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Relationship between Lean Manufacturing and High Involvement Work Practices and perceived results*

Juan A. Marin-Garcia[1], M. Rosario Perrello-Marin[1], Julien Maheut[1], Maria Valero-Herrero[1]

[1] ROGLE- Dept. Organización de Empresas, Universidad Politécnica de Valencia, ETSII-Edificio 7D, Camino de Vera s/n 46022 Valencia-SPAIN, jamarin@omp.upv.es

Resumen

Our research aims to empirically test the relationship between Lean Manufacturing and High Involvement Work Practices; and the effect these practices have on the operational outcomes in the factory. These effects are tested by recording management perceptions, as well as objective measurements in an industry different than those usually studied in previous research (ceramic manufacturers in the Valencia region of Spain – a highly competitive and internationally successful sector). The results of our research show significant relationships between the implementation of these practices and competitive advantage.

Keywords: Lean Manufacturing, High Involvement Work Practices, empowerment, training, remuneration, communication, operational performance, absenteeism, employee turnover

1. Introduction

Lean Manufacturing has been applied as a way of improving activities and performance in firms (Tari et al., 2007; Wang, 2008). Several studies have showed the direct relationship between Lean Manufacturing practices and improved performance (Nair, 2006; Sila, 2007).

Some of these studies were based on samples of companies from different sectors (Cua et al., 2001; Fullerton et al., 2003; Shah y Ward, 2003). Others have focused on a broad sample of firms from a few sectors; usually the automobile, electronics, and machinery industries (Bañegil, 1993; Sakakibara et al., 1997). There is also some evidence of the successful implementation of Lean Manufacturing in sectors such as construction (Pheng y Teo, 2004), assembly (Jun et al., 2006), and optics (Wang, 2008). However, much of the research in various sectors of the automobile, electronics, and machinery industries is based on studies of isolated cases.

There are several works that explain an improvement in operational performance by suggesting a close relationship between Lean Manufacturing and High Involvement Work Practices (Holman et al., 2004; Kochan y Lansbury, 1997; Yates et al., 2001). Some of these works suggest that High Involvement does not directly affect the results, but does help to the implementation of Lean Manufacturing – and this has a direct relationship with the results (Fullerton y McWatters, 2002; Sakakibara et al., 1997; Sila, 2007).

However, there are only a few studies which analyze the characteristics of the relationship between Lean Manufacturing and High Involvement. Some of these studies look at only one

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component of Lean Manufacturing, for example, Total Quality Management (Nair, 2006; Sila, 2007), or Pull Systems (Koufteros et al., 2007) and their relationships with some components of High Involvement Work Practices. Others focus on studying High Involvement Work Practices in detail, but only relate these practices with Total Quality Management (Lawler III et al., 2001). Finally, a series of papers discuss in depth the relationship between the components of Lean Manufacturing (Total Quality Management, Just-In-Time, and Total Productive Maintenance) and some of the components of High Involvement Work Practices in terms of operational performance (Birdi et al., 2008; Cua et al., 2001; Fullerton y McWatters, 2001; Sakakibara et al., 1997).

These works are often incomplete because their main focus is centred on an analysis of the practices of Lean Manufacturing, or an analysis of High Involvement Work Practices. The other sets of practices being a somewhat tangential addition to the study – and not a major part of the research. Therefore, extensive research seems essential to facilitate theory development (Sila, 2007). Consequently there is a need to broaden empirical research in the direction of determining the performance implications of implementing Lean Manufacturing and High Involvement Practices (Tari et al., 2007) in a set of firms all in the same industry (Shah y Ward, 2003). For instance, the extension could be based on analyses carried out in countries and industries other than those usually studied.

It is typical of the environment in which most industrial enterprises operate today that there is ever-increasing competition, faster change and fluctuating demand. Most markets are mature and customers demand quality products adapted to their specific needs (Suzaki, 2000). Consequently one would expect some degree of implementation of Lean Manufacturing practices in any sector that is subject to this kind of competition. For example, firms that manufacture ceramic flooring and covering, especially those in the leading producer countries (Andrés Romano, 2001; Gil et al., 1999; Hervas-Oliver y Albors-Garrigos, 2009; Rowley, 1996).

