A Multi-group Analysis of the Impact of Lean Manufacturing Practices on Operational Performance: Does the National Culture Matter?

Le Nguyen Hoang(✉)

Faculty of International Economics, Ho Chi Minh University of Banking, 36 Ton That Dam Street, Nguyen Thai Binh Ward, District 1, Ho Chi Minh City, Vietnam
hoangln@hub.edu.vn

Abstract. Although there are abundant studies addressing the technical aspects of lean manufacturing, few have been done to examine the influence of national culture on its effectiveness. Moreover, the "true" relationship between national culture and operational performance from practising lean manufacturing is probably non-linear, thus leading to an inconsistent role of national culture in previous research. By employing multi-group invariance analyses that do not face the strict assumption of linearity relationships, this study aims to investigate how the impact of lean manufacturing practices on operational performance differs across groups with different national cultural dimensions. Seven models associated with five cultural dimensions and two control variables (i.e. type of ownership, size of enterprise) were developed and tested based on 271 global manufacturing plants located in Vietnam. The results indicated that lean manufacturing is more effective in plants with a small size that value a low power distance, low uncertainty avoidance, and feminine culture. These results partially support the practice-culture congruence perspective. In terms of theoretical implications, this study provides an alternative analytical approach for studying the role of natural culture and shows what specific cultural dimensions are congruent with lean manufacturing practices. These empirical results contribute to a deeper understanding of the reasons why certain companies find lean manufacturing practices difficult and/or fail to achieve their target performance.

Keywords: Lean manufacturing · National culture · Practice-culture congruence · Hofstede's cultural dimensions · Operational performance · Multi-group invariance analysis

1 Introduction

Since the late 1980s, lean manufacturing (LM) has been seen as the most widely effective practice for achieving operational excellence [1]. In particular, LM focuses on waste elimination through continuous improvements [2]. By practising LM, an organisation can reduce costs, increase efficiency, improve flexibility and thus maximise the value

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offered to its customers [3]. This concept first appeared in the article entitled "Triumph of the lean production system" [4] and was later popularised by the book "The machine that changed the world" [5]. In that book, [5] highlighted the positive impact of the Toyota Production System (TPS) in the automotive industry to illustrate the superiority of Toyota's operation based on LM.

Despite the advantages, the implementation of a bundle of LM practices in various contexts has constantly been unsuccessful. Previous researchers [6, 7] reported that failed transitions to LM are common. A review by [8] indicated that successful companies implementing LM have been found in 10% of the cases or less. One possible explanation for such failures could be that success in sustaining LM is determined largely by the "hybridisation" with the context of where LM is being implemented [9]. A hybrid implementation of LM probably necessitates different approaches according to the context. More specifically, LM was created in Japan but the relevance of the Japanese societal culture could generate conflicting opinions about the replication of LM in different national cultures [10]. Although national culture has been recently suggested as the underlying force that guides managers in the successful implementation of LM [11], the contradictory results on how certain national cultural dimensions affect the operational performance from practising LM raised a question of whether national culture really matters [7].

Previous studies have failed to address this question for two reasons. First, although there are abundant studies addressing LM's technical aspects, few have been done to examine the influence of national culture on LM effectiveness. Second, instead of challenging the role of national culture on the success of the LM practices, this study departs from the expectation that the "true" relationship between national culture and operational performance from practising LM is probably non-linear, thus leading to an inconsistent role of national culture in previous research. Unlike previous studies that were based on the assumption of linearity relationships between independent variables (e.g. national culture dimensions) and dependent variables (e.g. operational performance) [10, 12, 13], this study employs multi-group invariance analyses that do not face the strict assumption of linearity relationships [14]. In other words, it aims to investigate how the impact of LM practices on operational performance differs across groups with different national cultural dimensions. Consequently, the findings will not only help managers prepare for their implementation of LM but also provide possible modifications to adapt such practices to particular cultural contexts.

2 Literature Review

2.1 Lean Manufacturing and Its Impact on Operational Performance

Several different definitions of LM could be found in the literature. [5] defined LM as a dynamic process of change driven by a systematic set of principles to achieve continuous improvement. According to [5], this concept is seen not only as unique tools but also as methods and strategies in product development, supply chain management, and operations management. In particular, LM consists of a wide range of management practices such as just-in-time (JIT) (e.g. producing the units needed at the time needed without unnecessary inventories), team working, total quality management (TQM) (e.g.

a continuous process of identifying and eliminating errors in manufacturing), supplier collaboration, cellular manufacturing (e.g. grouping machines together based on the family parts produced to reduce the travelling distance of materials), and total preventive maintenance (TPM) (e.g. keeping equipment performing stability to support the manufacturing process). In line with [5, 15] viewed LM as a philosophy focusing on delivering the highest quality product at the lowest cost and on time. As the first ones who considered the human side of LM, [16] defined LM as an integrated socio-technical system aiming to eliminate waste by continuously minimising internal and external variability. Other researchers [17, 18] agreed with Shah and Ward's [16] definition in that LM extends the scope of the TPS philosophy by providing an enterprise-wide term that draws together many technical and human constructs. When viewing LM as a philosophical mindset rather than a bundle of practices, implementing LM in a non-Japanese culture requires careful consideration of cultural components at the national level [10].

