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Competitive Priorities and Lean–Green Practices—A Comparative Study in the Automotive Chain' Suppliers

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Abstract: For organizations to remain competitive, they must now adapt to sustainability requirements, which have become performance criteria for supplier selection for most original Equipment manufacturers (OEMs). In this sense, environmental performance is now included as a competitive priority throughout the supply chain. Therefore, this study aims to verify, through two case studies, the competitive priorities of two first-tier suppliers from the automotive chain that have adopted lean and green practices. The findings show that the quality priority is the main source of competitive advantage and the focus of the operations that are analyzed here, while the environmental priority is not considered the most important by the companies. However, it is still included as a priority. Furthermore, it is demonstrated that lean practices could generate compatibility for the environmental priority, even indirectly, while trade-offs can arise between priorities. Therefore, the integration between lean and green practices can facilitate the inclusion of the environmental priority into the operations strategy and management systems.

Keywords: lean–green; sustainability; competitive priority; operations strategy; supplier

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1. Introduction

1.1. Contextualization and Research Objective

As shown by Skinner (1969) [1] in his seminal article, manufacturing balances consumer demands and production function resources. Thus, industrial operations play a crucial role in achieving these goals. Remarkably, operations strategies that address environmental issues have been adopted by organizations through the inclusion of environmental performance as a competitive priority, referred to here as the "environmental priority" [2–4].

In this context, to be competitive, organizations have to establish long-term strategies to achieve environmental sustainability, and all supply chain members have an essential role in supporting this [5]. Besides managers, researchers in operations management also face a significant challenge in including an environmental priority [6]. In this context, equalizing the cost, quality, delivery, flexibility, and service priorities in a stable trade-off become an urgent necessity [7]. Along these lines, organizations and researchers have sought solutions that promote the integration and alignment of practices, enabling operational (lean) and environmental (green) gains [8,9].

The literature discusses the integration of lean manufacturing, known as the production management philosophy, and green manufacturing, an approach to reduce environmental impacts in manufacturing. This integration is named lean–green manufacturing and has been understood as a key to improving the competitiveness of organizations as a way to balance the environmental priority with the other competing priorities [3,7,10,11].

The literature also points out several compatible aspects between these approaches. Especially regarding the reductions in waste generated by lean processes that lead to the efficient use of resources, this approach can indirectly lead to the removal of negative environmental impacts caused by production flows [12]. Additionally, there are studies such as the paper by Jamali et al. (2017) [13] that argue that competitive strategies can implement lean and green practices. However, there are studies such as the one by Suifan (2019) [7] that point out that the competitive priorities can differ in each approach. However, these studies still do not provide a wide understanding of the relationships between lean–green and operations strategies.

Furthermore, a literature review [14] showing the current state of the trade-offs between the competitive priorities of lean and green processes found a few studies that have developed and validated a conceptual framework that seeks to put into context these practices. Additionally, there are discussions about digital innovations and their impacts on improving environmental performance, as presented by Yin et al. (2022) and Queiroz et al. (2022) [15,16].

Therefore, although synergies between lean and green processes and issues related to new technologies have been presented, these studies have not provided a discussion from a strategic perspective while presenting and understating the competitive priorities of such integration [4]. Considering the relevance of the operations for an organization's global strategy and the lack of studies about the lean–green approach from the operations strategy perspective, an analysis of the competitive priorities can provide an update about how these practices relate to the competitive strategy.

In this fashion, the following question arises, "What are the competitive priorities in companies that adopt lean and green practices?".

Given this background, this paper aims to identify the competitive priorities of two first-tier supplier companies of the automotive chain that have adopted lean and green practices, specifically to understand how these priorities are ordered and how the environmental priority is considered. This industry is considered a reference case for lean manufacturing. Consequently, most of the lean–green models are developed in organizations in the automotive industry [17].

The remainder of this paper is organized as follows. Section 2 presents the fundamental concepts about the competitive priorities of operations strategy and the lean and green approach. Next, Section 3 describes the research method. Section 4 presents the results and a discussion. Finally, the final considerations of this study are also given.

1.2. Theoretical Background

1.2.1. Competitive Priorities

The corporate strategy gives rise to the functional designs of a company, among them the operations strategy, which will be the focus of this study and is considered the primary source of competitive advantage over the last 40 years and until today, meaning it deserves attention [18,19]. Additionally, the operations strategy seeks to define an organization's business operations and decisions regarding the acquisition and allocation of resources. It is aimed at the entire organization [20].

Skinner's (1969) [1] study was the pioneer in highlighting and conceptualizing operations strategy, showing the importance of incorporating and aligning the operational elements of the production function into the corporate strategy. According to this author, production should be considered strategic and a source of competitive advantage. In this way, companies must recognize and establish a relationship between corporate and operations strategies so that the production systems are competitive and collaborate to achieve the organization's goals [21]. Hence, the operations play a decisive role in achieving a favorable competitive position [22].

