Application of Strategy Planning Method to Integrated Development Sustainable Product Process (PEPDIPS)

TEIXEIRA, G. F. G.*, CANCIGLIERI, O. JR.

Pontifical Catholic University of Paraná – PUCPR, Curitiba

**Grazielle Teixeira, grazielle.teixeira@pucpr.edu.br*

Abstract

With the reduction of borders promoted by globalization, the level of consumption grew dramatically, characterizing our consumer society. However, if on the one hand this growth means progress, on the other hand, this means progress without a future, since consumption can only symbolize progress if it occurs within a form of sustainable development. Faced with this scenario, society and government have been pushing the industries to adopt more sustainable practices in their processes, especially the Product Development Process (PDP). In this new perspective, the PDP with sustainable characteristics can add a long-term competitive advantage to the company. Therefore, the present study presents the application of the conceptual method for the Strategic Planning of the Integrated Process for the Development of Sustainable Products (PEPDIPS), which aims to guide the integration of sustainability in the PDP through the qualitative evaluation of the requirements and phases of the PDP, from the initial phase of designing the project for the launch and distribution of the product. The PEPDIPS is characterized as a maturation method composed of a cyclic process with two macro phases and four micro phases. With the objective of developing a support evaluation focused on the process of continuous improvement that aims to integrate sustainability into the PDP, guiding the designers the best strategic choices applied in the planning and elaboration of a new or existing product. Extending your assessment to business management, necessary to structure and substantiate such changes. The application of the PEPDIPS method is presented through the case study developed in a textile industry.

Keywords: *Maturity Model, Sustainability, Strategic Planning, Product Development Process.*

1. Introduction

Sustainability is a field of research with greater development, especially in the last decades, when sustainable development is an important factor, influencing as characteristics of business and industries in the 21st century. The main factors that cause the interest of the corporate sector for sustainability is the social pressures to improve their production process in a more sustainable way (Lozano and Huisingh, 2011; Ritter et al., 2015) and later the competitiveness of the market. In this sense, another factor that is also relevant is an innovation that the integration between sustainability and the Product Development Process (PDP) can generate a new perspective of product planning, which composes a field of research with continuous growth.

The PDP aims to identify and translate as user requirements and requirements into data that allow an elaboration of a product. In this way, the PDP will drive each phase of the product life cycle to suitable solutions. That is, their stages have a direct influence on the final product, since decisions are

more taken in the PDP, such as: cost, performance, innovation, selection of materials, sustainability and quality. This is why a meeting of two themes aims to increase the percentage of companies' competitive capacity, making it essential for a better performance in their performance (Hallstedt et al., 2013). In this direction, in a matter of interdisciplinary of the document, several discussions on its applicability were fomented. In this way, a multiple search direction that explores, for example, the use of sustainability as a means of implementing continuous improvement within the PDP (Carter and Rogers, 2008), as well as the models of sustainable PDP (Luttropp and Lagerstedt, 2006) and also as an update to the tools used in the PDP (Carnevalli and Miguel, 2008). From this perspective, a sustainability assessment with an innovation can stimulate as companies and elaborate their products in order to provide, in addition to a new evaluation of their consumers, a new and more sustainable consumption option (Bhuijan and Thomson, 2010). Thus, the present study presents the conceptual method for the Strategic Planning of the Integrated Process for the Development of Sustainable Products (PEPDIPS), with the objective of integrating sustainability into the PDP by qualitative evaluation of the requirements and phases of the PDP, from the initial step, since the project until the product launch and distribution. After, the application of the conceptual method is exemplified through a case study developed in a textile industry.

2. The Strategic Planning Method of the Integrated Sustainable Products Development Process

The Strategic Planning Method of the Integrated Sustainable Products Development Process, which has the acronym PEPDIPS aims to guide the integration of sustainability into the PDP through the qualitative evaluation of the requirements and phases of the PDP, starting from the initial stage of designing the project to launching and distributing the product. PEPDIPS is characterized as a maturity method composed of a cyclic process with two macro phases and four micro phases. Designing a support assessment focused on the process of continuous improvement that aims to guide designers and engineers the best strategic choices applied in the planning and elaboration of a new or existing product. Extending its assessment for business management, necessary to structure and ground such changes.

