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**The impact of manufacturing and supply chain improvement initiatives:
comparing make-to-order and make-to-stock firms**

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ABSTRACT

Manufacturing firms aim at improving both internal and external processes to improve the competitive advantage. Such initiatives include lean practices as well as supplier rationalization and integration. In this paper, we analyze these improvement initiatives and their impact on business performance. In particular, we explore potential differences between make-to-order (MTO) and make-to-stock (MTS) firms. We use data from 216 Australian manufacturing firms. We find a clear differentiation of improvement focus between MTO and MTS firms. MTO firms exhibit a significant impact of supplier integration on business performance, but not for lean practices and supplier rationalization. The situation is completely reversed for MTS firms, since they have significant effects for internal lean practices and supplier rationalization, but not for logistics integration with supplier. These results show that the distinction between MTO and MTS firms is important when analyzing manufacturing and supply chain improvement initiatives.

Keywords:

Empirical research, lean practices, logistics integration, supplier relationships, business performance.

1 Introduction

Manufacturing firms increasingly understand that gains in competitive advantage is not restricted to improvements in their internal operations but that external supply chains need to be considered as well. A wide range of potential improvement initiatives is available for shaping internal and external processes. Lean practice, logistics integration and supplier rationalization are all examples of such initiatives. Lean practice is an example of internal process improvement initiative, while the other two are examples of externally oriented initiatives. Such practices and programs are generally considered to be beneficial to any type of manufacturing firm, while some researchers suggest that some improvement initiatives are more applicable in certain manufacturing environments. Thus, there is some disagreement. Furthermore, we have not found any previous large-scale empirical research that contrasts different types of firms and explores potential differences.

For example, lean production is typically considered a fundamental program for any firm that wants to improve their manufacturing operations, by e.g. removing waste and create a smooth production flow. However, the research stream on “leagility” that contrasts lean with agile, suggests that lean production is applicable for MTS operations and upstream the decoupling point in the supply chain material flow, while agility is preferable for MTO operations and downstream the decoupling point.

Furthermore, logistics integration is considered a vital part for any firm in a supply chain context. In order to create a strong supply chain, the logistics between successive partners need to be integrated. Many researchers regard this as important for all supply chain operations. However, some suggest that this is particularly true for MTO firms that rely on the support of their suppliers for providing variant-creating

components and for delivering customized products on time. On the other hand, MTS firms purchase standard components and may prefer arms-length relationships with suppliers and subsequently do not require logistics integration with suppliers.

Thus, lean production may be more applicable to MTS operations and logistics integration more applicable to MTO operations. Consequently, it should be both important and fruitful to explore if such differences exist.

As a third example, supplier rationalization is an improvement initiative that seems to be generally applicable according to the literature. A limited supply base can be beneficial for both MTO and MTS operations, being able to focus on a few suppliers that provide quality items and components and dependable deliveries. We therefore include supplier rationalization in our study to have a full set of alternatives related to MTO and MTS operations: one that may be more applicable to MTO operations (i.e. logistics integration), one that may be more applicable to MTO operations (i.e. lean practices), and one that seems applicable to both MTO and MTS operations (i.e. supplier rationalization).

In this paper, we first present the theoretical background and related literature, and discuss the hypotheses. We then present the research methodology, and the results. Implications for managers and researchers are discussed and finally the conclusions are drawn.

2 Theoretical background and hypotheses

In this section, we first explain the notion of business performance, internal lean practices, logistics integration, and supplier rationalization. We then discuss the role of make-to-order versus make-to-stock in this context.

2.1 Business performance

The use of business performance as a performance measure is common for capturing the long-term behaviour of the firm (Da Silveira 2005, Gonzalez-Benito 2005, 2007, Papke-Shields and Malhotra 2001, Rho et al. 2001, Sun and Hong 2002, Kannan and Tan 2002, 2005, and Rosenzweig et al. 2003). Typically, market share, return on investment, assets, and sales, or similar measures (e.g. the change in these measures), are used to capture business performance. A reason for using business performance instead of operational performance is that MTO and MTS firms may well focus on different competitive priorities and performance outcomes. For example, cost efficiency and flexibility are typically trade-offs, such that MTS firms focus on cost efficiency while MTO firms focus on flexibility. Thus, MTO and MTS firms may use different practices or paths to reach high levels of business performance. Consequently, business performance is not associated with a particular type of decoupling point, and can therefore be used to measure how well certain practices are used in manufacturing firms irrespective of decoupling point.