In this sense, the operations strategy is defined as a sequence of decisions that over time allow a business unit to achieve a structure, the desired production infrastructure, and a set of specific resources, i.e., a consistent pattern of decision-making in the production function, aligned to the business strategy [20].

The content of the operations strategy is related to the company's decisions around the corporate system's effectiveness [23]. This is a set of competitive priorities related to the operations and decisions in the structural and infrastructural areas of production [24]. The competitive priorities are related to the performance objectives that the production function adopts to align with the company's competitive strategy [1]. In other words, as the organization outlines a strategy to meet the market requirements, it is determined how the operations need to be performed [25].

The competitive priorities of production, also called performance objectives, competitive dimensions, and production missions, should be part of the priorities that will guide the programs to be implemented by the production function of a company. This means competitive priorities represent how the company will meet customer needs concerning the production function's performance targets. In other words, they define how the company intends to compete in the market to meet the needs of its customers [26].

In this article, the competitive priorities proposed by Garvin (1993) [27] and Slack and Lewis (2011) [25] are adopted, which represent the most recurrent studies on operations strategy. Hence, the adopted priorities for this research are the cost, quality, delivery, service, flexibility, and environment. The cost priority may be related to the objectives of reducing the costs of acquisition, production, and distribution and the price to customers. The quality priority involves aiming to produce goods according to specifications, aesthetics, perceived quality, and performance. Flexibility is the ability to react to changes in the volume and mix of products and in the production schedule. The delivery priority is related to reductions in lead time between the beginning and the end of the operations. Additionally, it is related to the availability and quicker delivery of the product and meeting the agreed delivery deadline. Finally, the environmental priority is the search to reduce the environmental impacts from energy consumption, the use of materials, gas emissions, and waste generation from certain processes, as presented in the lean and green literature [3,28–31].

The inclusion of the environmental priority might make operations management even more complex, given that this impacts the company's performance in a multidimensional manner [32]. Thus, when the environment is considered a competitive priority, it is essential to consider the environmental issues in the operations strategy. Consequently, modifications or redesigns of the operations strategy are required [33].

Furthermore, it is crucial to consider that there are trade-offs between the competitive priorities, as argued by Skinner (1969) [1]. For this author, the organization must prioritize only one or another competitive priority, seeking to be better than its competitors. The operations must be focused once it is not possible to obtain low cost and quality at the same time. To this effect, Skinner (1969) [1] explains that organizations must make certain decisions regarding the size of the manufacturing unit, whether to have high stocks or low stocks, the types of equipment to be used, and the level of standardization. In summary, Skinner (1974) [34] introduced the concept of a focused factory, which concerns the impossibility of a factory working well for all competing priorities.

However, Sarmiento, Thurer, and Whelan (2016) [35] consider it is possible to focus on more than one priority. However, choices need to be made and trade-offs are inevitable, since a production system must be excellent to meet all criteria to create a competitive advantage. In a context where competitiveness increases and it becomes necessary to meet more than one customer need, the trade-off model proposed by Skinner (1969) [1] is questioned. Such questioning culminated in the proposal of a cumulative capabilities model that simultaneously implies high performance in more than one competitive priority [36].

In one of the first studies on cumulative production capabilities, as pointed out by Boyer and Lewis (2002) [36], Japanese organizations developed productive capabilities based on a previously established order, and the practices adopted allowed cost reductions and the production of quality products simultaneously. Ferdows and De Meyer (1990) [37] propose the "sand cone model", which establishes that the organization can achieve all competitive priorities over time and that there is an adequate sequence for their construction, with quality being considered the basis for the implementation of other improvements. In this way, Ferdows and De Meyer (1990) [37] also argue that it is important to focus on avoiding failures in the system, and that in this way the costs could be reduced by means of other capabilities, such as via better quality in the processes. The authors also point out that improvements obtained through good production practices are more lasting and stable.

However, Flynn and Flynn (2004) [38] noted no evidence for the sequence of priorities presented in the sand cone model. The authors argue that the development of cumulative capabilities is complex and not limited to a specific sequence, as several factors influence it.

Regarding the inclusion of the "environment" as a new competitive priority, the literature emphasizes possible trade-offs that may arise between the environment and the other priorities [4,39]. Vargas-Berrones, Sarmiento, and Whelan (2020) [39] show for small- and medium-sized enterprises (SMEs) that the implementation of some green initiatives may be extraordinarily costly, and this scenario could discourage businesses from pursuing them. However, according to Porter and Linde (1995) [40], it is possible to meet the economic and environmental objectives of products and processes, since the preservation of resources generates greater process efficiency.

1.2.2. Lean–Green

Lean manufacturing emerged in the 1950s. It is considered a management philosophy and has been one of the most widely used approaches to managing operations [41]. Lean manufacturing has been considered a great solution to improve all kinds of processes, in the production of both goods and services [42]. Lean manufacturing is a set of principles and practices that seek to eliminate all forms of waste from processes. The main lean practices are 5S, Kaizen, value stream mapping, just-in-time (JIT), rapid tool change, total productive maintenance, standardization work, visual management, 5 whys or Ishikawa diagram (fishbone), and Kanban (pull production) [43]. In addition, the focus on the implementation of lean systems is via delivery (lead time reductions), quality, and cost reduction [7,42,44]. Organizations from various industries around the world are adopting lean practices to become more competitive [45].