The aim of this research is to investigate the model of relationships between Lean Manufacturing and High Involvement Work Practices, and the links between these two sets of practices on operational results. This approach is developed using path analysis to determine whether the relationships between practices and their effects on manufacturing outcomes can be replicated in the firms that operate in the tile industry in Spain. Our results would test the generalizability of existing theory and models.

2. Theoretical framework anf hypotheses

The complete model of Lean Enterprise includes not only Lean Manufacturing, but also the activities of Lean product development, Lean procurement, and Lean distribution (Karlsson y Ahlström, 1996). However, our research interest focuses on the activities that take place in manufacturing activity, and this leads us to analyse and describe only aspects regarding Lean Manufacturing.

The term ‘Lean’ has been used to denote the set of tools designed to increase business competitiveness by systematically eliminating all types of waste (Shah y Ward, 2007). Numerous studies have concluded that applying ‘Lean Manufacturing’ enables a business to improve its operational performance (Fullerton y McWatters, 2001; White y Prybutok, 2001). This is true for both for large companies and for SMEs (White et al., 1999).

The benefits most often mentioned include: a reduction in stock levels, improved quality, faster manufacturing, and more frequently met deadlines (Cua et al., 2001; Fullerton y McWatters, 2001; Jackson y Dyer, 1998; Sakakibara et al., 1997; Shah y Ward, 2003; White et al., 1999).

Most research on Lean Manufacturing takes into account, to a greater or lesser extent, the relationship with those human resource management programs which encourage employee involvement in the production of a company's products or services (Cua et al., 2001; Fullerton y McWatters, 2002; Shah y Ward, 2007). These programs for the management of human resources are termed 'High Involvement Work Practices' (Combs et al., 2006; Guthrie et al., 2002). The list of which practices are included varies among authors. However, there is agreement about how these practices can be categorised. The categories most often cited coincide with those proposed by Lawler (1991): empowerment, training, communication, and remuneration.

Various studies in different nations have provided evidence of the positive effects of High Involvement Work Practices on the indicators of results (Lawler III et al., 2001).

Empowerment can be characterised as the sharing of power with employees and increasing their level of autonomy. (Guerrero y Barraud-Didier, 2004). It would seem clear that companies implementing a higher degree of Lean Manufacturing practices need to have previously increased empowerment (Fullerton y McWatters, 2002).

If employees can rotate jobs and receive suitable information and training, then the workforce may develop shared abilities and a better understanding of the processes in which they participate. In this way, they can contribute to improving company results (Guerrero y Barraud-Didier, 2004).

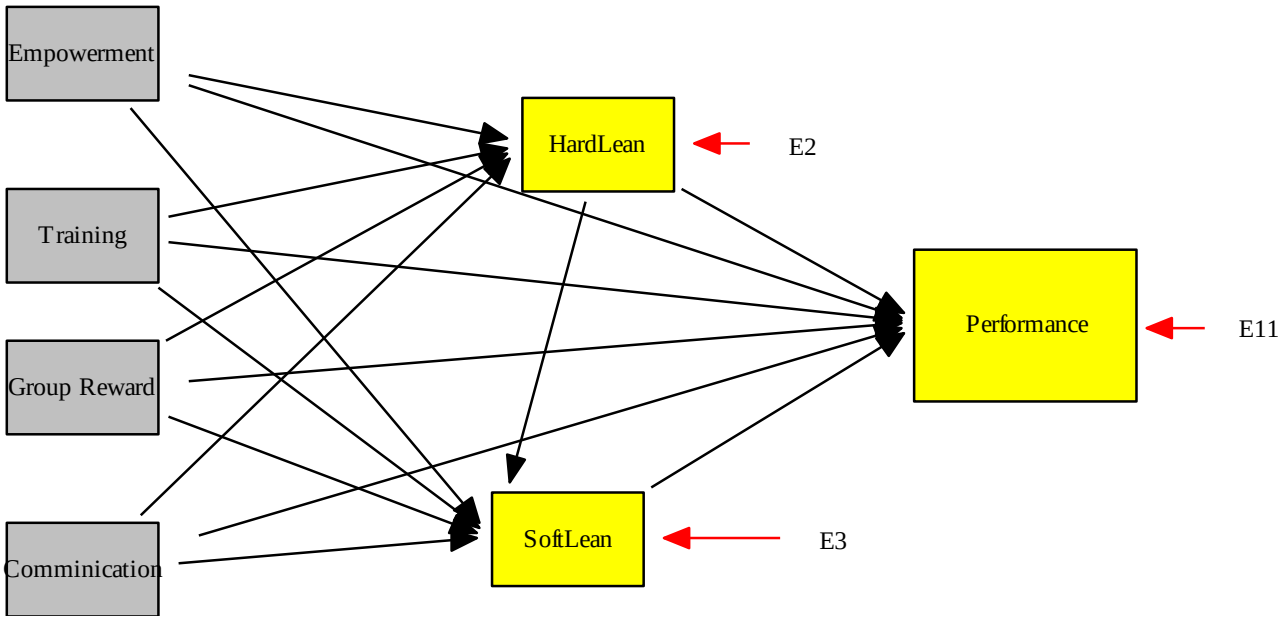
Although various authors have included variable remuneration in their studies on Lean Manufacturing, (Fullerton y McWatters, 2002), the link between remuneration systems and successful Lean Manufacturing has received little attention in the literature. (Sakakibara et al., 1997). Remuneration based on group effort (incentives for reaching group targets and gain-sharing related to suggestions) helps align employee interests with the organisation of the work teams. These incentives also mean that employees are more likely to make a greater effort and contribute more fully to the team (Lawler III, 1996; Zatzick y Iverson, 2006). There are many studies in English-speaking nations linking these practices with productivity and improved company profitability. However, these relationships have not always been confirmed in European or Asian cultures (Guerrero y Barraud-Didier, 2004; Wood y de Menezes, 2008). Based on the literature reviewed in this section, the research model is shown in Figure 1.