The majority of previous studies have found a positive relationship between LM practices and operational performance [10, 12, 13, 19, 20]. For instance, [19] found that investments in LM practices are positively related to operational performance and that operational benefits from LM are significantly enhanced within an organisation with intellectual capital. In their study, intellectual capital is seen as "a system of knowledge-based resources" that includes human capital (i.e. employees' knowledge, experience, professional skills, and abilities), structural capital (i.e. well defined manuals, structures, and processes), and social capital (i.e. collaboration across employees and departments) (page 3). Meanwhile, [20] surveyed top managers in manufacturing firms and figured out that learning orientation for mobilising relational resources helps organisations develop LM capabilities, and consequently leads to better operational performance. Another stream of research has focused on contextual and contingency factors. The investigated factors include firm characteristics such as size [21], employee development [22], and organisational culture [13, 23, 24]. Finally, few studies examined the role of national culture in realising operational performance from practising LM [10, 12]. While there is consensus that LM practices will improve operational performance, workforces with cultural beliefs that are not in line with LM's practices will struggle to achieve LM's full potential [10].

2.2 A Practice-Culture Congruence Perspective: The Influence of National Culture

[25] defined culture as "the collective programming of the mind that distinguishes the members of one group or category of people from another" (page 9). [25] further added that cultural dimensions can exist at different levels from the country to the corporate or departmental level. Initially, [26] conceptualised national cultures according to the four distinct dimensions of individualism, power distance, uncertainty avoidance, and masculinity. Through further development of his model, [25] added the fifth dimension in the form of short-term versus long-term orientation. Although Hofstede's work has been widely used, it has been criticised for its lack of generalisability, the assumption of homogeneity in the studied cultures and that the data was solely collected from a single corporation with multiple subsidiaries [27, 28]. While it is recognised that there are limitations when using Hofstede's [25, 26] classification, the indisputable practicality of

Hofstede's framework to account for national culture has ensured its continued popularity in the management field [29, 30].

Because managerial practices vary in congruence with the prevailing cultural values of workers and managers, new practices do not diffuse into a cultural vacuum but rather into pre-existing cultural beliefs that define the roles and responsibilities of their respective actors [31]. In this regard, national cultural beliefs act as societal principles that give order and direction to activities [25], leading members in different cultural contexts to implement and use management practices differently [32], sometimes in ways that support the practice and sometimes not [31]. The management literature has found evidence for the national cultural dimensions moderating the relationships between LM practices and operational performance. For instance by arguing that there is great confusion in the literature about the role of national cultural dimensions in global LM programmes, [12] used Hofstede's [25] five dimensions of national culture to analyse the data collected from two companies with 80 factories/plants. Surprisingly, they found that there is no explanatory power in a national culture based on the results of the correlation analysis, even for the "individualism" dimension. Hence, they suggested that other factors such as the organisational culture and the strategic role of the plant matter far more than the natural culture in explaining the successful implementation of LM programmes.

More germane to this study, [10] applied a practice-culture congruence perspective suggested by [31] to examine whether national culture moderates quality management effectiveness. They used the data from the fourth round of Global Manufacturing Group's worldwide survey containing 1,453 facilities from 24 countries. Based on the measurement of national culture developed by the GLOBE study [10, 33] found that suitable countries for practising LM effectively will tend to avoid uncertainty in a cooperative and non-assertive manner. Yet, they further found that only two out of eight hypotheses relating to national cultural dimensions (i.e. uncertainty avoidance, assertiveness) are significantly supported by the hierarchical linear model approach. Their unexpected results underscore the importance of further research in understanding LM's cultural interactions.

Taking from another perspective, [13] argued that LM approach may be only dependent upon the cultural traits of the continuum between collectivism and individualism. As they argued, the success of many LM practices (i.e. batch size reduction or one piece flow, kanban, pull scheduling, multipurpose layout, and TPM) is fundamentally based on a group-oriented working culture that reflects a relatively low level of individualism of Japanese society (i.e. IDV = 46). With a sample of 932 plants in 6 different countries, [13] applied Hofstede's [26] measurement of national collectivism and found from the regression analysis that LM practices have a stronger impact on operations performance in plants that are located in relatively collectivistic countries.

