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Moretti, Isabel Cristina; Braghini Junior, Aldo

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## REFERENCE MODEL FOR APPAREL PRODUCT DEVELOPMENT

*Isabel Cristina Moretti*  
*Federal University of Technology – Paraná (UTFPR), Brazil*  
*E-mail: isabelmoretti@utfpr.edu.br*

*Aldo Braghini Junior*  
*Federal University of Technology – Paraná (UTFPR), Brazil*  
*E-mail: aldo@utfpr.edu.br*

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### ABSTRACT

The purpose of this paper was to develop a reference model for the implementation of the process of product development (PDP) for apparel. The tool was developed through an interactive process of comparison between theoretical. Managers in companies and professionals working in this market can utilize the reference model as a source for the organization and improvement of the PDP for apparel and the universities as a reference source for systematized teaching of this process. This model represents the first comprehensive attempt to develop an instrument at a detailed level (macro phases, phases, activities, inputs and outputs at each stage and at the gates) to systematize the PDP process for fashion products and to consider its particularities.

**Keywords:** product development; reference model; apparel.



## 1. INTRODUCTION

Apparel production is one of the industries with the most potential for exportation and one of the oldest industries in the world. It is also one of the most global industries because the majority of companies produce for the international textile and apparel market (GEREFFI; FREDERICK, 2010). In the textile chain, the apparel sector unites a large number of companies. However, it is the sector with the lowest level of innovation compared with other links in the textile chain. This fact originates from the production process, which demands a large amount of manual labor. Besides the lack of innovation, apparel industries mostly have low technical and managerial capacity (BNDES SECTOR, 2009). In view of these characteristics, it is essential for the industry to innovate in product design, management and operational processes to maintain profitability (SENANAYAKE; LITTLE, 2001).

The paradigm of effective management in the apparel industry is related to the prediction of consumer needs and desires. Accordingly, the companies in this sector need to respond with innovation and products that are designed and manufactured properly (DILLARD *et al.*, 2000; MAY-PLUMLEE; LITTLE, 2006). These companies need to develop and manufacture lines of high-quality, diversified and competitively priced products (KWAK *et al.*, 2010). They also need to reduce the product development (PD) time and manage employees effectively to meet these challenges (DILLARD *et al.*, 2000). In this environment, in which the competition is intense and dynamic, to dominate the market, a company's ability to conceive and design a great variety of quality products faster than its competitors is instrumental (WHEELWRIGHT; CLARK, 1992). For product development to meet these demands, the effective management of the product development process (PDP) as a whole becomes an indispensable factor.

Because of the competition, apparel manufacturers seek ways to be more flexible, more efficient and better focused in their forecasting, production and sale of products (KINCADE *et al.*, 2007). The dependence of the apparel industry on product design makes the PDP faster, requiring the development of a large number of products at the same time. May-Plumlee and Little (1998) present these aspects as follows. First, the industry products are developed in seasonal lines (collections) instead of as individual products. A line of apparel may be constituted by different



groups of products that should be managed simultaneously with the process. Consequently, the process proves to be more complex because some decisions made during the PDP have implications for the entire product line, while others apply only to a limited number of products. Second, several lines of new products should be produced per year. Third, the strategy for the development of any product in the line of apparel may be different from the strategy used in the development of other types of products (MAY-PLUMLEE; LITTLE, 1998).

Due to the specific aspects of the development of apparel products, they present some individual characteristics. The creation of a methodology, a reference model for the PDP, specific to the apparel industry and adapted to its characteristics, is a way for these companies to structure their PDP, increasing the performance of the development process and, consequently, the companies' market share. Other authors have proposed models for the product development process for fashion wear; however, the stages throughout the process and the relationships between them are not exploited, and the models have proved themselves to be superficial.

This study focuses on apparel companies that produce fashion wear and develop it in collections throughout the year, the characteristics of which increase the complexity of the PDP in this sector. The purpose of this research is to propose a reference model for the process of apparel product development (APDP). The developed model can be used as a reference for companies in the sector to structure the PDP. The use of the model will allow apparel professionals to systematize the stages of the PDP, resulting in a reduction of the lead time. The model may also become the basis for researchers working in the PDP, especially on research related to the apparel manufacturing industry, and in fashion education institutions, design and product engineering.

## **2. LITERATURE REVIEW**

Product development is a business process that aims to transform data and technical possibilities into market opportunities and information, enabling and assisting the development of product design (CLARK; FUJIMOTO, 1991). Krishnan and Ulrich (2001) defined product development as the transformation of a market opportunity into a set of assumptions about the technology of the product for sale, in addition to being the main source of product and process quality. The quality of the



PDP management is closely linked to the standardization process (AMARAL; ROZENFELD, 2007). A structured development process for new products is essential for most businesses to reach their goals, to provide new products continually to attain customer satisfaction (VALERI; ROZENFELD, 2004).

According to March-Chordà *et al.* (2002), one of the success factors in the development of innovative products is the formalization and planning of the product development process. However, many companies have difficulties in defining the most appropriate strategies to achieve significant and sustained improvements. This is due to the complexity of PDP technologies and procedures, which are often incompatible with the degree of industry maturity (OLIVEIRA; KAMINSKI, 2012).

The product development process has a multidisciplinary character, is technologically complex and occurs at the intersection of different fields (Revilla and Rodríguez, 2011). To deal with this fact and increase their competitiveness, many companies are actually reviewing their product development practices and implementing approaches that will enable them to cope with increasing uncertainty and ambiguousness (KOUFTEROS *et al.*, 2002). Thus, a documented and systematic process provides the use of the best design practices and a single and standardized language for the entire company. From the moment that this process becomes standard and can be utilized by several people, it is documented as a model (AMARAL; ROZENFELD, 2007).

The formalization of the PDP management model allows an overview of all the participants in the entire process (senior management staff of the company's functional areas and partners). Everyone involved in the development becomes familiar with the expected results for the PDP, which activities should be undertaken and how, which conditions must be met, the source of information and the decision criteria to be adopted. As development projects are defined from this model, it is known as a reference model (AMARAL; ROZENFELD, 2007).

The product development process can be defined as a set of phases (TROTT, 2008). First, the new market opportunities have to be identified; second, they must be evaluated in terms of technical and economic feasibility; third, new product concepts have to be developed; fourth, these must be converted into physical prototypes; and



fifth, eventually, these prototypes must be converted into products that can be marketed (GRUNERT *et al.*, 2011). Amaral and Rozenfeld (2007) presented a set of phases, executed in a reference model that describes the process of developing new products in various sectors, and this is the basis on which companies can develop this process in accordance with a common point of view. The model is divided into macro phases, namely pre-development, development and post-development. Each macro phase is subdivided into phases and activities.

From the literature concerning the development of apparel products, basic steps in the process can be identified, such as research for the drafting of ideas, conceptual lines and preparation for production and the market. Within each of the four basic steps are countless design and development activities that are carried out sequentially (KINCADE *et al.*, 2007). Many authors, through their research, have developed models for the PDP specifically for apparel (GASKILL, 1992; LAMB; KALLAL, 1992; MAY-PLUMLEE; LITTLE, 1998; WICKETT *et al.*, 1999; RECH, 2002; MONTEMEZZO, 2003; PITIMANEEYAKUL *et al.*, 2004).

### 3. METHODOLOGY

This research is based on extensive examination of the development process of the apparel product. The research is predominantly qualitative and of an applied nature. Regarding the technical procedure, bibliographic research was undertaken, as in the first stage of this work, studies of reference models for the existing PDPs in the literature were necessary to support the development of the proposed model (GASKILL, 1992; LAMB; KALLAL, 1992; MAY-PLUMLEE; LITTLE, 1998; WICKETT *et al.*, 1999; RECH, 2002; MONTEMEZZO, 2003; PITIMANEEYAKUL *et al.*, 2004; ROZENFELD *et al.*, 2006). This is a case study, since the study investigates a phenomenon, the case of the PDP in the apparel manufacturing industry. Having defined the method, data collection was carried out by means of field research. The data collection for this research was conducted in interviews with companies, professors and professionals in the area of apparel, following May-Plumlee and Little's (1998) research.

For the stratification of the sample of companies, the first criterion adopted was that the companies would produce fashion products under their own brand and that they would have an environment and a product development team in the



company. For the respondents in the sample of professionals, it was decided that only those who worked directly with the fashion APDP and who were directly involved in the whole process could participate. As for the professors, the parameter for the stratification was that the individual would have to be teaching or have already taught lessons in the discipline of apparel product development on a fashion course or fashion design course at the higher education level.

The script of the interviews was in the form of open questions, and it was structured differently for businesses, professionals and professors. The preparation of the script was undertaken after a bibliographic review of the subject. However, the interviews had the same goal: to answer, regarding the product development process, the questions of “what” the process is and “how” it is performed, both from the companies’ and from the academics’ perspectives.

