The influence of performance objectives on the implementation of lean manufacturing practices: an analysis based on strategic groups

Hamilton Pozo, hprbrazil@hotmail.com
Universidade Anhembi Morumbi/CEETEPS,

Orlando Roque da Silva
Universidade FMU

Abstract

This paper explores how the choices about, and implementation of, lean production practices are influenced by performance goals prioritized by firms in the context of operations strategy. We analyzed a set of fifty-six companies (divided into four strategic groups) in the auto parts industry in the Campinas and Jundiaí areas (Brazil). These groups of firms that adopt similar strategic orientations were used to investigate the relationship between the implementation of lean manufacturing practices and the choice of performance objectives. The results suggest that taking into consideration strategic groups can improve the understanding of how performance objectives define lean manufacturing practices adopted by manufacturing companies.
Keywords: operations strategy, strategic group, lean manufacturing, performance objective

Section heading: Manufacturing Operations

1. Introduction

Slack and Lewis (2009) state that operations strategy can have a heavy impact on business competitiveness, not only in the short term but also in the long run. The dilemma is that, when it comes to speeding up operations using distributed resources throughout companies, the impacts are difficult to identify in their entirety. This is the paradox of operations strategy, which is at the heart of the management of companies' strategic intentions and practices and plays a vital role in the success of organizations, but it is so comprehensive that it becomes easy to underestimate its importance.

The structure and competitive strategies of the auto parts industry have undergone profound changes in recent years, mainly due to the diffusion of the complex automotive production model of lean manufacturing, which brings together new forms of organization, new management practices, and an intensive use of automated equipment. The central pillars determining these changes include restructuring practices of automakers and the relationships between these and their suppliers, accelerating the process of product innovation and the creation of trade blocs.

The adoption of this model of production through the deployment of lean production practices has contributed to improvements in the operating performance of many companies but has also created some frustration (Womack et al., 2004).

This paper examines how the implementation of lean production practices can influence the operating performance of companies in the auto parts industry. As the deployment of these practices is rarely quantified using a cross-section data type (Cua et al., 2001), we used a quantitative approach supported by nonparametric statistics linked to the concept of strategic groups. According Bozarth and McDermott (1997), strategic groups have received more attention in research on operations strategy since Porter (1991) focused on these in his book *Competitive Strategy*. The utility of strategic groups manifests itself where there are many competitors, in that it facilitates conclusions in analyses of industrial sectors. However, in these analyses, precision is lost since the focus is on what companies have to be like to put them in strategic groups. We lose the level of detail in what makes each company different. Nonetheless, the benefit is that we can better understand what happens in industries by focusing only on strategic groups.

This paper is structured into six sections. After this introduction, section two presents the theoretical basis, which focuses on the role of lean production practices in the general framework of operations strategies. The third section describes the methodology used, including the sample and measures. The next section describes the analyses performed, the fifth section discusses the results, and, finally, the sixth section provides concluding remarks and suggestions for future research.

1.1 Operations Strategies

A vast literature already exists on strategies and operations. For this paper, we consider both the most recent publications and some older classics on the analysis of operating strategies. Initially developed by Skinner (1969) and most recently refined by Hayes and Wheelwright (1984), Platts and Gregory (1990), and Slack and Lewis (2009), this literature seeks to show that there is no single optimal path for companies operating within their resources, as Henry Ford once believed.

The two central elements of this framework are the competitive priorities and decision categories within which the array of decisions that make up production strategies have to be made (Hayes and Wheelwright, 1984). This basic structure for operations strategy detailed in 1984 is still used in research (e.g., Boyer and Lewis, 2002). There is a high degree of agreement that operations strategies focus on competitiveness in cost, quality, delivery, and flexibility (Dangayach and Deshmukh, 2001), but there are still debates about additional constructs.

Operations strategy, however, is changing from a "market-based" to a "resource-based" vision. The first view sees operations as a perfectly adjustable system and focused on successfully following the rules dictated by markets, while the second view suggests that it is more profitable to focus on developing, protecting, and leveraging operational resources of companies when seeking competitive advantage.

This paradigm shift began with evidence that high performance can be mainly explained by the strength of the resources of a company and not by the strength of its market position (Rumelt, 1984; Wernerfelt, 1984). The resource-based view has gained more importance since Prahalad and Hamel (1990) emphasized the link between core competencies and competitiveness. Unfortunately, the application of these concepts in real business strategies may be insufficient (Pisano and Hayes, 1994). Even today, it is difficult to find companies that use operations functions as a competitive weapon. One reason is the difficulty of "operationalizing" the content of operations strategy (Hum and Leow, 1996).