On the other hand, green manufacturing emerged in the 1990s as an operational and philosophical approach to reducing the adverse environmental effects of products and processes [3]. In short, this approach aims to reduce the impacts generated by operations and deals with the search for reduced pollution, energy consumption, and emissions of toxic substances through the development of new processes in manufacturing [46].

Green manufacturing is composed of different practices. These practices seek to reduce the environmental impacts generated by production processes, such as via the environmental accreditation of suppliers and the use of product life cycle analyses, reverse logistics, environmental management systems, waste management policies, and effluent treatments, as well as via programs for water conservation, energy, recycling, materials consumption, and environmental education [47].

The pioneering study on lean and green manufacturing was presented in 1996 by Florida (1996) [11] and discussed the integration of these approaches, exploring how organizations could include the environmental issue in manufacturing through the "lean–green" approach, arguing that the waste reduction generated by lean manufacturing contributes to environmental performance. Based on the previous literature, the lean–green concept is understood as an approach that supports the search for sustainable development in the economic, environmental, and social pillars of a production system [48] and focuses on waste reductions and the efficient use of resources [3,12,49].

Some studies [50–52] have shown that lean manufacturing can bring environmental benefits and that this can be attributed to the more efficient use of resources (such as water and other inputs). In lean implementation cases, it is possible to note many improvement efforts to reduce variation or waste from operations [53,54]. Thus, the congruent aspect of lean and green manufacturing is waste reduction [49].

The lean–green literature [55,56] suggests that implementing lean practices can offer significant advantages and synergy with a firm's environmental performance, without compromising other competing priorities. Lean and green processes are considered complementary [29,57,58]. Moreover, according to these studies, the organizational structure and lean culture facilitate the development of environmental management and the formation of a "green" company. Additionally, it was demonstrated that the vital link between operational excellence and the lean–green approach enables the achievement of competitive advantage in the sustainability era [59].

However, generally lean manufacturing does not directly cover environmental impacts. In the literature, surveys about the lean implementation model [60] did not find a framework for lean implementation that considers environmental impacts. Therefore, there are blind spots in lean manufacturing concerning the environment, such as the environmental risks of the improvements and practices [61]. Along these lines, organizations need to use green tools to fill this gap [29] and make the "environment" a competitive priority. Consequently, since lean and green processes have different objectives, trade-offs may arise between competitive priorities [4,7]; it is an urgent necessity to integrate green processes into lean manufacturing explicitly by considering the environmental aspects of lean performance indicators and practices [55,62,63]. Some studies point out that digitalization can be an enabler in supporting this integration and solving these trade-offs [8,16].

The lean–green literature emphasizes that the main trade-offs are between delivery and the environment, because JIT can increase emissions [4,64,65]. Additionally, the trade-off between the environment and quality is relevant because of the utilization of raw materials to achieve the best product quality [66]. Other trade-offs pointed out in the literature are related to flexibility and the environment, since small batches allow more product variety, but they may increase the number of setups [12,67]. Additionally, the cost can present a trade-off to green implementation [39]. Some studies point out that cost can be a motivation for lean organizations to reduce their environmental impacts [55,68]. Additionally, environmental performance has been considered an important criterion for supplier selection [69].

Therefore, based on the literature, the use of lean–green practices can be understood as an approach that supports the pursuit of sustainable development in the economic, environmental, and social pillars of a production system [48] and focuses on reducing waste and focusing on the efficient use of resources [70,71].

The lean paradigm was created in the automotive industry. Additionally, considering the concept of lean–green manufacturing, it is possible to find studies that sought to understand these practices in the automotive industry. In Iran, it was identified that the lean–green efforts are focused on packaging materials and concentrated on increasing the useful life of recyclable materials. At the operational level, the focus is on reducing pollution and waste. Finally, the strategy is seen as the basis for enhancing operational and environmental efficiencies [72]. Another example of lean–green manufacturing in the automotive chain [73], taking the concept of waste "Muda" and based on lean tools, is another case study in Iran that concluded that the assembly body and paint rooms are the areas, in this order, where the lean practices impact the green performance more.

The study also investigated how the integration between agility and lean manufacturing led to enhanced sustainability in the Indian automotive industry. The main conclusion of this investigation was that the legislation represents a driver for automotive companies to improve the ecological aspects of their business operations. Ecological aspects are seen as antagonist forces to competitiveness [74]. In another case [75] in Indonesia, it was demonstrated that some green issues need to be improved in line with lean and green criteria, namely the guidelines for "ISO 14000 and OHSAS Certificates", "Collaboration with Suppliers and Customers in Protecting the Environment", "Carrying out Industrial Waste Recycling", and "Product Design that can Reduce the Consumption of Energy and Raw Materials".

