asserts that the simultaneous implementation of technical and social systems improves performance, thereby supporting the involvement of HRM practices in LP (Cua et al., 2001). The present study extends the literature in proposing that adopting social systems could be insufficient and that firms should instead focus on HRM bundles, which improve employees' abilities and motivation in LP. Therefore, this study agrees with Thirkell and Ashman (2014), who asserted that HR professionals must participate in LP to design ability- and motivation-focused HRM. AMO theory provides a complete theoretical background of the influences of HRM. LP is not the same as mean production (Babson, 1993). A lack of appropriate HRM bundles places stress on employees. Organisations should no longer isolate manufacturing operations from HRM professionals who can perceive the effects of LP on workplaces and develop suitable ability- and motivation-focused HRM to support employees (Cardoso et al., 2012).

We advocate the use of the contingency model to improve our understanding of LP implementation. The literature on strategic HRM emphasises two types of fit that enhance performance. One is vertical fit, which is the alignment of HRM practices and organisational strategies. The other is horizontal fit, which refers to the congruence between HRM practices (Wright and Snell, 1998). HRM bundles reflect horizontal fit, which is established on the basis of the consistent philosophy of employee investment. HRM practices provide multiple channels for firms to enhance employees' abilities and motivation, which in turn reinforce each other (Datta et al., 2005; Dyer and Reeves, 1995; Evans and Davis, 2005; MacDuffie, 1995; Tomer, 2001). In addition, the results of the interaction effect of LP and HRM indicate vertical fit. LP could be perceived as a strategic goal that minimises waste and accelerates response speeds (Arbós, 2002; Shah and Ward, 2003, 2007). HRM enhances employees' abilities and motivation to achieve the strategic goal of LP (Niepce and Molleman, 1998; Parker, 2003; Taira, 1996; Wright and Snell, 1998). The findings of this study confirm that the vertical fit between HRM bundles and LP is positively associated with performance.

6 Limitations and future research

This study has several limitations. First, although the data were obtained by pairing factory chiefs with HR managers, this was a cross-sectional study. In the future, longitudinal studies should be conducted to further extend the literature. Second, the data of LP and HRM bundles were collected from factory chiefs and HR managers; however, the performance data were provided only by factory chiefs. Therefore, our results might have been inflated by common method variance (CMV) because the same respondents completed the questionnaires on LP and organisational performance (Organ and Ryan, 1995). We utilised factor analyses for all questionnaire items. If a single factor or item explained most of the variance, CMV may have represented a major problem (Podsakoff and Organ, 1986). Factor analyses generated 14 factors, with any single factor explaining a maximum of only 34.6% of the total variance. Additionally, previous studies have asserted that CMV seldom inflates moderating effects (Aiken and West, 1991). Therefore, we do not consider CMV to have adversely influenced our results. Third, other moderators may be present among HRM, LP and performance; for example, previous studies have claimed that LP and HRM practices can improve the flexibility of organisations (Arbós, 2002; Datta et al., 2005; Shah and Ward, 2003). Business marketing is becoming increasingly competitive and dynamic. Thus, flexibility is becoming a more critical source of competitive advantage for organisations and may be a crucial moderator. Future research should investigate further the moderating effects of flexibility.

7 Conclusions

In summary, this study revealed that in plants with a low degree of implementation of ability- and motivation-focused HRM, LP is negatively associated with performance. According to AMO theory, the positive performance effects of LP must be complemented by high implementation of ability- and motivation-focused HRM. Furthermore, manufacturers must cooperate with HRM professionals. The integration of these two independent professional systems stands to yield success for firms.

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Appendix

Table A1 Questionnaire items

A	Lean production	
	To what extent does your plant implement quality control circles? (1 = 'not at all'; 5 = 'fully')	
	1	Quality control circle
	2	Employee suggestion system
	3	Employee participation in decision-making
	4	Total quality management
	5	Just-in-time (JIT) system
	6	Production scheduling and maintenance
	7	Manufacturing resource planning (MRP II)
	8	Computer-aided design (CAD)
	9	Numerical control (NC)
	10	Computer numerical control (CNC)
	11	Direct numerical control (DNC)
	12	Flexible manufacturing systems (FMS)
	13	Robotics
	14	Automated materials handling
	15	Computer-aided test and inspection
	16	Computer-aided process planning
	17	Maintenance and materials handling
	18	Supply chain partnering

