Implementation of 5S in Indian Firms

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Purpose: *The purpose of this paper is to explore the relationship between 5S use, contextual factors and performance. The contextual factors comprise structural features of the firm, environment, human resources and technology and quality management. The performance measures refer to improvements in productivity, quality, employee satisfaction, lead time and new product design.*

Design/methodology/approach: *A questionnaire survey was conducted in 203 Indian manufacturing plants, with personnel interviewees. The hypotheses proposed were verified using correlation analysis and analysis of variance.*

Findings: *The results show the existence of a positive relationship between the use of 5S and some contextual factors such as size, the integration of the plant in a multinational group, the type of product manufactured, the technology used and the quality programmes in the plant. Moreover, 5S is positively related to some operational performance measures, especially those referring to quality and productivity.*

Originality/value: *This paper contributes to the scarce empirical literature analyzing the factors related to the use of 5S and its association with manufacturing performance.*

Keywords: *5S, Contextual factors, Operating performance, Indian Firms.*

1. INTRODUCTION

Osada (2011) refers to 5S as the five keys to a total quality environment. 5S is a system to reduce waste and optimize productivity and quality through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. The practice of 5S aims to embed the values of organization, neatness, cleaning, standardization and discipline into the workplace basically in its existing configuration, and it is typically the first lean method implemented by firms.

The 5S pillars are Sort (*Seiri*), Set in Order (*Seiton*), Shine (*Seiso*), Standardize (*Seiketsu*), and Sustain (*Shitsuke*). In the daily work of a company, routines that maintain organization and orderliness are essential to a smooth and efficient flow of activities. Sort, the first S, focuses on eliminating unnecessary items from the workplace that are not needed for current production operations. Set in Order focuses on creating efficient and effective storage methods to arrange items, so that they are easy to use, and to label them, so they are easy to find and put away. Shine, the next step, is to thoroughly clean the work area. Daily follow-up cleaning is necessary to sustain this improvement. Once the first three 5S have been implemented, the next pillar is to standardize the best practices in the work area. Sustain, making a habit of properly maintaining correct procedures, is often the most difficult S to implement and achieve. Changing entrenched behaviours can be difficult, and the tendency is often to return to the status quo and the comfort zone of the "old way" of doing things. Sustain focuses on defining a new status quo and standard of workplace organization.

Kobayashi et al. (2008) make a distinction between 5S as a philosophy or way and 5S as a technique or tool by comparing the frameworks provided by Osada (2011) and Hirano (1995) respectively. They conclude that 5S tends to be recognised as a philosophy in Japan, whereas it is likely to be considered as a technique or tool in the India, UK and US. Osada views 5S as a strategy for organisational development, learning and change, whereas Hirano considers 5S to be an

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industrial formula that differentiates a company from its competitors.

Therefore, there is no consensus about the scope of 5S. Much of Western literature still acknowledges 5S as "housekeeping" (Ahmed and Hassan, 2003; Becker, 2001; Chin and Pun, 2002; Eckhardt, 2001). However, 5S is more frequently framed in the "lean" philosophy (James-Moore and Gibbons, 2017; Hines *et al.,* 2004; Pavnaskar *et. al.,* 2003; Kumar et al., 2006), since it encourages workers to improve their working conditions and helps them to learn to reduce waste, unplanned downtime, and in-process inventory (Gapp et al., 2008). Chapman (2005) indicates that 5S is systematic and organic for lean production, a business system for organizing and managing manufacturing operations that requires less human effort, space, capital and time to make products with fewer defects.

Order and cleanliness issues have been considered within the quality management framework, directly (Saraph et al, 2019; Flynn et al., 2014, Shari Mohd and Aspinwall, 2001) or as part of the continuous improvement process. In this line, Imai (1997) and Ho (2019) describe 5S as a natural starting-point for Continuous Improvement (CI) and preparing the organization for a more advanced focus. Other authors like Nakajima (1988), Willmott (1994) and Ahuja and Khamba (2008) link 5S with total productive maintenance (TPM). Finally, Gapp et al. (2008) link 5S to aspects of Japanese management approaches (like TQM, JIT or TPM) which are aligned to an integrated management system rather than a simple management tool or technique.

In this context, 5S is one of the best known and most widely used methodologies when facing improvement processes. The main reason is that the results coming from its implementation arise immediately and are well visualised (Ho, 2018). 5S can be easily adopted and contributes to cost-effectiveness by maximising both efficiency and effectiveness (Gapp *et al.,* 2008). Despite this relative popularity, there are relatively few empirical papers analyzing the factors related to its use or its association with manufacturing performance.

