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Comparative Analysis of Product Development Process Management Models

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Abstract Due to the increase of the products offered in the market and the reduction of the time of their life, Product Development Process (PDP) is considered a business process that become increasingly important for the competitiveness of companies. Products must be managed in order to quickly enter the market, better meet customer needs, are easier to manufacture, are attractive in the market and ensure a profit for the company. Since the beginning of the twentieth century, the main incentives for the development of new products in the food industry are related to the development and incorporation of technological innovation. Nowadays, PDP evolution is mainly due to concerns of industries to improve their economic performance, and at the same time increasing the quality of their products and meets the requirements of consumers. Although there are studies that seek to standardize the development of food products, implementation of PDP models is very new. This paper aims to analyze methods developed by different authors about the PDP oriented to food industry and make a comparison with the general model proposed by Rozenfeld et al. [9]. Among current models are the following: Fuller [5], Rudolph [6], Earle [4], Polignano and Drumond [7] and Penso [8]. These authors state sequences of structured phases that facilitate the understanding and implementation of a new product development in food industry.

Keywords: *Product Development Process, food, comparison, models*

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1. Introduction

Product Development Process (PDP) is a process by which an organization transforms market opportunities and technical possibilities in information for the manufacture of a commercial product [1]. Meanwhile, Ulrich and Eppinger [2] define it as a set of steps or activities through which, from a market need, a company conceives, designs and markets a product that seeks to meet the needs identified [3].

Since the beginning of the twentieth century, the main stimulus for the development of new products in the food industry is related to the development and incorporation of technological innovation. Currently, PDP evolution is mainly due to concerns of industries to improve their economic performance, and at the same time increasing the quality of their products and meets the demands of consumers [4]. Although there are studies that seek to standardize the development of food products, the implementation of PDP models is very new. Some product development models that stand out are: Fuller [5], Rudolph [6], Earle [4], Polignano and Drumond [7] and finally Penso [8]. These authors' state phases structured sequences that facilitate the understanding and realization of a new product development in food industry.

2. Objectives

The main objective of this paper is to analyze methods developed by different authors about the PDP-oriented to food industry and make a comparison with the general model proposed by Rozenfeld et al. [9]. Among the current models are the following: Fuller [5], Rudolph [6], Earle [4], Polignano and Drumond [7] and Penso [8]. To do this, the specific objectives are the following: (i) Conduct a literature search of models that structured and sequenced PDP Management oriented to food industry, (ii) organize and analyze the information collected and (iii) compare Management Models in the literature with the Unified Model proposed by Rozenfeld [9].

3. Methodology

This is a qualitative research. In qualitative methodology inductive logic prevails. The information obtained is "context-bound" leading to theories and theoretical patterns or trends helps explain PDP Management. Qualitative studies do not begin with a theory that is to be verified or tested. Consistent with the inductive model of thinking, the theory can emerge during data collection and/or analysis stage, or be used relatively

late in the research process as a basis for comparison with other theories.

In a qualitative study, research inductive model requires to follow the following steps: (i) collecting data, (ii) ask questions, (iii) form categories, (iv) search patterns (theories) and (v) develop patterns compared with theory or other theories.

In relation to the target approached, research is exploratory in nature. The technical procedure or research method applied, first, is bibliographic research. It consists of a set of techniques and strategies that are used to locate, identify and access documents used to obtain information for research. Literature reviews aim to analyze and synthesize the literature on an specific topic and then assess various aspects of the material, resulting in a single work a detailed description of the state of the art of a specific topic. The main instrument used for data collection is the analysis and review of documents, books and publications.

A documentary study of Process Development Product Management models aimed at the food industry in the literature, allows to survey theory based on the area under study. Finally, the models are compared with the proposed by Rozenfeld [9].

4. Product Development Process Management Models

Currently, in the literature there are different proposals for systematization of activities in PDP models, depending on the area of knowledge from which the authors come. However, as highlighted Roozemburg and Eekels [10], in most cases the differences between these proposals are terminological.

Forward-engineering models give more importance to the construction stages of the product, and therefore, are mainly for technical aspects. In contrast, models with marketing vision highlights the importance of pre-development stage, which should be considered market characteristics and strategies of the company, and the post-development phase, comprising monitoring activities and product recall where he had been released.

4.1. Rozenfeld Model

The model proposed by Rozenfeld et al. [9] seeks to integrate engineering and marketing visions, as well as organizing best practices developed in academia and in business. For this reason, this model is known as "PDP Unified Model", bringing together different academic perspectives into a single theoretical model.

PDP Unified Model consists of three different parts: (i) a PDP reference model, (ii) a PDP maturity model and (iii) an intervention or transformation model.