Finally, for the consolidation of the theoretical basis of this paper, and as presented in the research by Carvalho et al. (2014) [76], it is important to highlight that given the fact the lean and green paradigms can lead to opposite goals depending on the focus on each paradigm, an exploratory case study was conducted in the automotive supply chain context.

All companies belonging to the observed supply chain required higher implementation levels for all lean–green practices. Two separate sequences of capabilities were found, one for the automaker and another for the first-tier supplier. According to the authors, the first-tier supplier echelon should develop their "quality" first, then their "flexibility" and "delivery", and finally their "cost" and "environmental protection" aspects.

2. Materials and Methods

This article adopted the case study as a research strategy, since it is suitable when questions such as "why?", "what?", and "how?" are asked, which must be answered with a complete understanding of the nature and phenomenon studied and when the focus is on contemporary phenomena embedded in a real context [77]. Moreover, the main trend in all case studies is that they try to shed light on why a decision or set of decisions were made, how they were implemented, and what results were achieved [78]. This research sought to compare two cases of companies in the automotive chain, specifically two first-tier suppliers. In Figure 1, it is possible to see a summary of the research steps based on the case study method proposed by Yin (2017) [78].

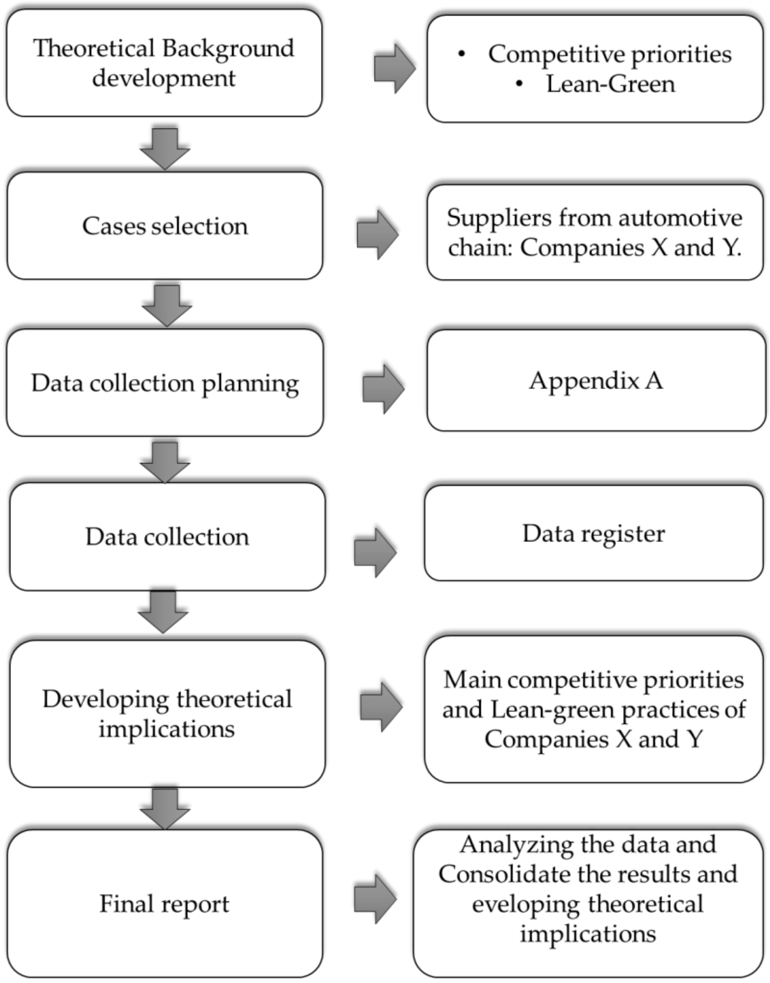

Figure 1. The followed research steps.

The first step of this research consisted of elaborating a theoretical background about the competitive priorities of the operations strategy and lean–green approach. Subsequently, the protocol for the case studies was elaborated and experts validated it. The next step was the pilot case study, followed by adjustments to the protocol and conducting the case studies.

The first step of the data collection consisted of a structured questionnaire that helped identify the main characteristics of the companies, the strategies adopted, the ranking priorities, and the practices adopted. The second part was a semi-structured interview to understand the major complementarities and conflicts generated between competitive priorities by the lean and green practices. The section about competitive priorities was based on the study by Ward et al. (1998) [79], the lean questions were based on the study by Shah and Ward (2003) [43], and the green section was based on practices presented by Thanki, Govindan, and Thakkar (2016) [80].

The criterion for selecting the companies was a search for two companies that acted as first-tier supplier companies of the automotive chain that had implemented lean and green practices in their operations. The study on these companies was conducted in May of 2021. Thus, the two selected companies will be referred to in this study as company X and company Y. They are in southern and southeastern Brazil. The interviewees were the production manager and the environmental manager of each company using the questionnaire in Appendix A. The questionnaire was sent to the interviewees in advance, and the interviews were recorded.

