This paper aims to investigate the lean and green practices. The objective is find out the main lean and green practices treated in an integrated way from literature review. From our method we found out 31 integrated lean and green practices in 21 different papers. Our results show that waste reduction was the most cited practice and that they can be classified in three different ways: suppliers, operations and customers.

Palavras-chave: lean, green, waste reduction, practice
1. Introdução

Studies linking environmental management and manufacturing cannot be considered something new. Some authors argue that the success of environmental management is directly proportional to the support from manufacturing (González-Benito, 2008; Sarkis, 2001). According to Simpson and Power (2005) improvements in the production system can generate both direct and indirect benefits to companies with respect to environmental management practices, especially waste reduction. González-Benito (2008) also pointed out that the more proactive the manufacturing area of a company, better tends to be its environmental management. And the fact that the company adopt lean manufacturing practices can still bring interesting contributions.

Lean manufacturing, also known as lean production, can be considered one of the most influential new paradigms in manufacturing. It was initially developed in Japan by Toyota Company, where it was known as Toyota Production System. After the mass production, it can be considered a new management system focused on the reduction of waste in all aspects of its operations. Since then, it has been used in a wide range of industries around the world.

On the other hand, we have environmental management and green practices that emerge as a concern for companies in order to improve the environmental efficiency of their operations, while still achieving their financial objectives (Garza-Reyes, 2015).

In an independent way both visions, lean and green, can be considered deeply explored in academy and in companies (see Shah and Ward, 2007; Anand and Kodali, 2010; González-Benito, 2008; Arantes et al., 2014, Azevedo et al., 2011). However, studies of both paradigms together are relatively new (Garza-Reyes, 2015; Dües et al., 2013; Azevedo et al., 2012) and only some research has highlighted the importance of studying the influence of both paradigms on supply chain performance (Carvalho et al., 2010; Dües et al., 2013; Wiengarten et al., 2013). Therefore there is a lack of studies addressing the relationship between lean and green approaches (Jabbour et al. 2013b; Dües et al. 2013).

The aim of this paper is to present the main lean and green integrated practices used and discussed in literature review. To address the aforementioned objective, this paper is organized as follows. First, we reviewed the relevant literature on lean and green paradigms and practices. Next, we present the method we used to achieve the main objective. The fourth
section presents the results and some discussions. Finally, the main conclusions are drawn at the fifth section.

2. Theoretical Background

2.1 The Lean and Lean Practices

The concept proposed by Womack, Jones and Roos (1990) assumes that there is waste everywhere in an organization and the lean vision emerges as an “antidote” to do more with less, and always in order to offer customers what they really want, at the time they need. So, the main objective of lean is to find out and eliminate waste (Shah and Ward, 2007), and waste can be defined as any activity in a process that does not add value for customers. Womack and Jones (1996) developed this lean vision for what they call lean thinking, and feature the so-called principles of lean thinking (value, value stream, flow, pull, and perfection). According to the authors, understanding these principles of lean thinking is crucial to the implementation of lean manufacturing.

According to Zokaei et al. (2013) lean might be described as understanding the customer’s need and values, and the reviewing the value streams that produce them so that the eight wastes of lean can be minimized. Shah and Ward (2007), in turn, present a similar definition. For the authors lean is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability. The authors also point out that lean can be generally described from two points of view, either from a philosophical perspective related to guiding principles and overarching goals (Womack and Jones, 1996;), or from the practical perspective of a set of management practices, tools, or techniques that can be observed directly.

From this practical perspective Shah and Ward (2007) conducted a survey in order to define and develop measures of lean production in the supply chain. The authors identified 41 practices/tools to represent the operational space surrounding lean production. Some of them are related to suppliers (supplier feedback, JIT delivery by suppliers, supplier development), some are related to operations (pull system, set-up, flow, employee involvement) and some related to customers’ relationship.

This is an important previous work that set a list of practices that we can find out in companies that use lean. But some other important research regarding lean practices in supply chain can be cited as well (Anand and Kodali, 2010; Panwar et al., 2015). However, despite
the existence of many papers related to lean practices, there are few that link the lean and green point of view and they are relatively recent (Garza-Reys, 2015).

2.2 Green and GSCM practices

The green vision is very wide. In the case of this study the main focus will be green practices in the aspect of the supply chain, or more specifically green supply chain management (GSCM) practices. Srivastava (2007) defined GSCM as “integrating environmental thinking into supply chain management, including product, design, material sourcing and selection, manufacturing process, final product delivery to customers as well as end-of-life disposal”.