3. Research method

We developed an ad-hoc data collection questionnaire. We worked with several highly experienced technicians from ASCER (Asociación de Fabricantes de Azulejos, Pavimentos y Baldosas Cerámicas) in order to make the necessary adaptations to the peculiarities of the ceramic tile industry. We held two working sessions with managers of firms which are members of ASCER. Approximately 20 managers (production or human resource managers) from various ASCER member firms attended each session. Details of the questionnaire can be requested to the first author.

For measuring the implementation of Lean Manufacturing practices we asked what percentage of employees used a given tool during their shift (soft Lean), and what percentage of shop floor zones used a given tool (hard Lean). Most items were measured on scale of 0 to 5 (0%, 1-20%, 21-40%; 41-60%; 61-80% and 81-100%). Some questions could be answered by simply stating whether the company had certain items – such as quality certification, preventive maintenance plans, or statistical process control (Wood y de Menezes, 2008).

Figure 1: Model



Empowerment has been measured using a scale of 1 to 4 (employees are informed, employees are consulted, decision-making shared with management, decision is delegated) in decisions regarding (six items): production targets; setting of quality standards; synchronisation and work pace; machines and tools to be used in a task; assignment of tasks and job rotation; problem-solving for simple task-related problems (Marin-Garcia, 2002).

Training (eight items) was measured as the percentage of production employees receiving systematic and programmed training regarding tidiness and cleanliness in the workplace, data collection, graphic design and data interpretation, group problem solving, continuous improvement, preventative machine maintenance, standardisation of operations, quality control, reduction of machine start-up times, teamwork and meeting management (Benson et al., 2004; Tari et al., 2007). The same 0 to 5 scale used for measuring the use of Lean Manufacturing tools was also used for this variable – (0%, 1-20%, 21-40%; 41-60%; 61-80% and 81-100%).

Communication and remuneration were measured with a single item on a scale of 0 to 5 (0%, 1-20%, 21-40%; 41-60%; 61-80% and 81-100%)– a question regarding the percentage of shop floor zones where charts are posted to show employees the following: defect rates; schedule compliance; machine breakdowns; quality performance and productivity (Cua et al., 2001; Shah y Ward, 2007). And what percentage of production workers received following incentives meeting group targets (Lawler III et al., 2001; Marin-Garcia et al., 2008). We used a 0 a 5 scale (0%, 1-20%, 21-40%; 41-60%; 61-80% and 81-100%).

Perceived performance was measured on a Likert scale of 1-5 (very little satisfied to very satisfied) regarding 7 aspects of the business: adaptation of the product to the characteristics requested by the client; product quality; the capacity to adjust production to meet fluctuating demand; production costs; speed of order completion; ability of production employees to handle differing tasks; level of production employee motivation. These values were reported by the manufacturing managers.

