

Study of the Management of the Development of Products in Food Production Companies

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Abstract

In competitive sectors such as food, it is essential to have processes that allow maintaining and conquering new markets. In this context, product development is particularly important, a process aimed at generating new products or modifying existing ones.

Process vision involves identifying and improving the processes of the company, in this case the Product Development Process (PDP), increasing what is called the Maturity Level, which consists mainly of the application of best practices. It is, then, essential to know first how this process is carried out in organizations.

This paper studies the current situation of the PDP in food producing companies located in the Greater Santa Fe - Argentina, belonging to three sectors of activity: dairy, supplies and refrigeration. For this, variables and categories of analysis were constructed, 17 firms were interviewed and, based on the information obtained, the companies were related to the three proposed Maturity Levels.

Among the main conclusions, it can be seen that the companies interviewed show notable differences in PDP management: a group performs the process intuitively and with low systematization; another group presents greater stability and begins to conceive the PDP as a business process and, finally, companies that present the standardized PDP. This validates the categorization of proposed Maturity Levels (Basic, Intermediate and Advanced). Finally, the analysis indicates that dairy and input companies have a higher PDP maturity level, while most refrigerators are at a Basic Level.

Keywords — Product Development Process, Diagnosis, Management, Levels of Maturity, Food Industry.

I. INTRODUCTION

The scenario where companies develop is characterized by a growing interest in the supply of products with strong consumer orientation [1]. This is especially true in the food industry, a mature sector where competition forces us to generate new products that allow us to maintain and conquer new markets [2, 3, 4]. This situation entails a growing interest in the development of products.

From the point of view of Business Process - understanding, following Kotler [1], as a set of

activities carried out in a logical sequence with the objective of producing a good or service for a specific group of internal or external customers-, the Process of Product Development (hereinafter, PDP) consists of the generation of information and resources in order to offer value to customers and interested parties [5, 6].

The main objectives of the PDP are aimed at developing new products, or modifying existing products, meeting consumer interests and preferences and optimizing quality goals, times and development costs [7, 8, 9]. Process vision involves identifying and improving the company's processes (in this case, the PDP). In this way, it is desirable for organizations to increase their PDP Maturity Level [10, 11, 12, 13, 14], defined from the application of best practices in said process -from the conception of the product to its launching and monitoring in the market- and ranges from basic levels (random activities, without planning or repetition) up to advanced levels (structuring and standardization) [15, 16, 17, 18]. It is essential, then, to first know how the PDP carries out the companies, investigating practices and activities, and determining the level of maturity in which they find themselves [19, 20].

The objective of this paper is to make a diagnosis of the current situation of the PDP in food producing companies of the Greater Santa Fe - Argentina. To do this, analysis variables are constructed that allow classifying the data obtained and, based on this information, companies are related to the three proposed Maturity Levels. It should be noted that the work is part of a Research Project aimed at proposing a PDP Management Model for food producing companies in the Province of Santa Fe (Argentina) based on the diagnosis of companies from different sectors of activity.

II. METODOLOGÍA

The research in which this work is framed is of an exploratory-descriptive nature [21]. After a bibliographic search, a series of variables and categories were elaborated to diagnose the situation of the PDP in the organizations, 18 semi-structured interviews were carried out with companies producing food of the defined region (identified with the letters "A" a "R" to maintain confidentiality), and, based on the information obtained, the level of maturity of the process in each of them was defined. The selected companies are part of the universe of analysis defined for the Research Project: food companies of the

Greater Santa Fe that have carried out product development actions in the last year.

The bibliography that served as the basis for the construction of the variables, subvariables and categories were the models proposed by: Rozenfeld et al. [5], which describe a unified model for product development, Echeveste [22], who presents a PDP structure for companies that do not have a formalized process, and Penso [23], which proposes a model for food companies of Brazil. The contributions of these authors also served to define three levels of Maturity in the PDP used in the work: Basic, Intermediate and Advanced. Based on the variables and categories developed, each company was examined and classified, and, based on a simple frequency analysis, it was associated with one of the proposed maturity levels.