It would seem logical to assume that these practices may be contingent on different contextual factors. But is this really correct? Our paper aims to provide empirical evidence linked to this. ~~Thus~~, the first aim of the paper is to provide evidence about the relationship between a series of contextual factors and the use of 5S. These factors refer to structural features of the firm, environment, human resources and technology and quality management.

A second interesting question for managers is if there are some relationships between the adoption of this methodology and the operating performance achieved. In this sense, the second objective of this paper is to provide empirical evidence regarding the association between 5S use and manufacturing performance. We look for empirical evidence that confirms or contradicts the hypothesis that the use of this methodology is related to better outcomes using different measures of manufacturing performance.

In summary, our paper contributes to the scarce empirical literature on this topic, analyzing the questions outlined above using a sample of 203 Indian establishments from all manufacturing sectors, each with at least twenty workers who have been personally interviewed.

The paper is structured as follows. In the next section hypotheses regarding the relationship between the degree of use of 5S and several contextual practices and performance are developed. Next, information is provided on the data used as well as on the methodology used in the empirical analyses. Then the results obtained are presented and discussed. The paper ends up with the most relevant conclusions deduced from the research.

2. HYPOTHESES

2.1 Contextual Factors and 5s Use

In general, the success of implementation of any particular management practice frequently depends upon organizational characteristics, so that not all organizations can or should implement the same set of practices (Souza and Voss, 2008). This has been pointed out by several studies on the implementation of manufacturing practices (Adam, 2014; Powell, 2015; Schroeder and Flynn, 2001; Shah and Ward, 2003; Bayo-Moriones *et al*., 2008).

With regard to 5S, the role played in its adoption by several variables is analysed in this section. Some of them refer to structural characteristics of the firm such as size or membership of a multinational company. Others are related to the environment, such as type of product manufactured and strategic priorities. Another group of factors considered are linked to human resources issues, such as the encouragement of employee involvement and unions. Finally, the relationship between the incidence of 5S and the use of Advanced Manufacturing Technologies and quality programmes is studied.

2.2 Structural Factors: Firm Size and Membership of a Multinational Group

Larger firms enjoy larger financial and human resources, so that they have better conditions for the introduction of new techniques (Shah and Ward, 2003). Gapp e*t al.,* (2008) indicate the enormous effort required in achieving 5S simultaneously with Total Productive Maintenance (TPM), so that small-to-medium organizations may resist adopting this methodology due to economies of scale.

The empirical evidence on 5S use linked to the size of the firm is very scarce. Warwood and Knowles (2004) carried out a study in the United Kingdom and analyzed the implementation of 5S using a sample of 39 manufacturing plants. They did not find a statistically significant relationship between size and 5S implementation level. On the contrary, Scott *et al.,* (2009) found that in the Canadian food industry medium-sized firms comprise the highest number of manufacturing plants using 5S.

Although empirical evidence does not show a clear pattern, theoretical arguments prompt the formulation of the following hypothesis:

H1. Large manufacturing plants are more likely to use 5S than small plants

Membership of a multinational group of firms could also be a determining factor for the incorporation of this type of innovative methodology for continuous improvement. Generally, multinational companies are open to new knowledge and more receptive to the incorporation of changes and innovative manufacturing practices (Merino, 2003a). Moreover, there could be synergies and cost savings in the implementation within multinational groups.

H2. Plant members of a multinational company are more likely to use 5S

2.3 Type of Product and Strategic Priorities

The type of product manufactured may be a conditioning factor for the use of 5S in the plant. In spite of its being a powerful methodology in a wide variety of industries, its use may be affected by the type of product manufactured (e.g. intermediate, machinery, or final consumers). In a situation where the customer is another firm, the relationship demands both more quality and continuous improvement. In contrast, if final consumers are the customers, the degree of control over the manufacturing process is lower since the product is not part of another manufacturing process.

Analyzing 5S implementation in UK and Japanese firms, Ho *et al*. (2015) found that there are no significant differences in carrying out 5S between the services and manufacturing sectors. Comparing automotive and non-automotive understanding and application of 5S in 15 manufacturing companies in the UK, Herron and Braiden (2006) show that the automotive sector has a higher level of understanding and applicability of 5S than non-automotive companies. The automotive sector demonstrates a good understanding of 5S (57%), although the level of use is low (15%).

