LEAN AND GREEN NPD IN THE LATIN AMERICAN ALUMINIUM INDUSTRY

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Abstract
Over the decades, companies have been taking cooperative actions in organized groups (clusters). They seek to gain mutual benefits, as they can be more innovative and create more jobs. This exploratory study investigated the 35-company cluster of Aluminium utensils and products (CAUP), located in Latin America, in Brazil. First, through a qualitative approach, the cluster coordinator explained the upcoming challenges and difficulties. The research suggests the potential implementation of both lean and green strategy. The paper has investigated the 35-company cluster of Aluminium utensils and products (CAUP), located in Latin America, in Brazil. First, through a qualitative approach, the cluster coordinator explained the upcoming challenges and difficulties. The research suggests the potential implementation of both lean and green strategy for the new product development processes (NPD) of the studied cluster. Secondly, a case study is presented investigating how an SME of the CAUP addressed the NPD maturity level. The maturity analysis suggests that the NPD processes need to evolve. This paper has shown that there is potential for the implementation of both lean and green practices. The wide variety of products urges for more efficient portfolio management in this cluster.

Keywords:
Lean and green, product development, cluster, sustainable development, innovation.

1 INTRODUCTION
A substantial amount of work has been done to assess the role that small and medium-sized enterprises (SMEs) play in GDP growth and employment. The evidence suggests that SMEs are crucial for economic health, in both high-income and low-income economies worldwide. Evidence also demonstrates that when SMEs become internationalized, their contribution to their home economy increases. Substantial barriers need to be overcome by SMEs. They can face difficulties in financing international activity, identifying opportunities and making appropriate contacts in their target markets [1].

In developing countries, such as the case of Brazil, there is some evidence that earnings rise with firm size for workers with similar functions. There is also evidence showing that jobs in SMEs are less stable and secure than jobs in larger enterprises. Additionally, SMEs are less likely to offer training to their workers compared to larger firms. Finally, SMEs contribute comparatively less to GDP than to employment, because they are, on average, less productive than large firms [2].

Analysis conducted by the World Trade Organization (WTO) estimates that SMEs in developing countries are 70% less productive than large companies. The lower productivity is often attributed to SMEs’ inability to take advantage of economies of scale, the difficulties they face in getting access to credit or investment, the lack of appropriate skills, and their informality [2].

Entrepreneurship has been progressively growing in Brazil. SMEs are responsible for around 50% of the country’s GDP [3]. Empirical results of Brazilian states indicate that the relative importance of SMEs is negatively correlated with economic growth. Besides, these results show that the human capital embodied in SMEs may be more important for economic growth than the relative size of the SME sector [4].

Motivated by this scenario, this paper aims to investigate the challenges and barriers faced by SMEs of a cluster located in Latin America, Southwest Parana state in Brazil. The paper focuses on evaluating the adherence of a lean and green approach to the NPD in these companies, as means to improve their efficiency (Lean perspective) and manufacturing environment-friendly products (Green perspective).

2 LEAN, GREEN, AND PRODUCT DEVELOPMENT
The literature is rich with descriptions of concepts and philosophies associated with the term lean. Nowadays, lean goes beyond the manufacturing context. In a simple reference to lean, this term can be defined as the set of efforts to minimize waste and maximize value in any organization [5].

The framework of the lean concept is solid and well established worldwide. However, its development ignores the dissimilarities among countries, such as cultural, political, and economic differences. A revision of the original lean concept considering these dissimilarities can better respond to such differences. In a lean construction study in China, this issue was tackled through the improvement of the project managers’ understanding of lean construction basics [6].

As the lean approach evolved, environmental perspective has been gradually introduced into the lean agenda of the organizations. Consequently, integrated lean and green models are already available.

In one of these integration attempts, six prerequisites were identified for implementing a lean and green model: (i) a stable process, with delivery records over 90%, (ii) a sufficient deployment level in terms of using and applying lean tools, (iii) electronic information systems in place, (iv) a supportive management team, (v) environmental awareness and (vi) significant use of natural resources [7].

Lean and green integration efforts have been investigated, and these studies ask for suitable strategies [8] [9]. Previous evidence suggests that lean is beneficial for green and the implementation of green practices, in turn, has a positive influence on existing lean business practices [10].