III. RESULTS

A. Proposed categories for analysis variables

This section describes the different variables, subvariables and categories that were built to classify

the companies under study. This allows to diagnose the current situation in relation to the Product Development Management in each of the productive organizations.

The variables considered to perform such analysis are: (i) Development Structure: it is the relevance that the organization gives to the PDP in terms of material structures, (ii) Activities carried out in relation to the PDP: are the activities carried out by the company specifically to the PDP, (iii) Gates: these are the so-called "decision points" that are applied in critical stages, they allow to decide to continue, redirect or freeze the development, (iv) Schedule: it is the list of terminal elements of the project with dates of start and end, (v) Communication: are the internal information exchange mechanisms and (vi) Documentation: are the types of documents that the company produces and uses for the PDP, including level of standardization and storage. The Table I shows the subvariables and categories related to the variable "Development Structure".

Table I. Subvariables and diagnostic categories of the variable "Development Structure"

Variable	Subvariable	Category
DEVELOPMENT STRUCTURE	Formalization of the area Existence of a specific area.	Basic: There are no development areas or departments.
		Informal: There is in the organization chart, secondary level: there is an area or department of development (third or fourth hierarchical level).
		Formal: It exists in the organizational chart, priority level: there is an area or department of development (second or third hierarchical level).
	Composition of the área People involved and how the process is carried out.	Basic: Unipersonal The process falls on a person, usually the owner or principal manager.
		Informal: There is a group of people who manage the new product ideas. However, the people involved vary throughout the process.
		Formal: There is a work team that is responsible for developing, approving and managing new product ideas. The equipment is stable throughout the process.

The Table II shows the subvariables and categories of the variable "Activities carried out in relation to the

PDP related to strategic aspects of Pre-development". Said variable is divided into four subvariables.

Table II. Subvariables and diagnostic categories of the variable "Activities carried out in relation to the PDP related to strategic aspects of Pre-Development"

Variable	Subvariable	Category
Activities carried out in relation to the PDP related to strategic aspects of PRE-DEVELOPMENT	Strategic and product planning Alignment between the planning of the PDP and the strategic plan.	Basic: The general strategy of the company focuses on the experience/intuition of managers, and the development of products follows the same logic.
		Informal: The company has some strategic objectives and tries to guide the PDP towards these goals, reviewing and updating the product portfolio.
		Formal: The strategic planning of the company considers the planning of the PDP, which allows meeting corporate objectives through the development of products.
	Surrounding analysis Analysis of the market and the company.	Basic: There are no systematic analyzes; The possibilities that the environment or the company can offer to the PDP arise from the experience or intuition or suggestions.
		Informal: Every certain period of time information is collected about the environment and about the company's technical possibilities seeking to detect opportunities.
		Formal: There is a structured analysis of environmental variables (consumers, competitors, suppliers, patents) and the company's processes.
	Process of generation and selection of ideas Collect information, generate ideas for new products and select them.	Basic: The generation and selection of ideas occurs spontaneously (during a meeting or making them reach the manager/s).
		Informal: Meetings are held to generate ideas, and the selection is made after relieving some general conditions (technical feasibility and commercial possibility).
		Formal: Techniques are used to generate ideas (Brainstorming, SWOT Analysis, Benchmarking) and patent research/scientific and technological advances. The selection of the ideas to be developed requires a quantitative and qualitative analysis.
	Evaluation and approval of ideas Evaluation and approval of ideas Analysis of the opportunity of the selected idea/s, and their viability	Basic: After the selection of the idea/s, the approval is given by a voting process, based on the experience of the participants, without too many evaluations.
		Informal: We proceed to approve the ideas according to certain pre-established criteria (technical capacity, demand to attend, competing products).
		Formal: There are standardized steps to evaluate ideas from strategic, commercial, financial and technical aspects. The approval of the ideas is given after the analysis of the information and has a series of formalized steps.

The Table III shows the subvariables and categories related to the variable "Activities carried out in relation to the PDP related to strategic aspects of Development". This variable is divided into six subvariables.