The concept of the PEPDIPS method was based theoretically on the evidences and directions identified in a systematic literature review, whose objective was to identify and describe the factors that facilitate and prevent the integration of sustainability in the product development process. This systematic literature review covered studies dating from 2006 to 2017. In all, was analyzed studies classified in five domains of knowledge: (1) methods/models/tools to sustainable products development; (2) methods/models/tools to developing environmentally sustainable products; (3) methods/models/tools to developing socially sustainable products; (4) consumption of sustainable products and (5) strategic planning for the development of sustainable products.

The PEPDIPS method, illustrated in Fig. 1, consists of two knowledge domains: Organizational Management and Product Development Process (PDP). The first domain, called Organizational Management, contains the two macro phases of the method. The Recognition stage (first macro phase) is responsible for evaluating and categorizing the level of maturity of organizational sustainability. This evaluation is structured by a set of five levels of maturity. At the end of the first step, the results are presented for the elaboration of the action plan, containing the areas that need improvement and the priorities of these improvements. So, the PEPDIPS method is composed of five levels of maturity, termed PEPDIPS maturity that delineate performance and business interaction with the theme as illustrated in Fig. 2 the maturity levels.

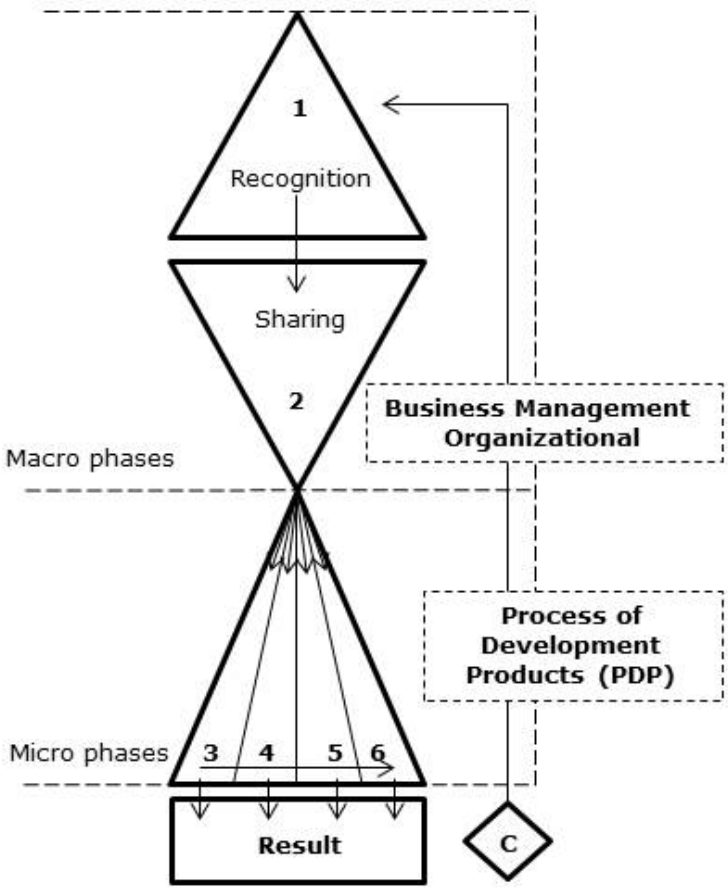


Fig. 1. The Strategic Planning Method of the Integrated Sustainable Products Development Process (PEPDIPS).

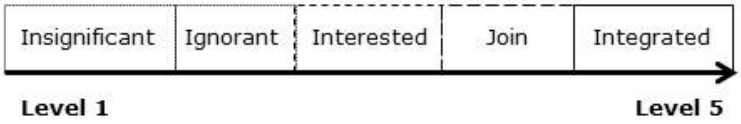


Fig. 2. PEPDIPS maturity levels.

The PEPDIPS maturity levels are:

- Level 1 - Insignificant: refers to companies that do not aim at sustainability. In effect, it does not provide for certification, adoption of any type of technical / organizational measure, nor the application of resources to the cause.

- Level 2 - Ignorant: refers to companies that are not aware of the advantages of implementing sustainability, but through market competition and the influence of marketing strategies to attract customer sensitivity, may have some experience through initial projects. The progress of its progress would only be to comply with the legislation. This effort is still not significant to change production or organizational structure, so the company still does not seek certificates or dedication of resources above what is necessary to meet the goal.