The reason for choosing companies from the automotive industry was attributed to the origins of lean manufacturing, as the lean management approach was created in this industry. Womack, Jones, and Roos (1991) [81] explained that the origin of lean manufacturing lies in the Toyota Production System. Moreover, as shown in the study by Caldera and Dawes (2017) [17], most of the lean and green models were developed in companies in the automotive industry. Additionally, this industrial segment is representative in terms of benchmarking for lean implementation [41,82–84]. Thus, companies in the automotive sector chain were the focus of this investigation, since it is a sector that can provide more empirical data on operations strategies regarding the adoption of lean and green approaches.

3. Results

3.1. Company Overview

Brazil produces passenger vehicles, trucks, and agricultural machinery. In 2020, 27 vehicle manufacturers and 446 auto parts companies were in operation in the country. In 2019, 2.94 million vehicles were produced [85]. Both of the studied companies are multinational automotive tier-one suppliers. Company X has over one thousand employees. Its operations are in southern Brazil, and it is headquartered in Germany. The products manufactured by company X are considered strategic components in the vehicle's final assembly, such as tires and mechanical belts. Company Y is also large and has over one thousand employees in southeastern Brazil. However, it is headquartered in the United States. Company Y produces components for assembly in its product portfolio, such as coatings, adhesives, and safety products. The products manufactured by Company Y are considered less strategic than those manufactured by company X.

3.2. Competitive Priorities of the Companies

Firstly, it is vital to highlight the aspects related to the companies' competitive strategies. They are mainly directed toward quality. In other words, quality is the main positioning factor for both companies in the market. According to the results, company X's main competitiveness factor is only quality. On the other hand, company Y also considers innovation capacity and flexibility. Regarding the main competitive advantages vis-à-vis competitors, company X competes on quality and price, while company Y competes only on quality. Figure 2 summarizes in a graphic main factors and their respective levels of importance for the competitiveness of these companies, according to the interviewees, with 1 being the least important and 5 being the most important.

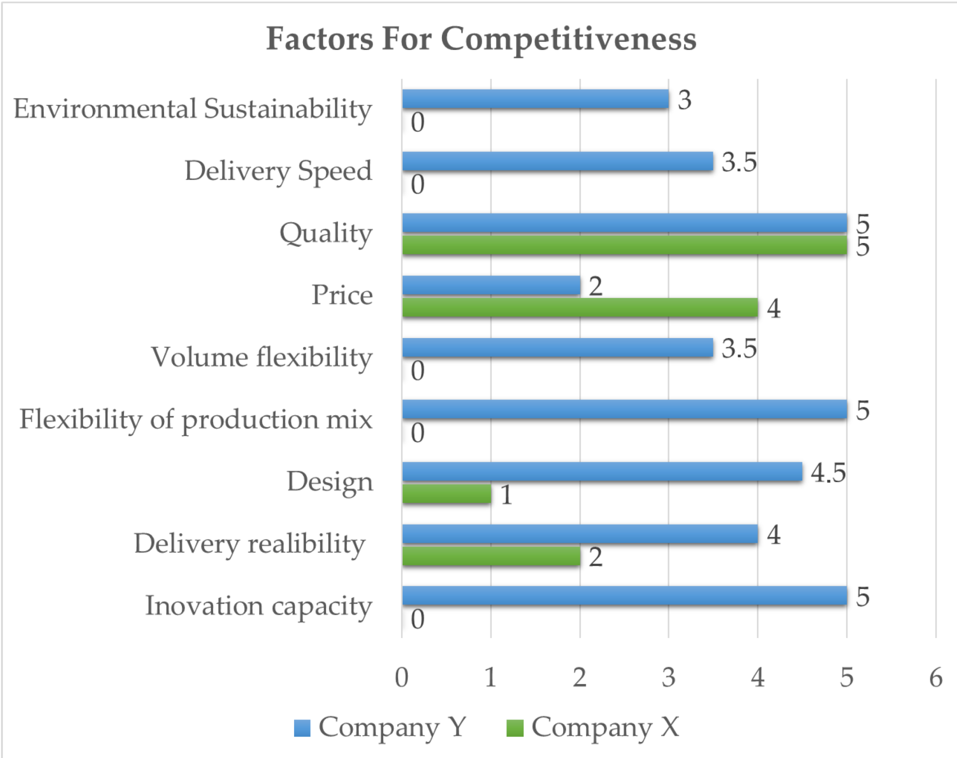

Figure 2. Factors for competitiveness.

In addition to quality, as already highlighted, it was observed that company X attributes a high degree of importance to price, and in a less critical manner to innovation, delivery, and flexibility, while considering the others not important at all. On the other hand, company Y considers other criteria important to ensure its competitiveness in the market. For example, flexibility in the production mix, product design process, and innovation capacity is considered very important, followed by the reliability and speed of delivery and finally the price and environmental sustainability.

Regarding the overall objective of the operations strategies, both companies consider cost reductions very important via defect reductions. In the case of defect reductions, these are convergent with the competitive strategy being driven by quality. Table 1 shows the order of competitive priorities as adopted by each company.