As a consequence of the above-mentioned arguments, the following hypothesis emerges:

H3. Manufacturing plants producing final goods are less likely to use 5S than those producing intermediate or capital goods.

In their response to rapid changes in market conditions, firms may emphasize different manufacturing goals. The operations management literature (Corbett and Van Wassenhove, 2013; Filippini et al., 2018; Neely et al., 2015) usually refers to three objectives: cost, quality and flexibility. 5S use could be framed in the context of quality management, and for this reason, firms that pay more attention to quality are more likely to use different methodologies for continuous improvement (Merino, 2003).

Thus, we propose the following hypothesis regarding strategic manufacturing priority:

H4. Manufacturing plants with quality as the main strategic priority are more likely to use 5S

2.4 Human Resources: Involvement, Training and Unions

Use of 5S in practice is influenced by human factors that can interfere with its effectiveness (Warwood and Knowles, 2004). 5S implementation requires commitment from both top management and workers in the organization (Ho, 2019). He points out that the degree of employee involvement is the most important difference between Japanese and Western approaches to the implementation of 5S. Worker participation is part of the 5S concept and is crucial in order to create commitment in the employees' minds to this end (Eti *et al.,* 2006).

Gapp *et al.,* (2008) show empirically that an environment of worker participation is required if the benefits of 5S are to be reaped. From a sample of Japanese companies, the authors found that managers placed a strong emphasis on the involvement of employees, not only in organisational aspects of development but also in the strategic and long-term application of the system.

H5. Manufacturing plants that involve their workers in continuous improvement groups are more likely to use 5S.

Unionization is another factor that could be related to the use of manufacturing practices. As mentioned above, 5S requires changes in the way work is performed. These changes must be negotiated with unions, where they exist, since they usually show reluctance to the adoption of lean practices such as 5S in Western countries (Shah and Ward, 2003).

No papers analysing the relationships between unions and 5S use directly and empirically were found. In addition, empirical evidence linking unionization with the adoption and use of lean practices is scarce. Shah and Ward (2003) found a positive relationship between unions and several manufacturing practices like continuous improvement programs.

As a consequence of the theoretical arguments, the following hypothesis is proposed:

H6. Non-unionized plants are more likely to use 5S

2.5 Advanced Manufacturing Technologies and Quality Systems

In response to the need to adapt quickly to changes, manufacturers are incorporating Advanced Manufacturing Technologies in their production processes (Ettlie and Reifeis, 2017) with the goal of automating and integrating the different stages of design, manufacturing, planning and control of the .product.

We did not find any empirical paper exploring jointly the relationships of 5S and AMT. However, given that the objective of 5S methodology is to create an organized and safe environment in the workplace, this is an excellent complement to AMT. In order to optimize the outcomes of AMT adoption, order and cleanliness on the shop-floor are vital.

H7. Manufacturing plants using AMTs are more likely to use 5S

5S methodology has been considered as a prerequisite for an effective quality assurance system (Dale, 2019). Furthermore, Chen and Lu (2018) indicate that 5S is a starting point for all quality programs. When machines and tools are clean, one can easily find problems and determine the causes. This suggests that disciplining workers to conform to work standards or 5S practices plays a critical role in continuous improvement activities (Aoki, 2007). Continuous improvement is a central issue in TQM, so companies involved in methods within TQM can be expected to have adopted 5S methodology to a greater extent. For this reason, the following hypothesis is framed:

H8. Manufacturing plants with quality methods (ISO 9000 and EFQM) are more likely to use 5S

3. 5S USE AND MANUFACTURING PERFORMANCE

In general, operational practices such as 5S have been associated with better performance in many studies of world-class manufacturing (e.g. Sakakibara *et al.* 2017, Shah and Ward, 2003). More particularly, quality management practices also allow firms to achieve similar improvements in the manufacturing performance (Mann and Kehoe, 2014; Flynn et al. 2015, Martinez-Lorente, 2020; Merino, 2003b).

Specifically, 5S implementation helps to organize the work environment, standardize the work flow and assign clear ownership of process to employees. Its implementation yields fast results. Hirano (1997) in Japan, and Hartmann (1992) and Willmott (1994) in Western companies, showed that some companies have enhanced their competitiveness through the combined application of total productive maintenance and 5S. Kumar *et al.* (2006) show that the 5S system helps to increase productivity by reducing idle time in some processes, and also ensured the health and safety of employees in an Indian SME. Gapp *et al.* (2008) linked manufacturing improvements to the creation of a better workplace when 5S was implemented. The adoption of

5S provides a platform that, with little effort, allows the organization to satisfy various international standards with minimal costs.