### 3.1. Results from the Field Research

#### *Analysis of the companies interviewed*

Eight companies with their own brands were interviewed, which performed the PDP internally and manufactured fashion products, that is, they developed products through seasonal collections and followed fashion trends. The characteristics of the companies that were interviewed for topic exploration are presented in Table 1.

Table 1: Characteristics of the interviewed companies

Companies	No. of employees	Time in the market	No. of collections per year	Type of product	Professional interviewed
A	28	18 years	2	Women's, men's and children's fashion: <i>fitness</i> , beach and swimming	Designer
B	60	14 years	3	Women's fashion	Designer
C	70	11 years	3	Women's fashion: knitting and woven fabrics	Designer
D	90	20 years	3	Female and male fashion: jeans, knitwear and shirts	Designer
E	130	25 years	3	Children's fashion	Designer
F	200	48 years	3	Female and male fashion: jeans, knitwear and woven fabrics	Designer
G	320	30 years	2	Women's fashion: <i>fitness</i> and beach	Designer
H	1600	15 years	4	Women's, men's and children's fashion: jeans, knitwear	Designer





All of the companies' respondents were designers. This fact highlights the importance of these professionals for the apparel PDP, since in most companies these professionals are the PDP managers in charge of the process as a whole in addition to the creation of the pieces.

The companies interviewed work through collections (product lines). These collections are usually named after seasons (for instance, summer, high summer, winter, autumn/winter), but each company employs a different strategy regarding the number of collections and the number of models developed by each collection. On average, the companies interviewed develop three collections a year, ranging from 30 to 500 models each, depending on the company.

The PDP of each company was mapped to gain a better visualization and understanding of the phases and activities. The sequences of activities that these companies undertake in the PDP do not display large variations. In general, basically the same phases are performed, differing in nomenclature, group activities and especially the degree of depth in which each stage is conducted. The comparison among the stages developed by each company can be seen in Figure 1.

Through this comparison, it was possible to identify the phases that are similar in the product development process and the gates (verification activities) that are utilized by the companies in the process. Similar gates are displayed in the same color.

Similar activities are grouped taking into account nomenclature variations and the breakdown of activities from the phases and gates, as shown in the row marked "Stages". The top-ten phases for PDP companies were identified: planning, research, raw materials selection, development styles (drawing), modeling, pilot run, development of the technical data sheet, marketing of the collection, production and launching. Through the modeling of the PDP, it was also possible to group the activities and documents generated in the process of the industries in a generic way. The gates used by the companies were related to the decision-making process for the approval of the theme, the approval of raw materials, the approval of sketches and the pilot run apparel approval.





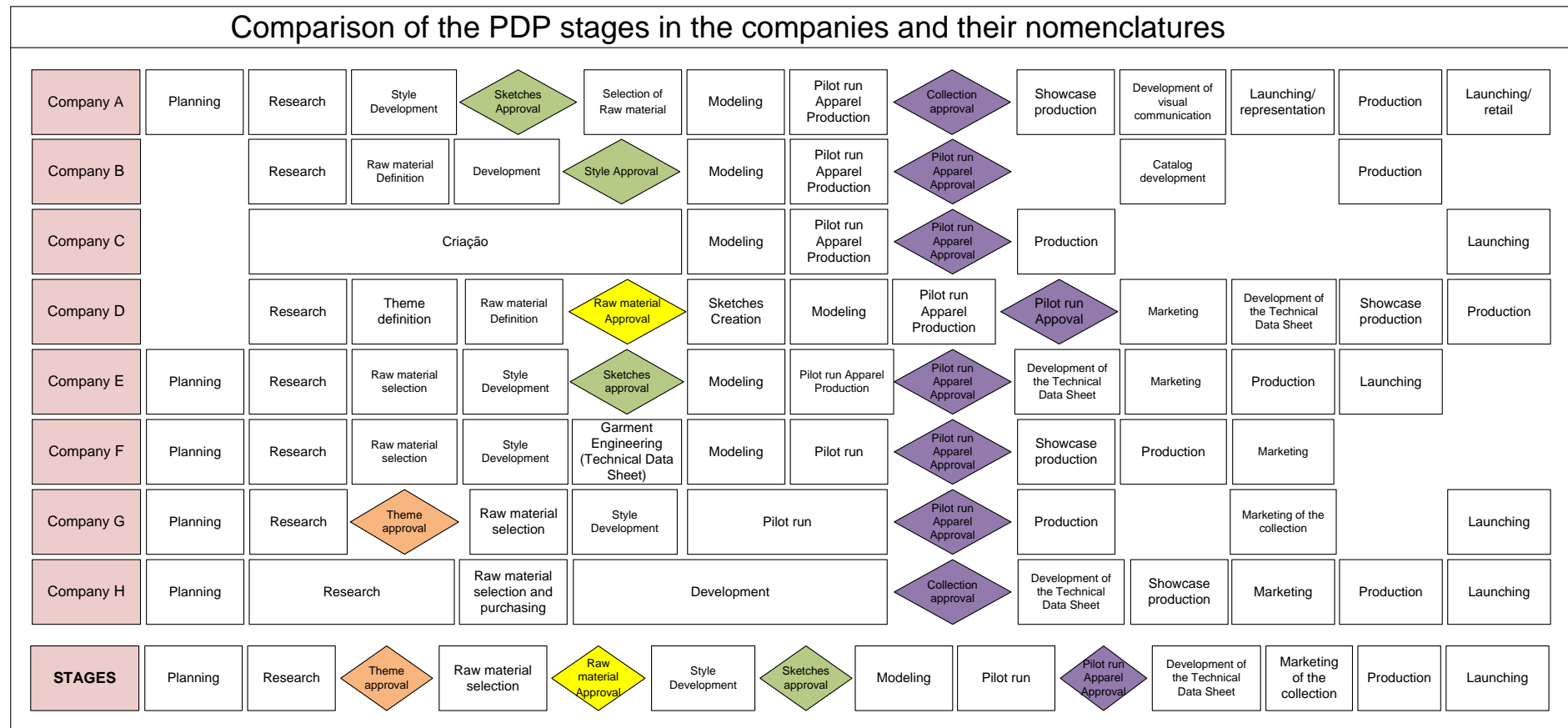


Figure 1: Comparison of the phases of the companies' PDP and their nomenclatures



*Analysis of the professionals who were interviewed*

The questions in the script used for the interviews with the professionals concerned the activities that make up the PDP, the organization of the process and issues relating to the development and use of a reference model for the PDP in the apparel industry. Interviews were conducted with four professionals who work directly with the PDP in the apparel industry and follow fashion trends.

Through the interviews, it was possible to characterize the PDPs of the apparel according to the design of each professional. The stages were mapped as well as the stages of the companies. From the maps, it was possible to make a comparison between the stages reported by each subject, as shown in Figure 2.

Eight main stages for the PDP were identified according to the professionals, as shown in the "Stages" row: schedule definition, research, sketches drawing, raw materials definition and selection, modeling, pilot run production, development of the technical data sheet, production. In addition, two gates were identified in the process: sketches approval and pilot run approval. Through a comparison, it was possible to identify the phases and gates common to all professionals. Similar activities were grouped taking into account the variation in the nomenclatures and the detachment of the activities from the phases and gates.

*Analysis of the professors' interviews*

In the interviews, the professors were surveyed about the phases that make up the apparel PDP for the teaching process, about issues related to the availability of materials in the PDP of the apparel industry and about the development and use of a reference model for teaching the apparel PDP. Eight professors were interviewed, who were teaching courses on apparel PDP in institutions of higher education. After the general information was collected, the professors were questioned about the phases that comprise the PDP in the apparel industry.



