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Lean contribution to the companies' sustainability

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Abstract. In recent years, there has been an increase in the adoption of lean manufacturing principles, as well as tools, in multiple industrial sectors. In fact, this management philosophy, which is already well-established, has been applied successfully in other various contexts than just production. However, companies are under pressure to manage their activities, considering their effects in social and environmental terms. In this sense, this study aims to characterize the acceptance of lean by Portuguese companies, as well as the results obtained both in terms of Environmental, Social, and Governance (ESG), as well as in terms of organizational competitiveness (COM) by companies with lean implemented. To this end, a questionnaire was distributed to 3957 companies operating in Portugal, having obtained a total of 373 responses, of which 201 were validated, i.e., a rate of 53.89% valid responses. The results of this study show that companies with lean adopted, also adhere to green management practices (GMP), managing to improve their performance relative to each one of the dimensions of the triple bottom line (TBL), i.e., their ESG outcomes, as well as their COM.

Keywords: Lean, Sustainability, Competitiveness, Triple Bottom Line, Survey.

1 Introduction

Lean, also known as lean manufacturing, or lean thinking, seeks to continuously improve production processes, through the removal of what does not bring value for the product [1] and/or service.

In fact, for lean philosophy, avoiding the occurrence of waste is a key point [2]. In this sense, given the success in this chapter, its tools and principles can currently be noticed in various sectors of the industry, showing interesting outcomes [1], as well as in contexts beyond the industrial one [3]. Nevertheless, there is an increased pressure for companies to handle their activities in a responsibly way with regard to their effects on the environment and on society [4]. In addition, there is still little empirical studies about the impacts of lean on the environmental pillar [5,6], as well as on the social one [7], so there is a lack of clarification of these aspects [5]. Thus, the present study aims to assess the degree of adherence to lean by the companies that operate in Portugal and

what results have been obtained, by the ones who adopted lean, in relation to its ESG, as well as in terms of its organizational COM. In this sense, a questionnaire was distributed to 3957 companies operating in Portugal to assess if they have lean adopted and, if so, what results they have obtained in terms of the ESG components and its organizational COM.

2 Literature Review

2.1 Lean connection with triple bottom line

Lean and its methodologies are recognized on a global scale for the gains they bring to companies [8], since it emerged as an alternative for the management and organization of manufacturing companies [9], above all. According to the literature, which addressed the adoption of this type of practices, most of them report gains related to cost reduction and increases in the quality of products and/or services, as well as gains in productivity [10,11]. As such, considering the eight types of waste that lean seeks to eliminate, i.e., defects, inadequate processing, overproduction, transportation, unnecessary inventory and movement [1], besides the waste of workers skills [2], this indicates that it has also potential for help companies in achieving a production system more environmentally sustainable and socially responsible. In other words, better outcomes in terms of ESG [6]. However, as mentioned before, not many studies have listed lean contributions to the environmental pillar [12], and, mainly, to the social one [9].

In fact, given the pressure from companies' stakeholders, it is necessary today to have a positive performance in all components of the TBL [13]. This led to the introduction of green management term, which translates into a set of environmental strategies and methods with the aim of making companies more ecologically efficient [6,14]. In this sense, there is some literature that points out that lean enables green concept to be adopted [15]. As such, with the joint adopting both lean and GMP, companies can potentially enhance their cost and environmental risk reduction, enabling them to obtain a better social image among their stakeholders [16]. This indicates that both concepts (lean & green) are concerned with the efficient use of resources, i.e., removing waste [17,18] and by that way, sharing a common point with sustainability concept [19].

2.2 Lean & green techniques and sustainable outcomes

There is a significant amount of literature that points out lean positive effects on economic/operational dimension, namely through its practices and tools. According to Rodrigues et al. [20] study in a metalworking organization, through the implementation of ten lean tools (e.g. 5S and daily kaizen), it was possible to obtain “quick-wins”, i.e., fast positive gains, namely in terms of operational efficiency and increased workers motivation. However, even though lean has already proven to help obtaining positive results, mainly in operational terms, there is a lack of holistic studies about its impacts on the TBL in an integral way [21]. In this sense, there are a few studies that have reported positive benefits to the other components of sustainability, including through

its combination with green concept. For instance, in the case study of Cheung et al. [22], at a plastic injection molding company, through the application of a model which integrated lean tools (e.g. Kanban and 5s) and green tools (life cycle assessment), it was possible to reduce the organization ecological impact by 40%. This allowed also to decrease its pollutant emissions (40%) and its electricity costs (41%).