- Level 3 - Interested: refers to companies that know the advantages of implementing sustainability, evaluating punctually the areas for the application of the first incremental improvements and pilot projects, focusing on going beyond compliance to the legislation. That is, it aims to meet the requirements of stakeholders and establish an internal awareness and motivation to progress. Therefore, there is the commitment of resources and

modifications in both production and organizational structure. And there may be activities in the process of certification.

- Level 4 - Involved: refers to companies that already have some certified activities, being systematically in progress to include sustainability in the process of product development, aiming at the radical innovation of their products. However, it still has problems in its organizational structure.

- Level 5 - Integrated: refers to companies that obtain recognition for the implementation of sustainability due to their considerable experience and to treat sustainability together with the company's priority objectives, aiming to support the decision-making process for strategies, goals, technical and financial factors. At this level, the organizational structure and production processes are key to maintaining the certifications already achieved and those in progress, making available a relevant part of the resources. However, there are still some problems in the integration of sustainability in the organizational aspect.

Sharing (second macro phase and step) corresponds to the transmission of the action plan elaborated in the previous stage. In order to work with the action plan, communication must maintain a channel of dialogue with the whole organization through a common language. Through this common language will be transmitted the new values, mission and conduct adopted by the company in the action plan, as well as the needs for improvements.

The second domain, Product Development Process (PDP) contains the following four steps of the application, which correspond to the micro phases of the method. The first micro phase and the third step is called Strategic Planning, which outlines the strategies and advantages of integrating sustainability by means of the market analysis. The second micro phase and fourth step is the Project, corresponding to the planning of the product from the goals architected in the macro phases and in the first micro phase. The third micro phase and fifth step is Production, in charge of evaluating the method or model of product more appropriate to the need. Finally, the fourth micro phase and sixth step is the Presentation, in charge of the elaboration of marketing for the launch and description of the product.

The result of the final process will be evaluated by the length of the action plan elaborated in the Recognition macro phase. The cyclical process is the evaluation of the result achieved in comparison with the action plan. For this, the process is structured by two questions:

- What was the breakthrough?
- What does it represent in the organizational structure of the company?

In the first question, a comparison is made between the one planned in the first macro phase and the result. And in the second, the degree of importance and effect of the results on the organizational structure is evaluated, that is, the level of improvements, changes achieved.

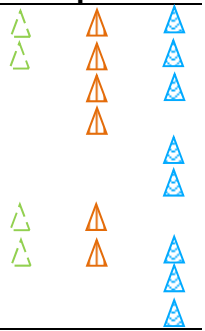
3. Application of the PEPDIPS Method - Case Study in a Textile Industry

The case study in the textile industry was constructed from information declared by the company researched in its annual sustainability reports, which were elaborated following the Global Reporting Initiative (GRI) model. The definition with the highest recognition is described by World Business Council for Sustainable Development (WBCSD), which describes: sustainable development report are reports published by companies to provide internal and external stakeholders an image of the position of companies and their activities in the economic, environmental and social dimensions (WBCSD, 2002). In this way, the case study used the use of sustainability reports due to the fact that it is an important instrument of corporate accountability, where organizations dialogue with their clients and partners. In this section a summary clipping of the application of the PEPDIPS method is presented.

The analyzed industry is in Brazilian territory. In Brazil, the textile sector is one of the industrial segments that most contributes to its development. Therefore, the country is listed as one of the best and largest producers in the world textile and clothing sector, according to the National Confederation of Industry (CNI) and the Brazilian Textile and Apparel Industry Association (Abit). However, in the sustainable development aspect, there are few companies that carry out sustainable practices in their routines. Based on this context, the application of the PEPDIPS method was performed through the use of the benchmark and a qualitative-quantitative research to identify the most relevant themes for improvement and consequently their perpetuity. Resulting in a new strategic planning for the sustainable process of product development operated in the company.