Although there are few existing quantitative studies in the management literature to address the role of national culture, the mixed evidence about its effect on the operational performance from practising LM has raised concerns about the analytical approaches used by previous researchers. More specifically, the concept of correlation and/or the measure of association underlying the regression analysis is based on a linear relationship between variables in the analysis. These analytical approaches are restricted to linear relationships only so that the results can be misleading if variables of concern are associated with non-linear relations. This drawback is actually inherited from the features of Pearson's correlation [34].

2.3 The Moderation Role of National Culture on LM Effectiveness

Previous research in the management literature seemed to all agree on the assumption that the relationship between LM practices and operational performance may be moderated by the national culture. The majority of those papers are qualitative research rather than quantitative ones and frequently use Hofstede's [25, 26] framework of national cultural dimensions [7]. According to [25], Japanese culture displays a relatively large power distance, a low level of individualism, a masculine society, strong uncertainty avoidance, and long-term orientation.

A widely studied national cultural dimension is individualism/collectivism. This dimension describes "the relationship between the individual and the collectivity that prevails in a given society" [25] (page 209). Because LM practices are team-based and employees are expected to collaborate across the organisational units to reduce costs and maximise return; a country with high collectivism promotes LM [13]. Loyalty to the organisation [35] and dedication to work [35–37] are well-known Japanese cultural traits related to collectivism. A study conducted by [38] in China is the only one in which the influence of collectivism on LM was found to be negative. As they explained, such contradictory results could be due to the fact that Chinese collectivism, as in Japan, tends to be more associated with the family than with the organisation. Meanwhile, other researchers found that the national cultural dimension associated with individualism/collectivism does not have any significant effect on operational performance [10, 12], indicating a divergent view on this dimension. Given that LM practices are team-based, it is hypothesised that:

H_1: The positive influence of LM practices on operational performance is stronger in manufacturing plants with a collectivist culture.

Within organisations as units of society, it is common to find inequality of members' abilities and inequality of power. [25] defined the term "power distance" between a boss and his subordinate in a hierarchy as the difference between the extent to which a boss can determine the behaviour of his subordinate and vice versa (page 83). Although the extant literature reports a large power distance as a Japanese cultural trait (i.e. PDI = 54) [25], most studies [7, 30] have considered its negative effects on LM success. Based on these studies, restrictions from sharing opinions prevent employees' participation in problem-solving and continuous improvement, thus violating the LM principles [7]. Multi-functional teams required in LM will not work properly if employees do not feel comfortable with different hierarchical levels operating as a team [39]. The fear of losing face (i.e. the fear of bringing shame to the group) is also mentioned as an obstacle to employees' participation [37, 40]. Meanwhile, opposing views stated that a hierarchy is a part of LM culture and acts as a discipline engine by strengthening obedience with procedures [36]. Despite mixed evidence about this dimension, it is expected that a high power distance imparts employees' unwillingness to expose problems and share opinions [30]. Thus, LM practices in a high power distance culture will not be as active as they are supposed to be. Given the above discussion, it is hypothesised that:

H_2: The positive influence of LM practices on operational performance is stronger in manufacturing plants with a low power distance culture.

Uncertainty avoidance refers to "a norm for intolerance of ambiguity" [25] (page 146). Members in such cultures often pursue orderliness, reliability, structure, and proper procedures in their daily lives [41]. The extant literature showed that the Japanese cultural trait of high uncertainty avoidance is an underlying success factor for LM implementation. For instance, previous researchers [35, 36] have emphasised the importance of decreasing uncertainty to achieve consistency, through advanced and systematic planning, in LM implementation. Moreover, employees must be aware of potential problems and new solutions must be verified and approved before being implemented to avoid drastic changes [42]. Conversely, other researchers argued that uncertainty avoidance impedes empowerment as it requires employees to follow orders from their superiors when making autonomous decisions to avoid any uncertainty [7, 39]. Regardless of conflicting views, the purpose of LM is to reduce process variability and thus requires standard operating procedures that are congruent with a high uncertainty avoidance culture [43]. Therefore, it is hypothesised that:

H_3: The positive influence of LM practices on operational performance is stronger in manufacturing plants with a high uncertainty avoidance culture.

Previous studies have considered a long-term orientation as a Japanese cultural trait [35] which has a positive impact on LM [42, 44]. A long-term orientation stands for "the fostering of virtues oriented towards future rewards" [25] (page 359). In other words, businesses based on a long-term orientation are familiarised with working towards building up strong positions in the markets and do not expect immediate outcomes. The willingness to sacrifice short-term outcomes for long-term achievements is a foundation of LM implementation [44, 45]. Moreover, a long-term orientation aids long-term relationships with suppliers and employees [46]. Although this dimension has no significant effect on LM effectiveness in a study conducted by [10], it was argued that making short incremental improvements and being responsive to the external environment may make it tougher for organisations to adopt a long-term perspective facilitating LM. Therefore, it is hypothesised that:

H_4: The positive influence of LM practices on operational performance is stronger in manufacturing plants with a long-term orientation.