2.2 Internal lean practices

The source of the term lean production can be traced to the International Motor Vehicle Program (Krafcik, 1988). Lean manufacturing was offered as a synonym for the practices pioneered by Toyota (Womack et al., 1990). However, the concepts and techniques under the lean label were basically the same as those of just-in-time a decade earlier (Schonberger, 2007). Womack and Jones (1996) provided five lean principles: value, the value stream, flow, pull, and perfection, described in the following way: (i)

value is defined by the ultimate customer, (ii) the value stream is the set of all the specific activities required to bring a specific product through the internal value chain, (iii) make the value-creating steps flow, (iv) use a pull schedule, and (v) make improvements a continuous effort. Following these principles, internal lean practices include set-up reduction, pull production system, small lot sizes, and streamlining the layout through e.g. cellular manufacturing or focused factory concepts (Li et al., 2005, Shah and Ward 2003, 2007). More specifically, these are internally related operational measures, rather than customer or supplier related (Shah and Ward 2003, 2007).

Several studies have found evidence of improved business performance associated with the use of JIT/lean methods. Gains in both financial (Callen et al. 2000, Fullerton and McWatters 2001, Germain and Droge 1998, Huson and Nanda 1995, Germain et al. 1996), and market performance (Germain and Droge 1998, Germain et al., 1996) have been observed.

Hence, the first hypothesis is concerned with the impact of internal lean practices on business performance.

H1: Internal lean practices have a positive relationship with the firm's business performance.

2.3 External logistics integration with suppliers

The increasing competition has driven firms to not only improve their internal operations (such lean practices), but also focus on integrating their suppliers into the overall value chain processes. The contribution of suppliers in delivering values to customers, hence, building competitive capabilities (quality, delivery, flexibility, and

cost) has been well recognized. Improved logistics integration between supply chain partners yields a number of operational benefits as well as improvement in customer service and sales (Seidmann and Sundararajan 1997). DeToni and Nassimbeni (1999) found that better performing plants exhibit a higher level of logistical interactions, and Frohlich and Westbrook (2001) that the widest arcs of integration had the strongest association with performance improvement. In a recent study, supply chain integration was found to be significantly related to business performance (Flynn et al., 2010).

H2: External logistics integration has a positive relationship with the firm's business performance.

2.4 Supplier rationalization

Supplier rationalization is an important component in the strategic partnership with suppliers, and refers to the practice of limiting the supply base to a few strategic suppliers that can provide high quality and dependability (Li et al., 2005). In a study of the impact of supplier selection and assessment on a buying firm's business performance, Kannan and Tan (2002) found that "strategic commitment of supplier to buyer" has a significant impact on business performance. In a case study concerning supplier selection and rationalization using data envelopment analysis, Narasimhan et al. (2001) discuss supplier rationalization has a beneficial effect on the business growth for the case study company.

H3: Supplier rationalization has a positive relationship with the firm's business performance

2.5 *Make-to-order and make-to-stock*

2.5.1. Internal lean practices for MTO and MTS

Lean companies have experienced problems when faced with “too much product variety”, “offering too many options for customers”, resulting in “very small and very rare orders too frequently” (Cusumano, 1994). This variety requires constant equipment setups and kanban exchanges, as well as many deliveries of small lots of components. As a solution to this problem, Cusumano (1994) proposes that lean firms should reduce variety and use more parts standardization instead. Large product variety is a typical characteristic of MTO firms, while parts standardization is a typical characteristic of MTS firms. Consequently, Cusumano (1994) supports that lean is more relevant for MTS than MTO operations. Leagility advocates argue that leanness should be emphasized for MTS operations, while agility is useful for MTO operations (Naylor et al., 1999; Mason-Jones et al., 2000; Aitken et al., 2002; Childerhouse et al., 2002; Bruce et al., 2004; Krishnamurthy and Yauch, 2007). The recognition that MTS companies face different problems to MTO or ETO companies has had a large impact on the development of production control mechanisms for lean production systems (Riezebos et al., 2009). They argue that Kanban is limited to MTS firms while CONWIP and POLCA were designed for MTO environments. Thus, internal lean practices seem more applicable to MTS environments.

H4: Internal lean practices have a stronger positive relationship with the firm's business performance for make-to-stock firms than for make-to-order firms.

