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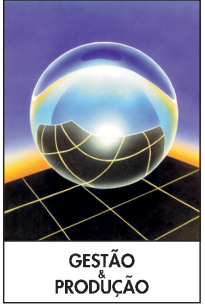

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Relationship between PDP maturity and ISO certification in the food industry

Relação entre a maturidade das indústrias de alimentos e suas certificações da qualidade

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Abstract: Food companies have been seeking certification of their Product Development Processes (PDP) as a symbol of quality, however, few are prepared to obtain it. One of the hypotheses is that some companies are not mature enough to obtain this certification and maintain it in the long term. To guarantee the product quality, it is important that all the activities responsible for the PDP are aligned, integrated, measured and controlled, thus characterizing the PDP maturity. Therefore, the aim of this work is to analyze the PDP maturity level of the food industry to identify the compatibility with the situation of their Quality Certifications. For this, an adapted method of the Capability Maturity Model Integration (CMMI) is used to measure the company's maturity, seeking also to identify the status of their certifications. Information was collected from five companies in the food industry, which presented consistency between their certifications and maturity levels; four are level 1 and have no certification and one is level 2 and is certified by the International Organization for Standardization (ISO)

Keywords: Quality certification; Food industry; CMMI.

Resumo: *As empresas do setor alimentício vêm buscando a obtenção da certificação como símbolo de qualidade, entretanto, poucas estão realmente preparadas para obtê-la. Uma das hipóteses é que algumas empresas não possuem maturidade suficiente para obter essa certificação e mantê-la em longo prazo. Para garantir a qualidade de um produto é importante que todas as atividades responsáveis pelo Processo de Desenvolvimento de Produto (PDP) estejam alinhadas, integradas, medidas e controladas. Caracterizando desta forma, a maturidade do PDP Sendo assim, o objetivo deste trabalho é analisar o nível de maturidade do Processo (PDP) das indústrias do setor alimentício para identificar a compatibilidade com a situação de suas Certificações da Qualidade. Para isso, um método adaptado do CMMI (Capability Maturity Model - Modelo Integrado de Maturidade e Capabilidade) é utilizado para medir a maturidade das empresas, buscando identificar, também, a situação de suas certificações. Foram coletadas informações junto à cinco empresas do setor, as quais apresentaram coerência entre suas certificações e seus níveis de maturidade; quatro possuem nível 1 e não possuem certificação e uma possui nível 2 e é certificada pela ISO.*

Palavras-chave: *Certificação da qualidade; Indústria de alimentos; CMMI.*

1 Introduction

With a new economic scenario of globalization, characterized by intense competitiveness, the companies search for innovations of their products as a solution for their survival in the market. This reality also involves the food sector. According to data found in ABIA (2018), the Brazilian food sector closed the 2016 financial year with a positive balance in exports. Data from 2017 show that the sector exported approximately two hundred billion dollars. This result made the food segment remain with the highest invoicing in the manufacturing sector, totaling BRL 614.3 billion (ABIA, 2018).

Aiming to achieve or maintain the competitive level demanded by the global market, the food industries

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are searching for implement control programs in their quality management processes. The implementation of these programs affects all those involved in the production process, and not only the company that develops it, including those that provide services to their contractors (Mello, 2002).

Searching for evidence of quality for the consumer market, companies seek quality certifications, such as the Brazilian Standard (NBR) ISO 9001 (ABNT, 2008). However, companies fail to meet the minimum requirements to obtain this quality certification, or when they get it, they lose in a short time because they cannot maintain the minimum quality status required by the standard. The graphs generated by INMETRO (2018) present these indicators. Analyzing the chart between the years 2015 to 2018, there were approximately 6,000 certificates canceled.

The certification of quality systems allows the standardization of quality practices and the formal commitment to adopt a culture of continuous improvement. However, the system certification for quality does not guarantee that the customer will receive products that meet the specified requirements. After all, the standardization of practices in a good process will not differ from a bad process (Mott, 2001). This way, the quality programs and certifications do not determine or guarantee the quality of the processes and, consequently, do not guarantee the final product quality. In fact, the development process should have enough maturity to guarantee the final product quality, but the certification programs do not point this way. They do not show the way the company must follow to increase its process maturity level.