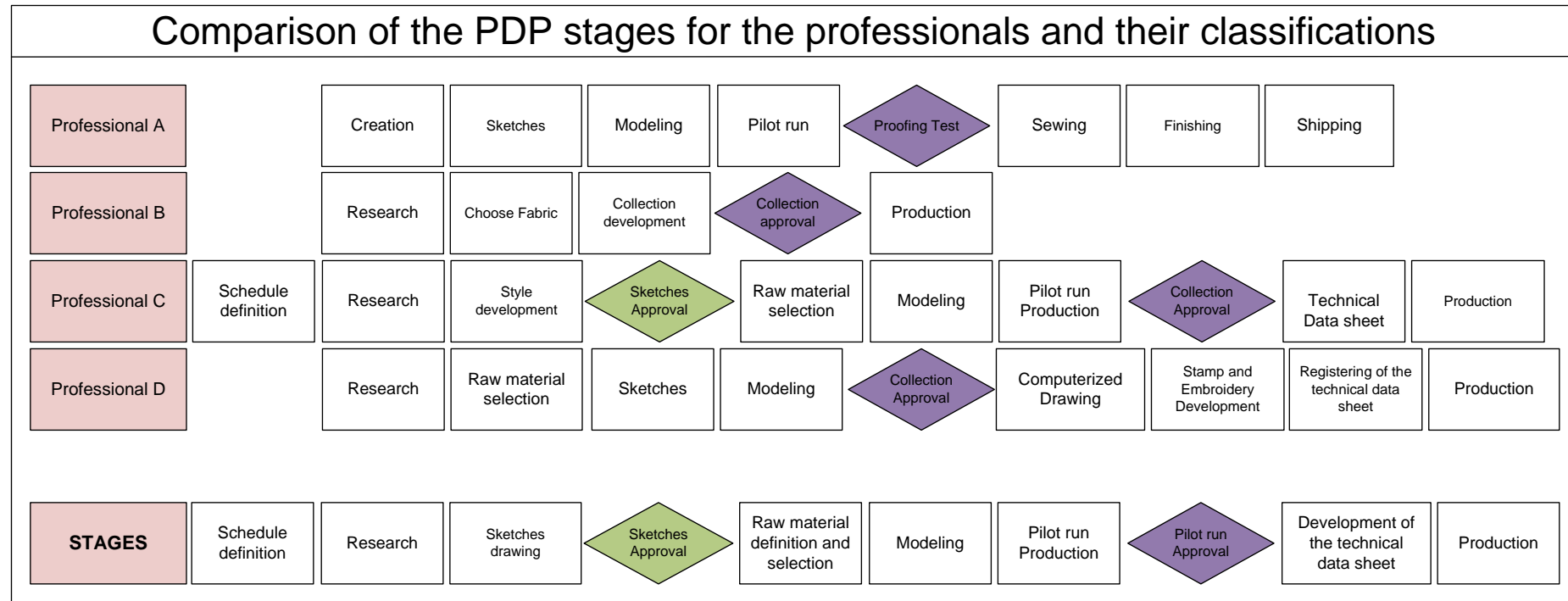


Figure 2: Comparison of the PDP stages for the professionals and their classifications



In the analysis of the phases reported by the professors, it was possible to identify the early stages of the process, such as design, creation, market analysis, target audience analysis, definition of the labor sector, preparation and organization of the mind for creating and purpose of the collection. This characteristic of the teaching process is due mainly to the fact that the professors themselves teach the discipline on fashion and fashion design courses, in which professional training is more oriented towards the early stages of the PDP.

#### **4. PROPOSED APDP REFERENCE MODEL**

This chapter presents the proposal of a reference model for the conducting of the PDP in fashion apparel companies. The development of the proposed model was divided into three stages and entailed unifying the knowledge obtained from the literature and the interviews and the experience gained by the author of this study. In Stage 1, a theoretical description was developed for the APDP. In Stage 2, a comparison was made of the theoretical description and the results of the field research with companies, professionals and professors. In Stage 3, both the architecture and the proposed reference model for the APDP are presented.

##### **4.1. STAGE 1: Theoretical representation of the APDP**

The phases of the generic models for Rozenfeld's (2006) PDP and of the specific models developed by Gaskill (1992), Lamb and Kallal (1992), May-Plumlee and Little (1998), Wickett et al. (1999), Rench (2002), Montemezzo (2003) and Pitimannayakul et al. (2004) all served as references for the development of the theoretical model for the apparel PDP shown in Figure 3.

The model for the PDP of Rozenfeld et al. (2006) was the only generic model selected to compose the structure of the theoretical model of apparel, because it is a generic model with a high level of detail and breaks down the phases into activities. Other specific models of apparel found in the national and international literature were used. This is due to a lack of specific literature on the apparel PDP; as a result, it was decided to utilize the greatest amount of information possible instead of choosing only one model to serve as a basis for the theoretical model.



Comparison of stages and classifications of generic PDP model and specific apparel model									
Rozenfeld <i>et al.</i> PDP Model (2006)	Pre-development		Development					Post-development	
	Strategic Planning	Project Planning	Informational Project	Conceptual Project	Detailed Project	Production Preparation	Product Launching	Monitoring of Product/Process	Product Discontinuation
Lamb and Kallal (1992)	Problem identification		Preliminary ideas	Design refining		Prototype development	Evaluation	Implementation	-
May-Plumlee and Little (1998)	Line research and planning			Concept development	Design development and style selection	Pre-production	Line optimization	Line marketing	-
Gaskill (1992), Wickett (1999)	-		Research	Line concept	Evaluation and Concept visualization		Technical development	-	
Rench (2002)	-	Concept generation	Screening	Preliminary project		Evaluation and improvement	Prototype and final project	-	
Montemezzo (2003)	-	Planning	Project specifications	Conceptual delimitation	Alternatives generation	Evaluation and creation		Fulfillment	-
Pitimanneyakul, Labat and Delong (2004)	-		Concept development	Design Level (Concept)	Detailed project	Tests and refining		Production	-

Figure 3: Comparison of stages and classifications of the generic PDP model and specific apparel models



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The development of Figure 3 enabled a comparison to be made between the phases of the specific model and those of the generic model with the respective classifications used by the authors. The arrangement of the phases of the specific apparel models was based on the macro phases and stages of the model developed by Rozenfeld et al. (2006). A general analysis of Figure 3 shows that most of the specific phases of the apparel models, compared with the generic model of Rozenfeld et al. (2006), are in the development macro phase and some phases of the macro stage of pre-development.

Following an examination of Figure 3, a theoretical model was proposed that, along with the research results, provided the basis for the development of the model for the apparel PDP, which is grouped into three so-called macro phases: (i) pre-development, (ii) development and (iii) post-development.

#### **4.2. STEP 2: Comparison of field research analysis**

The field research aimed to support the development of the reference model; interviews were performed following three different approaches: apparel manufacturing companies, professionals in the area and professors of higher education who teach the discipline of apparel product development. The interviews aimed to map the APDP in three different areas. Table 2 shows the phases for the APDP included in each area of the field research. The phases/activities were separated into three macro phases defined in the theoretical representation.

In Table 2, it is apparent that some phases are repeated in the three areas studied; however, some phases are specific to a certain area.

Generally speaking, the phases described by the professors showed greater variation in the stages of pre-development and post-development. Specific phases of this area were identified as, for example, the phases/activities of scenario outlining/target audience analysis and definition of the work sector in the macro phase of pre-development and the phase/activity of post-use (disposal) in the post-development macro phase.

Table 2: Comparison of the APDP phases among the surveyed areas

Macro phases of the theoretical representation	Phases/activities – Field research		
	Company	Professional	Professor
<b>Pre-development</b>	Planning	Schedule definition	Planning (collection objectives) Outline scenario/audience target analysis Definition of work sector
<b>Development</b>	Research Selection of raw materials Development of models Modeling Steering Technical specifications' development Marketing campaign Production Launch	Research Design of models Definition of raw material Modeling Manufacturing of the pilot apparel Technical specifications' development Production	Research/design/market analysis Idea/ideas' generation Theme definition Creation/design (project) Modeling (project) Development/steering (project) Production
<b>Post-development</b>	-	-	Post-use (disposal)

The various stages described by the professors show the greater concern of the academics with the phases/development planning activities and post-product development. This fact confirms the lack of activities related to the planning of the collections, that is, the activities that precede the development of the product itself, and the lack of concern by the companies, in general, regarding the destination of their product after sale or even the possibility of the environmental degradation that it may cause.

The phases for the APDP that emerged from the field research were grouped, excluding the stages that were repeated and separated, according to the phases of the theoretical representation. It is possible to identify four phases/activities in the outcomes of the interviews that could not be identified or associated with any phase/activity of the theoretical representation:

- (i) Outline scenario/target audience analysis
- (ii) Definition of the work sector
- (iii) Generation of ideas
- (iv) Post-use (disposal)



The other phases/activities resulting from the interviews coincided with activities or phases of the theoretical representation. Another comparison that was necessary for the construction of the reference model was related to the gates defined in the theoretical representation and identified in the field research interviews. One can identify two gates in the field of research that do not relate to any gates in the theoretical representation:

- (i) Selection of ideas
- (ii) Approval of the raw material

Gate (i) is related to the selection of ideas collected in the trend research phase. These selected ideas serve as inspiration for the collection definition, in the creative process of the development of models and in the selection of raw materials. Gate (ii) is related to the evaluation and selection of the raw materials to be used in the collection. The phases/activities and the different gates identified in the comparisons above will be incorporated into the theoretical representation for the construction of the reference model.

#### 4.3. STAGE 3: Reference model for the apparel PDP (APDP)

The reference model for the apparel product development process is shown in two versions, a macro version and an extended version, with the details of each phase of the APDP. Figure 4 is a macro view of the model, considering the macro phases, phases and gates.