Although the theory of a resource-based perspective has a clear call, there have been studies on advantages based on resources within a more general, network context, extending the theory of resource-based viewpoint further. This view assumes that extended strategic resources that are outside companies emphasize inter-firm relationships. An example of this is the development of Toyota's highly efficient supply network (Slack and Lewis, 2009).

Decisions in operations strategy, according to Slack and Lewis (2009), consider a set of areas—such as capacity, supply chains (including procurement and logistics), process technology, and organization development—familiar to managers in a wide variety of operations. Researchers involved in manufacturing futures surveys have suggested that actions rather than decisions should be included within operations strategy (Kim and Frohlich, 1994).

The use of lean production practices within operations strategy represents both decisions and actions and, therefore, can be an important part of company standards, although lean production practices may not necessarily cover all aspects that make up the decision areas suggested by Slack and Lewis (2009). For example, questions about location are not extensively described in the literature on lean production, and these are not a part of practices suggested in later research. Still, the strategic model of operations is a means by which companies should be able to improve their internal and external processes, which should lead to improved performance (Bozarth and McDermott, 1997). Slack and Lewis's (2009) model of decision areas and performance objectives is an appropriate benchmark with which to analyze the implementation of lean production.

1.2 Lean Production Practices and Performance Objectives

Many papers have been published since the 1990s on the relationship between lean production practices and performance (Dangayach and Deshmukh, 2001). Generally, it is believed that just-in-time (JIT) practices lead to shorter lead times and lower inventories, and practices of total quality management (TQM) lead to improved quality. Empirical studies show that this relationship is not always in fact true. Extremely little research has been done on lean production as a concept, in order to validate or refute claims about lean production practices and performance objectives. Cua et al. (2001) mention some studies that consider the main pillars of lean production to be JIT, TQM, and total productive maintenance (TPM) working together.

While researchers recognize the value of investigating these interrelated practices simultaneously (i.e., JIT, TQM, and TPM), there are few studies that provide an empirical examination of the joint implementation of TQM, JIT, and TPM practices (Wakchaure et al., 2011). Based on a literature review of practices considering all three pillars of lean manufacturing (i.e., TQM, JIT, and TPM), notably, TQM is quite broadly defined, encompassing relationships between product design, suppliers, and customers, while JIT and TPM have more specific features. Performance objectives, therefore, reflect traditional competitive priorities, such as quality, cost, delivery on time, and flexibility to allow changes in volume.

Wakchaure et al. (2011) analyzed practices that best explain performance differences in firms. This was done on two levels: on sets of practices (e.g., TQM, JIT, TPM, and common practices) and individual practices. The results showed that JIT, TPM, and TQM were significant in explaining the relationship between lean production and performance objectives. On the practice level alone, not all practices contributed to explaining this relationship. Hence, in a conclusion relevant to this work, the researchers found that it is more appropriate to consider the three pillars of lean production (i.e., JIT, TPM, and TQM) together to understand better how they are influenced by performance goals, when these are given priority.

1.3 Strategic Groups

Grouping together companies operating with similar strategies forms a strategic group. Industry analysis done with the concept of strategic groups assumes that a given company is not in competition with every other company with the same intensity. Generally, an industry consists of several strategic groups, which include companies that have similarities across multiple strategic dimensions, such as degree of specialization, which refers to the extension of product lines; brand image—usually based on advertising and a sales force; and the choice of distribution channels, whether companies' own or other generalist or specialist distributors. Other dimensions include product quality, in terms of raw materials, specifications, and so on; the technological domain, whether companies mimic or lead in adopting new technologies; degree of vertical integration; position in terms of costs; extent of additional services offered, such as technical assistance; pricing policies; and relationships with public authorities, which may be reflected in obtaining grants or submitting the firm to regulations.

The formation of strategic groups is related to companies' ownership of different resources and capabilities, which enable some of them to make specific investments in mobility barriers. Companies are likely to adopt different strategies even when they have the same features and capabilities, if they have different preferences as to how to make investments and position themselves in relation to risk (Short, 1994). Another factor that explains the differences between business strategies is the historical evolution of industries, since the cost of adopting a strategy tends to be lower for the first companies in an industry. As industries develop, barriers to mobility are strengthened by exogenous causes or as a result of investments made by already established companies (Porter and Caves, 1977).