Masculinity refers to “a society in which social gender roles are clearly distinct: Men are supposed to be assertive, tough, and focused on material success. Women are supposed to be more modest, tender, and concerned with the quality of life” [25] (page 297). Some studies have discussed the dimension of masculinity as another Japanese cultural trait affecting LM success [7, 47, 48]. For instance, a feminine culture is likely to better handle job rotation and autonomy, both vital to LM success [7]. The aspect of assertiveness in the masculinity culture also seems to reduce LM effectiveness because aggressive behaviours impede employees’ collaboration in detecting and solving problems, thus inhibiting the development of cooperativeness among employees and their superiors [10]. In other words, while a masculine culture values control and efficiency in LM, a feminine culture values employment involvement and creativity [48]. Indeed, it was argued by [25] that a feminine culture has a competitive advantage in industries with a small volume production rate and the requirement for building customer relationships. Hence, the following hypothesis is developed:

H_5: *The positive influence of LM practices on operational performance is stronger in manufacturing plants with a feminine culture.*

2.4 Control Variables

Finally, the author also considers the key estimation problem that is usually ignored by most previous research involving the endogeneity bias. Such endogeneity bias is commonly rooted in the absence of variables that are embedded in the errors, thus simultaneously affecting both independent and dependent variables [49]. To avoid the endogeneity bias, two additional constructs that are likely to cause the potential endogeneity are examined including the type of ownership (i.e. Eastern versus Western-owned enterprises) and the size of the enterprise (i.e. small versus large enterprises). More specifically, it was found that many Western enterprises demonstrate a relatively low level of LM effectiveness as compared to Eastern enterprises [50]. Meanwhile, small enterprises tend to be flexible and thus changes can be evolved quickly [51]. Given that, the author advances the following hypotheses:

H_6: *The positive influence of LM practices on operational performance is stronger in Eastern-owned manufacturing plants.*

H_7: *The positive influence of LM practices on operational performance is stronger in small manufacturing plants.*

The research framework is illustrated in Fig. 1.

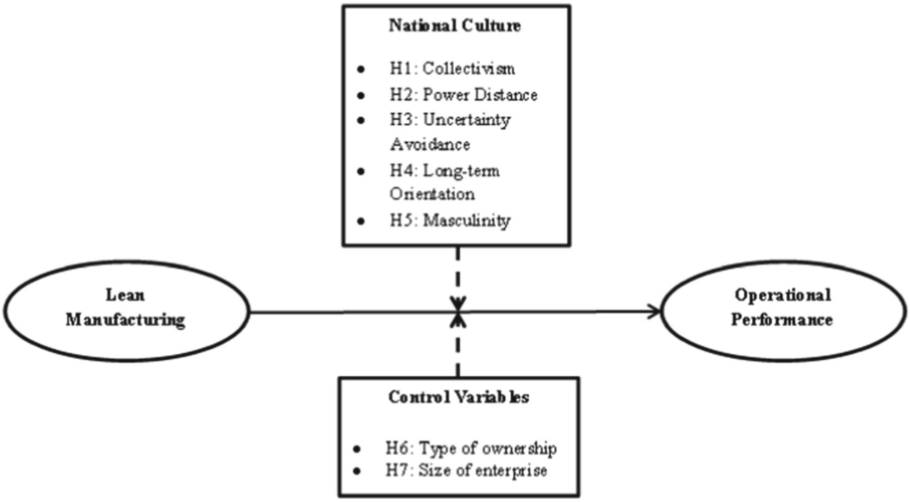

Fig. 1. Conceptual model.

3 Methodology

3.1 Measures

The survey applied the cultural values scale (CVSCALE) that includes twenty-six items to assess Hofstede's five cultural dimensions at the individual level including collectivism (CO), power distance (PO), uncertainty avoidance (UN), long-term orientation (LO), and masculinity (MA) [52, 53]. Seven items for measuring the lean manufacturing practices (LM) construct (i.e. setup reduction, statistical process control, cellular manufacturing, just-in-time, process redesign, throughput time reduction, and waste reduction) were drawn from [10]. As for the operational performance (OP) construct, five items (i.e. product reliability in service, defects, customer delivery commitments met, customer satisfaction, and productivity) were based on [13].

All items used in this study were measured on a 5-point Likert-type scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). In addition to these items, some descriptive questions were added to the questionnaire including gender, age, education, job position, experience, type of ownership, year of operation, industry, and the number of employees.