Within the universe of subjects studied in GSCM, the study of practices is gaining importance (Arantes et al., 2014; Jabbour et al., 2013a; Azevedo et al., 2011; Zhu et al., 2008; Zhu et al., 2005) and to became a consolidate subject (Arantes et al, 2014) needs to be better exploited (Jabbour et al., 2013a). For Azevedo et al. (2011) GSCM practices are considered as any action that is performed by chain - within the focal company and their relationships with suppliers (upstream) and consumers (downstream) of the chain - to eliminate or reduce any negative environmental impact without sacrificing quality, productivity and operating costs. Zhu et al. (2011) argue that to adopt GSCM practices is necessary to develop cooperation within the chain. One way to develop this collaboration process would be to disseminate knowledge about environmental issues among the various companies that make up a supply chain (Arantes et al. 2014; Dües et al., 2013). Lai et al. (2013) also raised this point, when they affirm that among the areas of production one of those with more difficult to insert the environmental issue properly is the logistics area. The reversal of this scenario, according Jabbour (2015), requires that the focal company supply chains begin to adopt the practices of GSCM, exerting this pressure on the remaining links in the chain incorporate environmental aspects into their activities.

One of the most cited works on the classification of GSCM practices is the paper authored by Zhu et al. (2008). In this article, the authors presented a proposal for measuring model for GSCM practices and statistically validate the key dimensions of these practices, which are: i) internal environmental management (for example TQEM, ISO 14001, certification, cooperation for reducing packaging), ii) green purchasing (eco labelling, suppliers ISO 14001 certification, etc.), iii) cooperation with customers (for eco-design, for cleaner production, for
green packaging), iv) eco-design (design of products in order to reduce consumption of material or energy, 3R policy, among others), and v) investment recovery (sales of scrap and used material, for example). After this paper, the authors have developed other complementary works (Zhu et al., 2011; Zhu et al., 2012), which as the Srivastava (2007)'s previous work also puts the reverse logistics as an important practice of GSCM.

More than empirically investigate the construct of and the scale for evaluating green supply chain management (GSCM) practices implementation among manufacturers, these three papers of Zhu, Sarkis and Lai (2008; 2011 and 2012) became a reference for many others that intended to identify and/or measure green or GSCM practices (Azevedo et al., 2011; Jabbour et al., 2013a; Arantes et al., 2014).

3. Method

As our focus is on lean and green practices in supply chain, studying in depth this issue, we construct the Table 1. This table shows the 31 main lean and green practices from literature review. The search of articles comprised papers published from 1990 to 2015, using EBSCO, ISI Web of Science and Scopus databases. The period for this research was established to comprise papers from 1990 to 2015, including articles ‘in-press’ that would be later published in 2016. The search strings included the words “lean and green” (for title, key words, abstract and/or text). After deleting duplicated papers, we obtained 178 papers. Next, we read all the abstracts and selected 26 papers related specifically with lean and green practices. After analysing all of them five were not considered due at least one of these reasons: i) they present only one practice, or iii) they were authored for authors considered before (presenting the same practices).

4. Results and discussion

After studying these papers (Table 1) we better understand that the association of lean and green practices can bring competitive advantages to the company. The lean production acts directly on the more efficient use of inputs along the product to the value addition process, and the environmental management (or green practices) focuses on efforts to reduce environmental impacts. The outcome of this application results in the reduction of waste, whether of raw materials or human resources, adding value and maximizing profits of the organization.
As we can check from Table 1, “waste reduction” was the most cited practices involving lean and green. Approximately 76% of the papers (16 from 21) mentioned waste reduction as a lean and green practice, even if the reduce of waste can have a distinct perspective from lean and for green. As pointed out by Corbett and Klassen (2006), Dües et al. (2013) and Zokaei et al. (2013) waste reduction in lean perspective is more related with elimination of waste in all operational processes, internally and externally, that arise from overproduction, waiting, transportation, inappropriate processing, defects and unnecessary inventory. On the other hand, waste reduction for green perspective is more related to disassembly, redesign, waste segregation, and reuse and recycling.

From the group of suppliers, the S1 “Supplier network/collaboration/training (through a long-term relationship)” was the most cited (12 from the 21 papers). And S4 “Geographic concentration” and S6 “reducing number of suppliers” were the practices less cited by literature review, both with only two lean and green practices mentioned.

Faced with a highly competitive scenario and the challenge to remain competitive, organizations seek to take advantage of cost and quality through the application of lean practices. They also achieve differentiation by reducing the environmental impacts through the environmental management (Melnik et al. 2003; Pampanelli et al, 2014).

Thus, we can argue that the development of lean and its interrelation with environmental management should preferably take place in a systemic way, mobilizing the various operational areas of the company in order to achieve concrete results through a strategy integrated management.