2. Material and methods

The conceptual framework used in this research is represented by Figure1, below. This is a simplified version of operations strategy, where companies are grouped into strategic groups according to their competitive priorities.

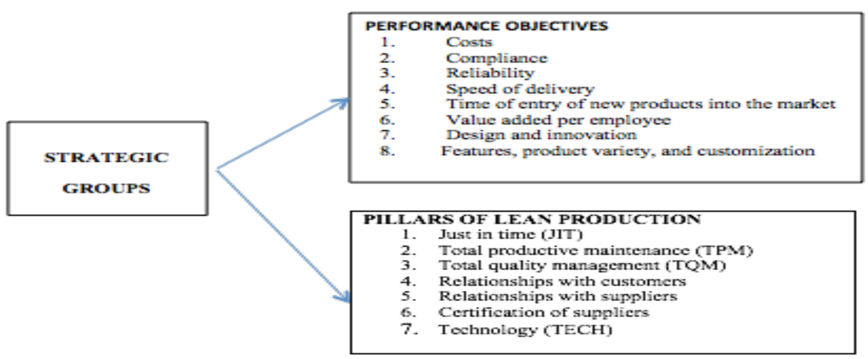

Figure 1. Conceptual framework

Two relationships were investigated, one being the relationship between strategic groups and operational performance and the other, relationships between strategic groups and degrees of implementation of lean production pillars (as summed scales). Due to space limitations in this paper, the connections between practices of lean manufacturing and operational performance are not examined directly but instead dealt with by constructing relationships through strategic groups. The call is then addressed indirectly.

2.1 Sample

A questionnaire was administered by the researcher in a group of fifty-six companies located in Campinas and Jundiaí, from March to October 2012. These companies are auto parts manufacturers divided into five industries: metallurgical, mechanical processing, plastics, machinery and equipment, and electrical and electronic.

The questionnaire consisted of four categories of questions: contextual issues, questions about competing priorities, practicalities and issues related to performance goals, and both current performance objectives and performance objectives of the past five years. The performance objectives were considered to be cost, quality, reliability, speed of delivery to the customer, time to market entry of new products, value added per employee, design/innovation, product features, product variety, and customization of products.

2.2 Measures

In this study, we used Cronbach's alpha to estimate the reliability of the questionnaire used in this research. We measured correlations between questionnaire responses by analyzing answers given by respondents, looking at average correlations between questions. The software used was BioEstat version 5.3 for data analysis.

The general rule used was that the existing scales should exceed a Cronbach's alpha level of 0.70. This proved to be the case for the three pillars considered: JIT, TPM and TQM. Compared to Cua et al. (2001), the JIT and TPM pillars have the same content, while the third pillar was divided into TQM itself, client relations (RCLI), supplier relations (RFOR), and supplier certification (CFOR) for this study—although RCLI and RFOR presented values below the minimum Cronbach's alpha of 0.70. The pillar "technology" (TECH) is also a pillar of lean production, per se, and it was included to check the influence of technology on lean production practices. These interrelated pillars and practices are shown in Table 1 below.

Table 1. Pillars of analysis and their lean production practices

PILLAR OF LEAN PRODUCTION	LEAN MANUFACTURING PRACTICES	Alpha Cronbach
J I T **(α_C = 0.826)**	1. Production processes	0.610
	2. Reduction in cycle time	0.571
	3. Agile manufacturing	0.742
	4. Rapid techniques and tools	0.733
	5. Production systems focused on the factory	0.708
	6. JIT production flow/continuous	0.658
	7. Pull system/Kanban	0.754
	8. Bottleneck/removal restriction	0.523
TPM **(α_C = 0.717)**	1. Autonomous maintenance	0.679
	2. Planning and scheduling of maintenance	0.601
	3. Preventive or predictive maintenance	0.904
	4. Program improvements in safety	0.748
TQM **(α_C = 0.720)**	1. Formal programs of continuous improvement	0.570
	2. Software quality management	0.794
	3. Total quality management	0.885
	4. Measures of process capability	0.667
	5. Benchmarking	0.617
TECH **(α_C = 0.681)**	1. Planning systems and advanced programming	0.630
	2. Enterprise resource planning systems	0.741
	3. Finite capacity scheduling	0.832
	4. Demand management/forecast	0.678
RCLI **(α_C = 0.641)**	1. Continuous program replenishment	0.771
	2. Customers participate in product development	0.712
	3. Evaluation of industrial plant by clients	0.606
	4. Survey of customer satisfaction	0.701
RFOR **(α_C = 0.742)**	1. Major suppliers based on JIT deliveries	0.730
	2. Stocks managed by supplier	0.595
	3. Suppliers commit themselves to reducing costs	0.773
	4. Suppliers involved in development of new products	0.720
CFOR **(α_C = 0.619)**	1. Program for certification of suppliers	0.680
	2. Suppliers evaluated based on total cost and not unit prices	0.572