Table 1. Ranking of the companies' competitive priorities.

Company	1st Priority	2nd Priority	3rd Priority	4th Priority	5th Priority
X	Quality	Cost	Flexibility	Service and Delivery	Environment
Y	Quality	Cost and Delivery	Environment and Flexibility	Service	-

The results show that the quality priority is considered very important in all its aspects, being scored as the first priority, converging with corporate strategy, and demonstrating alignment between corporate strategic and operational objectives. On the other hand, cost comes in second place. Another observation point is the similarity in the ordering of priorities, differing in the prioritization of delivery and the environment. In the case of delivery, company X ranks it as the fourth most crucial priority, whereas company Y ranks it as the second, followed by cost. The environmental priority is considered the least essential priority by company X, while company Y considers it the third most important priority.

3.3. Lean–Green Practices

This topic highlights the main aspects of the lean–green practices in the studied companies. Tables 2 and 3 present the implemented practices and the stages of implementation.

Table 2. The companies' lean practices.

Lean Practices	Implementation Level	
	Company X	**Company Y**
Visual Management	Fully deployed and tracked	Partially deployed
Just-in-Time (JIT)	Nothing done	Partially deployed
Kaizen	Fully deployed and tracked	Fully deployed and tracked
Kanban (Pull Production)	Currently at "project" level but not yet implemented	Partially deployed
Cellular Manufacturing	Partially deployed	Fully deployed and tracked
Total Productive Maintenance (TPM)	Partially deployed	Fully deployed and tracked
Value Stream Mapping (VSM)	Fully deployed and tracked	Partially deployed
Poka-Yoke (mistake-proofing system)	Fully deployed and tracked	Partially deployed
Standardized work	Partially deployed	Fully deployed and tracked
5 whys/Ishikawa diagram (fishbone)	Fully deployed and tracked	Fully deployed and tracked
5s (five S's)	Fully deployed and tracked	Fully deployed and tracked
Other Lean practices		Tier Meetings—daily leadership briefings.

Table 3. The companies' green practices.

Green Practice	Implementation Level	
	Company X	**Company Y**
Environmental accreditation of suppliers	Early Implementation	Partially deployed
Product life cycle analysis	Early Implementation	Partially deployed
Reverse logistics	Early implementation	Incipiently implemented
Environmental Management Plan/System	Fully implemented and controlled	Fully deployed and controlled
Waste management policy	Fully implemented and controlled	Fully deployed and controlled
Water consumption reduction program	Early implementation	Partially implemented
Energy conservation program	Incipient implementation	Partially implemented
Recycling program	Fully implemented and controlled	Incipient implementation
Environmental education programs for the community	Incipient implementation	Incipiently implemented
Program to reduce material consumption	Fully implemented and controlled	Currently at "project" level but not yet implemented
Cross-process resource sharing programs	Early implementation	Currently at "project" level but not yet implemented
Cleaner production program	Incipient implementation	Nothing done
Publication of reports with environmental information	Fully deployed and controlled	Fully implemented and controlled
Effluent treatment	Fully implemented and controlled	Fully deployed and controlled

Company X has implemented lean processes since 2006, but only in 2010 did the program became part of the company's management system. As for their green practices, they have been implemented since 2002, since these practices were adopted to meet the environmental laws required at the time. According to the production manager, their lean approach focuses on quality improvements, and in as much as their green practices are concerned, according to the environmental manager, these are focused on meeting the current standards and legislation.

Currently, company X integrates lean and green issues through their strategy, whereby the company needs to comply with international corporate targets for reducing carbon emissions. To this effect, in addition to the practices taken to comply with environmental regulations, environmental indicators are being deployed utilizing the Hoshin–Kanri approach, a practice widely used in lean manufacturing to deploy the strategy for operations. Still, in the interviewees' view, this integration is very incipient, but it was emphasized that lean manufacturing reduces waste and that this leads to improvements of some environmental aspects, especially in terms of energy and material consumption. Furthermore, lean manufacturing is a facilitator for the inclusion of green practices and environmental improvements, since the environmental management system is based on its philosophy and practices.

Regarding company Y, the person responsible for managing their operations pointed out that the program made its first attempt to implement lean practices in 2013, but only in 2015 did the program become part of the management system to improve quality and achieve process standardization. Regarding green manufacturing, the company first implemented their practices in the 1990s, with their specific cleaner production initiatives being some of the forerunners in implementing this program. However, despite being a pioneer, the company operates these practices as an isolated program that seeks to encourage isolated projects to achieve environmental impact reductions for products or processes. The integration of green processes into lean procresses, as at company X, is still very nascent. Tables 2 and 3 present, respectively, the lean and green practices and their implementation levels.

It was possible to observe that only the safety indicator is addressed in the daily management of lean practices, and occasionally projects to improve environmental performance occur within the lean system. Additionally, according to the interviewees from company X, it is believed that the organizational structure and lean culture can contribute to an improvement of the environmental priority. Similarly, they exemplify lean projects in which reductions in energy and material consumption were achieved. However, despite the green gains being measured in some lean projects, there are still no environmental performance indicators in the lean management system.