All of these variables were standardised before beginning the analysis (Lowe et al., 1997; Rungtusanatham et al., 1998)..

Scales with several items were calculated as the average value of all the items – after standardizing their values (Dabhilkar y Ahlstrom, 2007; Rungtusanatham, 2001). As additive indices are used, we assumed that each practice has an equal effect on organizational performance (Wood y de Menezes, 2008). For the validity of the scales, we took as a criterion that the value of Cronbach's alpha will be greater than 0.60 (Hair et al., 1995).

The relationship between Lean Manufacturing or High Involvement and operating results are evaluated using path analysis (Rungtusanatham et al., 1998; Tari et al., 2007). The maximum likelihood method was used for parameter estimation with Structural Equations Program, EQS (Bentler, 2002; Ullman y Bentler, 2004).

3.1 Sample

The studied population consisted of ceramic companies in the Valencia region which are members of ASCER (N = 157). It represents more than 85% of Spanish ceramic tiles manufacturing firms (ASCER, 2003). The final response rate was 64% (101 visits completed). The data was compiled between July and September 2001. The questionnaire was administered during a personal interview of 30 minutes average duration. Immediately after the interview, a visit to the facilities was made to obtain some of the data by direct observation. These visits took an average of 40 minutes per plant. The objective measures were obtained from the plant files. Two researchers took part in the process. Participating plants received a detailed profile of their own results and a sample means profile for comparison.

4. Results and discusion

The variables for uniform workloads, as well as Pull and Cellular manufacturing systems –in hard lean scale-, were found to be constant in all of the sampled companies (their value being zero for all cases). In other words, no company in the sample used these tools. The same is true for the variables for preventive maintenance and maintenance optimization in soft lean scale – as no sampled company asked its employees to participate in these activities. Table 1 shows the descriptive statistics for the scales calculated using direct data.

	Items	α	N	Min	Max	Mean	Std. Dev.
Hard Lean	10	0.60	101	,40	2,67	1,50	0,41
Soft Lean	6	0.60	101	,00	5,00	1,70	0,97
Empowerment	6	0.76	101	,00	3,00	1,51	0,58
Training	8	0.87	100	,00	5,00	0,77	1,12
Group rewards	1	--	100	,00	5,00	0,39	1,18
Communication	1	--	101	,00	5,00	0,79	1,61
Perceived performance	7	0.62	101	2,43	4,71	3,55	0,51

Table 1. Descriptive statistics.

These tools are little used in the industry. The average level of use of these tools is between 0.39 and 1.70. The value that represents 100% use in the factory is five. However, the variation between factories is very large. At some scales, there are companies which have

reached the maximum value. This coincides with the training, communication, remuneration, and involvement of employees in the use of Lean tools (soft lean). However, the most advanced companies are only just above the midpoint of the scale in the use of hard lean, as well as in the scale of empowerment. Although there is theoretical evidence that worker involvement is necessary, many companies may be resisting because they fear that employees may behave opportunistically and against the shared interests of the organization (Spreitzer y Mishra, 1999).In terms of results, we note that the satisfaction of managers with the perceived results is moderately high.

The correlations between variables calculated using standardized values are moderate-low. We found relationships between the scales of Lean Manufacturing, as well as empowerment and training (Cappelli y Neumark, 2001; Shah y Ward, 2007). Communication only seems associated with the use of Lean tools by employees (soft lean), but not with the use of Lean tools in factories (hard lean). Yet remuneration is not associated with Lean Manufacturing (Fullerton y McWatters, 2002). However, there is an association between remuneration based on group results and empowerment and training. This relationship was not set in our model, but it suggests that remuneration helps orientate the actions of employees (Lawler III, 1996; Zatzick y Iverson, 2006).

Table 2 shows how the model fit is very good; while the constrained model offers a pretty good fit. Standardized solution of the model is shown in Table 3.

Chi2S-B (P-value)	CFI	IFI	MFI	GFI	RMSA (conf. Interval)
9,599 (0.143)	0.960	0.965	0.982	0.962	0.078 (0.00; 0.164)

Table 2. Model fit

Reviewing the coefficients of those equations which have proven significant, there is a positive association of perceived performance with the involvement of employees in developing Lean activities in their daily tasks (soft Lean).