Table III. Subvariables and diagnostic categories of the variable "Activities carried out in relation to the PDP related to strategic aspects of Development"

Variable	Subvariable	Category
Activities carried out in relation to the PDP related to strategic aspects of DEVELOPMENT	Development of concept and evaluation Translate the idea into product specifications.	Basic: There are no activities that link business opportunities and product specifications. Once the idea has been approved, the process continues with basic formulation proposals to move on to prototypes or to the production line.
		Informal: There are activities oriented both to the investigation of the needs and requirements of the product, and to formulations and methods, although they vary between each product idea and do not follow a structured sequence.
		Formal: There are numerous standardized steps to advance in the development of the product concept. The approval is given after the detailed analysis of the information and also has a series of formalized steps.
	Realization and evaluation of prototype Physical-chemical, microbiological, sensorial and useful life analyzes.	Basic: Some basic tests are performed in laboratories, and others are outsourced. The evaluation consists mainly of observing if results are achieved, basic tests are carried out among staff or relatives and the most chosen version is chosen.
		Informal: Tests are carried out in their own laboratories, and are evaluated based on a series of established analyzes, but they vary between each product and do not follow a structured sequence. The prototype/s that continue the process are chosen primarily from the experience of the participants.
		Formal: There are numerous standardized steps for the tests, which must be documented and developed in our own laboratories (except complex analyzes, where the collaborator is evaluated in detail), given the emphasis on confidentiality. Trained panels evaluate the organoleptic properties of the products, with steps and documentation for the evaluation. The prototype/s that continue the process are chosen based on these evaluations.
	Feasibility analysis It implies, from the prototype, a more precise commercial, financial and technical analysis.	Basic: The analysis is based fundamentally on fixing some costs to evaluate if the final price is competitive with respect to similar products.
		Informal: There are analyzes that provide more information to decide on the continuity of the development, where they participate in charge of different areas (commercial, production, finance) but they vary between each product and they are not structured.
		Formal: There are standardized steps to evaluate ideas from strategic, commercial, financial and technical aspects.
	Execution of the pilot lot Planning and execution of the pilot lot (number of units).	Basic: After some laboratory tests, the process continues directly in the lines and is added to the production planning.
		Informal: A pilot batch is run to test the performance of the product, usually without too much planning, in free moments of the lines.

Table III (continuation).

Variable	Subvariable	Category	
Activities carried out in relation to the PDP related to strategic aspects of DEVELOPMENT		Formal: The pilot lot is planned (process, programming, acquisitions, training) and executed according to that procedure.	
	Evaluation of the pilot lot and preparation of the production	Basic: The evaluation consists mainly of observing if acceptable results are achieved, and concludes with the approval of the new product by the corresponding agencies. The required manuals are elaborated (such as the Manual of Good Manufacturing Practices) and production begins for its launch.	
		Evaluation: fisco-chemical, microbiological, sensory, shelf-life and stability analyzes Approve and register the product and the process, and release the production.	Informal: The analyzes are carried out, but they vary between each product and do not follow a structured sequence. Mandatory manuals and other reports are produced (product and process registration, quality specifications for suppliers, etc.).
			Formal: There are numerous standardized steps for evaluation activities that must be properly documented. The trained panels continue the evaluation to corroborate that the organoleptic properties of the products were not altered, and the steps and documentation involved are structured. There are standards for the homologation and registration of the process and the product.
	Product Launch		Basic: The strategy is based on offering the product from distributors or points of sales with which the company works assiduously.
		Develop distribution strategies, sales, advertising, etc.	Informal: There is an analysis of the points of sale, some sales strategies (eg, advertising material and testing at points of sale) but varies in each product.
			Formal: A detailed analysis of the distribution and marketing channels is carried out, and the launch strategy corresponding to each of them is detailed.