3.2 Participants and Procedure

Enterprises which have applied LM in Vietnam were considered as the target population in this research. Because no suitable sampling frame was identified, this issue made the possibility of using a probability sampling method difficult to envisage [54]. Hence, a convenience sampling method was adopted to collect data. The database of the manufacturing plants was collected by GMarks Consulting & Investment, a global consultant company in Vietnam. Before the main study, a pilot study with 15 professional managers was conducted and there was no problem with the contents of the questionnaire. In total, 309 manufacturing plants were studied and 38 responses were seen as outliers (cases fall well to the outer boundaries of the distribution of values or cases with standardised values fall outside the range of ±3) [14]. As a consequence, only 271 responses were found valid for further analysis.

When considering the sample size, the size was determined by [14] for covariance-based structural equation modelling and [55] for multi-group invariance analyses. In particular, the minimum sample size for covariance-based structural equation modelling (with an effect size of 0.3; a power level of 0.8; two latent variables (excluding the latent variables involving the CVSCALE because they were later recoded into binary variables for multi-group invariance analyses); twelve observed variables; and a probability level at 5%) must be at least 200 observations [14]. Meanwhile, for multi-group invariance analyses, the rule of thumb is 100 observations per group as suggested by [55]. Thus, the sample size of 271 observations (with more than 100 observations in each group) in this study is considered sufficient.

Since the data can be seen as self-reported, the issue of common method bias was also considered using Harman's single-factor test [56]. All of the observed variables in the present study were loaded into an exploratory factor analysis with a single factor. Based on the results, the total variance extracted by a single factor is 35.6% which is less than the threshold of 50%, indicating that common method bias is not a potential issue in this study.

3.3 Sample Characteristics

The final sample (see Table 1) consists of 271 plants of which 120 plants (44.3%) are owned by the West and 151 plants (55.7%) are owned by the East. More than half of manufacturing plants (65.3%) have 10 or above 10 years of operation. All plants have been applied LM; 16.2% of them are in the electronics industry; 16.6% of them are in the textile industry; 11.4% of them involve the footwear products; 20.3% of them are in the food industry, 13.7% of them manufacture the metal-based products, and 21.8% of them are considered as others. The majority of manufacturing plants have 200 employees or above.

Table 1. Sample characteristics.

Type of ownership:	
Western-owned enterprises	44.3%
Eastern-owned enterprises	55.7%
Industry:	
Electronics and related products	16.2%
Textile products	16.6%
Footwear products	11.4%
Food and related products	20.3%
Metal-based products	13.7%
Others	21.8%
Average year of operation:	
Below 5	10.7%
From 5 to below 10	24.0%
From 10 to above	65.3%
Number of Employees:	
Below 50	8.9%
From 50 to below 200	19.9%
From 200 to below 500	41.7%
From 500 to above	29.5%

4 Results

This study applies multi-group invariance analyses (MGA) to analyse the survey data and empirically test the hypotheses mentioned above in AMOS 26 and SPSS 20. The measurement and structural models are used to test the direct relationship between LM and OP. The variables of interest for the categorical moderation mainly involve Hofstede's five cultural dimensions (i.e. CO, PO, UN, LO, and MA) and the control variables (i.e. the type of ownership, the size of enterprise based on the number of employees). These variables are then recoded into binary variables (e.g. Low/High, Western/Eastern-owned enterprises, Small/Large enterprises) for the multi-group invariance analyses. The results are shown as the followings.

Table 2. Means, standard deviations, and correlation.

Construct	Mean	SD	AVE	LM	OP	CO	PO	UN	LO	MA
LM	4.125	0.701	0.660	**0.813**						
OP	4.066	0.803	0.569	0.291***	**0.754**					
CO	4.130	0.965	0.812	0.461	0.309	**0.901**				
PO	4.248	0.529	0.501	0.269	0.257	0.596***	**0.708**			
UN	4.252	0.940	0.859	0.410	0.243	0.719***	0.525***	**0.927**		
LO	4.072	0.892	0.734	0.280	0.202	0.437***	0.371***	0.465***	**0.857**	
MA	4.103	0.948	0.777	0.368	0.197	0.475***	0.326***	0.390***	0.661***	**0.881**

Note: SD = standard deviation; AVE = Average Variance Extracted; Diagonal elements (bold) indicate the square root of AVE between the constructs and their measures; *** $p < 0.01$

4.1 Measurement Model Results

The descriptive and validity statistics for each construct are presented in Table 2. A significant positive correlation between LM and OP is found. While constructs relating to five cultural dimensions significantly correlate with each other, none of them is found to significantly correlate with either LM or OP. These findings partly support the author's argument about the non-linear relationship between national culture and operational performance from practising LM.

For checking the convergent and discriminant validity of the scales, the author follows the suggestions made by [57]. To assure convergent validity, AVE values need to be larger than 0.5; meaning that factors should explain at least half the variance of their corresponding indicators. Meanwhile, the square root of AVE should exceed the inter-correlations between that construct and other constructs in the model to assume discriminant validity. Based on the results presented in Table 2, all constructs have AVE values of over 0.50 and none of the inter-correlations of the constructs exceeds the square root of AVE. Thus, the validity of the scales is assured.