2.5.2. External logistics integration for MTO and MTS

Tighter supply chain integration in make-to-order supply chains through information sharing and physical flow coordination provides substantial opportunities for improved economic performance (Sahin and Robinson, 2005). While information sharing reduces costs, the main economic benefit comes from coordinated decision-making (Sahin and Robinson, 2005). Firms that use delivery, customer service, quality and/or flexibility as order winners present differences in the extent to which they integrate their external supply chains (Quesada et al., 2008). On the other hand, firms that choose to use price as an order winner do not show any significant difference in the extent of external supply chain integration (Quesada et al., 2008). Firms with high levels of external integration were those that lead in delivery, customer service, quality and flexibility, when compared to firms with low integration (Quesada et al., 2008). Firms looking for delivery, customer service, quality and flexibility as order winners, should focus on ways to externally integrate with both their customers and their suppliers (Quesada et al., 2008). Frohlich and Westbrook (2001) provide empirical evidence that higher external supply chain integration show higher improvement levels on delivery lead-time and on-time deliveries. Johnson (1999) showed how firms seeking flexibility are emphasizing on strategic integration with suppliers. Zailani and Rajagopal (2005) present results from US and Japanese firms' where flexibility is improved after external supply chain integration. Thus, external logistics integration seems more applicable to MTO environments, that compete on flexibility and delivery lead time.

H5: Logistics integration has a stronger positive relationship with the firm's business performance for make-to-order firms than for make-to-stock firms.

2.5.3. Supplier rationalization for MTO and MTS

MTO firms need reliable suppliers and high quality items (with short and reliable delivery lead times and high design flexibility) to support the logistics integration between supplier and buyer. MTS firms need reliable suppliers and high quality items (at affordable prices) to support the internal lean processes that they have developed. Thus, the impact on business performance of supplier rationalization is assumed to be positive for both MTO and MTS firms.

H6: Logistics integration has similar positive relationship with the firm's business performance for make-to-order firms than for make-to-stock firms (null hypothesis).

3 The research model

The research model is shown in Figure 1. Internal lean practices, external logistics integration and supplier rationalization are all modeled as potential antecedents of business performance. The model will be tested for the whole sample and for two sub-samples, distinguishing between MTO and MTS firms. We further control for firm size.

[Insert Figure 1 about here]

4 Methods

4.1 Sample and procedures

The empirical data for this study was drawn from managers of Australian manufacturing firms. The list of the respondents was randomly selected and purchased from a mailing

list company. In total, 1,800 surveys were mailed out, and 232 usable responses were received; hence, the response rate is 13.1%. Sixteen of these did not indicate the decoupling point, wherefore this research is based on 216 responses. The data were checked for bias using correlations of responses between early respondents and late respondents based on industry sectors and organizational size. The chi-square tests on both categories did not indicate any significant difference between the two groups of respondents.

In terms of industry sectors, 16% of the respondents came from electronic / electrical, 25% from machinery, 8% from automotive, 11% from chemical, 4% from food processing, 7% from construction, and 12% from other manufacturing sectors. The remainder sectors identified as “others” included medical equipment, wood, printing and paper, defense. In terms of organizational size (based on the number of employees), 46% of the respondents came from firms with less than 100 employees, 35% of the firms have between 100 and 500 employees, and the remainder 19% of the respondents came from large manufacturing with over 500 employees. Nearly half of the respondents (45%) held a position as operations managers, 27% supply chain / logistics managers, 18% procurement / purchasing, and 3% customer services managers.

4.2 Measures

The measurement items for all constructs are based on earlier empirical research discussed in previous sections. A 7-point Likert scale was used for all items; the responses ranging from 1 (strongly disagree) to 7 (strongly agree). For operational performance, the respondents were asked to assess their firm’s business performance relative to the best competitor in the market with the scale ranging from 1 (weakest in

the industry) to 7 (strongest in the industry). The items used in this study can be found in Table 1.

[Insert Table 1 about here]

5 Results

5.1 Scale validity and reliability

As a first step, the four scales were subjected into principal component analysis to examine their unidimensionality, following the methods employed in the studies by Flynn et al. (1994), Koufteros et al. (2002), Meyer and Collier (2001), and Ward et al. (1995). The result supports the validity of these four constructs as indicated by their variance explained, which exceeds 50% and the loading factors of all items within each scale exceed 0.5 (Hair et al. 1998). One item, however, was dropped from supplier rationalisation (i.e. “we terminate contracts with ‘incapable’ suppliers”) due to poor loading. The reliability analysis was conducted by calculating the Cronbach alpha for each scale. The result shows that the Cronbach alpha measures for the four constructs surpassed the threshold point of 0.6 (Nunnally 1978). The results of the confirmatory factor analysis and the Cronbach’s alpha are presented in Table 1.