The Table IV shows the subvariables and categories "Post-Development". This variable is divided into two related to the variable "Activities carried out in subvariables. relation to the PDP related to strategic aspects of

Table IV. Subvariables and diagnostic categories of the variable "Activities carried out in relation to the PDP related to strategic aspects of Post-Development"

Variable	Subvariable	Category
Activities carried out in relation to the PDP POST-DEVELOPMENT	Evaluation of customer satisfaction Customer satisfaction (experience, loyalty, etc.), to provide feedback to the PDP.	Basic: In passive form. Eventually, complaints are received from clients and they seek to solve them, but learning that does not always turn into improvements in the process.
		Informal: In addition to receiving and handling complaints, information is sought through conversations with vendors or distributors, but they are informal.
		Formal: There are channels and mechanisms to assess customer satisfaction that must be completed as part of the PDP. The information is collected in a standardized manner and serves to provide feedback to the process.

Table IV (continuation).

Variable	Subvariable	Category
Activities carried out in relation to the PDP POST-DEVELOPMENT	Product performance Monitoring on commercial, productive aspects and services.	Basic: Only the sales level of the product is analyzed to decide its continuity.
		Informal: Commercial and technical analyzes are carried out contrasting the planned with the performance, but without a specific pattern or systematization.
		Formal: The product is monitored in commercial, productive and post-sale aspects in a structured and systematized way. Emphasis on detecting opportunities.

Table V. Diagnostic categories of the variables "Gates" and "Chronogram"

Variables	Category
Gates	Basic: There are basically two Gates, which arise from the need to address the PDP, without systematization: move forward with the test of ideas, and approve the launch.
	Informal: The process has some decision points established from the experience, and although in each new development the approval criteria are enriched, there are no foreseen steps for its formalization.
	Formal: The decision points are standardized: there are guidelines so that they can be carried out (meetings and deliveries with planned and known dates depending on the activities, necessary participants, required reports, etc.). Gates feed back the evaluation criteria according to each new development.
Schedule	Basic: There are no schedules and, sometimes, tentative dates are agreed upon; the PDP advances according to the availability of the managers.
	Informal: It is a tentative schedule, but it is not documented or strictly monitored.
	Formal: The elaboration of the schedule is a fundamental step of the PDP, and it is usually done from a Work Breakdown Structure (EDT). Once established, there are people in charge of monitoring the progress of the project.

The Table V presents the categories related to the variables "Gates" and "Chronogram". It should be noted that these variables do not have subvariables. The Gates are the "Decision Points" in critical stages, which allow to decide to continue, redirect or freeze the development. The schedule is the list of terminal elements of the project with start and end dates.

The Table VI shows the subvariables and diagnostic categories related to the variable "Communication". This variable represents the internal information exchange mechanisms.

The Table VII presents the diagnostic categories related to the variable "Documentation", which does

not have subvariables. This variable represents the types of documents that the company produces and uses for the PDP, including the level of standardization and storage of information.

The Table VIII shows the categorization of the 17 companies interviewed based on the 19 variables and subvariables presented previously, based on a simple frequency analysis of the categories of each of them. The companies "A" to "F" inclusive, belong to the dairy sector; "G" to "L" inclusive, to the input sector, and "M" to "R" inclusive, to the refrigeration sector.

Table VI. Subvariables and diagnostic categories of the variable "Communication"

Variable	Subvariable	Category
Communication	Meetings Grouping of people in a given time and space, with a common purpose.	Basic: While there may be some scheduled meetings, people meet spontaneously to resolve issues related to the PDP, usually in the course of their daily work.
		Informal: The meetings between those involved in the PDP are convened with some advance and have preparation, but are carried out as necessary.
		Formal: The PDP has standardized meetings in the different moments of the process, they are foreseen in the schedule (with emergency exceptions).
	Information flow Forms used: channel (oral or written) and use of records (individual/shared).	Basic: The information circulates mainly orally; the records are used individually and eventually shared via email.
		Informal: Although information circulates orally, written channels tend to be used. The records are used individually and shared (via e-mail).
		Formal: Mostly written channels are used. The records are shared in a network (via intranet or cloud services).

Table VII. Diagnostic categories of the variable "Documentation"

Variables	Category
Documentation	Basic: Only the mandatory documentation is prepared by the corresponding agencies (ASSAL, SENASA). The documents are not standardized and there are no guidelines for storing the information.
	Informal: Other documents are added, in different phases (Plans, Reports of results and specific of the Physico-chemical Analysis) that do not follow standardized patterns. The relevant documents are stored, in charge of those in charge of the process, depending on them the possibility of retrieving information in the future.
	Formal: There are documents for most of the activities and decisions of the PDP. The formats are standardized. A relevant aspect of the PDP is the storage of information, which facilitates its subsequent consultation.