Construct reliability is considered by calculating Cronbach's alpha and composite reliability [34]. Besides, as [14] suggested, individual reflective item reliability is acceptable when an item has a significant factor loading on its corresponding construct. As shown in Table 3, all Cronbach's alpha and composite reliability values are above the threshold values of 0.80, except for PO which is only seen as acceptable (α = CR = 0.751) after removing two items (i.e. PO3 and PO4) due to the issue of convergent validity (factor loadings are below the cut-off value of 0.35 when the sample size is 250 or above) [14]. After removing PO3 and PO4, all items load strongly and significantly above the cut-off value of 0.35. Thus, it is possible to confirm the reliability of all scales in this study.

Table 3. Factor loadings, Cronbach's α, and composite reliability.

Construct	Item	α	CR	Factor loading	T-value
LM	LM1	0.931	0.931	0.728	N/A
	LM2			0.769***	12.593
	LM3			0.802***	13.151
	LM4			0.830***	13.648
	LM5			0.877***	14.453
	LM6			0.865***	14.257
	LM7			0.807***	13.246
OP	OP1	0.852	0.862	0.751	N/A
	OP2			0.851***	8.803
	OP3			0.900***	8.989
	OP4			0.884***	8.937
	OP5			0.754***	6.657
CO	CO1	0.963	0.963	0.884	N/A
	CO2			0.906***	20.872
	CO3			0.928***	22.070
	CO4			0.913***	23.307
	CO5			0.903***	22.411
	CO6			0.873***	21.904
PO	PO1	0.751	0.751	0.716	N/A
	PO2			0.732***	9.375
	PO5			0.675***	8.965
UN	UN1	0.968	0.968	0.895	N/A
	UN2			0.936***	25.676
	UN3			0.920***	24.487
	UN4			0.944***	26.392
	UN5			0.938***	25.866
LO	LO1	0.943	0.943	0.792	N/A
	LO2			0.870***	16.584
	LO3			0.857***	16.248
	LO4			0.888***	17.088
	LO5			0.894***	17.248
	LO6			0.836***	15.699

(*continued*)

Table 3. (*continued*)

Construct	Item	α	CR	Factor loading	T-value
MA	MA1	0.932	0.933	0.898	N/A
	MA2			0.916***	23.295
	MA3			0.870***	20.775
	MA4			0.840***	19.264

Note: α = Cronbach's alpha; CR = Composite reliability; PO3 and PO4 were removed due to the issue of convergent validity; *** $p < 0.01$; N/A = Not available due to items constrained for identification purposes in AMOS

4.2 Tests of Invariance Results

To test invariance, $\Delta\chi 2$ and Δdf between the unconstrained and the constrained model were calculated [58, 59]. It is essential to emphasise that, although the tests for different groups vary, the hypothesised relationship between LM and OP remains the same across models. The results are represented in Table 4. First, the author begins by considering the model fit across the groups in each model. As shown in the Table 4, all models meet the requirements of a good overall fit [14]. Next, the chi-square differences and p-values for difference are examined. Based on the results, only categorical moderators including PO ($\Delta\chi 2 = 5.114$; $p = 0.024$); UN ($\Delta\chi 2 = 4.584$; $p = 0.032$); MA ($\Delta\chi 2 = 6.845$; $p = 0.009$); and the size of the enterprise ($\Delta\chi 2 = 5.540$; $p = 0.019$) are found to significantly affect the strength of the relationship between LM and OP. Thus, the hypotheses including H1, H4, and H6 are rejected.

Table 4. Tests of invariance results.

Model	Groups	χ^2	df	$\Delta\chi^2$	Δdf	P-value
Model 1a	Low/High CO	145.862	96	N/A	N/A	N/A
Model 1b	Low/High CO	146.095	97	0.233	1	0.629
Model 2a	Low/High PO	156.419	96	N/A	N/A	N/A
Model 2b	Low/High PO	161.533	97	5.114	1	0.024**
Model 3a	Low/High UN	189.904	96	N/A	N/A	N/A
Model 3b	Low/High UN	194.488	97	4.584	1	0.032**
Model 4a	Low/High LO	148.785	96	N/A	N/A	N/A
Model 4b	Low/High LO	149.613	97	0.828	1	0.363
Model 5a	Low/High MA	153.024	96	N/A	N/A	N/A
Model 5b	Low/High MA	159.869	97	6.845	1	0.009***
Model 6a	Western/Eastern-owned enterprises	148.685	96	N/A	N/A	N/A
Model 6b	Western/Eastern-owned enterprises	149.440	97	0.755	1	0.385