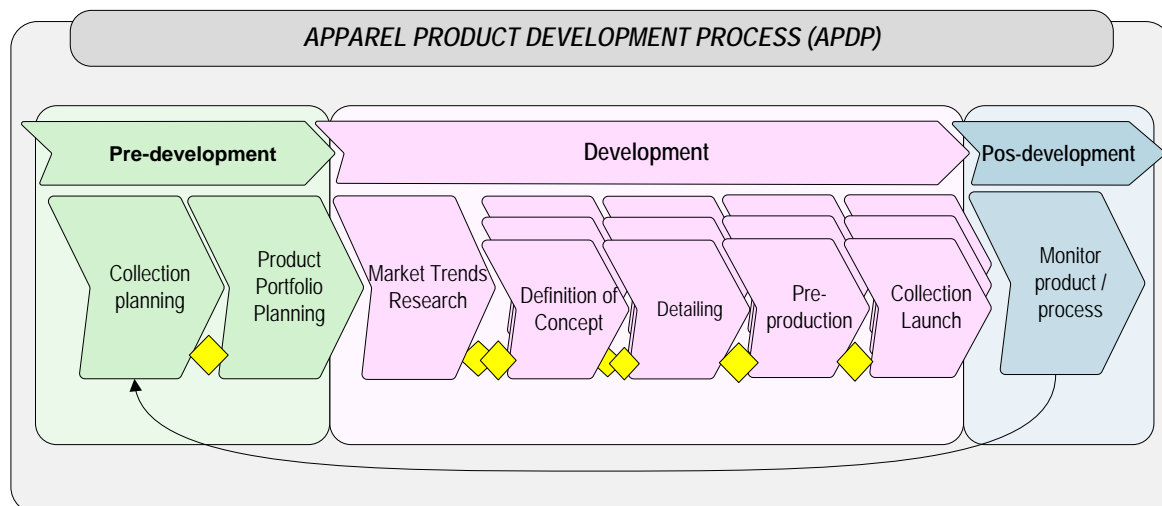


Figure 4. Macro view of the reference model proposed for the apparel PDP

According to the structure of the theoretical model, the reference model shows the macro phases of (i) pre-development, (ii) development and (iii) post-development and the phases of (i) collection planning, (ii) portfolio product planning, (iii) market research, (iv) concept definition, (v) details, (vi) pre-production, (vii) product launch and (viii) monitoring the product/process. In Figure 4, the definition of activities, detailing, pre-production and launching of the product are represented as overlapping figures, since they must occur individually for each product of the collection. However, some activities in the phases were modified and/or added after comparing the theoretical representation with the PDP modeling collected in the field research. Tables 3, 4 and 5 display the summary of each macro phase of the APDP reference model.

Table 3: Summary of the pre-development phase of the reference model for the APDP

Macro phase	Phase	Phase goal	Activity
Pre-development	Collection planning	Identify the parties involved in the collection and assess the needs and controls for the process	Team definition
			Define the activities and sequence
			Prepare the schedule
			Develop performance indicators
			Analyze the sales data of past collections
			Scenario and target audience analysis
			Define the work sector
			Set the production strategies, marketing and sales
			Analyze the economic feasibility of the collection
			<b>Gate 1 – Evaluate the strategies for the collection</b>
	Planning the collection portfolio	Set the grid apparel that will be developed in the collection	Prepare the project plan
			Set the size grid
			Set the types of apparel to be developed
			Specify the quantity of apparel to be developed by model and size
			<b>Gate 2 – Assess the final grid</b>
			Document the decisions taken

Table 4: Summary of the pre-development phase of the reference model for the APDP

Macro phase	Phase	Goal of the phase	Activity
Development	Research the market trends	Research the needs of consumers and the fashion market trends	Research the model trends
			Research the trends for fabrics and trims
			Research the color trends
			Generate ideas for the collection
			<b>Gate 3.1 – Select ideas</b>
			Set the style specifications for the collection
			Set the collection theme
			<b>Gate 3.2 – Theme assessment</b>
			Document the decisions taken
	Definition of the concept	Develop alternatives for collection apparel	Create sketches of models (style design)
			Select the raw material for the collection
			<b>Gate 4.1 – Filter the raw material</b>
			Associate the trends of materials/colors with the models
			Monitor the economic feasibility of each product
			<b>Gate 4.2 – Filter models</b>
			Document the decisions taken
	Detailing	Detail product specifications and develop pilot parts	Submit the raw material to quality testing
			Detail the architecture of the apparel (technical drawing)
			Develop the modeling apparel
			Produce pilot apparel of each piece in the collection
			Submit the apparel to trim, usability and ergonomic testing
			Develop the operational sequence of each piece
			Develop the technical record of approved parts
			Develop the packaging for the collection
			Monitor the economic feasibility of each product
			<b>Gate 5 – Assessment of the pilot apparel</b>
			Modeling the measurement of the approved apparel
	Pre-production	Develop and detail the manufacturing processes to meet the collection's demands	Acquisition of raw material
			Production of showcase for sales representatives
			Establish the initial price of the apparel
			Obtain manufacturing financial resources
			Develop/optimize the manufacturing processes
			Promote training
			Free production
	Collection launch	Launching products in the market involves planning of sales and distribution processes and marketing campaigns	Document the decisions taken
			Marketing and launch planning
			Develop sales processes
			<b>Gate 6 – Evaluate the collection marketing</b>
			Promote the launch marketing
			Launch the collection
			Manage the release
			Document the decisions taken

Table 5: Summary of the post-development phase of the reference model for the APDP

Macro phase	Phase	Phase objective	Activity
Post-development	Monitor product/process	Monitor, document and treat post-release information	Evaluation of customer satisfaction
			Monitor product performance (technical, economic, production and services)
			Encouragement of and assistance with disposal practices of the products (post-use)

The phases are explained separately in a detailed version. This was created from the theoretical representation model, the field research and an array of activities versus responsibility prepared by the authors.

The areas involved in the apparel industry PDP are: (i) top management, (ii) product development (PD), (iii) management of PD, (iv) commercial, (v) marketing, (vi) purchasing, (vii) production, (viii) quality and (ix) engineering. To achieve a good performance of the process and use of the reference model for APDP, the utilization of cross-functional teams is necessary. According to Rozenfeld et al. (2006), the development productivity or the quality of the products developed and the speed of the response to consumer demands depend directly on the use of cross-functional development teams with strong leadership and strong active participation of experts from various functional areas.

#### *Pre-development: Collection planning*

The first phase of pre-development planning is dedicated to the collection, ensuring the connection between the PDP and the company's strategic planning. During this stage, the parties involved in the collection are identified and the needs and control indicators for the process are identified. At this stage, the individuals in charge of the process are members of senior management, commercial, product development (PD) and engineering. Some activities include advising the marketing and the management of PD. The starting point of this phase is associated with three sources of data inputs: strategic planning, staff list and fitness data and past collections. The graphic representation of this phase containing the activity flow is shown in Figure 5.