Quintella & Rocha (2007) state that the maturity level is an evolutionary process stage, with defined goals, which provides the foundation for improvements in each stage, leading the growth of the organization process capability. According to Siqueira (2005), the maturity model is a structure designed to characterize a system evolution, from a less orderly and less effective state to a more orderly and highly effective state. The concept of maturity levels began to be discussed in the scope of quality management when Crosby (1999) emphasized how the activities related to quality management in a company were subjective and difficult to be defined and measured, making it hamper to manage.

Vaz (2010) and Lisboa (2010) investigated two industrial sectors and found ISO certified companies with low maturity level. In cases like these, two situations can happen: the company can improve its maturity and maintain this certification, or may lose it in subsequent audits, due to the inconsistency and instability of its product development process.

There are some methods that help a company to identify their maturity level. Among them, there are the follow ones: The Maturity Model in Design Management presented in Prado (2005), the Maturity Model from Project Management Institute (PMI - Project Management Institute), called Organizational Project Management Maturity Model (OPM3) (PMI, 2003), the Project Management Maturity Model (PMMM) (Kerzner, 2001), and others. However, the most complete is the CMMI (Capability Maturity Model Integration), used by the software industry, created by Software Engineering Institute (SEI).

The CMMI is a method that evaluates the processes ability on the achievement of goals and serves as a guide improve (Oliveira & Florian, 2013). The CMMI evaluates a company providing a diagnosis ranging from level 2-5 or considering part of its process, scoring it from 1 to 5. In both cases, the maturity level increases with the number: (1) defined, (2) managed, (3) measured, (4) controlled and (5) effective (Lockamy & McCormack, 2004).

Although this feature intends to identify the maturity of a development process, it has been little used in industrial product companies since it started in the information technology sector. In addition, the companies use their own certification as a means to make improvements. However, the certification process does not have the potential to indicate ways for improvement; there is only one incentive to do so.

Works that associate Quality Certification with methods to evaluate the process maturity are few, especially when it comes to the food sector. A study that addresses both themes is that of Bamford & Deibler (1993), whose compared the IS0 9001 with CMM (Capability Maturity Model), showing that the two models should be employed together. However, the authors do not explain or detail about this proposition. Helgesson et al. (2012) deal with the two subjects in general terms, defending the use of a maturity model to guide in the choice of the best techniques combinations to improve the process quality, such as Kaizen, Total Quality Management (TQM), ISO 9000, Six Sigma, and others. Tonini et al. (2008) also found that the quality and maturity models could help each other in a work of process improvement. According to CMM levels, the proposed approach has four improvement steps that direct the company's focus to manage its organizational development process, up to the maximum level — "level five".

Despite the works presented, none of them conducted this association or tested it in industrial products companies. Who did something in this sense was Quintella & Rocha (2007); they used a simplified version of CMMI in the automotive companies, all with quality certifications, aiming to identify their maturity levels. Among the results, the authors highlight this relation, showing that the industries with minimum maturity level 2 had quality certification, however, the main focus was not this kind of discussion: maturity level and quality certification.

In any case, we did not find specific studies to that end, that is, studies that could evaluate the compatibility of industrial maturity levels with their quality certification conditions. Considering the research opportunity, this paper seeks to analyze this correlation, focusing on the food sector. For this purpose, this study carried out a bibliographic review on some themes, such as the PDP and its peculiarities in the food industries, the maturity of the PDPs, the CMMI method, a simplified version of the CMMI proposed by Quintella & Rocha (2007), and the Quality Certification. Then, a study of multiple cases, applying the method proposed by Quintella & Rocha (2007), is used to understand this correlation in the food industry. The case study is conducted according to the Yin (2015) guidelines, performed in five companies of the food industry. In addition to the general maturity assessment of these companies, some additional questions related to the Quality Certification process were collected, in order to find the situation of this correlation in companies: the level of maturity and the condition of their Certifications.