3. Analysis and results

Before describing the data analysis, we present the results of further analysis that led to the formation of strategic groups. Four strategic groups were identified, all significantly different in their most important competitive priorities. The companies surveyed received 100 points to distribute between a series of performance goals, which formed the basis for the identification of groups. This process was suggested in a somewhat different form by Hill (2000) and used by Berry et al. (1999). The strategic groups were named based on performance objectives considered important, as shown in Table 2.

Table 2. Classification of performance objectives in strategic groups

COMPETITIVE PRIORITY		STRATEGIC GROUPS			
		GE-A	GE-B	GE-C	GE-D
COST	average	46.3	18.0	18.2	3.8
	classification	1	3	2	4
QUALITY	average	14.1	36.2	20.3	18.4
	classification	4	1	3	2
RELIABILITY	average	10.9	26.2	30.1	9.8
	classification	3	2	1	4
SPEED OF	average	11.4	7.3	20.1	3.2
DELIVERY	classification	2	3	1	4
TIME PLACING	average	4.8	24.4	5.9	6.3
PRODUCTS ON	classification	4	1	3	2
THE MARKET					
DESIGN &	average	8.8	12.8	5.1	41.9
INNOVATION	classification	3	2	4	1
PRODUCT	average	8.9	15.2	5.9	17.5
FEATURES	classification	3	2	4	1
VARIETY OF	average	10.9	15.1	6.2	20.1
PRODUCTS	classification	3	2	4	1
CUSTOMIZED	average	8.9	14.1	8.7	15.7
PRODUCTS	classification	4	2	3	1

Thus, strategic group A (GE-A) puts a quite heavy emphasis almost exclusively on cost. Strategic group B (GE-B) and strategic group C (GE-C) put an emphasis on quality and delivery reliability but differ on the time needed to introduce new products into the market (strategic group B dominates this) and speed of delivery (strategic group C dominates this). Strategic group D (GE-D) cares about an extra dimension: aesthetics in their products. This is a new perspective, where the subjectivity of clients and changes of style and fashion can strongly influence companies' performance.

All tests for differences between the strategic groups were nonparametric. Parametric tests assume, among other things, normal populations groups and homogeneity of variance. In practice, these conditions are based on the central limit theorem, which normally requires the use of many cases (Virgillito, 2006). Since this study used a small amount of cases, the assumptions for parametric tests are not necessarily applicable, which is why we used non-parametric tests.

One of the tests used was the Kruskal-Wallis test and it showed that the strategic groups differ significantly from each other. The Mann-Whitney test, conducted later, also showed that the groups differ in their performance objectives: cost for strategic group A, quality and reliability for strategic group B, reliability and speed of delivery for strategic group C, and design and innovation for strategic group D.

When we analyzed the role of strategic groups in choices of priority performance goals, a further question appeared: Do the strategic groups alone explain choices of performance goals?

To answer this question, it was necessary to show statistically significant differences between the groups and then turn our attention to a more qualitative assessment. Table 3 shows the statistical results. Strategic group A presents the lowest value added per employee of the four groups. Strategic group D has the highest value added per employee. However, as revealed in Table 3, strategic group D is in a vulnerable position, because, for this group, the cost of guarantees, rate of rejection by customers, and production costs increase significantly more than for the other groups. Indeed, the other groups showed decreasing values for these three measures.