Includes three macro-phases called: pre-development, development and post-development. Each of these macro-phases is split into phases, activities and tasks. Although this model presents the stages sequentially, it is normal that sublevels of activities and tasks were simultaneous. This depends on the type of activity to be performed and available resources. This model also includes, at the end of each stage, specific activities for review and approval to advance to the next stage [9].

This model is systematic, structured and serves as a guide to guide their implementation. It originated from the union of methodologies, case studies, models, experiences and best practices developed and identified by the author and his team of researchers.

The major contribution of this model is to see the PDP management on a global way, encompassing all phases. It integrates the views of earlier models, considering the PDP as a whole, mainly unifying vision between marketing and engineering. This model considers the entire life cycle of the product, and is therefore included in the post-development macro-phase. That is, the PDP management does not end with the launch of the product to market, but it is necessary to monitor their performance and consider their subsequent withdrawal. Figure 1 shows graphically the Reference Model proposed by Rozenfeld et al [9].

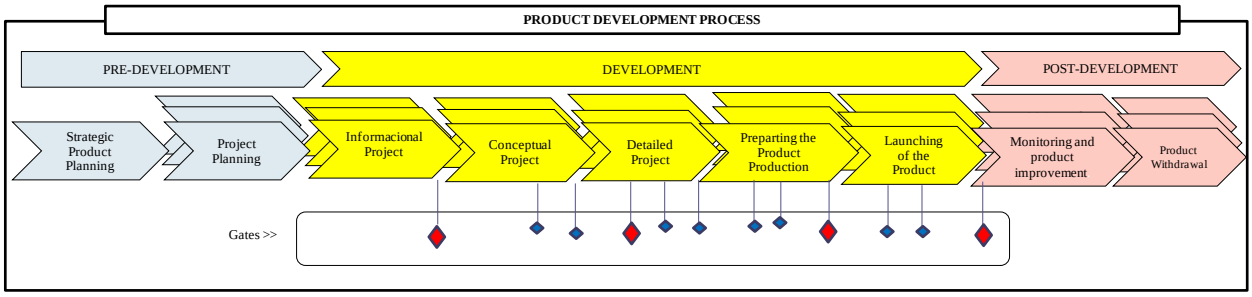

Figure 1. Rozenfeld Model (2006)

The three macro-phases are:

1. Pre-Development: seeks to ensure the best decision about the product portfolio and projects and a clear definition of them.

2. Development: refers to what is necessary for the information, conceptual, design for product creation and its market launch.

3. Post-Development: focuses on monitoring the performance of product in the market and also includes its withdrawal.

4.2. PDP Management Models Oriented to Food Industry (PDPA)

This section contains a set of specific PDP models for the food industry. Five authors whose models are recognized and used in practice to guide product development are selected.

4.2.1. Fuller Model (1994)

This author proposes a sequence of four macro-phases: (i) idea generation process, (ii) development process, (iii) production process and (iv) product launch in the market. Provides that, to the extent possible, these macro phases should be interpreted concurrently rather than sequentially.

The starting points for the PDP are establishing business objectives and identify consumer needs. The development team conducted a process of generating ideas for new products, trying to meet business objectives and customer needs. In the next phase all ideas are analyzed and the best one is selected, taking into account criteria of market, technical and financial.

Once the best ideas were selected, proceed to the stage of technical development, in which products prototypes are developed, following design specifications determined by the development team.

From the moment the prototype product is selected, in parallel, the financial department of the company analyzes a business plan based on the information related to the costs of raw materials, process and marketing. Marketing department will be responsible for market research, market strategy plan and develop advertising and promotional material. Production department performs scheduling of facilities, equipment and labor. In turn, establishes contacts with suppliers of raw materials and supplies.

If all activities of development process stage were approved, the process continues to the production phase of pilot scale product; otherwise, it returns to the previous phase.

Upon completion of the development phase, the production phase begins. First, different tests on products and processes for setting information are made. After setting up the product/process, mini-tests are performed from the marketing department to gather necessary information to make adjustments before launch.

The final step is to test the product in the market. From this stage, the product is already in production scale. The author notes that, if the market test is not successful, you must learn from mistakes before developing a new product. On the other hand, if the market test is successful, the company must identify the causes and assimilate this learning in the PDP.

4.2.2. Rudolph Model (1995)

This author argues that the ideal PDP model must be structured according to important events or facts, called "milestones", and steps to identify and assign each functional element of the company its tasks. These events are seen by the author as an opportunity to monitor the PDP evolution and business plan objectives. In this way, problems can be expected, errors are easily identified and can initiate a program of changes as soon as possible, reducing development costs and the failure of the products after launch.