We used Harman’s single-factor test to check for common method variance (Podsakoff 1986). This test was conducted using principal component analysis and loading all 16 items on one factor. The test checks if one single factor would emerge from factor analysis, which would point towards the presence of common method bias. The factor analysis indicated that less than 25% variance was extracted and that half of the items suffered from poor factor loadings, well below 0.5. These results suggest that common method variance was not a significant problem in the data set.

Having met the requirement of construct validity and reliability, the composite score of each scale was measured by calculating their mean scores (Hair et al. 1998).

5.2 *The effects on business performance (for the total sample)*

The effects of supply chain and operational activities on business performance were examined using multiple regression analysis. Three MRA models were run separately with the first model using the whole sample, while the second and the third models using MTO plants and MTS plants respectively. Organizational size was included as a control variable. The results are collated in Table 2.

[Insert Table 2 about here]

In the whole sample, logistics integration and lean production show a significant relationship with business performance, and lean practices appears to be the strongest predictor.

5.3 *The effects for make-to-order and make-to-stock firms*

The sample was split into two groups based on the main production system identified by the respondents. Out of the 216 firms, 107 firms run its operations with MTO and 109 with MTS systems. These two groups of firms were tested with respect to the four variables above, and the results are presented in Table 3. There are no significant differences between MTO plants and MTS plants with respect to the mean values for lean practices, logistics integration, supplier rationalization, or business performance. Thus, looking at the averages for MTO and MTS plants does not suggest that these types of plants do things differently.

[Insert Table 3 about here]

When investigating the impact of various improvement initiatives on business performance, the distinction between MTO and MTS plants, is highly significant. None of the three initiatives has a significant effect for both types of plants, and supplier rationalization has a significant effect for one of the plant types.

For MTO plants, only logistics integration shows a significant effect on business performance. Lean practices do not show a significant effect although the magnitude indicates a positive direction.

For MTS plants, lean practices and supplier rationalization show equally significant effects on business performance, while the impact of logistics integration is virtually non-existent.

Comparing the results between MTO and MTS, we can infer that the predictors of business performance seem to be almost in contrast.

5.4 *A comparison between make-to-order, make-to-stock and the whole sample*

The regression results of the whole sample show differences compared to the two sample groups (MTO and MTS). *Internal lean practices* have a significant impact (at the 1 % level) on business performance, when studying the whole sample, thus providing support for hypothesis 1. However, a detailed look at the two subsamples shows that there are significant differences between the impacts for MTO and MTS firms. MTS firms have a significant impact (at the 1 % level) while the impact for MTO firms is not significant, which supports hypothesis 4. The regression coefficient for the MTS firms is higher than for the whole sample, indicating that the role of lean practices is especially strong for MTS firms and much stronger than for the average firm.

External logistics integration is significant (at the 1 % level) for business performance for the whole sample, supporting hypothesis 2. But the analysis of the two sub-samples shows differences, such that the impact is only significant (at the 1 % level) for MTO firms, while there is no significant impact for MTS firms. This result supports hypothesis 5. The difference in regression coefficients is very large: 0.03 for MTS, 0.19 for the whole sample, and 0.39 for MTO firms. This shows that logistics integration has a much stronger impact for MTO firms.

Supplier rationalization does not have a significant impact on business performance, when studying the whole sample, which is contrary to the theoretical expectations. Thus, hypothesis 3 is not supported. A detailed MTS-MTO analysis shows that there is a significant impact (at the 5 % level) for MTS firms, but not for MTO firms. A possible explanation lies in the product design. MTS firms typically have more stable product designs, which allow for stable relationships with key suppliers over longer periods of time, while MTO firms may need a wider set of suppliers to support a large product variety.

The results of the six hypotheses are summarized below.

H1: Internal lean practices have a positive relationship with the firm's business performance. This hypothesis is supported, since the parameter (0.20) is significant for the whole sample.

H2: Logistics integration has a positive relationship with the firm's business performance. This hypothesis is supported, since the parameter (0.19) is significant for the whole sample.

H3: Supplier rationalization has a positive relationship with the firm's business performance. This hypothesis is not supported, since the parameter (0.07) is not significant for the whole sample.