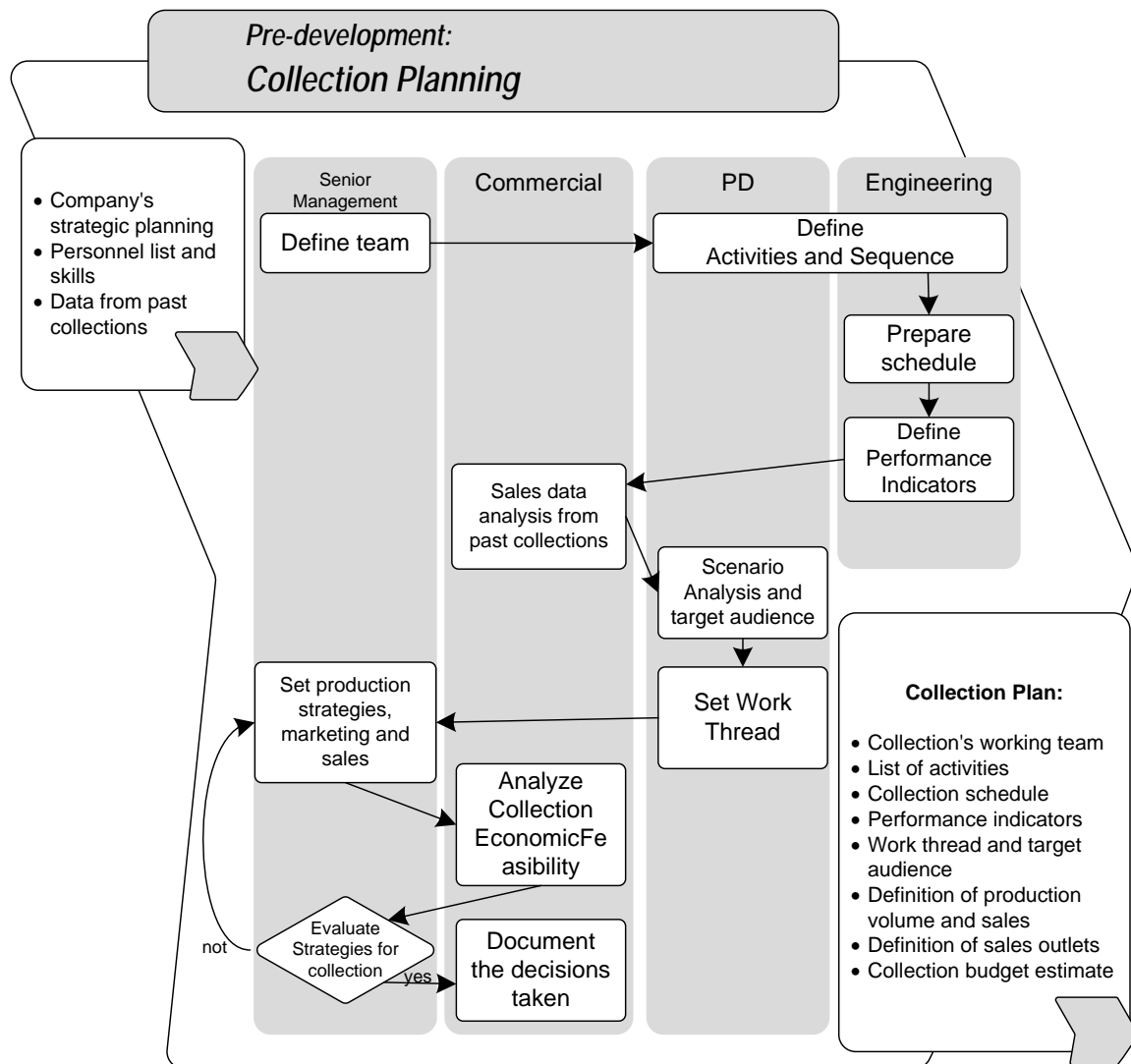


Figure 5: Collection planning phase

At this stage, the scenario and the target audience are analyzed for the definition of the work sector. These activities are developed to identify new market opportunities or companies that want to change their focus of work, companies that are developing a new brand or product line or companies that are entering the market.

The activity of preparing the schedule is instrumental in guiding the collection's work team during the APDP, and it is the responsibility of the company's engineering department. The definition of production strategies, marketing and sales made by the senior management aims to guide the decision making throughout the development of the collection.

At the end of this stage, the top management evaluates the decisions taken during the phase, and then this information is documented in the COLLECTION

PLAN, which contains the following information: collection working team; to-do list; collection schedule; performance indicators; work sector and target audience; definition of the production and sales volume; definition of sales outlets; and collection budget estimate.

*Pre-development: Planning of the collection portfolio*

The collection portfolio planning phase is in charge of defining the grid pieces that will be developed in the collection. This planning is important as it provides a direction for the creation of the apparel collection as well as making the planning of the sales of the collection possible.

The COLLECTION PLAN information provides support for the definition of the size grid, the type of apparel that will be developed and the quantity of collection products by type and size. These activities are developed jointly by the DP and the commercial team, then this information is evaluated by the senior management and documented by the commercial team, which updates the COLLECTION PLAN with the information generated during the phase. The graphic representation of that phase with the activity flow is shown in Figure 6.

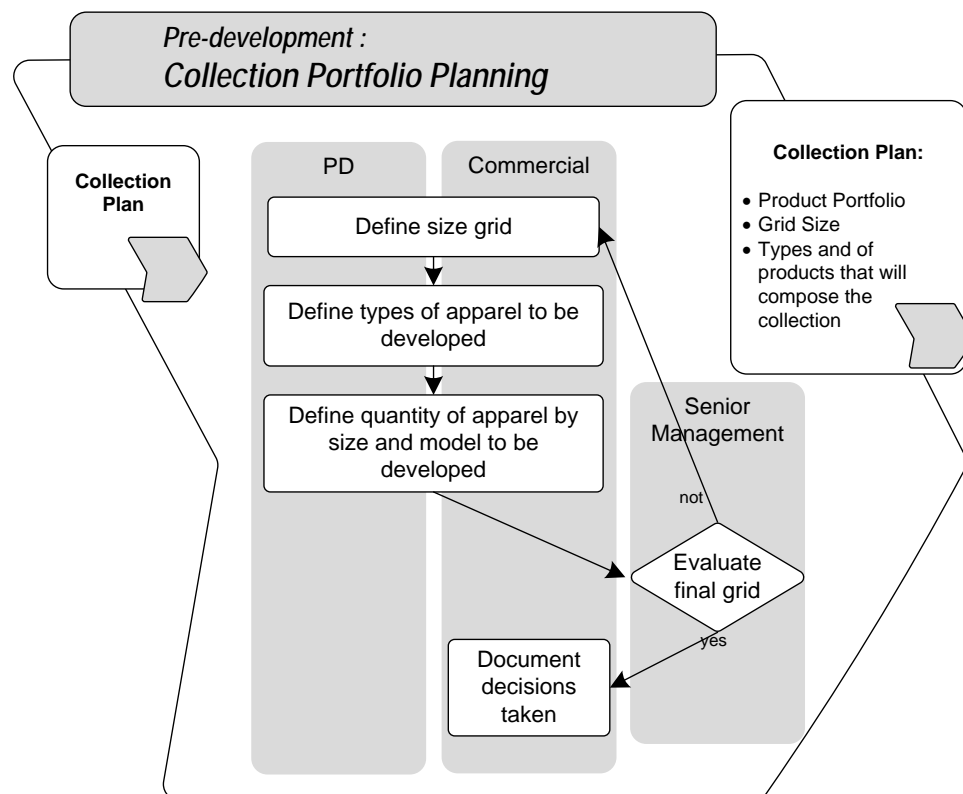


Figure 6: Planning phase of the product portfolio

### *Development: Research the market trends*

In this stage of researching the market trends, the consumer needs and market trends for fashion apparel are investigated. The trends in models, fabrics and trims, and colors for the collection are researched, then the management of DP evaluates this information. With this research, the DP defines the style specifications and sets the theme for the collection that will later be evaluated by the senior management.

Regarding the output, the style information and theme for the collection are documented in the TRENDS PLAN. In addition to the DP, the DP management and the senior management as well as the commercial and marketing teams provide support for these activities. The graphic representation of that phase with the flow of activities is shown in Figure 7.

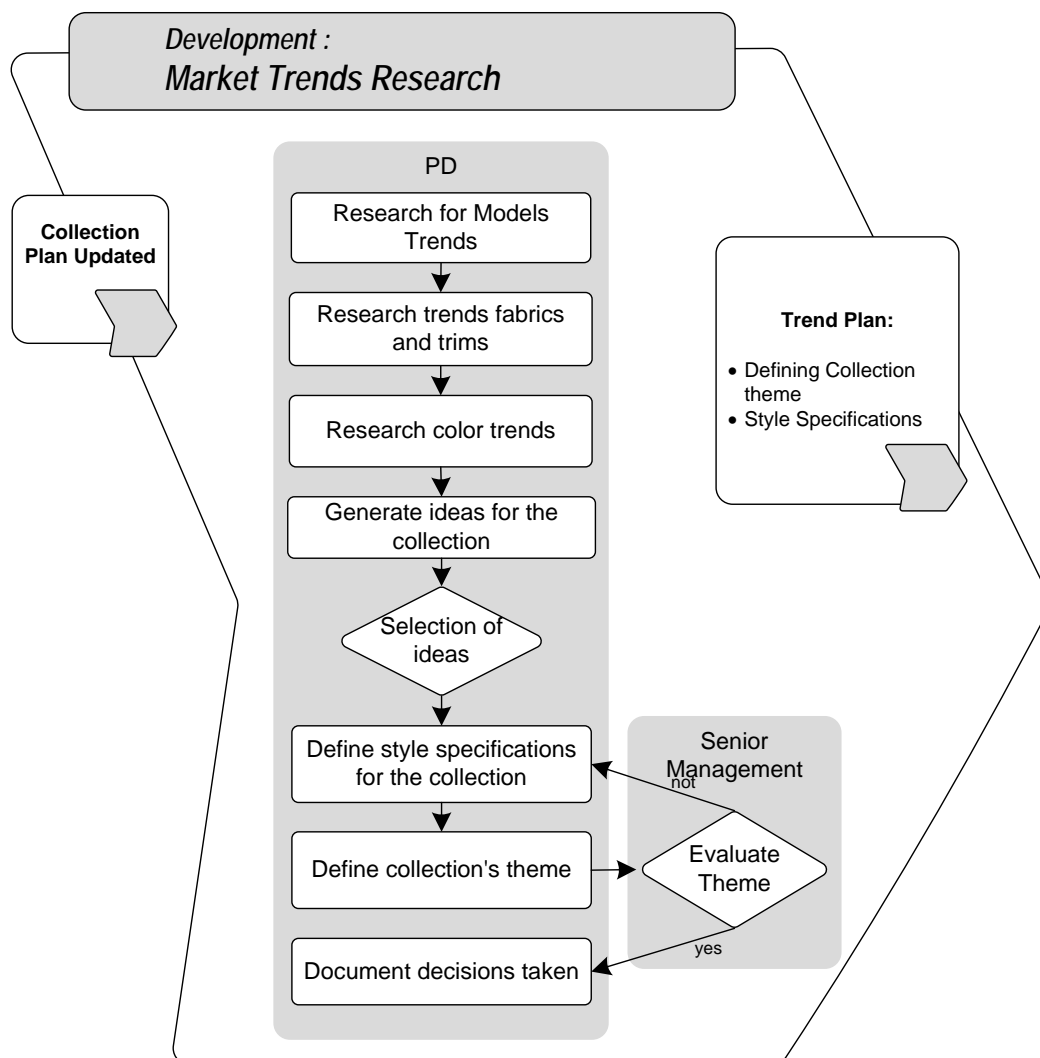


Figure 7: Phase for the research of market trends



### *Development: Definition of the concept*

The objective of the concept definition phase is to develop the collection's apparel alternatives. The graphic representation of this phase with its flow of activities is shown in Figure 8. It is in this phase that the designers have the freedom to create the outline of the apparel for the collection, through manual or computerized drawings. The designer needs extra time to create the number of apparel items, more than is planned in the collection plan, so that, after assessing the collection, it does not become depleted.