In terms of social impact, Cordeiro et al. [9] found, through a case study in a hospital maintenance services organization, that lean tools (e.g. 5S and One Point Lesson), induces better working conditions (e.g. 80% decrease in the time spent in routes for picking materials and tools). As for Gonçalves et al. [8] study, these researchers created the Safety Stream Mapping (SSM) tool, in order to assess the safety risk level of a textile organization. This came from the combination of two tools (Value Stream Mapping and Waste Identification Diagram), which allowed to pinpoint this company most critical areas and by that way, to contribute to its social pillar.

3 Method

This investigation is based on an online questionnaire that was addressed to companies from multiple sectors of activity in Portugal, namely 3957, gathered from Portuguese Institute of Accreditation (IPAC) annual list. Its distribution, done through Google Forms followed by a short message, took place during the four final months of the second semester of 2020 until the middle of the first semester of 2021. The contacted firms were asked to forward the questionnaire, preferably, to people who held leadership positions and who had knowledge about lean and/or continuous improvement.

The criterion used for validating the responses was that the contacted companies had adopted lean and, if they did not have it, the questionnaire was then automatically closed. The questionnaire was divided into 10 sections. The first one with a short presentation of the investigation aim. The second one, related to demographic questions about the organization and the third one about the respondent profile. The fourth one, determined if the respondent could progress to the following sections. This advance depended on whether the organization had (or not) lean adopted, and for this the respondent was asked about which lean management practices (LMP) and tools were in place and how long ago. From the fifth to the tenth section, the respondent was asked to score, according to a Likert scale from 1 ("strongly disagree") to 7 ("strongly agree") a set of different items. Fifth section aimed to assess the degree of implementation of LMP, through a set of 15 items that sought to capture the different types of waste that lean aims to eliminate. Sixth section aimed at capturing whether the companies also applied GMP, i.e., they also incorporate the green concept, through 13 items. Sections seven to nine, sought to evaluate the results in terms of companies' TBL, i.e., operational performance (OPE), environmental performance (EPE) and health and safety performance (HSP), considering their last year, but without the effect caused by the covid-19 pandemic, through a set of 7, 14 and 10 items, respectively. Finally, tenth section sought to understand how respondents scored their companies in relation to their organizational COM, through a set of 9 items. Moreover, it is worth mentioning that respondents were instructed to respond to sections seven to ten, based on their

responses in the previous two sections. A total of 373 responses were obtained, but only 201 were validated, i.e., 53.89% valid responses, since only these were from firms with lean adopted, these being this study sample.

3.1 Sample and Data Collection

In this section, this study sample is described. The responses obtained demonstrate that most of the companies have their headquarters in Portugal (98%) with only 2% being based abroad, namely in Spain, France, Brazil and the United States of America (Table 1). In terms of its regions' distribution throughout Portugal (Table 1), considering the Nomenclature of Territorial Units for Statistical Purposes (NUTS II), it is verified that most companies' headquarters are based in the North and Center regions (79.5%).

Table 1. Distribution of companies' headquarters by country and region (based on NUTS II)

Country	Total	%	Region of Portugal	Total	%
Portugal	197	98%	North	89	45%
Brazil	1	0.5%	Center	68	34.5%
France	1	0.5%	Lisbon Metropolitan Area	37	19%
Spain	1	0.5%	Alentejo	2	1
United States of America	1	0.5%	Algarve	1	0.5
Total	201	100%	Total	197	100%

Regarding the sector of activity (Fig. 1), most of the companies operate in the industrial sector (62%). Within this sector, the metallurgical one is the most representative (30%), followed by the textiles and clothing sector alongside with the automotive one, both representing 12% of all the companies that compose the industrial sector percentage.