The model is structured as follows:

- Structure of "milestones": Strategic Planning, Market Analysis, business plan for the product, prototype development, market strategy, pilot test and production, product introduction, product support;
- PDP Phases: Product Definition, Product Implementation and Product Introduction in the market;
- Areas involved: Management, Marketing, Research and Development, Manufacturing, Sales, Distribution and Technical Support.

4.2.3. Earle Model (1997)

This model is structured in four macro-phases. It is proposed as an objective model, structured into a system of decisions using quantitative tools. The aim is to reduce the time and cost of development, focusing on the business goals of the company and the needs of consumers.

Four macro-phases of the model are:

1. Strategic Product Planning
2. Generating ideas, product project/ process
3. Production, market strategy, quality assurance and marketing
4. Product Launch and support

Each phase consists of activities which vary from one project to another, due to the greater or less need to generate results that can be evaluated by the team and the project manager. To each activity tools and techniques of project and product planning are linked.

Project management aims to control the process, so that it meets the technical requirements defined for the product quality and within the planned budget. The PDP is managed by senior management, which is involved in major decisions between phases of the process to ensure that it is meeting the business objectives of the company.

4.2.4. Polignano and Drumond Model (2001)

This model is divided into four macro-phases.

1. Portfolio management: market research techniques are employed to obtain information on the market and competitors. Thus, it provides an estimate, creating a definition of projects that will be conducted by the company in the short, medium and long term.

2. Identifying opportunities: In this stage, new product ideas are generated, researched, compared and selected. Different creative techniques can be used, such as brainstorming. At the end of this stage, the project team and product project management which will decide the products to be developed based on the opportunities identified in the market.

3. Definition of Test Concept: The main objective of this stage is to transform the best ideas in product concepts.

4. Product Development and Process: At this stage, the product concept selected must be translated from the language of market to the technology environment of the project. The project team is responsible for making the product detail, develop prototypes, subjecting them to sensory tests, set control parameters to ensure the final quality, conduct a pilot-scale test, perform tests with consumers and finally, describing the project and plan the production.

4.2.5. Penso Model (2003)

This reference model is structured into three macro-phases:

1. Pre-Development: aims to generate the Product Project Plan. Therefore, its phases, activities and tasks are focused on the specification of the opportunity for the new product that meets the strategic and financial objectives, as defined in the strategic planning of each company. It

also includes activities related to the planning of the product portfolio, which gives priority to projects that will develop in the short, medium and long term. The project team has members from different departments of the company to execute its activities, such as senior management, marketing, R & D and finance. The Product Project Plan is the final document that contains the results expected at this stage of the process and allows the committee responsible for the evaluation of the results obtained the opportunity to decide whether the new product is viable for development.

2. Development: aims to transform the business opportunity of a new product into a final product to be launched in the market. Therefore, it is necessary that activities and tasks from different phases of this stage focus on the design of products and processes for the preparation of the production and the release of the product on the market. The project team includes members from many departments, including: senior management, marketing, finance, R & D, quality, purchasing, sales, production, engineering and support of external members to the company, such as suppliers.

3. Post-Development: is the final stage of the PDP and its phases, activities and tasks focus on the support of the product in the market and, when the time is right, the product recall, ending all activities of the PDP for the product developed. The team responsible is composed of members of senior management, marketing, R & D, quality, finance, logistics and sales. That team is responsible to evaluate the performance of the product in the market and the financial and business results achieved throughout the process.

In conclusion, PDP is an integrated and complex process, requiring the formation of multidisciplinary teams, involving investments, resources and time to ensure that the products are competitive in the market.

5. Model Comparison

Compared to Rozenfeld model [9], Fuller model [5] described in less detail and formality activities of the development phase. Rozenfeld provides a more comprehensive analysis of the PDP in this macro-phase, generating more detail as it progresses in the process. This has the advantage that if any flaw is previously detected can be solved without having advanced the project unnecessarily. Rozenfeld begins development macro-phase with what he calls "informational Project", which proposes a set of activities that contain the definition of the target specifications. This allows a preliminary analysis to the development of prototypes, which represent a major advance in cost and time. Rozenfeld actually intending to continue the process and analysis of prototypes, after making sure that the informational project runs successfully, avoiding a possible unnecessary development thereof. Moreover, the model of Fuller [5] does not determine how the product is withdrawn from the market when the cycle life thereof. Furthermore, in regard to product support, a formal method or their respective activities to perform is not emphasized.