Table 3. Significant differences in performance between groups with strategic application of Mann-Whitney

	GE-A x GE-B	GE-A x GE-C	GE-A x GE-D	GE-B x GE-C	GE-B x GE-D	GE-C x GE-D
Value added per employee during the year	0.056(B)[a]	0.054(C)	0.164(D)	-	-	-
Warranty cost	-	-	0.011(D)	-	-	0.018(D)
Rate of rejection by customers	-	-	0.068(D)	-	-	0.153(D)
Cost of production (without the cost of purchasing materials)	-	-	0.020(D)	-	0.043(D)	-
Cost of production (with the purchase cost of materials)	-	-	0.091(D)	-	0.241(D)	0.072(D)

[a] The letters in parentheses indicate the strategic group that has the greatest value, there is no other significant difference in value.

One possible explanation for strategic group D being quite different from the others may be the fact that growing numbers of customers are becoming more demanding with respect to the design of products. The fact of this strategic group showing an overly low yearly added value per employee indicates that it has a low contribution margin, probably due to price competition. Therefore, this group has to focus on lowering costs, so cost is a priority. Group A has a well-defined strategic choice of performance goals when compared with other strategic groups, as shown in Table 4. The group also gives a high degree of importance to quality, but its importance is not as evident as other performance goals.

Table 4. Scoring for classification of competitive priorities related to performance objective

		GP-A	GP-B	GP-C	GP-D
COST	1. Scrap and rework	1[a]	3	2	4
	2. Cost of warranty	1	3	2	4
	3. Cost of quality	1	3	2	4
	4. Inventory turnover of raw materials	1	3	2	4
	5. Inventory turnover of goods in process	2	3	4	1
	6. Inventories of finished goods	2	4	1	3
	Average	**1.63**	**3.13**	**2.00**	**3.25**
QUALITY	7. Finished product with no rework	2	3	1	4
	8. Defect rate in plants	3	1	4	2
	9. Rejection ratio per customer	2	1	3	4
	Average	**2.33**	**1.67**	**2.67**	**3.33**
RELIABILITY	10. Delivery on time	4	2	1	3
	Average	**4**	**2**	**1**	**3**
SPEED OF DELIVERY	11. Lead time of purchase	3	4	2	1
	12. Lead production team	4	3	2	1
	13. Lead sales team	4	3	2	1
	Average	**3.67**	**3.33**	**2.00**	**1.00**

[a] Points are based on the rating that each group receives for the strategic performance measure in question.

The prioritization of cost and quality performance objectives by strategic group A offsets its delivery speed and reliability. Strategic group B places a higher degree of priority on quality, but, overall, this group has the worst score. This group emphasizes quality and reliability, which is also reflected in the choice of lean production practices. Strategic group C has its prioritization better distributed in its total score, but it puts an emphasis on speed of delivery and reliability. This strategic group shows a high degree of external fit, so much so that it is able to deliver what the market wants quickly and reliably.

Finally, strategic group D's prioritization shows evidence of good speed of delivery, but, overall, this group does not emphasize any of the performance objectives that have a direct relationship to practices of lean production, as shown in Table 4 above. Quality alone seems to have a high degree of importance, but, in reality, this is a consequence of prioritization of design and innovation. Table 3 above shows that strategic group D has a significantly worse outcome than other groups regarding rejection rates per customer. The data analysis shows that its rate of rejection, unlike other groups that focus on action, is due to poor acceptance of its products' design.

This can lead to the conclusion that an adjustment is needed in choices of lean production practices in this group. However, this strategic group is new in the context of determining research operations. It also has a strong emphasis on multifunctional performance goals. Therefore, it should not be judged solely on the basis of the degree of priority given to performance goals. Nonetheless, an analysis of the performance objectives of this group indicates that it needs to improve its choices in the future if these companies want to be able to sustain a high value added per employee.

3.2 Strategic Groups and Implementation of Pillars of Lean Production

To analyze the implementation of pillars of lean production by strategic groups, we based this on the results shown in Table 1 and the degree of implementation of these pillars in different groups. Various tests to measure the differences between groups were performed. First, we ran a Krustal-Wallis test for differences between the groups and then performed a Mann-Whitney test for differences between the pillars, seen individually and group to group. Finally, using the Wilcoxon test, we looked at whether the deployment of the pillars of lean production is different in each group. The results are shown in Table 5.