There is a lack of consensus on the definitions of lean and sustainability. This fact reflects how the different perspectives are highly influenced by the context in which they were developed. On studying the relationships between lean and sustainability, several contradictions were identified in the literature. On the positive side, lean
tends to facilitate the adoption of environmental practices mainly by involving people and enhancing their problem-solving skill sets. Lean practices and projects may also facilitate the focus on sustainability. On the negative side, lean can lead to solutions that, albeit cost efficient and with enhanced quality, may cause greater harm to the environment [5].

The product development (PD) process faces similar difficulties for lean and green integration. A unified lean and green strategy for PD demands the understanding of the dissimilarities between the two approaches. Lean product development (LPD) and green product development (GPD) concepts lie in their goals and focus, value constructs, process structures, performance metrics, and tools/techniques. Lean product development is a way to achieve efficient processes, reducing time and project teams’ efforts. On the other hand, enterprises will manufacture environment-friendly products if they consider a green approach. Fortunately, both concepts share some similarities that indicate a synergistic relationship [11].

3 RESEARCH DESIGN AND METHODS

This exploratory study investigated the 35-company cluster of Aluminium Utensils and Products (CAUP), located in Latin America, Southwest Parana state in Brazil. The research hypothesis places a both lean and green strategy as a suitable way for the new product development processes (NPD) of the studied cluster.

First, a documental analysis on the CAUP’s websites allowed a general view of these companies. This preliminary step was necessary to improve the researchers’ understanding about the cluster and contributed to outlining the interview, which is/was the next step.

Therefore, through a qualitative approach and a semi-structured interview and interpretative analysis, the cluster coordinator was asked about the challenges and the main difficulties faced by the CAUP’s companies. The framework of the interview was based on three pillars: previous documental analysis, the eleven component LPD model of Hoopman et al. [12], and green issues from the maturity model for sustainability in NPD of Hynds et al. [13].

The interview was carried out on May 5th, 2017 in the cluster coordinator’s company. For approximately two hours, the interviewee explained about the topics as follows:
1. Interviewee data and background, and cluster activities.
2. Current and future challenges and difficulties for the CAUP’s companies.
3. NPD operations into the cluster.
4. Evidence of lean and green actions in the CAUP.
5. The CAUP demands with potential to be investigated by academia.

Thirdly, this paper also discusses and presents a case study of how an SME of the CAUP addressed the NPD maturity level based on [14]. This company, cited during the interview as one of the most structured members of the CAUP, had its NPD operations evaluated in April and September of 2015. The connection between the two approaches (interview and case study) is the NPD maturity level. The studied company potentially shows the highest level of NPD organization that can be found in this cluster. Therefore, the understanding of NPD in the CAUP context is improved.

4 CLUSTER CHARACTERIZATION

The cluster coordinator has a background as an accounting and business management technician, with 24 years as an entrepreneur of the aluminium industry and recently assuming his second cluster coordination.

Most of the companies in the cluster (Table 1) produce aluminum kitchen utensils exclusively for the domestic market, such as saucepans, pots, teapots, kettles, baking sheets, and mugs. They are family businesses, where the managers are the owners and maintain direct contact with the employees. Among the companies in the cluster, a maximum of six are larger and have a more complex structure.

Several decades ago, Brazilian families of up to 12 people were common, but they gradually became smaller. In practice, this entailed the reduction of the size of kitchen utensils. Until the 1990s, companies had local representatives who went to distant regions to make purchase orders. Over time, it was observed that this practice was not efficient. Currently, representatives are hired in the regions where companies usually have a market, which has shown to be a more effective practice. The demand for cooking utensils is strongly influenced by cultural factors in each region of Brazil, aligned with local cuisines. Therefore, the success of the cluster’s companies depends on the understanding of regional peculiarities.

4.1 Challenges and difficulties

In 2013, the product certification process of the companies in the cluster was begun, which consists of the adaptation to the requirements of Ordinance No. 398 of the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) [15]. The companies considered micro have until April of 2018 to adapt and those classified as small and medium have until April of 2019. This process is the major challenge currently faced by the companies in the cluster. In general terms, In general terms, the INMETRO ordinance mentioned above defines the technical requirements for conformity evaluation regarding the safety of utensils. Materials, alloy composition, traceability, and testing are among the key recommendations.

Approximately 80% of the tasks are still done on spinning lathes, which involves artisanal labor. Consequently, productivity is low. To illustrate the problem, the teapots and kettles can be cited as they are considered to have complex geometry and cannot be stamped like the pots. The body of these products during their spinning process has significant variation in thickness, causing great variability of the final characteristics among the parts produced. This variability is a strong constraint to the certification process and is thus considered a technical difficulty.