The model presented by Rudolph [6] has many similarities regarding Rozenfeld. It is structured in three macro-phases similar to the model used as a reference. Both end the first macro-phase with the list of products to be developed after selection that considers the needs of market and technical requirements established by determining the specifications for the product by using QFD tool. The second macro-phase presents a small difference. Rozenfeld et al. [9] included in it, the activity of "Product Launch", leaving monitoring for the third macro-phase. Meanwhile, Rudolph [6] completes the second macro-phase when begins with scale production and launch is included in the third. However, this fact is not very relevant as the production scale is inevitably continued the launch instantly. Finally, it should be noted that Rudolph [6] emphasizes on the use of different tools for efficient development of the various activities, as well as the use of IT tools to support the PDP.

With respect to Earle model [4], is inferred that the second and third macro phases may be in the development macro-phase proposed by Rozenfeld et al. [9]. First, the first macro-phase of Earle model [4] contains a definition of the product portfolio driven by the business strategy and market opportunities, finally making a technical analysis. Although the specifications are not yet defined, as it proposes Rozenfeld et al. [9] for the Pre – development, through the analysis of technology needs Earle presents a technical study which will then be developed further in the second macro-phase. As discussed above, the second macro-phase of Earle model [4] proposed selecting the best product concept and ends with the project product and process. However, unlike Rozenfeld model [9], places the scale production process and market strategy at third macro-phase and product launch and product support in the last macro-phase. Finally, a difference between the two models is observed in terms of the role of the top management with respect to the decisions on transitions of each of the macro-phases, being more prominent in the model proposed by Earle [4]. Thus, a more centralized development and less performing activities are raised having a very close relationship to the objectives of the company.

Polignano and Drumond model [7] presents important differences with Rozenfeld et al. model [9]. Polignano and Drumond [7] develop in first and second macro-phases what Rozenfeld et al. (2006) included in the first one. This shows a greater emphasis in the pre-development. They propose defining the strategy of new products through various analyzes of the market and consumers, getting the product portfolio and, in the second macro-phase, start a process of generation and selection of ideas for new products, according to the opportunities identified in the market. The subdivision made by the authors, emphasizes the need for a complete market study in relation to competitors and families of products offered on the market, for the further development of new ideas and identifies new opportunities. Both macro phases are developed on the basis of strategic planning of the company. Finally, the model does not provide launch activities and product support in the market, which could be considered a deficit, as it is important to standardize action patterns showing how to act at different stages of the product cycle life form make improvements and establish documented courses of action.

The reference model developed by Penso [8] seeks to make improvements in relation to previously published models, in order to adapt them to food industry. The

author schematizes PDP, providing an approach to the particularities of food product development, facilitating the integration between project team members. The main important features of both models are: (i) alignment of new products with the strategic planning of the company, (ii) validation phases of development through gates and (iii) formalization and documentation of activities during product development. Both models are structured into three macro-phases: pre-development, development and post-development. Macro-phases and phases proposed by Penso [8] are similar to those of Rozenfeld et al. [9], differing from it by adding specific activities to model the area of food in the development macro-phase, which is summarized as follows: (i) conceptual project: definition of product formulation, packaging manufacturing processes, parameters to be respected and validation periods, (ii) detailed project: product project development and packaging, further specification of the production process, of packing, stock and distribution, performing the revision of Good Manufacturing Practices, staff training and development of quality manuals as HACCP (Hazard Analysis and Critical Control Point), (iii) production preparation: pilot production and implementation of physical- chemical, microbiological, sensory analysis and batch test product stability [8].

From the entire above, Penso model [8] presents special considerations for the food industry, which also benefits when applied in companies in the sector.

Next, in Table 1, a comparison between Rozenfeld model and Penso model is exposed.

Table 1. Comparison between Penso model and the Rozenfeld et al

Macro-Phase	Rozenfeld et al.	Penso
Pre-Development	• Strategic Product Planning • Project Planning	• Strategic PDP Planning • Product portfolio Planning • Product planning
Development	• Informational Project • Conceptual Project • Detailed Project • Preparation of production • Production launch	• Informational Project • Conceptual Project • Detailed Project • Preparation of production • Production launch
Post-Development	• Product tracking • Withdrawal from the market	• Product tracking • Withdrawal from the market

6. Conclusions

In the present paper the methods developed by various contemporary authors about the PDP oriented to food industry were analyzed and they were compared with Rozenfeld model. This model considers the PDP Management in a global and comprehensive manner of all phases and is taken as a reference to companies that want to systematize their PDP management.

First a documentary study of Product Development Process Management models oriented to food industry existing in the literature was performed, obtaining a theoretical survey based on the area under study. Then, each of these models was discussed in detail. Finally, they were compared with Rozenfeld model.

It is concluded that Penso model is the best suited for the food industry as it considers particularities of this sector without neglecting important aspects that favor a systematic, standardized and integrated developing. The objective of this model is to achieve lower costs and time in the development of new food products, as well as the generation of multidisciplinary teams that increase quality and probability of success of a new product.

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