The productive process of the products of the analyzed company concentrates greater complexity in the management of the supply chain than the projection of the products themselves. Therefore, the integration of sustainability in this company must be developed more broadly in the requirements of the structure and the organizational aspect. In this sense, in the first macro phase - Recognition, it was identified that the level of maturity of the company was interested. Therefore, it was possible to observe that company recognized the advantages of implementing sustainability through strategic analysis and began to consider it in decision making and in the development of competencies and capacities, evaluating punctually the areas for the application of the first incremental improvements and pilot projects. In this way, it maintained its objective to balance stakeholder requirements and strategic preferences related to sustainability, establishing an awareness and internal motivation to progress, presenting opportunistic behavior. In this context, the application of the PEDPIPS method went to the next macro phase: Sharing, where the action plans were elaborated that would allow the company to balance the integration of sustainability at the entry level. Table 1 depicts the plans to be performed. Table 1 also outlines in which of the three sustainability aspects the action plan operates, these being represented by triangles in the colors: green (environmental aspect), blue (social aspect) and orange (financial aspect).

Table 1. Action Plan

Action Plan	Sustainable Aspects
- Redevelopment of company objectives and mission	
- Enlargement of the number of integrated products	
- Behavioral reshaping of employees	
- Re-planning of applied processes	
- Development of a communication channel	
- Restructuring of the training program	
- Implementation of long-term improvements in company infrastructure	
- Improvement and expansion of control and measurement systems	
- Increase cooperation between teams	
- Publicize and engage employees on the new mission and purpose of the company	

Subtitle: environmental aspect; financial aspect; social aspect.

With the elaboration of the action plans, the application of the PEPDIPS method followed for the second domain: Product Development Process. Where are located the micro phases that work directly with the production of consumer goods. Thus, the product was selected from the product portfolio of the company: women's jeans. This choice was based on data the company has in its report. This is a product of small technical complexity and with low production costs. In addition, it is a product with a more expressive percentage of impact generation in the production and disposal phases. For, the impact index caused in the phase of use of the product depends on the type of behavior that the user has. In the sequence, Fig. 3 shows the product and its characteristics.

Fig. 3. Product selected: women's jeans.

Based on the plans and characteristics of the product analyzed, the Strategic Planning (first micro phase) was developed for the development of the company's operations and production through the sustainable bias applied to the female jeans product. Thus, the study elaborated the objectives that the company could assume. They are objectives that act in multiple areas of business, including the company's sustainability committee, executive board and board of directors. Generating encouragement and support from top management. The objectives are:

Table 2. Objectives

Objectives	Sustainable Aspects
1) Produce the products respecting the environment and the rights of the worker.	△ ▲
2) Identify, measure and reduce environmental impacts.	△
3) Generate value to the product through innovation in the mode of production or the use of sustainable raw materials.	△ ▲ ▲
4) Generate knowledge and training to employees and other stakeholders about the development of sustainable products.	▲ ▲
5) Implement continuous sustainable improvements in the company's infrastructure.	△ ▲ ▲
6) Structuring the supply chain with partners seeking sustainable development.	△ ▲ ▲

Subtitle: environmental aspect; financial aspect; social aspect.

Based on the Strategic Planning, the Project (second micro phase) describes in the information stage the materials used in the product, along with the alternatives that can be selected. In continuity, the Conceptual and Detailed Project, where the solutions used were defined, it was noticed that the product of women's jeans needed more changes in the selection of materials, resources and processes than in their design. Therefore, it established the following decisions, illustrated in table 3.

Table 3. Project

Product	Decision Making	Company Objectives	Sustainable aspects
Cotton	Cotton produced with little use of chemicals	1 - 3 - 6	△◬◭
Elastane	Renewable bio-derived elastane	1 - 3 - 6	△◬◭
Ornaments	With recycled metals	1 - 3 - 6	△◬◭
Dyeing	Organic dye + electrochemical reduction	1 - 2 - 3 - 5 - 6	△◬◭
Benefit	Ozone	1 - 2 - 3 - 5 - 6	△◬◭
Production	Eco-efficiency and impact neutralization	3 - 5 - 6	△◬◭

Subtitle: △ environmental aspect; ◭ financial aspect; ◬ social aspect.