The CAUP is far from the big centers and access to the new technologies is restricted, not only by the geographic issue but also by the high cost of these technologies. Additionally, and perhaps more critical is the fact that if these costs are added to aluminum household appliances, their final price will become close to products considered of higher quality (stainless steel, copper, and ceramic) and make them less competitive.

Finally, as the majority of the companies of the CAUP are family companies that lack structure, this also contributes to their technological lag. In this sense, the coordinator of the cluster set the necessary goal of growth, innovation and consequent professionalization of these companies. Without this process, it is understood that many companies will not be able to stay in the market.
Table 1. Cluster characterization.

<table>
<thead>
<tr>
<th>City</th>
<th>Companies</th>
<th>Products categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francisco Beltrão</td>
<td>17</td>
<td>Kitchen utensils (14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machinery and equipment (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kitchen utensils and electrical accessories (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kitchen utensils and sheets, plates and coils (1)</td>
</tr>
<tr>
<td>Marmeleiro</td>
<td>5</td>
<td>Kitchen utensils</td>
</tr>
<tr>
<td>Pato Branco</td>
<td>5</td>
<td>Kitchen utensils (4)</td>
</tr>
<tr>
<td>Bom Sucesso do Sul</td>
<td>2</td>
<td>Kitchen utensils (1)</td>
</tr>
<tr>
<td>Nova Prata do Iguacu</td>
<td>2</td>
<td>Kitchen utensils and electrical accessories (1)</td>
</tr>
<tr>
<td>Coronel Vivida</td>
<td>2</td>
<td>Kitchen utensils</td>
</tr>
<tr>
<td>Realeza</td>
<td>1</td>
<td>Kitchen utensils</td>
</tr>
<tr>
<td>Flor da Serra do Sul</td>
<td>1</td>
<td>Kitchen utensils</td>
</tr>
</tbody>
</table>

There is consensus, especially among the smallest companies of the CAUP, that a new approach could be studied to satisfy the regulatory compliance. The main idea consists in a joint structure. A subgroup of the cluster could invest in a new SME, whose main objective would be to perform the processes and operations its owner companies are not able to process according to the new legislation. This cooperative approach is being evaluated. Despite the difficulties to implement such action, the advantage is the fact investing in new equipment is supposed to be inviable for the familiar companies, which will be at risk of not survive on the market. This cooperative action can be classified as a supply chain collaboration, as recently seen in the Taiwan networking communication industry [16].

4.2 NPD operations

The product development process is essentially informal and reactive. This means that the products undergo few changes, motivated by needs observed with no defined periodicity. These changes occur when companies realize that their products are losing market share (decrease in sales).

 Changes and improvements occur incrementally. There are no radical innovations, which seems natural when it comes to cooking utensils. The sources of inspiration for the changes are the technical fairs where companies observe the launch of competitors' products outside of the cluster. New materials, especially for utensil accessories (cables and grippers), are presented by the suppliers and eventually tested within the company.

These activities are usually conducted by the owners, along with their operational level employees. This practice is due to the absence of specialized personnel with technological training in the vast majority of the CAUP's companies. The low complexity of the products allows this process to occur without a technical staff. An exception is pressure cookers, which involves increased risk in use. This type of pot must necessarily pass through technical analysis of specialized personnel. However, with the certification process still in progress, it is believed that even the simplest items will require labor with technological training.

Maintaining a varied portfolio is a necessity for competitive advantage and insertion in different regions. The cultural aspects previously cited support this. The fact that the products are of low complexity reduces development efforts. However, the large variety of items produced is a common ingredient among cluster members. Portfolio management is, therefore, a critical and constant issue on the agenda of these companies, and overloads the managers, generally the owners.

4.3 Lean and green actions

There is knowledge of lean practices in the cluster's companies. There is, however, no evidence that lean philosophy and its tools are being used. The cluster coordinator understands that the wide variety of items is an obstacle to lean implementation in the CAUP.

Utensil companies have a need to be competitive in the variety of their portfolios, but at the same time, this constitutes daily difficulty in the production schedule. Matrix exchanges require at least 40 minutes. In the coordinator's company, for example, the spinning lathes have up to three setups per day.

Aluminum artifacts companies generate solid waste. The current legislation has been complied with. Aluminum waste is returned to the foundry companies. Polishing wastes are collected by companies outside the cluster.