What can be observed is that the companies are very close when it comes to the level of implementation of their practices, both lean and green. Regarding lean practices, company Y uses two practices, just-in-time and pulled production, which are in the preliminary stages. Still, it was possible to identify a similar implementation level or with a small difference between being partially implemented and totally implemented in the remaining lean practices. In the same way, company X presents a slightly lower level of green practices. However, it uses the practice of environmental accreditation of suppliers that is not implemented at company Y. On the other hand, company Y uses cleaner production and life cycle analysis practices at advanced levels.

A point of convergence between all interviewees is that lean practices, which help reduce waste, indirectly lead to the improvement of environmental aspects, especially concerning reductions in material and energy consumption. Furthermore, both companies mentioned that there is still a trade-off between cost and the environment. Projects that seek to reduce their environmental impact beyond what is required by law must bring some financial return to the company—regardless of the positive environmental impact. At the same time, cost reduction projects that generate environmental effects within the limits of the legislation and carbon reduction targets are not usually implemented.

4. Discussion

The main point to be discussed is the difference regarding the ordering of the competitiveness priorities. The environmental priority is positioned fifth and third. This may be attributed to the fact that only company Y considers environmental sustainability as a factor in competitiveness. In addition to practices for the compliance of environmental aspects, it also has the cleaner production program, which is a proactive strategy for the eco-efficiency of its processes, although it is still an isolated initiative from the lean program. Similarly, it is essential to note that despite the order of prioritization, this confirms what is shown in the literature, namely that environmental priority becomes included as a competitive priority in both companies [62].

Another point to be observed is that although the environmental priority is not considered the most important priority and is not a focus priority in lean manufacturing, the interviewees agreed with the literature [62]. They stated that the reduction in lean waste also impacts the environmental priority. Furthermore, the results confirm that lean manufacturing assists in achieving the main quality priority, as suggested by Ball (2015) and Suifan, Alazab, and Alhyari (2019) [7,44]. Moreover, the interviewees' account illustrates what is proposed in [29,57,58] when reporting that lean manufacturing can be a complementary facilitator for implementing green practices in management systems.

These results converge with the cumulative capabilities theory of the sandal cone approach presented by Ferdows and De Meyer (1990) [37] regarding competitive priorities when there are improvements in lean waste reductions; consequently, the companies achieve better environmental performance. Lastly, the results show that the lean and green level of company Y is higher than in company X. At the same time, the trade-offs between the environment and another competitive priority in company Y are less frequent. The environment is considered more important in company Y than in company X.

In the two cases, it was also observed that the investments in green initiatives depended on the investment level. The results showed that the trade-offs lens could be viewed from the perspective of Skinner (1969) [1] when companies do not adopt costly green initiatives. In addition, the trade-off between the cost and environment was exposed, as punctuated by Longoni and Cagliano (2015) and Vargas- Berrones, Sarmiento, and Whelan (2020) [4,39]. However, the question related to legislation pointed out by Mathiyazhagan et al. (2021) [74] was not clear, regarding how ecological aspects are seen as antagonist forces to competitiveness.

Given this background, based on the theory of cumulative capabilities, it is clear that by developing good practices that seek to improve the environmental priority, one also has the ability to reduce costs. Thus, integrated practices that make the environment a priority become essential. Additionally, compared with a study done in 2014 [76], it is possible to observe that environmental protection will become more important for first-tier suppliers. Finally, it is important to emphasize that previous studies [72,73,86] from the automotive industry also show that lean manufacturing can support the environmental priority.

5. Conclusions

This study indicated that the environmental priority has become a factor of competitiveness, whether incipient or behind other priorities, from the corporate strategy to the operations strategy. However, the priorities of quality, cost, and delivery in the cases presented here are still considered more important.

In the cases of the companies analyzed here, it was demonstrated that the integration between lean and green practices could facilitate the inclusion of the environmental priority in the operations strategy and in the management systems, as presented in the literature. Furthermore, as demonstrated in company X, this integration can help in unfolding long-term environmental and operational goals. In company Y, lean manufacturing is a facilitating factor, by means of the organizational structure and culture of this approach, for the implementation of green practices.

Additionally, it is essential to reinforce that the results show what the lean–green literature proposes, and most of the results are from cases in the same industry. Furthermore, the results show that the environment has become more important. They also show that legislation can be an influencing factor for strategic decisions regarding the adoption of greener practices.

Like all research, our study is not without its limitations. Consequently, these limitations can serve as the basis for further investigations. Although the results presented here can highlight relevant aspects regarding the integration of lean and green practices and their role in operations strategies, this is still a preliminary discussion. Only two cases were analyzed, and the choice of the sample was intentional due to the limited number of companies that already operate lean–green practices in the Brazilian context. This limitation prevents generalizations. Thus, the development of further research on this theme is necessary, especially in other relevant markets that have not yet been investigated. As a future research direction, empirical studies in other industries for comparative purposes are also recommended, as well as quantitative studies in larger samples, seeking to analyze in depth how much each practice contributes to each competitive priority when implementing lean and green practices. Finally, standardization in data collection can enable cross-country and cross-temporal analyses.