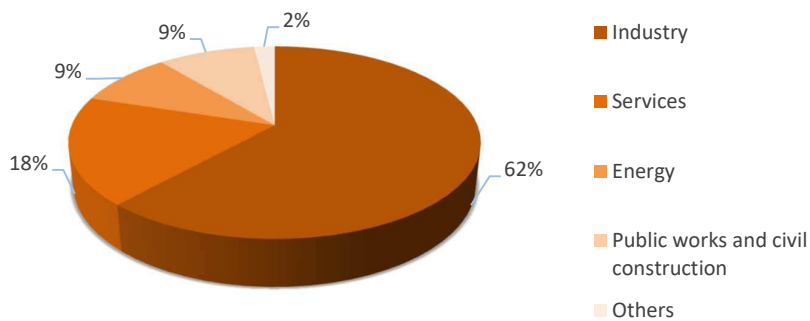


Fig. 1. Distribution of the companies for sectors of activity

As for the companies' size (Table 2), there is a higher representation of small and medium-sized companies (SMEs) (74%), i.e., companies with less than 250 employees.

In this sense, these data show that, in this sample, SMEs are predominant in relation to large companies (26%).

Table 2. Distribution of companies by size

Companies' dimension	Total	%
SMEs	149	74%
Large companies	52	26%
Total	201	100%

Table 3 shows the position held by each respondent in their company, which shows there is a greater predominance of department managers (47.8%).

Table 3. Respondent job title

Title	Total	%
Department manager	96	47.8%
CEO	33	16.4%
Quality manager	27	13.4%
Health and safety manager	5	2.5%
Sustainability manager	5	2.5%
Other	35	17.4%
Total	201	100%

4 Results

In this section, the results obtained through the questionnaire are reported. According to the LMP construct results (Table 4), which had a global score of 80.4%, it appears that indeed most of the companies that declared to apply lean, have in place practices to reduce improper processing, overproduction, transport, unnecessary stocks and movement, as well as the waste of the workers capacities. The aspects with highest score were the promotion of 5S (83.2%) and error proofing systems (i.e., poka-yoke) (82.8%). Similarly, the same happens for the GMP construct (Table 4), which had a global score of 77.0%, showing that companies that have lean adopted are also committed to the application of GMP, mostly in the design of environmentally sustainable products/services, which had a score of 80.9%, as well in promoting a policy of reusing equipment's and materials, which had a score of 80.6%.

Table 4. Questionnaire results for LMP and GMP

Measure	Construct	
	LMP	GMP
Score (%)	80.4	77.0
Average	5.6	5.4
Standard deviation	1.3	1.5

As for the respondents' assessment of their companies TBL performance (Table 5), it appears that, in each of its dimensions (financial, represented by OPE, environmental, represented by EPE and social, represented by HSP), there has been an improvement in the past year, which means that TBL was enhanced as well. In terms of the OPE construct, which had a global score of 78.0%, the aspects with the highest score were compliance with established commitments (80.8%), such as delivery deadlines, and the increase in the quality of products/services (82.4%), considering the perspective of its stakeholders. Regarding EPE construct, which had a global score of 76.0%, the aspects with the highest score were the reduction in the number of accidents and/or near-environmental accidents (78.9%), besides the compliance with the applicable environmental legislation (85.64%). In the HSP construct, which had a global score of 82.5%, the aspects with the highest score were compliance with the applicable safety regulations (87.0%), employees worked hours being lower than the maximum value stipulated by law (83.6%) and the reduction in the rate of occurrence of high-severity accidents (84.7%). Regarding the COM construct (Table 5), this was the one that got the highest global score (84.0%). In this sense, the aspects that contributed the most to this result were the score attributed to best social image, among their stakeholders (87.8%), and the highest degree of customer loyalty (87.1%), both in relation to their competition.

Table 5. - Questionnaire results for sustainability performance and competitiveness

Measure	Construct			
	OPE	EPE	HSP	COM
Score (%)	78.0	76.0	82.5	84.0
Average	5.5	5.3	5.8	5.9
Standard deviation	1.2	1.5	1.3	1.2