(*continued*)

Table 4. (*continued*)

Model	Groups	χ^2	df	$\Delta\chi^2$	Δdf	P-value
Model 7a	Small/Large Enterprises	165.674	96	N/A	N/A	N/A
Model 7b	Small/Large Enterprises	171.214	97	5.540	1	0.019**
Model Fit Across the Groups:						
Model 1: χ^2=145.862; df=96; p=0.001; GFI=0.920; TLI=0.966; CFI=0.975; RMSEA=0.044						
Model 2: χ^2=156.419; df=96; p=0.000; GFI=0.914; TLI=0.963; CFI=0.973; RMSEA=0.048						
Model 3: χ^2=189.904; df=96; p=0.000; GFI=0.905; TLI=0.940; CFI=0.956; RMSEA=0.060						
Model 4: χ^2=148.785; df=96; p=0.000; GFI=0.920; TLI=0.966; CFI=0.975; RMSEA=0.045						
Model 5: χ^2=153.024; df=96; p=0.000; GFI=0.918; TLI=0.961; CFI=0.972; RMSEA=0.047						
Model 6: χ^2=148.685; df=96; p=0.000; GFI=0.918; TLI=0.968; CFI=0.977; RMSEA=0.045						
Model 7: χ^2=165.674; df=96; p=0.000; GFI=0.914; TLI=0.958; CFI=0.969; RMSEA=0.052						

Note: Bootstrap sample=5000 with replacement at 95% confidence interval; a= Unconstrained nodel; b= Constrained model; *** p<0.01; ** p<0.05.

The author now proceeds in testing for determining which variances are contributing to the inequalities in Model 2, 3, 5, and 7 as illustrated in Table 5. The local tests indicated that the positive influence of LM practices on OP is stronger in manufacturing plants with a low PO culture at a 5% significance level (β = 0.359, t-value = 3.754; confidence interval = 0.183/0.578; p-value for difference = 0.024), a low UN culture at a 5% significance level (β = 0.285, t-value = 3.027; confidence interval = 0.150/0.635; p-value for difference = 0.032), a low MA culture at a 1% significance level (β = 0.323, t-value = 3.249; confidence interval = 0.183/0.543; p-value for difference = 0.009), and a small size plant at a 5% significance level (β = 0.506, t-value = 3.234; confidence interval = 0.316/0.924; p-value for difference = 0.019). Therefore, while H2, H5, and

Table 5. Local tests for the positive relationship between lean manufacturing (LM) and operational performance (OP).

The relationship between LM and OP	Standardised coefficient		Δβ	P-value	Conclusion
	Low/Small	High/Large			
Model 2	0.359***(3.754)[0.183/0.578]	0.107(0.948)[-0.012/0.259]	0.252	0.024**	Stronger for Low PO
Model 3	0.285**(3.027)[0.150/0.635]	0.158(1.419)[-0.056/0.253]	0.127	0.032**	Stronger for Low UN
Model 5	0.323**(3.249)[0.183/0.543]	0.078(0.784)[-0.022/0.193]	0.244	0.009***	Stronger for Low MA
Model 7	0.506**(3.234)[0.316/0.924]	0.167*(2.065)[0.057/0.351]	0.339	0.019**	Stronger for Small Enterprises

Note: Standardised coefficients reported; Bootstrap sample=5000 with replacement at 95% confidence interval; Values in parentheses are t-values; Values in square brackets represent the lower and upper confidence interval; *** p<0.01; ** p<0.05; * p<0.1.

H7 are supported; H3 is rejected because the actual moderating effect of UN is opposite to its hypothesised moderating effect.

5 Conclusions and Discussion

5.1 Theoretical and Practical Implications

The author started from the doubt that the "true" relationship between national culture and operational performance from practising lean manufacturing is probably non-linear, thus leading to an inconsistent role of national culture in previous research. Hence, this study employs multi-group invariance analyses that do not face the strict assumption of linearity relationships to investigate how the impact of lean manufacturing practices on operational performance differs across groups with different national cultural dimensions.

The results from multi-group invariance analyses showed that manufacturing plants finding lean manufacturing most effectively tend to follow a low power distance culture (H2 is supported). Consistent with previous research [37, 39, 40], a flat organisation (e.g. flat hierarchy or horizontal organisation) is an important organisational condition for lean manufacturing effectiveness. Because lean manufacturing cannot exist without shop floor employees' improvement activities, decentralised responsibilities not only help increase their participation and commitment towards the lean manufacturing processes but also improve the operational performance [5]. In practice, managers in lean manufacturing organisations should play the role of facilitators rather than supervisors reflected in the oyabun-kobun relationship [48]. In order words, the vital fundamentals in the relationship are that an oyabun [a facilitator] should provide his kobun [a subordinate] with assistance instead of dictating what changes should be made. As [9] suggested, tools and practices used in the Japanese management system can be exploited effectively only when implemented in organisations that are less autocratic and more collaborative.