Table 5. Degree of implementation of lean production practices in strategic groups

GROUP STRATEGIC	JIT	TPM	TQM	TECN	RCLI	RFOR	CFOR
GE-A	**-**	**(1,2,3,4)[a]**	**(1,2)**	**(2,4)**	**(4)**	**(1,3)**	**(2)**
average	**2.915**	**3.362**	**2.942**	**2.310**	**2.694**	**2.433**	**2.914**
classification	**1**	**1**	**1**	**4**	**3**	**1**	**2**
GE-B	**(3,5,6,7)**	**(1)**	**(3,4,5)**	**(1,3)**	**(3,4)**		**(1)**
average	**2.440**	**2.898**	**2.711**	**3.280**	**2.822**	**2.087**	**2.953**
classification	**4**	**2**	**2**	**1**	**2**	**3**	**1**
GE-C	**(1,2,3,4)**	**-**	**-**	**-**	**-**	**(1,2)**	**-**
average	**2.875**	**2.803**	**2.693**	**2.769**	**2.884**	**2.066**	**2.564**
classification	**2**	**3**	**3**	**3**	**1**	**4**	**3**
GE-D	**(1,4)**	**(4)**	**(2)**	**(4)**	**(2,3)**	**(4)**	**-**
average	**2.813**	**2.810**	**2.197**	**2.805**	**2.486**	**2.258**	**2.205**
classification	**3**	**4**	**4**	**2**	**4**	**2**	**4**

[a] Numbers in brackets refer to the lean production practices adopted, as shown in Table 1.

The Krustal-Wallis test revealed no significance, which indicates that all strategic groups should be considered as coming from the same population in terms of lean production practices. This finding is quite different when compared with the Krustal-Wallis test's results on competitive priorities in the strategic groups. The Mann-Whitney test for different degrees of implementation of pillars of lean production, when applied to the four strategic groups, showed that the other strategic groups differ from strategic group C in their degree of implementation of TPM and differ from group D in the degree of strategic deployment of TQM.

The Wilcoxon test for differences in the groups confirmed that the groups emphasize different pillars. For example, strategic group A has a significantly greater degree of implementation of TPM than most of the other pillars, while strategic group B has a significantly lower degree of deployment of RFOR. The Wilcoxon test showed that the groups differ in who chooses to apply what, but this difference is not significant between groups.

Table 5 indicates which groups emphasize the strategic pillars JIT, TPM, TQM, and RFOR. Table 1 shows that lean production practices, including these pillars, generally are favorable for lower and short-term costs, so these strategic groups reveal a high degree of internal adjustment.

An emphasis on CFOR was expected for group B because it has a strategic focus on quality rather than cost. Moreover, the implementation of new technologies by this strategic group can be explained by its emphasis on delivery reliability.

It can also be noted that the most customer-oriented group is strategic group C, which has the highest score for RCLI. This pillar is mainly the aspect of time in relation to customers and is thus consistent with the strategic focus of group C. Strategic group B is number two in TQM, while strategic group C is number two in JIT, which is also in line with their goals. Hence, these groups show a high degree of internal consistency.

The strategic choices of group D are difficult to explain, in part because other practices beyond pillars of lean production can be extremely important for these companies and we do not have enough information about these practices. However, based on the data at hand, we can see that this group emphasizes TECH and RFOR. The first has to do with the use of technologies to develop new products, and the second has to do with relationships with suppliers with respect to lower costs and shorter delivery times. This seems to be valid when considering delivery problems, but, as Table 3 shows, that group does not prioritize cost or quality. Based on Table 2, it can be seen that this group does not emphasize good performance in delivery, so this group does not have a high degree of internal adjustment.

The numbers in parentheses in Table 5 refer to the practices of lean production including TECH, which is not really a pillar of lean production but is an aid to understanding applications. These data suggest that strategic group A has more extensively applied lean production practices, followed by strategic group B, which for some yet unidentified reason is particularly interested in deploying technological, finite capacity scheduling. The group has deployed fewer lean production practices than strategic group D.

The analysis leads us to conclude that strategic groups A, B, and C have implemented lean production practices in terms of performance objectives and that prioritized groups are selective about the pillars that receive greater emphasis. This is most clearly demonstrated by strategic group A. Strategic group C shows overall good performance, which can be achieved without the implementation of a series of lean production practices. An analysis of the combination of the operating performance of group D with its strategic deployments of lean practices can lead to two possible conclusions: that these companies are not good at running their operations strategy or some of the companies included in the analysis do not attribute an important role to strategies for operations. Given these possibilities, we cannot reach more definite conclusions about that group.