5 Discussion

The results of this study show that the lean philosophy is increasingly adopted in companies from different sectors of activity, that operate in Portugal. Moreover, it shows that firms where LMP are implemented, GMP are also being considered, given the relatively high overall score that the GMP construct obtained (Table 4), which may be due to the lack of studies that report (positive) effects of LMP on environmental [12] and, mainly, on social terms [9]. Regarding the results related to the TBL performance of companies (Table 5), these suggest that both LMP and also GMP can promote its improvement in each of its three dimensions. In this sense, stands out the HSP (82.5%), namely not only through the aforementioned compliance with safety rules and working hours limits plus the decrease in the rate of high-severity accidents, but also in improving working conditions and the capacity for detecting safety problems, which had, respectively a score of 82.9% and 79.9%. This way, these results are aligned with Cordeiro et al. [10] study, who found that lean tools can lead to better working conditions. In addition, regarding the EPE (76.0%), it was found that the aspect linked to the reduction of polluting emissions was also scored high (78.2%). This corroborates the findings of Cheung et al. [22] study. In terms of the results related to the OPE (78.0%),

as expected, they were also positive, emphasizing, besides the previously mentioned aspects, the aspect related to the improvement in the management of available resources with a score of 78.1%. In this sense, these results corroborate the study of Rodrigues et al. [20]. Finally, it is interesting to note that the COM construct is where companies' respondents self-assessed themselves with a higher global score (84.0%), standing out, besides the aspects already mentioned, the aspect related to the greater reliability of their products and/or services, relatively to its competition, with a score of 85.9%.

6 Conclusion

The analysis carried out in this study, using data collected through a questionnaire, addressed to companies operating in Portugal, indicates that LMP, as well as GMP, can help to respond to stakeholders requests regarding the TBL performance by contributing (positively) to its improvement as a whole [13], i.e., ESG outcomes, in addition to the organizational COM. In addition, this study results also suggest that LMP and GMP may be compatible, allowing to achieve positive performance, not only in operational terms, but also in environmental and health and safety terms, conjunctly. As for the fact that the organizations surveyed have also assumed that they have GMP in place, this suggests that these organizations, where lean is adopted, seek to boost their TBL performance and, in turn, their organizational COM, by combining LMP with GMP. Future studies can focus on comparing the TBL performance, as well as organizational COM, between lean versus non-lean organizations, in order to verify if there are significant differences, since this study focused only on lean organizations. Another interesting possibility for future researches is to seek to analyze the effects of lean on sustainability and COM, considering the size of companies', namely the SMEs. Finally, future studies can consider the number of years that companies have adopted lean, in order to try validate the results obtained and to identify if there are significant differences.

References

1. R. Lopes, L. Teixeira, and C. Ferreira, "Lean thinking across the company: successful cases in the manufacturing industry," in *Lean Manufacturing: Implementation, Opportunities and Challenges*, F. Silva and L. Ferreira, Eds. Nova Science Publishers, Inc., 2019, pp. 1–31.
2. M. Brito, A. L. Ramos, P. Carneiro, and M. Gonçalves, "The Eight Waste: Non-utilized Talent," in *Lean manufacturing: implementation, opportunities and challenges*, Nova Science Publishers, Inc., 2019, pp. 151–164.
3. R. Lopes, F. Freitas, and I. Sousa, "Application of Lean Manufacturing Tools in the Food and Beverage Industries," *J. Technol. Manag. Innov.*, vol. 10, pp. 120–130, 2015, doi: 10.4067/S0718-27242015000300013.
4. H. C. M. Leon and J. Calvo-Amodio, "Towards lean for sustainability: Understanding the interrelationships between lean and sustainability from a systems thinking perspective," *J. Clean. Prod.*, vol. 142, pp. 4384–4402, 2017, doi: 10.1016/j.jclepro.2016.11.132.
5. J. A. Garza-Reyes, V. Kumar, S. Chaikittisilp, and K. H. Tan, "The effect of lean methods and tools on the environmental performance of manufacturing organisations," *Int. J. Prod. Econ.*, vol. 200, pp. 170–180, 2018, doi: 10.1016/j.ijpe.2018.03.030.