	Hard Lean	Soft Lean	Perceived Performance
Hard Lean	---	0.46**	n.s.
Soft Lean	---	--	0.24+
Empowerment	n.s.	n.s.	n.s.
Training	0.35**	0.48**	n.s.
Group rewards	n.s.	n.s.	0.23**
Communication	0.32**	n.s.	n.s.
R2	23.2%	59.9%	11.3%

Table 3. Standardized solution. n.s. non significative. +10%; * 5%; ** 1%

Analyzing the paths shown in table 3, it seems that perceived performance is affected directly by soft lean and group rewards. The other variables have indirect paths to influence performance. In this way, hard lean has no significative direct effect but it has an important effect upon soft lean. In similar way, training and communication may use indirect paths to influence performance. On the contrary, the group rewards does not affect the degree of implementation of practices, but they do directly on the performance.

However empowerment hasn't significative effects at all. This may be due to the small variation in this variable data. These results support the idea that, in this sector, Lean Manufacturing has been introduced with some employee consultation – but with little empowerment, and without changes to the traditional structures of power. The fact that Lean Manufacturing is not always introduced with an expansion of control or autonomy for employees has been discussed in previous studies (Fullerton y McWatters, 2002; McKone et al., 2001). We are surprised at the lack of direct association between the High Involvement practices and operational outcomes – given that several studies have shown small but significant effects (Birdi et al., 2008; Cua et al., 2001; Shah y Ward, 2003). One explanation is that these studies may have considered certain practices to be High Involvement – while we consider them to be soft Lean. In other words, employees in their daily tasks are involved in activities related to Lean practices. Another explanation is that, as shown in the table of descriptive statistics, High Involvement practices are little used in the sector – and with little variation between companies.

5. Implications, limitations and conclusions

Managers may feel that the use of Lean tools means the loss of the cushion represented by stocks; and as a result, they may be forced to change their production systems. Such changes by management are uncommon in the traditionally conservative ceramic industry. However, they think that efficiency improves when a company culture is transformed by giving employees training, information and new ways to rewards.

Our results seem to support the idea, that success in implementing Lean Manufacturing, lies as much in culture and mindset changes as in using the practices, tools and techniques (Dabhilkar y Ahlstrom, 2007; Spear y Bowen, 1999). In other words, organizational performance rest on the involvement of employees in lean activities and in rewarding them as a group. But previously, the organization has to activate the practices. To do so, it is needed training and communication.

However, in the industry studied, advanced operational management and human resource practices have been scarcely introduced. Therefore, several interesting issues are raised that we intend addressing in future research. For example, why are companies reluctant to empower their employees? Are there restrictions imposed by the nature of the product being manufactured, or the process, which prevent the greater use of Lean Manufacturing practices? What are the opinions of management regarding Lean Manufacturing and High Involvement practices – and are these views conditioned by the degree of use? Case study work would be especially useful in gathering the data needed for such an analysis.

Our work also has implications for company management because it provides a tool for auditing the level of use for various practices and outcomes. Assessment can be made of the current situation, and any future changes produced by the introduction of new practices.

Our research has some limitations. Firstly, no previous study has used exactly the same variables together – although all items used in our research were adapted from previous studies. Therefore, it is not easy to accurately compare equation coefficients, with the results of previous investigations. A second limitation comes from the fact that the study was

conducted in the context of a single country and industry. A third limitation is that there was a certain no-response rate, although response was very high. Furthermore, independent and dependent variables were measured using the same survey instrument, and this may have caused common method variance and potential common method bias. Another potential limitation is the bias of single informants. Although the use of single informants is widespread in operations management research; better quality data is produced by using multiple informants. Accepted methodological guidelines were followed to alleviate potential problems associated with using single informants. For instance, face-to-face interviews were used with the director of production, and subsequent factory visits were made to confirm and review the responses.

The Lean Manufacturing framework includes the use of human resource management practices which ensure the involvement of employees in their tasks. Our research aims to empirically test the relationship between Lean Manufacturing and High Involvement Work Practices; and the effect these practices have on the operational outcomes in the factory. These effects are tested by recording management perceptions, as well as objective measurements in an industry different than those usually studied in previous research (ceramic manufacturers in the Valencia region of Spain – a highly competitive and internationally successful sector). The results of our research show few significant relationships between the implementation of these practices and competitive advantage. This is probably because the above practices are very little used. This is true almost uniformly throughout all companies in the sector; with company cultures remains unchanged and employees enjoying little genuine autonomy or power

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