Table VIII. Categorization of the companies analyzed.

Company	Categories			Company	Categories		
	Basic	Informal	Formal		Basic	Informal	Formal
A	0	1	18	I	16	3	0
B	5	14	0	J	0	8	11
C	6	3	0	K	17	2	0
D	0	1	18	L	2	17	0
E	0	2	17	M	1	14	4
F	0	2	17	N	0	6	13
G	7	2	0	O	17	2	0
H	5	14	0	P	16	3	0
I	0	1	18	Q	0	8	11
J	5	14	0	R	15	7	0

Figure I shows the composition of each sector according to the categories of analysis. It can be concluded that seven companies (B, C, F, G, H, L and P) present the majority of the variables analyzed in the Formal category.

The organizations have Development areas, with a priority level in their structures, and the process is led by a formally constituted team. These organizations carry out most of the activities that make up the PDP in a structured and structured manner. They have standardized Gates, framed in a chronogram defined and monitored periodically. It is important for these firms to maintain formality in the communication: meetings are planned in advance and there are specific channels to share the information. Documentation is a determining factor: it allows the process to be objectified and enables its feedback.

On the other hand, another group of companies is observed (E, I, K, M and Q) in which the variables analyzed are located in the Basic category. These companies do not have areas of development, and the development of products usually falls on one person (owner or manager). Only a few activities of the phases that make up the PDP are carried out intuitively and unstructured. The programming in these organizations is simple, with tentative dates that are adapted to the availability of those involved, including the Gates, which consist of the basic

decision points of any development process. The communication is developed informally: the meetings are carried out according to the needs, without programming, and the flow of information circulates without standardized channels. Compulsory documentation required by the corresponding bodies is complied with and, if there are other records, they are documented in different formats in each new development.

Finally, in companies A, D, J, N and O, the variables analyzed are mostly in the Informal category. Most have development areas, although at non-priority hierarchical levels. The process is conducted as a team, although its conformation is not stable. Most of the PDP's main activities are carried out, some of which are internalized in the organization, although without formal structuring. Companies implement the Gate concept, identifying the need to approve certain phases of the process, applying a tentative schedule (although it is not documented or monitored).

In relation to communication, meetings, although carried out according to the needs, try to plan them in advance, tending to use written channels. In addition to the documentation required by the specific agencies of the sector, other registers are incorporated, which often do not follow standardized patterns and vary in each development.

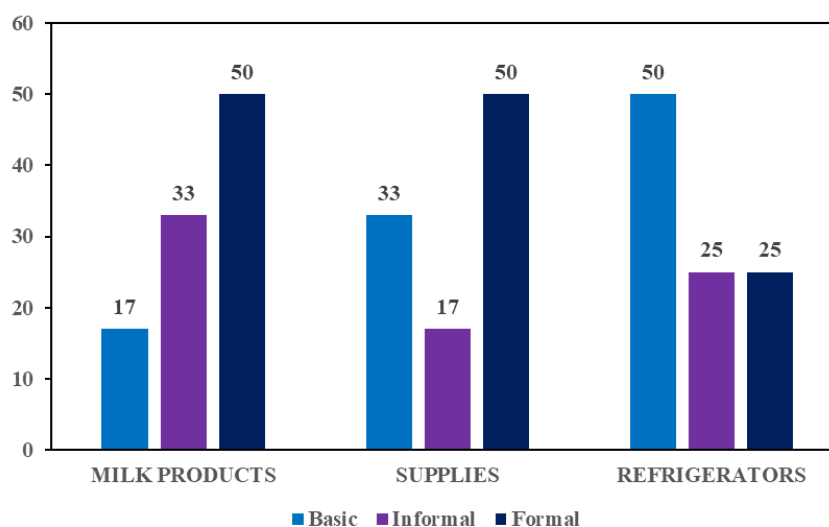


Figure I. Distribution of categories (basic, informal and formal) according to the sectors analysed (in percentage).