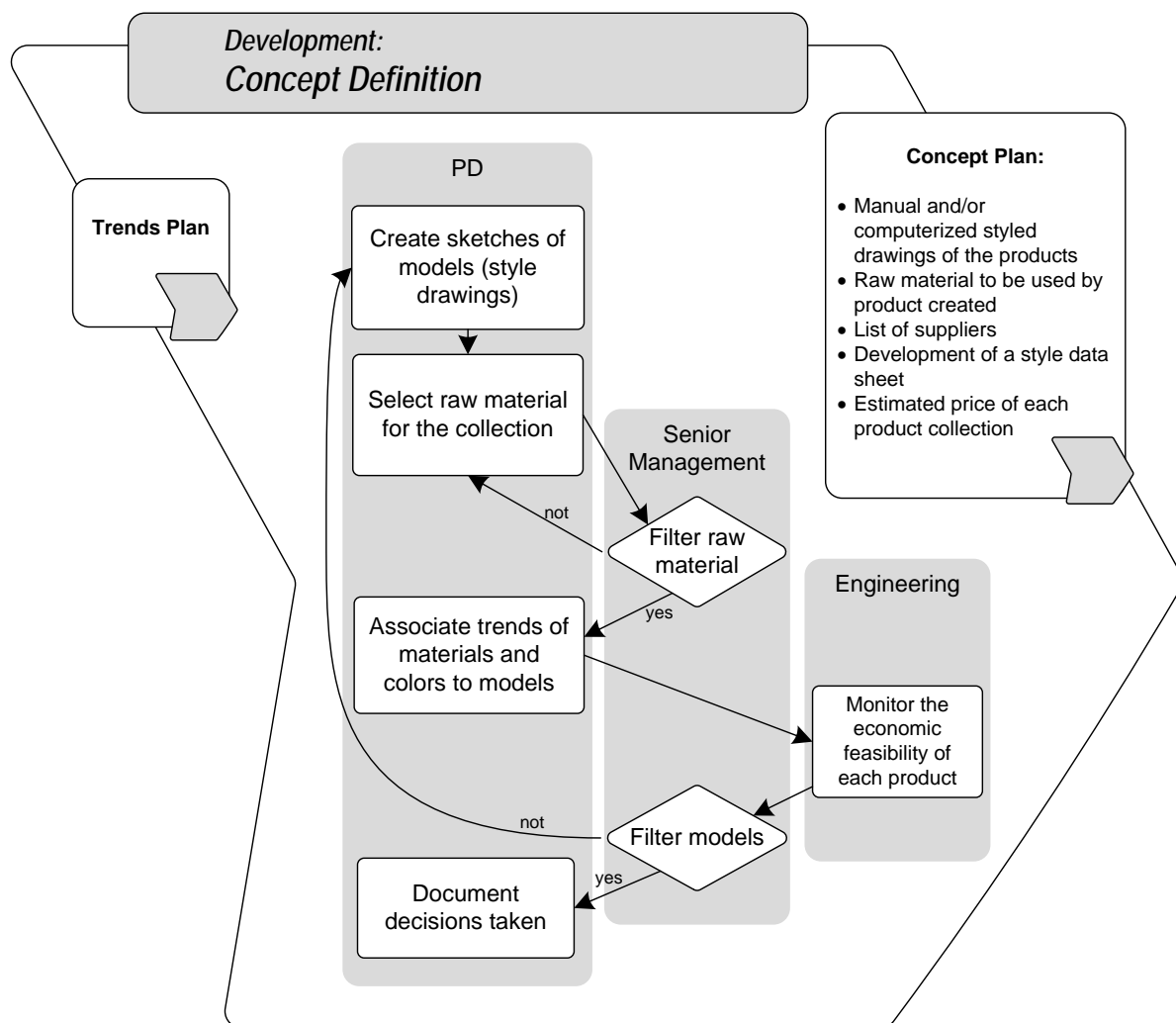


Figure 8: Concept definition phase

After the creation of sketches, the DP selects the fabrics and trims that make up the collection. This selection is evaluated by the top management, and the raw material to be used is defined. The raw material is linked to the sketches, which then

undergo a preliminary study on the economic feasibility of the piece. With the drawings and the initial economic feasibility information, they are evaluated by the senior management.

In this phase, information is generated about: manual style drawings and/or computerized products, the raw material to be used by the products created, a list of suppliers, the development of a style data sheet and a price quotation for each of the collection's products. The information is documented in the CONCEPT PLAN. In addition to the DP, senior management and engineering, this phase counts on the help of commercial and PD management.

### *Development: Detailing*

The detailing phase aims to identify the specifications of the apparel designed in the concept definition stage and to develop pilot apparel. The graphic representation of that phase along with its activity flow is shown in Figure 9.

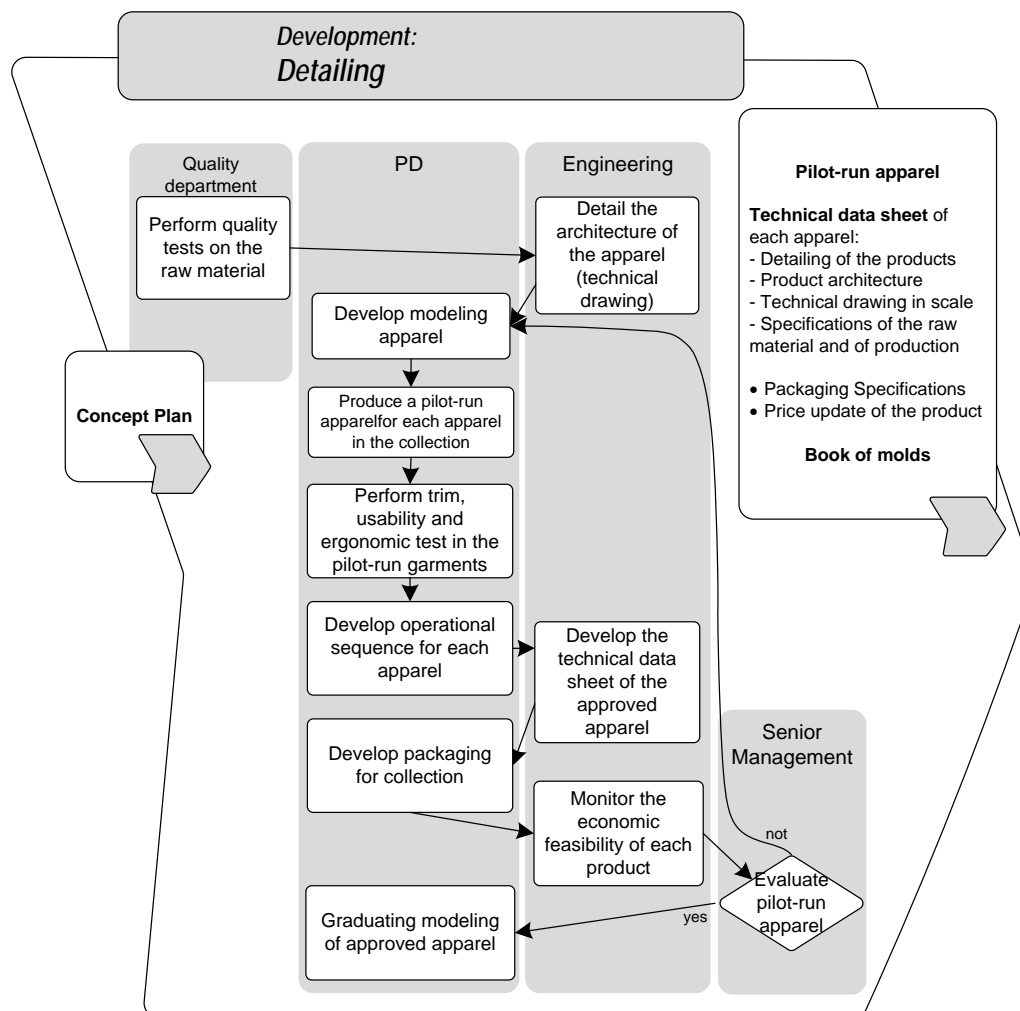


Figure 9: Detailing phase

In this stage, the company's quality department performs the raw material assessment to ensure final product quality and generate information that will support the construction of the mold of the apparel. The engineering department develops the architecture of the pieces through the style drawings developed in the previous phase; the development of technical drawings and detailing of the apparel are critical to the construction phase of the pilot apparel and aim to avoid misinterpretations in subsequent stages.