The results also indicated that manufacturing plants with a feminine culture are likely to better handle job rotation and autonomy, both vital to lean manufacturing success (H5 is supported). In line with other researchers [10, 47, 48], a feminine culture values enthusiasm, sympathy, employee involvement, and creativity which are considered as the pre-conditions for building an excellent lean manufacturing enterprise. For practical implications, this cultural dimension should be seen as an enabler for customer-focused practices and efficient communication [25] which are important for lean manufacturing success [7]. Furthermore, since lean manufacturing relies on several concepts including customer focus, waste reduction, smooth flow, and continuous improvement; small manufacturing plants are more flexible and able to achieve a better lean manufacturing performance (H7 is supported). Although the scarcity of resources has been a major obstacle in the implementation of lean manufacturing practices in small and medium enterprises (or SMEs), the ability to quickly adapt to the changing environment is an advantage of SMEs in implementing lean manufacturing [51]. In practice, it is not to suggest that manufacturing plants should reduce their economies of scale. Instead, lean manufacturing plants should learn how to be flexible for rapidly adapting to the situations and quickly carrying plans into action.

Interestingly, it was found that there is no significant difference in lean manufacturing effectiveness between low and high-collectivist manufacturing plants (H1 is rejected). While this result is contradictory to some previous research [13, 38], it is in line with others [10, 12]. One possible explanation for a divergent view on this dimension is that when employees are required to share information and collaborate in production for improving lean manufacturing effectiveness, they may struggle to compete with their peers. Such requirements for these contradictory practices to improve lean manufacturing effectiveness could lead to an inconsistent role of this cultural dimension. Moreover, it was found that the type of ownership (i.e. Eastern versus Western-owned enterprises) does not moderate the relationship between lean manufacturing practices and operational performance (H6 is rejected). It must be noted here that while lean manufacturing practices are team-based, the Japanese culture reflects a relatively low level of individualism (i.e. IDV = 46). In fact, although LM is associated with Toyota's culture; Toyota does not certainly embody the Japanese collectivist culture. As [10] argued, Toyota's headquarters are unconnected to the mainstream collectivist culture of Japan. Therefore, Eastern manufacturing plants with a collectivist culture should not assume that lean manufacturing will be more effective.

Results opposite to the hypothesised moderating effects of national culture in this study further showed that manufacturing plants with a low uncertainty avoidance culture significantly perform better (H3 is rejected). Perhaps, lean manufacturing can be seen as a bundle of practices to challenge and change existing structures. A low uncertainty avoidance culture allows empowerment, thus employees can voice and defend their views that can be channelled to the system-wide development [39]. Finally, there is no significant difference in lean manufacturing effectiveness between manufacturing plants with long-term or short-term planning (H4 is rejected). Perhaps, the importance of making short incremental improvements and being responsive to the external environment could be seen as equally vital as the long-term perspective facilitating lean manufacturing [7, 10].

In terms of theoretical implications, this study provides an alternative analytical approach for studying the role of natural culture and shows what specific cultural dimensions are congruent with lean manufacturing practices. These empirical results contribute to a deeper understanding of the reasons why certain companies find lean manufacturing practices difficult and/or fail to achieve their target performance. For managerial implications, although certain cultural dimensions do not moderate the relationship between lean manufacturing practices and operational performance, the benefits of practising lean manufacturing are significant across all cultural dimensions. Hence, managers are encouraged to apply lean manufacturing practices internationally because of their worldwide effectiveness. Furthermore, since companies can achieve their operational performances better in certain cultural dimensions, managerial interventions and behavioural adjustments may be required in those incongruent cultures.

5.2 Limitations and Future Research

There is always the issue of generalisability in the management field and this is not an exception here. Although the sample size is seen as sufficient for appropriate analytical techniques used, such a small and unrepresentative sample size (i.e. the author only examines manufacturing plants located in Vietnam and the sample is not random) might affect the generalisability of the findings to other contexts. A larger random sample incorporating more manufacturing plants per country and more countries is thus recommended for further studies to enhance the generalisability. Apart from the above, biases probably occur since the author examines the perception of lean manufacturing effectiveness at the individual level. In other words, the results may be affected by the respondent's background and knowledge. Therefore, combining both soft indicators (e.g. the respondent's perspective) and hard indicators (e.g. financial ratios, number of feedbacks or complaints from the stakeholders) may be used to triangulate the operational performance of practising lean manufacturing. Finally, this study only provides evidence of the impact of national culture on lean manufacturing effectiveness. More research is needed to shed additional light on whether or not organisational culture can offset the incongruence between practices and national culture. It is another avenue for future research.

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