H4: Internal lean practices have a stronger positive relationship with the firm's business performance for make-to-stock firms than for make-to-order firms. This hypothesis is supported, since the parameter (0.25) is significant for MTS firms and not significant (0.17) for MTO firms.

H5: Logistics integration has a stronger positive relationship with the firm's business performance for make-to-order firms than for make-to-stock firms. This hypothesis is supported, since the parameter (0.39) is significant for MTO firms and not significant (0.03) for MTS firms.

H6: Supplier rationalization has similar positive relationship with the firm's business performance for make-to-order firms than for make-to-stock firms (null hypothesis). This hypothesis is not supported, since the parameter (-0.09) for MTO firms is not significant, while the parameter (0.24) for MTS firms is significant. Thus, there is a significant difference in the impact of supplier rationalization on business performance between MTO and MTS firms.

These results suggest that the effects of manufacturing and supply chain activities on business performance must not be over-generalized across all types of firms, since the effects for the whole sample do not necessarily translate to the corresponding effect for MTS and MTO firms. Consequently, this research strongly suggests that controlling for the decoupling point is important for empirical research in operations management.

6 Discussion of the findings and their implications

This study contributes to the research on manufacturing and supply chain improvements by jointly considering internally and externally oriented improvement initiatives. Specifically, this study contributes with the following respects.

First, we find that both internal and external process improvements in general can impact business performance.

Second, the results show that there is a significant difference between MTO and MTS plants, with respect to how business performance is impacted. External logistics integration with suppliers significantly impacts business performance for MTO plants, while the business performance of MTS plants is significantly affected by both internal lean practices and supplier rationalization. Thus, there is a clear distinction as to what creates the business advantage for these types of plants.

Third, internal lean practices and supplier rationalization do not significantly impact business performance for MTO plants. MTO manufacturers customize products to specific customer requirements, with design flexibility and delivery speed as important competitive priorities (typical order winners; cf. Hill and Hill, 2009). With a wide product range and customization capabilities, the order winning criterion is typically not price (Hill and Hill, 2009). This implies that MTO plants typically have some excess capacity, reducing the need for pursuing lean practices internally. Also, MTO manufacturers rely on multiple suppliers for key parts to produce varieties of products to meet the specific customer needs and to offer a wide product range. The manufacturer must specially order such parts from the suppliers after receipt of the customer order (Yue et al, 2010). This implies that supplier rationalization could lead to

a reduction in the product range or level of customization offered to the ultimate customer.

Fourth, the impact of external logistics integration on business performance is non-significant for MTS plants. Producing products to finished stock implies that demand volumes are high and that demand variability is low – otherwise, the plant would not produce these products to stock. The volume per item and time period is non-decreasing through the bill of materials (from end products to raw materials and components), wherefore the volumes for purchase components is at least as high as for the corresponding end products (Olhager, 2002). Consequently, they can use arms-length relationships with suppliers, with a cost focus and competition among suppliers, instead of building logistics integration with suppliers.

The managerial implications of these results differ between MTO and MTS plants, implying that plants have to align its practices to the position of the decoupling point (i.e. MTO or MTS). MTO plants face difficult but important challenges in developing effective logistics integration with multiple suppliers; logistics integration significantly impacts business performance, while supplier rationalization does not. MTO manufacturers source many items from suppliers that are essential for product customization, wherefore the manufacturer needs to develop integrated logistics with all suppliers that provide key items. MTS plants, on the other hand, can use fewer suppliers that deliver standard components. Lean practices provide a complementary improvement initiative, streamlining the internal operations to a stable demand rate and allowing for a stable supply rate for the suppliers.

The research implication is that the market-manufacturing orientation in terms of MTO versus MTS is an important contingency variable to consider in empirical survey

concerning manufacturing and supply chains, since MTO and MTS are related to significantly different results concerning internal lean practices, external logistics integration with suppliers, and supplier rationalization. The results of this study represent three different potential interpretation errors, if the difference between MTO and MTS is not recognized. Internal lean practice has a significant impact on business performance for the whole sample, but not for MTO plants. External logistics integration has a significant impact on business performance for the whole sample, but not for MTS plants. Finally, supplier rationalization is not recognized as having a significant impact on business performance for the whole sample, but there a significant impact for MTS plants. These insights show that there the distinction between MTO and MTS operations can be an important factor to consider when analyzing survey results, when the whole sample includes both MTO and MTS plants.