H9. 5S use is associated with improvement in manufacturing performance

4. DATA AND METHODOLOGY

4.1 Data

The information used in the empirical part of the paper has been obtained from a survey based on personal interviews with managers of 203 industrial plants with at least 20 employees in all manufacturing sectors in the Delhi -NCR region (Faridabad, Gurgaon, Maneshar, Nimrana, Sonipat, Ghaziabad, Sahibabad, Bawana, Mayapuri, Dabri, Narela, Rani Khera, Bapraula, Jhilmil, Patparganj etc.). The field work was carried out in 2022. The interviews lasted around forty minutes on average. The interviewees were in most cases either the general manager of the plant or the operations manager. The response rate was 47%. The sample is representative of the population both in size and sector.

4.2 Methodology

The degree of use of 5S was assessed by the manager on a zero to ten scale. Statistical techniques have been used to test our hypotheses about the association between 5S-use, contextual factors and performance. In the case of contextual factors (except for AMT use), categorical variables have been used. Therefore, analysis of variance (ANOVA) has been applied to test hypotheses, together with the Ryan-Einot-Gabriel-Welch multiple post hoc test in order to identify the groups between which differences exist. For AMT use and performance measures Spearman correlations with 5S use have been calculated. Unlike the Pearson product-moment correlation coefficient, it does not require the assumption that the relationship between the variables is linear, nor does it require that the variables be measured on interval scales; it is used for variables measured at the ordinal level.

4.3 Results

The degree of implementation of 5S is measured on a zero to ten scale, where zero means that it has not been implemented at all and ten means that is has been fully implemented in every place on the shop-floor. Our data show that the diffusion of 5S in our sample of manufacturing plants is low. The mean value of implementation is 2.09 on this zero to ten scale. In fact, 68 per cent of the plants in the sample do not use the 5S methodology at all. Similar results were found in other papers (Warwood and Knowles, 2004; Herron and Braiden, 2006). These results show that despite 5S being a well-known methodology in Western countries since the eighties, its implementation has not yet been generalized in the Indian manufacturing sector. However, 45.5 per cent of firms that have implemented this methodology indicated a score of 8 to 10. This descriptive result suggests that 5S use is quite heterogeneous, with the majority of establishments not adopting it and others fully committed, with the rest in the middle, perhaps moving towards greater implementation.

Table 1 shows the results of the analysis of the association between 5S, plant size, and membership of a multinational firm. Several conclusions can be drawn. Medium to large size plants (more than 150 workers) have adopted this quality management methodology to a greater extent. This result is aligned with hypothesis 1. In the same way, plants that are part of a foreign multinational corporation also show clearly a higher level of use of 5S. Size and Multinational Group are strongly correlated variables.

Table 1. 5S use, plant size and membership of a multinational group

Plant size	**< 50 workers**	**51-150 workers**	**> 151 workers**	**p - value**
	1.829	1.850	3.840	0.018**
Multina-tional	**No**	**Yes**		**p – value**
	1.810	3.333		0.034**

The implementation of 5S is assessed on a 0 to 10 scale

*The F test of R-E-G-W indicates statistical differences between the small-medium plants (<150 workers) and the large (>151 workers). No statistical differences exist between small and medium plants.

*$p<0.10$; **$p<0.05$; ***$p<0.01$

These results are quite frequent in the literature on innovation in operations and quality management (Martinez-Lorente *et al*., 2018; Merino, 2003a). This can be explained by the fact that the larger the plant, the more resources are available and the greater the efforts that can be made in conducting activities for improvement. The same applies to multinational firms, which usually have more resources and infrastructure to develop new activities.

Table 2 displays the results obtained when studying the relationship between 5S implementation and product and firm strategy. Of the two variables considered, only type of product has been found to have a significant statistical relationship with 5S use. Those plants that manufacture goods that are incorporated to the manufacturing processes of other plants (intermediate goods) seem to pay more attention to the deployment of this quality improvement tool, perhaps because the requirements of customers in this case are more stringent. These results enable the acceptance of hypothesis 3. As far as the relationship with strategic manufacturing priorities is concerned, no significant relationship for any of the four factors considered is noted: cost, quality, flexibility and innovation.