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Appendix A. Case Study Questionnaire

A. Company description

1. *Number of employees*
   Less than 50
   50 to 100 employees
   100 to 500 employees
   500 to 1000 employees
2. *Main products manufactured*

   ____
3. *Position in the supply chain (Nominal level ranging from Original Equipment Manufacturer to n-tier supplier)*
   First tier
   Second tier
   Third Tier
   Fourth Tier
   Fifth tier or more

B. Operations strategy

1. *Who is the main clientele of your products?*
   Final user
   Original equipment manufacturers
   Replacement market (aftermarket)
2. *Which of the options below is your organization's main competitive advantage?*
   Price
   Delivery

Customization
Less environmental impact
Service Level
Another:

3. *Concerning your competitive strategy, please rank in order of importance the 5 main factors for your company's competitiveness (5 being the most important, 1 being the less important).*
5 4 3 2 1
Price
Design (product characteristics, technology)
Quality
Volume flexibility
Flexibility of production mix (product variety)
Delivery reliability
Delivery speed
Environmental sustainability
Innovation capacity
Another (Example: Location, aggregate services, etc.)
4. *Competitive Priorities (Please use this scale to signal the degree of importance for each competitive priority for your operations).*
5 4 3 2 1
Cost of production (total cost of products sold)
Direct costs (labor and material)
Overhead costs (administration, maintenance)
Design quality (projected performance of main product characteristics)
Conformance (a product manufactured according to design specifications)
Reliability (probability of the product not failing)
Product Flexibility (ability to adapt products to customer's needs)
Volume Flexibility (ability to respond to variations in required quantities)
Process Flexibility (includes production mix flexibility, sequencing flexibility, and routing flexibility)
Reliability (probability of delivering the right product in the right quantity and on time)
Speed of service (time elapsed between order and delivery of the product to the customer)
Customer problem solving
Supplier support (in-product development, process planning, and component production)
Actions to reduce material waste, energy consumption, water consumption, and emissions.
3R—Remanufacturing, reuse, and recycling.

C. Lean Manufacturing

1. *Indicate the year bracket in which Lean Manufacturing practices were implemented in your organization.*
Before 1990
Between 1990 and 2000
Between 2001 and 2005
Between 2006 and 2010
Between 2011 and 2015
From 2016 onwards
2. *To your knowledge, which of the following factors motivated the implementation of Lean Manufacturing practices in your organization? (You can choose several options if needed.)*
Cost reduction
Quality improvement
Customer's requirement

Market competition
Corporate strategy
Another:

3. *Lean Manufacturing Practices. Please use this scale to signal the level of implementation of Lean Manufacturing in your current operations.*

    Nothing has been done
    Currently at the "project" level but not yet implemented
    Incipient implementation
    Partially deployed
    Fully deployed and tracked

    Lean Manufacturing Practices:

    Kanban (pull production)
    Just-in-Time (JIT)
    Just-in-Sequence (JIS)
    Total Productive Maintenance (TPM)
    5S (five S)
    Value Stream Mapping (VSM)
    Poka-Yoke (error-proofing system)
    Cellular Manufacturing
    Visual Management
    5 why/Ishikawa (fishbone) diagram
    Kaizen
    Standardized work

D. Green Manufacturing

1. *Indicate the year bracket in which Green Manufacturing practices were implemented in your organization.*
    Before 1990
    Between 1990 and 2000
    Between 2001 and 2005
    Between 2006 and 2010
    Between 2011 and 2015
    From 2016 onwards
2. *To your knowledge, what factors motivated the implementation of Green Manufacturing practices in your organization? You can choose several options if needed.*
    Cost reduction
    Quality improvement
    Customer's requirement
    Market competition
    Corporate strategy
    Legislation
    Another:
3. *Green Manufacturing Practices. Please use this scale to signal the level of implementation of Green Manufacturing in your current operations.*

    Nothing has been done
    Currently at the "project" level but not yet implemented
    Incipient implementation
    Partially deployed
    Fully deployed and tracked

    Green Manufacturing Practices:

    Environmental Management Plan
    Waste Management Policy
    Effluent Treatment

Water consumption reduction program
Energy conservation program
Recycling program
Program to reduce material consumption
Publication of reports with environmental information
Product life cycle analysis
Environmental accreditation of suppliers
Environmental education programs for the community
Inter-process resource-sharing programs
Cleaner production program
Reverse logistics
Another (please, specify)

E. Understanding Lean–Green and Competitive priorities

1. *What is your opinion of the implementation of Lean and Green manufacturing practices in relation to the competitive priorities of your current operations?*
2. *In your opinion, what is the contribution of Lean manufacturing to Green manufacturing practices?*
3. *Do you consider that Lean manufacturing practices contribute to environmental performance? If so, in what way?*

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