B. Suggested categories to classify the maturity levels

The Maturity Level, following Chrissis [24], consists of the best practices related to aspects and activities that cover the life cycle of the product, from its conception to delivery, follow-up and its eventual withdrawal from the market. The study of the levels of maturity [25] allows to diagnose the process of the company (current level) and guide the experts on

forms of intervention to achieve a superior performance [26].

There are models of maturity proposed by authors and organisms, which present different classification scales. This paper considers the Rozenfeld et al. (5) and Penso [23] and proposes the following classification of PDP Maturity Levels:

Elementary: Only some essential activities of the PDP are carried out. The product requirements are

defined intuitively, and an outline of the product is made in relation to those characteristics. There is an initial integration between the strategic planning of the company and the product, although it is informal and through dialogue, taking into account the experience of those responsible. The launch of the product is carried out with little planning, in the usual channels, and the monitoring of the product is limited to evaluating the level of sales and receiving eventual claims. Many of the activities are aimed at complying with current legislation, and the development of products is not conceived as a business process.

Intermediate: The most relevant activities of each phase of the process are carried out, and in a repetitive manner. In addition to defining product requirements, prototypes are developed and evaluated (technical, commercial and financial analysis), although not systematically. The company thinks about a product portfolio, analyzing each project in a relative way. The company begins to apply the concepts of phase approval (gates). The planning of the launch is more elaborate, and some accompanying activities are carried out (comparison of predicted and real values). The PDP begins to be conceived as a business process, and simple initiatives are carried out to improve the process, without a systematic approach.

Advanced: Most of the activities of a structured process are carried out. Product requirements are defined based on detailed customer and environmental studies, prototypes and pilot / on-site tests are carried out, which are evaluated in detail (technical analysis). There are also economic, financial, commercial and legal analyzes, in a systematic way. The process is planned and all the actions are scheduled in detail. Portfolio management is carried out in an integrated manner with the strategic planning of the company. The launch strategies are planned and the monitoring activities in the market are formally carried out, being designated responsible for the product monitoring that constantly monitor key variables (costs, quantities, prices, risks). The PDP is considered a key business process.

IV. CONCLUSIONS

The objective of the present work is to make a diagnosis of the current situation of the Product Development Process (PDP) in companies of the food sector of Greater Santa Fe, Argentina.

Based on the results presented, it is observed that a group of eight companies (B, C, F, G, H, L, P and R) presents an Advanced Level of PDP, recognizing the importance of this process for the survival of the company and for the differentiation of its competitors. They are characterized by having standardization in most of the activities, it allows to manage the PDP based on performance indicators. It is highlighted that in the dairy and input sectors, these companies represent 50%, while in the refrigeration sector, 25%.

It is also observed another group of companies (E, I, K, M and Q) that, although it performs actions to

generate new products (or modify existing ones), it does not consider the development of products as a business process, and the activities are carried out in an unstructured manner. The process is based on a strategy that is only known and managed by the person in charge, making it difficult to manage the PDP systematically. This analysis allows locating them in the Basic Maturity Level. In the dairy sector these companies represent 17%, in the input sector, 33%, and in the refrigeration sector, 50%. Finally, the group of companies A, D, J, N and O is in the intermediate category of maturity level in the PDP: product development is more stable and begins to be conceived as a business process. In the dairy sector they represent 33%, in the input sector, 17%, and in the refrigerator 25%.

Based on the comparison between the different sectors, the information indicates that the dairy and input companies have a higher PDP Maturity Level, while most of the refrigerators are at a Basic Level. It is emphasized that the present work presents preliminary results, and it would be necessary to analyze a larger number of companies in order to be conclusive in this regard. The study of Levels of Maturity would imply, finally, propose a series of actions (called "Intervention Projects") that allow incorporating appropriate practices to achieve improvements in the PDP. Finally, it is observed that the built variables have been useful to make the diagnosis, given that they are wide enough to reflect the current situation of the PDP in each company.

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