6. F. J. G. Silva, R. M. Gouveia, "Cleaner Production – Toward a better future," Springer Nature Publishing, Cham, Switzerland (2020). ISBN: 978-3-030-23164-4.
7. P. K. Dey, C. Malesios, D. De, S. Chowdhury, and F. Ben Abdelaziz, "The Impact of Lean Management Practices and Sustainably-Oriented Innovation on Sustainability Performance of Small and Medium-Sized Enterprises: Empirical Evidence from the UK," *Br. J. Manag.*, vol. 31, no. 1, pp. 141–161, 2020, doi: 10.1111/1467-8551.12388.
8. I. Gonçalves, J. C. Sá, G. Santos, and M. Gonçalves, "Safety stream mapping—a new tool applied to the textile company as a case study," in *Studies in Systems, Decision and Control*, vol. 202, Springer International Publishing, 2019, pp. 71–79.
9. D. Powell and P. Coughlan, "Corporate lean programs: Practical insights and implications for learning and continuous improvement," in *Procedia CIRP*, Jan. 2020, vol. 93, pp. 820–825, doi: 10.1016/j.procir.2020.03.072.
10. P. Cordeiro, J. C. Sá, A. Pata, M. Gonçalves, G. Santos, and F. J. G. Silva, "The Impact of Lean Tools on Safety—Case Study," in *Studies in Systems, Decision and Control*, vol. 277, Springer, 2020, pp. 151–159.
11. F. J. G. Silva, L. P. Ferreira, "Lean Manufacturing – Implementation, Opportunities and challenges," Nova Science Publishers, NY, U.S.A. (2019). ISBN: 978-1-53615-725-3.
12. M. Dieste, R. Panizzolo, and J. A. Garza-Reyes, "Evaluating the impact of lean practices on environmental performance: evidences from five manufacturing companies," *Prod. Plan. Control*, 2019, doi: 10.1080/09537287.2019.1681535.
13. K. Das, "Integrating lean systems in the design of a sustainable supply chain model," *Int. J. Prod. Econ.*, vol. 198, pp. 177–190, 2018, doi: 10.1016/j.ijpe.2018.01.003.
14. L. K. Toke and S. D. Kalpande, "Critical success factors of green manufacturing for achieving sustainability in Indian context," *Int. J. Sustain. Eng.*, vol. 12, no. 6, pp. 415–422, Nov. 2019, doi: 10.1080/19397038.2019.1660731.
15. C. M. Dües, K. H. Tan, and M. Lim, "Green as the new Lean: how to use Lean practices as a catalyst to greening your supply chain," *J. Clean. Prod.*, vol. 40, pp. 93–100, 2013, doi: 10.1016/j.jclepro.2011.12.023.
16. S. Silva, J. C. Sá, F. J. G. Silva, L. P. Ferreira, and G. Santos, "Lean Green - The Importance of Integrating Environment into Lean Philosophy - A Case Study," in *Proceedings of the 6th European Lean Educator Conference*, 2020, pp. 211–219.
17. B. Verrier, B. Rose, E. Caillaud, and H. Remita, "Combining organizational performance with sustainable development issues: The Lean and Green project benchmarking repository," *J. Clean. Prod.*, vol. 85, pp. 83–93, Dec. 2014, doi: 10.1016/j.jclepro.2013.12.023.
18. D. Correia, F. J. G. Silva, R. M. Gouveia, T. Pereira, L. P. Ferreira, "Improving manual assembly lines devoted to complex electronic devices by applying Lean tools," *Procedia Manuf.*, Vol. 17, pp. 663-671, 2018. doi: 10.1016/j.promfg.2018.10.115.
19. A. de Carvalho, A. Granja, and V. da Silva, "A Systematic Literature Review on Integrative Lean and Sustainability Synergies over a Building's Lifecycle," *Sustainability*, vol. 9, no. 7, p. 1156, Jul. 2017, doi: 10.3390/su9071156.
20. J. Rodrigues, J. C. Sá, F. J. G. Silva, L. P. Ferreira, G. Jimenez, and G. Santos, "A Rapid Improvement Process through 'Quick-Win' Lean Tools: A Case Study," *Systems*, vol. 8, no. 4, p. 55, Dec. 2020, doi: 10.3390/systems8040055.
21. R. Henaio, W. Sarache, and I. Gómez, "Lean manufacturing and sustainable performance: Trends and future challenges.," *J. Clean. Prod.*, vol. 208, pp. 99–116, 2019, doi: 10.1016/j.jclepro.2018.10.116.
22. W. M. Cheung, J. T. Leong, and P. Vichare, "Incorporating lean thinking and life cycle assessment to reduce environmental impacts of plastic injection moulded products," *J. Clean. Prod.*, vol. 167, pp. 759–775, 2017, doi: 10.1016/j.jclepro.2017.08.208.