The DP department develops the pilot apparel, performs fit testing, usability and ergonomics, develops the operational sequence of each piece and develops the sizing of the approved apparel. The engineering department develops the technical file for each apparel item and monitors the economic feasibility of the apparel. Subsequently, the senior management evaluates and approves the pilot apparel, considering the margin of the pieces that were planned in the pre-development phase.

In this stage, the outcome of the work is the technical specifications, packing specifications, product price update and mold block. The technical specification data sheet provides a breakdown of the products containing the piece of architecture, the operational sequence with the stages of the manufacturing process, the technical design in scale and the specifications of the raw material and production.

#### *Development: Pre-production*

The pre-production phase aims to develop and refine the manufacturing processes to meet the collection needs. At this stage, the raw materials are also purchased for the collection and the showcases for sales representatives are produced. The graphic representation of that phase along with its activity flow is displayed in Figure 10.

The acquisition of the raw material is the purchasing department's responsibility. The showcases for sales representatives are produced, in the case that the company works with this type of sale, and this activity is the responsibility of the engineering and commercial departments. The engineering department establishes, in a definite way, the price for the apparel. Furthermore, it calculates, along with the production department, the resources necessary to produce the

collection. The engineering department is responsible for the development and optimization of the manufacturing processes.

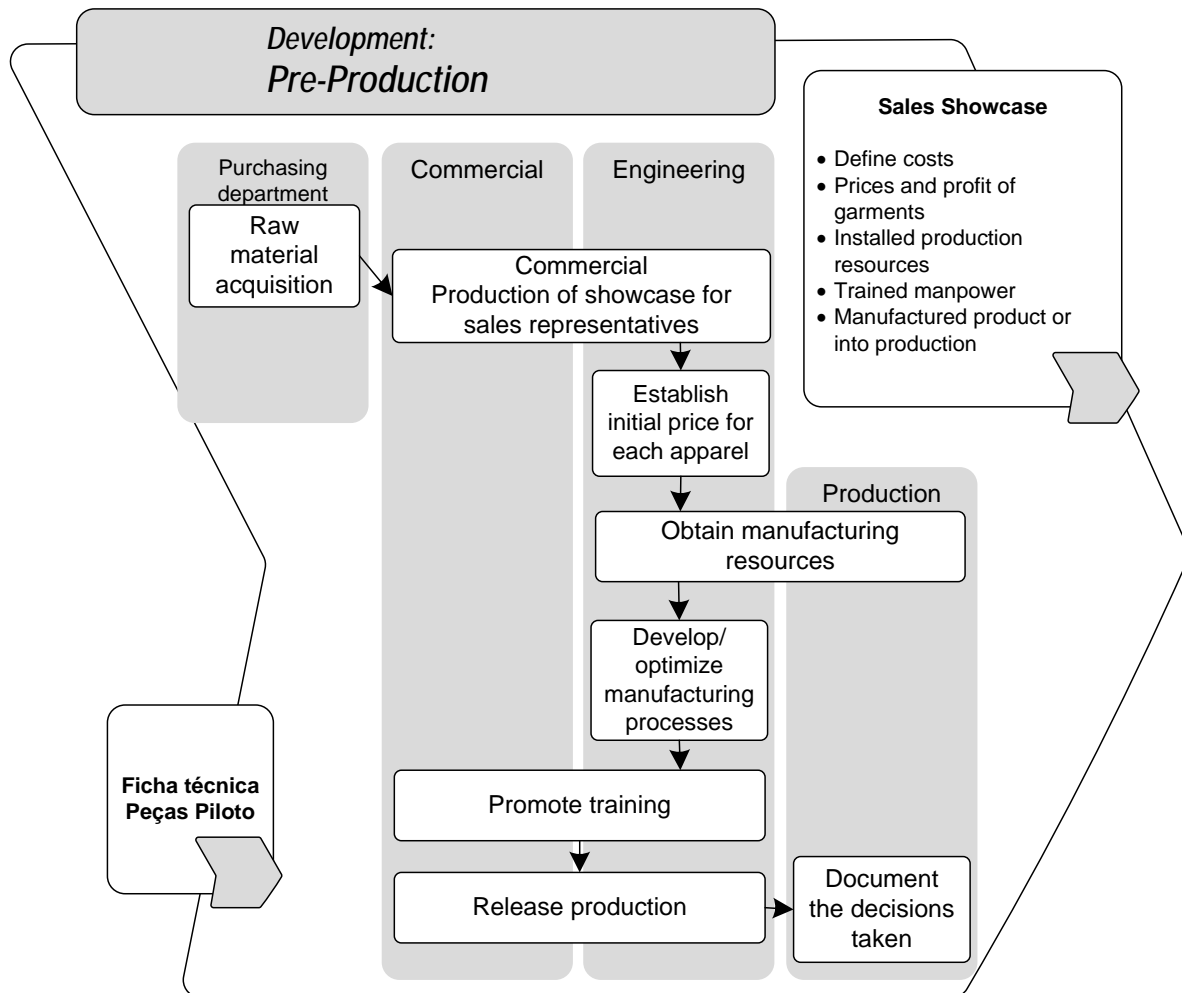


Figure 10: Pre-production phase

To provide support for new sales and production processes, training is promoted by the engineering department for production and by the commercial department for sales. Following the training, the production of the apparel is released by the engineering department, which makes its judgment based on the previous sales or the estimates produced together with the commercial department. In addition to the purchasing, commercial, engineering and production departments, the pre-production phase is advised by the DP and DP management. After this phase, the following are achieved: the showcase for sales representation, definition of costs, prices and profits of the apparel, installed production resources, trained labor force, manufactured products or production in progress.

*Development: Launching of the collection*

The collection launch phase aims to insert the product into the market. This phase involves the planning of the sales and distribution processes and of the marketing campaign. In this stage, the marketing department's task is to plan the marketing campaign of the collection, launch the collection and promote and manage the launch. Both the commercial and the marketing department are in charge of the launching of the collection. The senior management evaluates the marketing planning for the collection.

The outcome of this phase is the launch plan along with the sales promotional material (catalogs, outdoors, lookbooks, banners, etc.), the sales processes and the directions for launching the collection in the wholesale and retail markets. The graphic representation of this phase along with its activity flow is shown in Figure 11.