Table A1 Questionnaire items (continued)

B	Ability- and motivation-focused HRM	
	1	In general, how long does it take to select someone for a position in this unit when the job is open? (1 = 'short time'; 7 = 'long time')
	2	How much money is generally spent in selecting people for a job? (1 = 'very little'; 7 = 'a great deal')
	3	In which level of resource does your factory pay for selection? (1 = 'very low'; 7 = 'very high')
	4	How extensive is the employee selection process for a job in this unit? (e.g., use of tests, interviews) (1 = 'not extensive'; 7 = 'very extensive')
	5	How important is it to select the best person for a given job? (1 = 'not important'; 7 = 'very important')
	6	How many applicants are screened for each job to hire the best person? (1 = 'few'; 7 = 'quite a lot')
	7	How much priority is given to the employee training program in your unit? (1 = 'very little'; 7 = 'great deal')
	8	How formal or organised is the training process? (1 = 'very disorganised'; 7 = 'very organised')
	9	How many employees have received training last year? (1 = 'few'; 7 = 'quite a lot')
	10	How many different types of training programs are available for members of your work unit to attend? (1 = 'very few'; 7 = 'quite a lot')
	11	How much money is spent on training individuals in your work unit? (1 = 'almost none'; 7 = 'a great deal')
	12	How is employee training viewed in your plant? (1 = 'viewed as a cost'; 7 = 'viewed as an investment')
	13	To what extent is cross-function training used in your plant? (1 = 'not at all'; 7 = 'extensively')
	14	To what extent is teamwork training used in your plant? (1 = 'not at all'; 7 = 'extensively')
	15	To what extent is problem-solving training used in your plant? (1 = 'not at all'; 7 = 'extensively')
	16	To what extent is the conception of introductory training used in your plant? (1 = 'not at all'; 7 = 'extensively')
	17	To what extent is research method training used in your plant? (1 = 'not at all'; 7 = 'extensively')
	18	How much effort is given to measuring employee performance? (1 = 'very little'; 7 = 'a great deal')
	19	How much do employees participate in goal setting and appraisal? (1 = 'very little'; 7 = 'a great deal')
	20	To what extent does performance assessment focus on future performance? (1 = 'very little'; 7 = 'a great deal')
	21	To what extent does performance assessment focus on employee career development? (1 = 'very little'; 7 = 'a great deal')
	22	How closely are rewards such as raises and promotions tied to performance appraisal? (1 = 'not closely'; 7 = 'very closely')

Table A1 Questionnaire items (continued)

B	Ability- and motivation-focused HRM	
	23	How closely is salary increase tied to performance appraisal? (1 = 'not closely'; 7 = 'very closely')
	24	How often is performance discussed with employees? (1 = 'rarely'; 7 = 'daily')
	25	How would you rate the pay levels in this unit in relation to other firms? (1 = 'low'; 7 = 'high')
	26	The wages in this work unit are not very competitive for this industry. (1 = 'completely true'; 7 = 'completely false')
	27	How closely is pay tied to individual performance? (1 = 'not closely'; 7 = 'very closely')
	28	To what extent does the plant pay differently on the basis of each employee's contribution? (1 = 'very little'; 7 = 'a great deal')
	29	When your plant is compared with other companies in the same trade, to what extent does your plant pay differently across different work units? (1 = 'very little'; 7 = 'a great deal')
	30	How much emphasis is placed on paying people in this work unit as much as how they would be paid on similar jobs in other companies? (1 = 'very little'; 7 = 'a great deal')
	31	How much priority is given to internal promotion? (1 = 'very little'; 7 = 'a great deal')
	32	Does your plant pay annual bonuses? ('Yes' = 1 or 'No' = 0)
C	Organisational performance	
	When your plant is compared with other companies in the same trade, how do you rate the performance of your plant in the following aspects? (1 = 'very little'; 7 = 'a great deal')	
	1	Quality of products
	2	Morale of employees
	3	Efficiency of delivering products to customers
	4	Performance of managing stocks
	5	Productivity of employees
	6	Efficiency of utilising facilities
	7	Rate of yield
	8	Efficiency of lead time
D	Control variable: industry competition (1 = 'very little'; 7 = 'great deal')	
	1	Pressure of manufacturing performance
	2	Degree of rivalry in the industry