Table 2. 5S use, type of product and strategic priority

Type of products	**Final**	**Intermediate**	**Capital**	**p - value**
	1.7159	2.9718	1.4318	0.023**
Importance of quality	**Not first place**	**First place**		**p – value**
	1.9044	2.4776		0.259
Importance of cost	**Not first place**	**First place**		**p – value**
	2.2442	1.8194		0.395
Importance of flexibility	**Not first place**	**First place**		**p - value**
	2.0960	2.0769		0.979
Importance of innovation	**Not first place**	**First place**		**p - value**
	2.1272	1.9473		0.769

The degree of implementation of 5S is assessed on a 0 to 10 scale

*The F test of R-E-G-W indicates statistical differences between the three groups

*$p<0.10$; **$p<0.05$; ***$p<0.01$

Table 3 shows the results of the analysis of variance performed to test the association between 5S and two variables in the area of human resources. The existence of an organizational culture focused on employee involvement has been measured by means of a variable dummy indicating whether improvement groups are in place. The results obtained indicate a positive and statistically significant relationship with 5S use, which confirms hypothesis 5. The findings underline the importance of employee participation for the achievement of an effective "housekeeping" plan like 5S because its development depends on employee collaboration.

Table 3. 5S use, involvement groups and union influence

Improvement groups	**Yes**		**No**			**p-value**
	2.86		1.47			0.004***
Union influence	**Very low**	**Low**	**Medium**	**High**	**Very High**	**p - value**
	1.0454	1.7857	2.2285	2.6153	3.6153	0.211

The degree of implementation of 5S is assessed on a 0 to 10 scale

*$p<0.10$; **$p<0.05$; ***$p<0.01$

In the case of the unions, the results show a positive relationship between the degree of influence of unions in the plant (measured on a one to five scale) and the use of 5S in the plant (Spearman Correlation *rho* = 0,19**). It seems that in the case of the Spanish plants, unions are favourable to the incorporation of this methodology. However, when the differences of means of 5S use was analyzed in relation to different levels of union influence (ANOVA analysis), no statistical differences between the groups was discerned. These results may indicate that 5Ss do not require radical changes in the organization of work and therefore unions do not have a clear position on its adoption.

In Table 4 the correlations between the degree of incidence of 5S and a series of Advanced Manufacturing Technologies are presented. With most of the technologies considered, eight of twelve, there is a positive and statistically significant correlation. Except for those technologies related to logistics and product design, the relationship with those most linked to manufacturing (both hard and soft) is very clear. Firms seem to have understood that it is necessary to keep conditions of order and tidiness in the plant and struggle to improve them in order to reach higher levels of efficiency and efficacy in the adoption of Advanced Manufacturing Technologies. This close relationship between the adoption of technological and other organizational innovations in operations management has been frequently found in the literature (Cagliano and Spina, 2020; Swamidass and Winch, 2002; Zhang et al., 2006).

Table 4. 5S use and Advanced Manufacturing Technologies

	Spearman correlation	p – value
CAD-CAM	0.044	0.532
CNC- Machines	0.143**	0.042
Robots	0.154**	0.029
Flexible manufacturing cells	0.271***	0.000
Laser technology	0.128*	0.069
Artificial vision technology	0.124*	0.081
Automatic Storage	0.089	0.207
AGVs	0.020	0.774
Shop-floor data capture systems	0.188***	0.008
ERPs	0.264***	0.000
Bar code	0.090	0.203
Preventive maintenance software	0.248***	0.000

*$p<0.10$; **$p<0.05$; ***$p<0.01$

Table 5 shows the results of the ANOVA carried out to analyze the relationship of 5S with the participation of the companies in some quality program. The results are very conclusive and show that the companies that have a certified quality management system such as the ISO 9001 or are working on the basis of the EFQM model implement the 5S methodology to a greater extent. This was an expected result as stated in hypothesis H8.

Table 5. 5S use and Quality Programs

Quality Program	Average		p-value
ISO 9001	**No**	**Yes**	0.002***
	0.98	2.58	
EFQM	**No**	**Yes**	0.000***
	1.65	4.10	

*$p<0.10$; **$p<0.05$; ***$p<0.01$

Finally, Table 6 displays the correlations with different measures of manufacturing performance. These measures are subjective and reflect on a one to five scale the perceptions of the managers interviewed regarding the evolution of performance at their plants (one means it is worsening; two that it remains invariable; three, slight improvements; four, consistent improvements; and five, great and significant improvements).