4. Discussion of Results

Data analysis showed that the strategic groups differ, both with regard to different sets of performance goals and to the sets of pillars of lean production that they choose to deploy. The analyses also indicated that there are links between the deployment of pillars of lean production and the performance objectives prioritized. For example, the groups showed that the strategic deployment of the pillars TPM, TQM, and RFOR apparently goes hand in hand with good performance at low cost. However, a high degree of deployment is not necessary to achieve a satisfactory performance in key areas, as strategic group C demonstrated. This strategic group has good performance in speed of delivery but only uses pillars of lean production (i.e., JIT and RFOR) at a moderate level.

5. Conclusion

This study established connections between the defined groups' strategic pillars of lean production and performance goals by using cross-sectional data. Different strategic groups have different performance goals and emphasize the application of different pillars and lean production practices. In particular, strategic groups A and D show that they are parting ways. The results are indicative only, and the sample size is too small to obtain highly significant statistical results. However, the results summarized in Tables 2–5 indicate that ratings of lean production practices using strategic groups can produce important results in operations strategy and that there is reason to investigate lean production practices further in this context.

This study identified a new strategic group, where aesthetics and industrial design are given priority. Several articles have recently been published demonstrating the importance of image, design, and aesthetics in manufacturing companies, as well as how design can influence operations strategies. Within the limitations of this study and the sample, the linkage between pillars of lean production and performance goals has been thoroughly explored, as has the role played by lean production practices.

References

Berry, W.L., Hill, T., Klompmakerk, J.E., 1999. Aligning marketing and manufacturing strategies with the market. Int. J. Prod. Res. 37(16), 3599–3618.

Boyer, K.K., Lewis, M.W., 2002. Competitive priorities: investigating the need for trade-offs in operations strategy. Prod. Oper. Manag. 18(4), 356–73.

Bozarth, C., McDermott, C., 1997. Configurations in manufacturing strategy: a review and directions for future research. J. Oper. Manag. 15.

Cua, K.O., McKone, K.E., Schroeder, R.G., 2001. Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. J. Oper. Manag. 19, 675–694.

Dangayach, G.S., Deshmukh, S.G., 2001. Manufacturing strategy: literature review and some issues. Int. J. Oper. Prod. Man. 21(7), 884–932.

Davis, M.M., Aquilano, N.J., Chase, R.B., 2010. Fundamentals of Production Administration, third ed. Bookman, P A.

Frohlich, M.T., Dixon, J.R., 2001. A taxonomy of manufacturing strategy revisited. J. Oper. Manag. 19, 541–558.

Hayes, R.H., Wheelwright, S.C., 1984. Restoring Our Competitive Edge: Competing Through Manufacturing. John Wiley & Sons, New York.

Hill, T., 2000. Manufacturing Strategy: Text and Cases. Palgrave, New York.

Hum, H.S., Leow, L.H., 1996. Strategic manufacturing effectiveness. Int. J. Oper. Prod. Man. 16(4), 4–18.

Kathuria, R., 2000. Competitive priorities and managerial performance: a taxonomy of small manufacturers. J. Oper. Manag. 18(6), 627–641.

Miller, J.G., Roth, A.V., 1994. A taxonomy of manufacturing strategy. Manage. Sci. 40(3), 285–304.

Platts, K.W.,Gregory,M.J.1990. Manufacturing audit in the process of formulation strategy. Int J.Oper.Prod.Man. 10(9).

Rumelt, R.P., 1984. Towards a strategic theory of the firm, in: Lamb, R.B. (Ed.), Competitive Strategic Management. Englewood Cliffs, New Jersey.

Skinner, W., 1969. Manufacturing—missing link in corporate strategy. Harvard Bus. Rev.

Skinner, W., 1978. Manufacturing in the Corporate Strategy. John Wiley & Sons, New York.

Slack, N., Lewis, M., 2009. Operations Strategy. Bookman, Porto Alegre.

Virgillito, S.B., 2006. Applied Statistics. Edicon, Sao Paulo.

Wakchaure, V.D., Nandurkar, K.N., Kallurkar, S.P., 2011. Development and validation of integrated manufacturing practices model. Tenth International Conference on Operations and Management Quantitative (ICOQM-10), Nashik, India.

Wernerfelt, B., 1984. A resource-based view of the firm. Strateg. Manage. J. 5, 171–180.

Womack, J.P., Jones, D.T., Roos, J., 2004. The Machine That Changed the World. Campus, Rio de Janeiro.