7 Limitations and further research

A number of limitations of the current study can be noted, as well as some directions for future research. A limitation of this study is the sample population, which is restricted to Australian firms. Although we expect these results to hold for manufacturing and supply chains in general, we cannot claim that this is the case. Therefore, future research may extend this study to a broader population of firms, including other countries, for generalizability of the results and to detect potential country effects.

The potential differences between MTO and MTS plants are most likely not restricted to the three areas in this study, wherefore further studies of other factors are needed to detect other differences.

8 Conclusions

This study shows that manufacturing and supply chain improvement initiatives have a significant impact on business performance. However, there are significant differences between MTO and MTS plants. MTO plants benefit from external logistics integration with suppliers, while MTS plants benefit from internal lean practices and supplier rationalization. The differentiation between MTO and MTS provides an important contingency factor in manufacturing and supply chain research.

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FIGURES

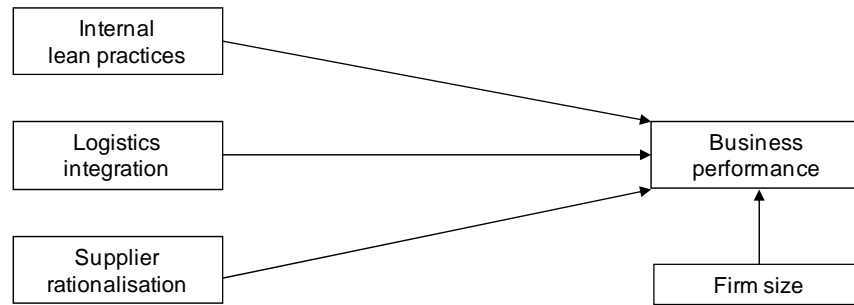


Figure 1 Research framework

TABLES

Table 1. Scale validity and reliability

Scales	Items	Loading factors	Cronbach's alpha
Internal lean practices	We have laid out the shop flow so that processes and machines are in close proximity to each other	0.82	0.64
	We are aggressively working to lower set-up times in our plant	0.73	
	We use a kanban pull system for our production	0.67	
	We use small lot sizes in our production	0.57	
External logistics integration	Inter-organizational logistic activities are closely coordinated.	0.75	0.92
	Our logistics activities are well integrated with suppliers' logistics activities	0.88	
	We have a seamless integration of logistics activities with our key suppliers	0.89	
	Our logistics integration is characterized by excellent distribution, transportation and/or warehousing facilities	0.85	
	The inbound and outbound distribution of goods with our suppliers is well integrated	0.78	
	Information and materials flow smoothly between our suppliers and us	0.67	
Supplier rationalization	We rely on a small number of high quality suppliers	0.89	0.77
	We rely on a small number of highly dependable suppliers	0.91	
	We only keep suppliers which contribute to our competitive performance	0.68	
Business performance	Sales	0.88	0.78
	Return on investment	0.78	
	Market share	0.85	

Table 2. Regression analysis results (for the whole sample)

Dependent Variable (Business Performance)	
Whole sample (N = 216)	
Control Variable	
Organizational size	0.07
Independent Variables	
Internal lean practices	0.20**
External logistics integration	0.19**
Supplier rationalization	0.04
R²	0.13

* Significant at 0.05 level

** Significant at 0.01 level

Table 3. t-test results between MTO plants and MTS plants

	MTO	MTS	Δ Mean (sig level)
	Mean (std.dev.) (N = 107)	Mean (std.dev.) (N = 109)	
Internal lean practices	4.72 (1.01)	4.86 (1.06)	0.14 (p>0.05)
External logistics integration	4.20 (1.08)	4.45 (1.26)	0.25 (p>0.05)
Supplier rationalization	5.14 (1.02)	5.21 (0.85)	0.06 (p>0.05)
Business performance	4.95 (1.09)	4.94 (1.02)	0.01 (p>0.05)

Table 4. Regression analysis results (for the whole sample, MTO plants, and MTS plants)

	Dependent Variable (Business Performance)		
	Whole sample (N = 216)	MTO (N = 107)	MTS (N = 109)
Control Variable			
Organizational size	0.07	0.08	0.06
Independent Variables			
Internal lean practices	0.20**	0.17	0.25**
External logistics integration	0.19**	0.39**	0.03
Supplier rationalization	0.04	-0.09	0.24*
R^2	0.13	0.23	0.13

* Significant at 0.05 level

** Significant at 0.01 level