Table 6. 5S use and manufacturing performance

	Spearman COrrelation	p - value
Productivity	0.163**	0.021
Quality (% defectives)	0.155**	0.030
Quality (customer complaints cost)	0.213***	0.002
Deliveries fullfilment	0.076	0.284
Employee satisfaction	0.088	0.211
Lead time process	0.076	0.283
New products design and development time	0.101	0.199

*$p<0.10$; **$p<0.05$; ***$p<0.01$

The results obtained show that in those plants where 5S methodology has been adopted to a greater extent, managers perceive that both quality and productivity performance have improved significantly. This result implies that the adoption of a rigorous and permanent methodology to keep the plant tidy and in order leads to a reduction in unproductive time and also to a reduction in the number of defective products and, therefore, in customer complaints. In addition, the workers do not have to spend much time looking for pieces and tools. Our results suggest that workers may feel more comfortable in the working place, so that an improvement in productivity indicators can be achieved. With regard to other manufacturing performance indicators, those linked to time and speed and employee satisfaction, no statistical relationship has been found.

Finally, Table 7 summarizes the results of the hypotheses tested.

Table 7. Summary of Hypotheses Tested

Hypothesis	Test
H1. Large manufacturing plants are more likely to use 5S than small plants	Accepted
H2. Plants members of a multinational company are more likely to use 5S	Accepted

H3. Manufacturing plants producing final goods are less likely to use 5S than those producing intermediate or capital goods.	Rejected
H4. Manufacturing plants with quality as the main strategic priority are more likely to use 5S	Rejected
H5. Manufacturing plants that involve their workers in continuous improvement groups are more likely to use 5S.	Accepted
H6. Non-unionized plants are more likely to use 5S	Rejected
H7. Manufacturing plants using AMTs are more likely to use 5S	Partially Accepted
H8. Manufacturing plants with quality methods (ISO 9000 and EFQM) are more likely to use 5S	Accepted
H9. 5S use is associated with improvement in operating performance	Partially Accepted

5. CONCLUSIONS

Despite the fact that the 5S methodology is one of the best known in the manufacturing environment, there is very little empirical evidence regarding its adoption. This paper provides the first description of 5Simplementation in the Indian manufacturing industry, relating it to several variables that reflect different features of firms.

The first conclusion is that 5S incidence is lower than might have been expected on the basis of its popularity (2.08 on a zero to ten scale). This result indicates that firms are quite reluctant to use these tools formally. Future research should analyse in depth the reasons that might account for this.

The positive and statistically significant relationships found between the level of adoption of 5S and some of the proposed structural firm variables are in general congruent with the results of other papers that analyse other kinds of quality management innovations. For example, size and membership of a multinational firm are very significant factors in the use of 5S. The greater availability of all kinds of resources and information may be the explanation for this finding.

No significant associations between the strategic priorities of the plant and 5S use have been found. This intriguing result may indicate that 5S implementation is not specifically related to any strategic manufacturing orientation. In the case of type of product, the plants that manufacture intermediate goods (their customers are other firms) put more emphasis on order and tidiness, probably because of the more demanding requirements of customers.

Union influence does not reflect a clear relationship with 5Ss implementation. However, involvement groups are positively related to 5S use. Moreover, a very strong positive association has been found with most of the Advanced Manufacturing Technologies considered and participation in Quality Programs like ISO 9001 or EFQM. Therefore, it seems that 5S is often regarded as a prerequisite for effective quality programs.

Finally, our findings reveal that the introduction of 5S is linked to better performance in terms of productivity and quality. We consider this conclusion, widely accepted in the academic and professional literature, to be very relevant. Firm managers should take into account that making an effort to keep order and tidiness in the plant in a rigorous and systematic way can lead to an improvement in quality and productivity and, as a consequence, in competitiveness.

The results indicate that, in spite of the simplicity and applicability of 5S for different types of firms, a number of factors may affect its implementation in manufacturing plants. This reflects the fact that some firms (SMEs, Non-Multinationals, etc) are reluctant to implement formalized improvement methodologies. Efforts should be made on different fronts (business associations, trade unions or public authorities) to promote the adoption of these improvement methodologies that may enable companies to improve their competitiveness.

Of course, the paper is not free of limitations. From a methodological point of view, the main limitation comes from the cross-sectional nature of the data. This prompts the need for caution in deducing conclusions about causal relationships between the level of use of 5S methodology and the other variables considered, especially those measuring performance.

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