Once the Project stage is completed, it is followed by the penultimate stage - Production. At this stage, the elaboration of the production plan composed of the stages of cutting, assembly, processing and laundry takes place. Based on all the analyzes presented up to this point, it was described that for the sustainable production of the product jeans was necessary changes in the infrastructure of the company, aiming at the Eco-efficiency and the neutralization of the impacts. In view of this, it was observed in the company's report that it did not wiring its fabrics, acquiring them ready for the processing and preparation. In this sense, the choice of cotton with little use of chemicals is a decision in favor of the selection of materials that generate less environmental impacts and the substitution / elimination of toxic inputs. Also, the option for renewable bio-derived elastane and recycled auctions. As observed in the study, the exchange of the raw material does not alter the quality of the fabric, therefore, does not impact the durability and comfort of the piece. Therefore, it is expected that the textile analysis tests to analyze possible dimensional changes, shrinkage and deformation skew, pilling formation and thermal resistance achieve the same result. In this way, the stages of dyeing, processing and confection will be the areas of improvement in the infrastructure of the company.

In the case of dyeing, the company has the best option to use the same dye in the organic version. Such a change does not alter the dyeing procedure, but requires the suitability / replacement of the employed machinery, aiming at dispensing the sodium dithionite by the electrochemical reduction which helps to make the dyeing cleaner and less toxic. Being a less need in the treatment of effluents, since oxidation does not use chemical components and the organic dye has its biodegradable effluents. For the oxone beneficiation, the company needs to change the machinery used, which means an improvement in the product (use of heavy metal free materials), process (reduction of stages and time) and the company's infrastructure (energy, water and inputs). In the confection, the most representative improvement consists in the change of the cut layout, where the parts of the mold of the piece are arranged for cutting the fabric. That is, it is necessary to generate knowledge and training to employees and other stakeholders on the development of sustainable products, which in this point can be directed to the recycling of flaps by the reprocessing of roving, destining the fibers for the production of other products, thermal insulation and tows. Also, by the use of zero waste technique in straight molds, such as: pockets, passers and fly. The technique, as the name itself describes, structures the cut layout so as not to produce any waste. Working thus, with the minimization of material content (better use); reduction of losses and wastes; extending the life of the materials and reducing the costs of landfill disposal.

Finally, the marketing plan was elaborated (sixth step). At this moment, the company seeking to add competitive advantage and isolation of its products from the competition, should generate knowledge to its consumer, informing them in what aspects and when was the progress of their efforts to make production more sustainable. In this sense, through the use of virtual networks, which by the speed of dissemination and the non-generation of solid wastes, is the most viable option.

In this way, the same product was re-presented (Table 4, Fig. 4), we can see that its design did not have to be altered to integrate aspects of sustainable production. As well as, product quality, comfort and durability have maintained the same level. For the most significant changes are focused on implementing changes to improve the production process, that is, on how the product is planned and done. Adding sustainability as an intrinsic value to the product. In this context, it can be compared that if the company manufactured the same product under analysis (female jeans) following the guidelines proposed by the PEPDIPS method presented here, it could achieve improvements in:

Table 4. Application result.

Input / Process		Improvement
Cotton	Planting	Reducing the use of chemicals, water, energy. Increased fiber productivity (compared to other sustainable options). Same fiber quality with traditional planting.
	Weaving	Reduction of generated waste (recycling of fibers).
Elastane	Source	Reduction of the impacts generated in the obtaining of the raw material by the substitution of the oil for the corn.
	Use	Same fiber quality. It provides the closed life cycle of the product, since it is a biodegradable input (waste reduction) that can be used in the planting of new raw materials.
Ornaments		Same quality. Reduced costs. It provides the closed life cycle of the product, since it is a recycled input (waste reduction).
Dyeing		It reduces the rate of pollution caused by being a closed-loop process where the process is cleaner (without generation of permanent residues), biodegradable waste, less the use of chemicals and the same coloring quality of the fibers.
Benefit		Reduction of 50% of water use, 60% of the time (speed and stages), energy and does not generate waste once they are neutralized before being discarded.
Production		Optimization of processes, better utilization of resources and inputs, reduction of waste generation, improvement of stakeholder engagement, generation of knowledge among partners, reduction of productive costs, direct incentives for development and social equity, relationship with community projects and support Cleaner Practices.
Marketing Plan		Generation of knowledge to the user, better market positioning and visualization for sustainable products, development of activities focused on waste minimization, income generation and social development.