Regarding operations, after waste reduction that was the most cited practices in general, we have O13 with 13 lean and green practices identified in these papers. And O1 “Employees involvement, training and empowerment” and O1 “Continuous improvement/kaisen” also cited 10 times. On the other hand we had O7 “Six sigma” and O10 “Kanban” mentioned only in 3 different papers. And finally for costumers we found out C1 and C5 mentioned in 7 different papers each one and C2, C3 and C4 mentioned in 4 papers each one.
### Table 1: Lean and green practices from literature review.

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**S1** Supplier network/collaboration/training (long-term relationship)

**S2** Supplier evaluation/certification/auditing (environmental requirements)

**S3** Use of green/less packages (from suppliers)

**S4** Geographic concentration

**S5** Environmental risk sharing with suppliers

**S6** Reducing number of suppliers

**S7** JIT delivery

**S8** Employees involvement, training and empowerment

**S9** Continuous improvement/Kaizen

**S10** Inventory reduction

**S11** Information shared through the chain or Information system

**S12** 5S

**S13** Total Productive/Preventive Maintenance (TPM)

**S14** Six sigma

**S15** 3Rs (Reduce, Reuse and Recycle)

**S16** TQM and/or TQEM

**S17** Kanban

**S18** Waste reduction

**S19** Pollution prevention

**S20** ISO systems certifications (or other systems)

**S21** Lead time and/or set-up reduction and/or total time reduction

**S22** Emissions reduction

**S23** Reduction of hazardous/materials/resources consumption

**S24** Use of green technology

**S25** Value stream map/focus or
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<td>Contribuições da Engenharia de Produção para Melhores Práticas de Gestão e Modernização do Brasil</td>
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<td>João Pessoa/PB, Brasil, de 03 a 08 de outubro de 2016.</td>
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<th>Sustainable VSM</th>
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<td>JIT philosophy</td>
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<td>Customer relationship/interaction</td>
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<td>C2</td>
<td>Reverse logistics</td>
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<td>Environmental risk sharing with customers</td>
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<td>C4</td>
<td>Environmental products and/or eco-design</td>
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<td>C5</td>
<td>Use of green/less packages (to customers)</td>
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</table>

* Total Quality Manag.; * Total Quality Environ. Manag.; * Within operations and transportation; * Meaning efficient uses of materials and resources as water, energy, etc.

References: 1-Sobral et al. (2013); 2-Jabbour et al. (2013b); 3-Rothenberg et al. (2001); 4-King and Lenox (2001); 5-Simpson and Power (2005); 6-Maxwell et al. (1998); 7-Dües et al. (2013); 8-Vais et al. (2006); 9-Pojasek (2008); 10-Corbett and Klassen (2006); 11-Miller et al. (2010); 12-Carvalho et al. (2011); 13-Espadinhia-Cruz et al. (2011); 14-Florida (1996); 15-Govindan et al. (2015); 16-Parveen et al. (2011); 17-Wiengarten et al. (2013); 18-Azevedo et al. (2012); 19-Hajmohammad et al. (2013); 20-Duarte and Cruz-Machado (2015); 21-Carvalho et al. (2010)
Regarding the link between lean and green, even if it is a relatively new topic (Garza-Reyes, 2015), we can find out some research that has been investigating this relationship (Florida, 1996; Maxwell et al., 1998; Rothenberg et al., 2001; King and Lenox, 2001; Vais et al., 2006; Azevedo et al., 2011; Azevedo et al., 2012; Pampanelli et al., 2013; Wiengarten et al., 2013). Some of them focused in similarities (Simpson and Power, 2005; Dűes et al., 2013), or differences (Dűes et al., 2013) between the two areas or advantages in adopting a model lean and green (Pojasek, 2008). And many argue that the environmental perspective linked with lean can improve the performance of the organization in general (Corbett and Klassen, 2006; Miller et al., 2010; Hajmohammad et al., 2013), adding value to the company.

However, as pointed out by Sobral et al. (2013), it is important to find additional empirical evidence regarding how this relationship happens in a factory’s operational level and how the people who work directly or indirectly on lean and green understand this synergy.

Garza-Reyes (2015) conducted a structured review of the state of the art of lean and green analysing 60 papers about this subject. He classified them into three categories: conceptual, supply chain and operations/processes. According to him, 22% (13 articles) of the analysed papers are related to conceptual issues between lean and green, 34% (20 articles) addressed the integrated management of lean and green in supply chain and finally, 44% (26 articles) have issues on the integrated management of lean and green in operations/processes.

5. Conclusions

From literature review we found out 31 lean and green practices that can be considered integrated. It means that they were mentioned in the papers with the possibility to be used together in a combined way. But, the combination of lean and green practices does not mean that they are synergic, bringing better results to both, lean and green.

So, a suggestion for future studies can be related to better understand the synergy of these practices, in for example, multiple case studies.

REFERENCES