5 NPD MATURITY LEVEL

The company studied, a member of the CAUP, was founded in the year 2000 and has 102 employees. Its main customers are door-to-door wholesalers. The products, aluminum kitchenware, are sold in the south, southeast, central-west, and part of the northeast regions. The portfolio has 20 product families and average monthly sales of 19,120 items.

The company has a product development method with a low degree of formalization of the steps performed. This process was monitored from April to September 2015. Using a reference model for NPD [14], the company's maturity level was evaluated in 23 questions:

1. Generic Activities (5 questions): performed in all of the stages of the NPD, these activities involve the Stage-Gate system proposed by Robert Cooper [17]. Economic feasibility and documentation are also covered.
2. Predevelopment (4 questions): corresponds to the strategic planning of products. The end of this stage is the definition of the portfolio and the outlines for the projects to be developed by the project teams.
3. Development (9 questions): this stage spans from the initial idea through the development of project specifications, concept, detail and manufacturing
processes, and ends with the product launch in the market.

4. Postdevelopment (5 questions): includes the monitoring of the product. This step involves customer feedback that must be considered to make incremental improvements throughout the lifecycle. At this stage, the removal of the product from the Market is also planned.

The NPD maturity was assessed considering five levels from [14]. They are: basic, intermediate, measurable, controlled and continuous improvement.

The company is in a transition from the basic level to the intermediate. The basic and intermediate levels are subdivided into sub-levels with the best practices, which are applied and grouped by areas of knowledge (Table 2).

<table>
<thead>
<tr>
<th>Level</th>
<th>Sub-levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Basic</td>
<td>1.1 Contains some activities related to product engineering.</td>
</tr>
<tr>
<td></td>
<td>1.2 Activities related to marketing and quality are added.</td>
</tr>
<tr>
<td></td>
<td>1.3 Activities related to process engineering, production and supplies are added.</td>
</tr>
<tr>
<td></td>
<td>1.4 It encompasses the previous sub-levels and contains activities related to project management and costs.</td>
</tr>
<tr>
<td>2. Intermediate</td>
<td>2.1 Product engineering evolves. Planning becomes more sophisticated as risk analysis and quality procedures are done.</td>
</tr>
</tbody>
</table>

6 DISCUSSION

In spite of the presented difficulties, the studied cluster has held a prominent place nationally in the manufacture of aluminum products, especially kitchen utensils.

The challenges and difficulties lie in the use of new technologies to improve productivity and product quality. The cluster coordinator understands that the varied portfolio, characteristic of the sector, is an obstacle to the implementation of lean practices. This statement shows that the lean philosophy can potentially be applied in the CAUP since the excessive number of setups is something to be studied in a lean environment.

The companies work with aluminum, which has high recyclability. Solid waste is reused or sent to specialized companies. Even the smallest companies in the cluster follow this practice.

After evaluating lean and green NPD issues based on [12] and [13] a synthetic analysis of lean and green adherence to the CAUP is presented (Table 3).

<table>
<thead>
<tr>
<th>Category analyzed</th>
<th>Current situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply Chain</td>
<td>Integration with suppliers exists, but is limited to development. Sustainability is not yet on the agenda in relation to suppliers. Some important suppliers are members of the cluster, which facilitates integration.</td>
</tr>
<tr>
<td>2. Product</td>
<td>Improvement studies occur in</td>
</tr>
</tbody>
</table>

Table 3 shows that there is potential for the implementation of lean and green practices, respectively focused on efficiency and sustainability. Lean practice focuses on people and processes and does not require high investments. Investment restrictions corroborate the lean path as a viable medium-term alternative in the CAUP.

7 CONCLUSION

In spite of the presented difficulties, the studied cluster has held a prominent place in the manufacture of aluminum artifacts, especially the kitchen utensils. There is potential for the implementation of lean and green practices in the studied cluster.

The analysis of maturity in one of the more structured companies showed that NPD processes need to evolve. The low complexity of the products eases the problem, but the wide variety of products urges for more efficient portfolio management in this cluster.

For the cluster it would be important, in relation to other countries, to establish a comparison of the current Brazilian legislation and its certification process with the standardization and certification of kitchen utensils. Of equal importance would be to analyze the cultural aspects of other countries that influence the products used in the cooking of food. Although it was not delivered by the coordinator of the cluster, these two points of investigation would be an initial mark to enable the export of the CAUP's products.

8 ACKNOWLEDGMENTS

The authors are grateful for the coordination of the cluster of aluminum utensils and products (CAUP), as well as the financial support of the Federal University of Technology (UTFPR) and Nottingham University Business School (NUBS).
9 REFERENCES