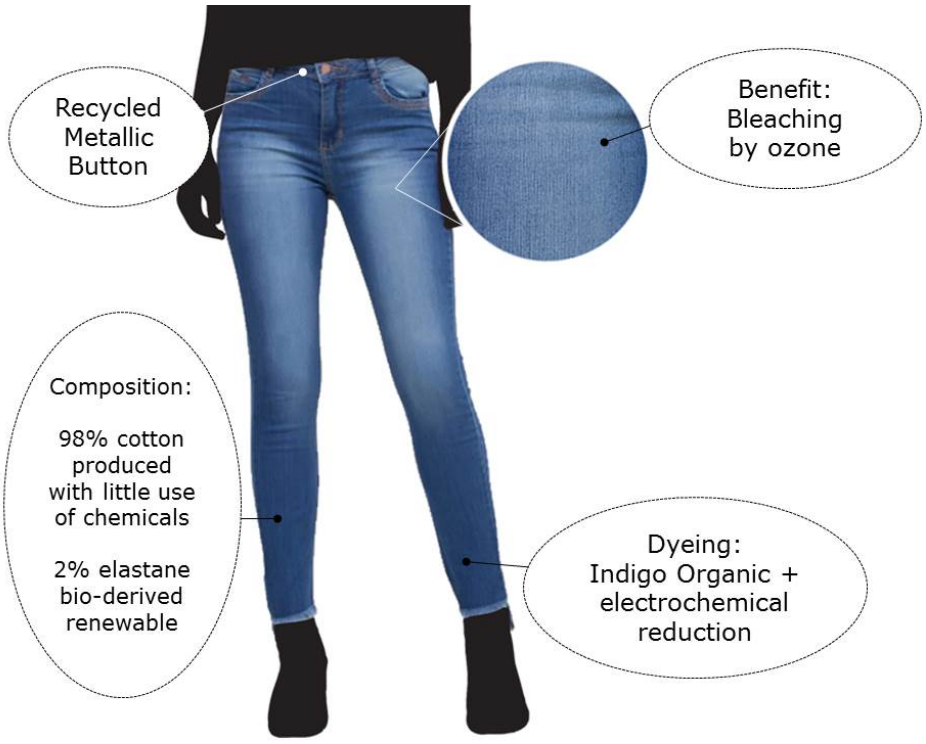


Fig. 4. Result of the selected product: women's jeans.

As a conclusion to the case study, it can be said that proposing textile articles in a more sustainable way means a means to attenuate the inherent habit of consumerism. Reducing its socio-environmental impacts, costs, adding differential and value to the product, increasing the reputation and competitive advantage of its producer. Socially, the propositions of these products can operate as a driver for environmental awareness on the part of users. Therefore, the changes made by the application of the PEPDIPS method proved to be more coherent in the planning phase, being a project challenge that must be solved with the commitment of multidisciplinary teams, not only by the designers. An example of this is the means by which the raw material and the work of generation and dissemination of knowledge are obtained and benefited so that the end users are also seen as participating factors and responsible for one of the life stages of these products.

4. Conclusions

The development of sustainable products is considered by the academic researchers as an important strategy that companies must use to ensure their longevity in the market. As a result, several studies on how to develop new PDP models for sustainable development have been presented over the last decades. However, few researches have focused on bridging the gap in how to bring academic advancement closer to business reality. This shortage has helped to create barriers to the introduction of these models, causing delays in sustainable development.

This paper presented the concept of the PEPDIPS method, which is capable of integrating sustainability into product pre-development, development processes, qualitatively assessing performance and the company's involvement in sustainability. Thus, the importance of the work presented focuses on building a new perspective for designers and engineers to plan, design and produce new products in order to develop them in a more sustainable way. Illustrating how product development plays an important role in transforming society towards sustainability.

With regard to the outcome of the case study, it can be observed that this helped to confirm the relevance of, firstly, implementing sustainability in organizational issues and, consequently, the PDP. In conclusion, it is pointed out that with the increasing recognition of the relevance of corporate participation for sustainable development, making sustainability more tangible through goals, action

plans and decision making helps in the process of integrating sustainability into the strategy of companies.

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