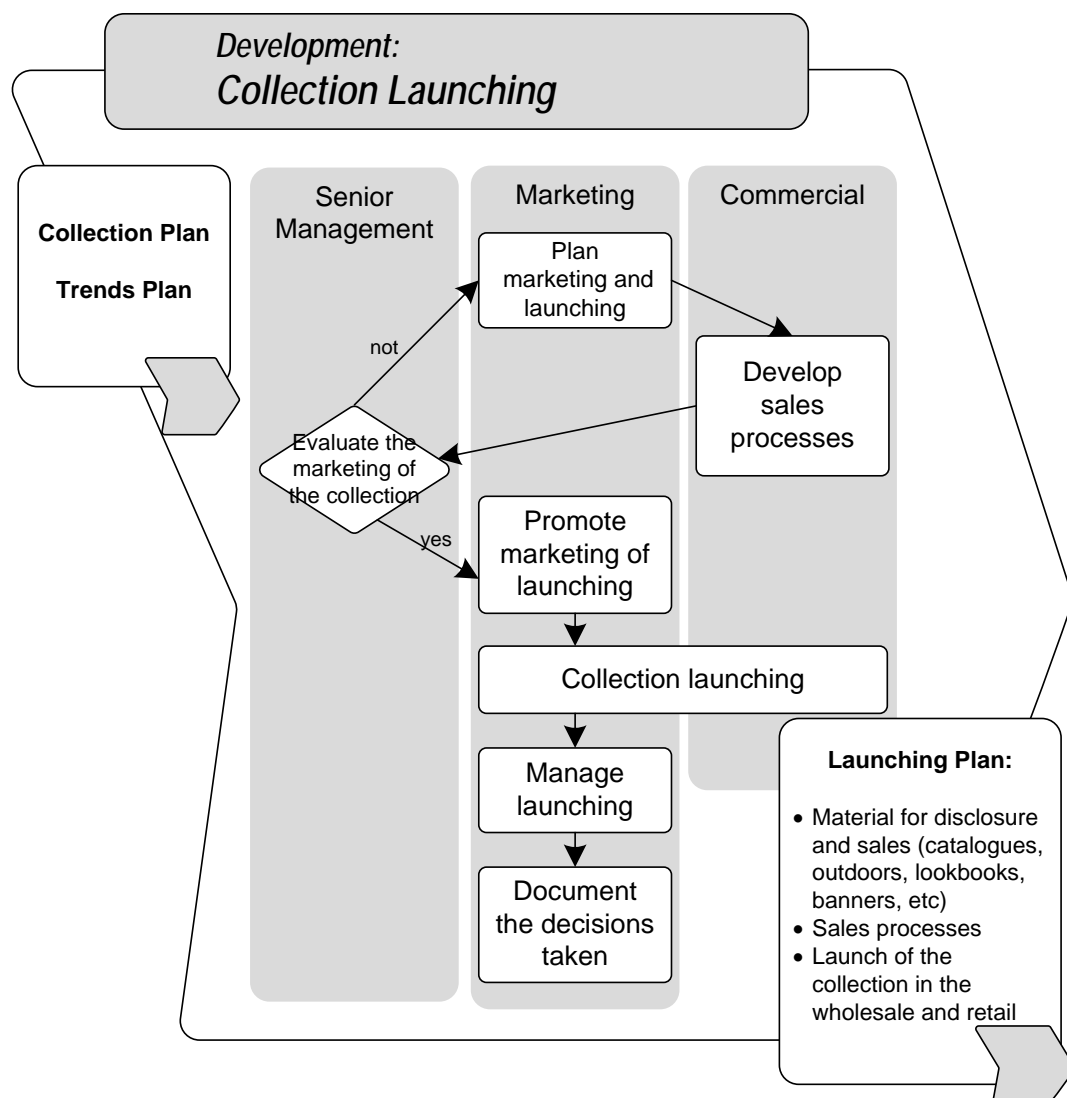


Figure 11: Collection launch phase

### *Post-development: Monitoring of the product/process*

The objective of the stage of monitoring the product/process is to monitor, document and handle post-release information and encourage and assist with the adoption of appropriate practices for the disposal of products. The graphic representation of this phase along with its activity flow is shown in Figure 12.

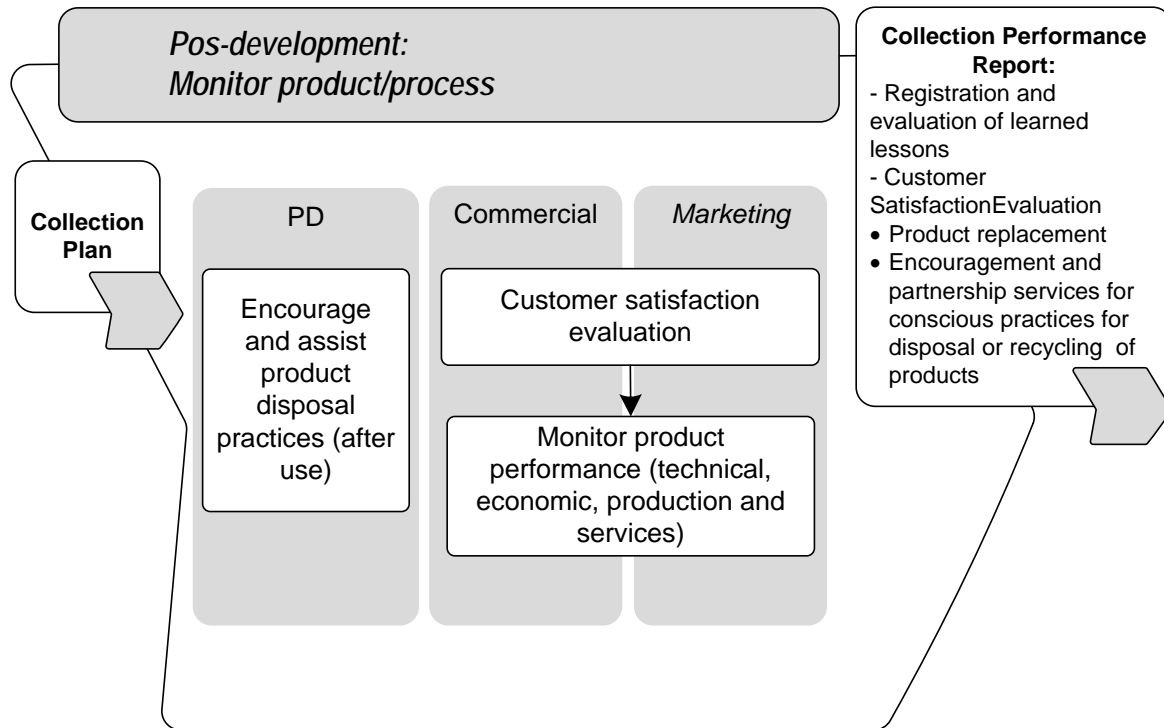


Figure 12: Product/ process monitoring phase

The outputs at this stage are the collection performance report, registration and evaluation of the lessons learned, customer satisfaction evaluation, product replacement and, if needed, encouragement and partnership services for conscious practices for the disposal or recycling of products. Those involved in this stage are the DP and sales and marketing departments, with the assistance of DP engineering and management.

### *Gates*

Eight gates were established (stage reviews) for the APDP reference model. The decision making throughout the APDP course aims to filter ideas or products that should move forward in the process. According to Rozenfeld et al. (2006), "... the introduction of systematic formalized Gates is a practice that brings great benefits to the company's performance."

The following describes each one of the gates of the process:

- **Evaluation of the strategies for the collection** – To evaluate the strategies that will guide the decisions regarding production, marketing and sales throughout the development of the collection. The senior management, supported by the areas of PD management, sales and marketing, gives its approval.
- **Evaluation of the final grid** – To evaluate the collection products' grid, defining which products will be developed and their quantities. This evaluation is approved by the senior management, supported by the PD management.
- **Selection of ideas** – Selection of the ideas collected and developed during the research on trends, raw materials and colors for the collection. These ideas form the basis of the development of the theme of the collection and are approved by the PD management, supported by PD, sales and marketing.
- **Evaluate the theme** – To evaluate the theme of the collection, defined by the trends research. This is approved by the senior management, supported by sales.
- **Filter the raw material** – To refine the raw material selected for the collection. This is approved by the senior management, supported by the PD management.
- **Filter the models** – To refine the models created that are still in drawings, excluding or redoing some drawings. Approval is given by the senior management, supported by the PD management, sales and marketing.
- **Evaluate the pilot apparel** – To evaluate the models in physical form, known as pilot apparel. In this stage, the apparel can be discarded or undergo changes in the modeling, raw materials or production process. This process is approved by the senior management, supported by the PD management and assistants.
- **Evaluate the collection's marketing campaign** – To assess the marketing campaign designed for the collection. In this stage, the senior management, supported by the PD, PD management, sales and marketing areas, evaluates whether the marketing campaign developed faithfully represents the proposed theme for the collection and then continues with the launching of the collection.

The execution of the gates is a joint activity and occurs through meetings. The designated time for carrying out such meetings is an investment that the company



performs during the development of the collection. Such meetings should be planned to avoid dispersion resulting from the contribution of various individuals involved in the process (Rozenfeld *et al.*, 2006). Whereas most apparel companies are small, meetings regarding gates can be held by a small group, considering that the fact that some people may assume different roles in the PDP.

## 5. FINAL CONSIDERATIONS

The structure of the reference model proposed for the fashion apparel has macro phases, phases, activities and inputs and outputs at each stage. The possibility of the greater detail presented in this reference model justifies the relevance of this work to the academic and business world.

Field research revealed that the main difficulties of APDP, acknowledged by businesses and professionals, were related to the lack of organization of the activities performed during the process, the difficulties in the relationships between departments, the lack of time for a research stage for trends and the definition. All these problems mentioned by the respondents can be resolved with better planning and structuring of the PDP. For the professors interviewed, the greatest difficulties were related to the lack of material available on the APDP, at all stages. The development of the reference model comes from encountering the difficulties reported in interviews and many other APDPs faced in the course of the day-to-day work, be it in business or academia, contributing to the design process and the lack of research in the area.

The reference model for the APDP was developed considering the particularities of the development of fashion apparel products, such as the development of products in seasonal lines (collections) instead of individual products, the development of several collections each year and therefore a short period of time for the development process of each collection. Once the structure of the model was presented in a simple way, the necessary dynamism for the APDP was not compromised by the great amount of activities and bureaucracy in the process.

It was also considered that the APDP characteristics are important and that the proposed model was not developed with the goal of being a single standard for the process, but as a combination of good practices that can be used in its entirety to structure the APDP with flexibility or used partially by means of adaption, adjusting to

the reality in which it is employed. In this case, the reference model is now called the adapted model.

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