2 PDP, maturity process and certification

This chapter will present some concepts about the PDP and its steps, the maturity level, as well as CMMI and ISO 9001 quality certification.

2.1 Product Development Process

Product Development Process (PDP) consists of a set of activities that try to get the specifications of a product and its production process design, to manufacturing to be able to produce it, starting with the needs of the market and technological possibilities and restrictions, considering the company strategies (Rozenfeld et al., 2006).

According to Rozenfeld et al. (2006), the main stages of a PDP are pre-development, development, and post-development. The "development" consists of the stages of design, manufacturing planning and manufacture of an industrial product, occurring internally in the industry, and it is the focus of this research, therefore, the only stage detailed in this review. In this stage, the design phase is the most critical because it involves a series of stages and variables inherent to typical uncertainties of the initial phase of the process. To avoid ignoring any important detail on the product project, Pahl et al. (2005) suggest that the development takes place in four phases; task definition, conceptual design, preliminary design and detailed design.

According to Back et al. (2008), in the task definition phase, also called by other authors as informational project, the study of the problem results in the preparation of the list of technical requirements where the required functions for the problem will be defined, differing the requirements mandatories from the desirable ones. The required must be met under any circumstances, but that one's considered desirable, it will depend on their viability. The list of requirements is the starting point for solving the task of planning. The requirements must be developed, taking into account the customers' needs and identifying the sequence of these requirements in order of importance to the consumer. The conclusion of this stage is an agreement between the parties involved in the project (technical staff, suppliers, customers, managers, etc.). The list of established requirements will serve as the basis for the following phases and stages of the product development process, specially for the design phases.

The conceptual design seeks to create, graph and select solutions, aiming to identify the best options for the consumer, considering the priority technical requirements. The search for solutions may consider existing or similar solutions. The creative process can be aided by methods that contribute to and exploit creativity. The representation of solutions can be done by means of schemata, sketches or drawings, which can be manual or computational. Finally, the process of solutions selection is based on appropriate methods, which are based on the needs or requirements previously defined (Rozenfeld et al., 2006).

The phase of preliminary design starts with a technical and economical design, including a preliminary layout based on spatial requirements, and proceeds considering safety, ergonomics, manufacturing, assembly, operation, maintenance, costs, reliability, and others. In this phase, various methods can be used, aiming to support these definitions (Estorilio & Posso, 2010; Estorilio et al., 2008).

The detailed design establishes the definitive descriptions of the preliminary design for the arrangement of elements, shapes, dimensions, surface finishes, materials, design verification and manufacturing costs. At this stage, the final documents are made in the form of drawings (Back et al., 2008).

After finishing the design stage, the manufacturing planning stage begins, which consists of the production of the pilot batch, starting with the definition of the production and maintenance processes to be accomplished. The manufacturing stage involves the activities of the production process, sales, distribution, customer service, technical assistance, and marketing (Rozenfeld et al., 2006).

The stages of the PDP in the food industry, according to Fuller (1994), do not show these stages and phases sequentially; sometimes, they may occur simultaneously. Moreover, when incorporating new information into the product development process, it

is necessary to return to the initial stages of product design for the information be considered in the process.

Fuller (1994), bearing in mind the stage "development", suggests the following phases for performing a PDP, considering the food industry:

a) Buyers' Market: identifying consumer needs;

b) Ideas: creating ideas from diverse sources (people in the company, sales points);

c) Ideas pointed out: the ideas raised are conceptualized by analyzing the viability;

d) Development: product specifications are created, and cost of materials information, ingredients, packaging, and equipment are analyzed;

e) Pilot Test: it is developed a prototype product like the real one;

f) Production: the product is effectively produced, however, can be altered due to the appearance of new decision variables and, if this happens, the viability is evaluated again;

g) Consumer/Market Test: this stage the company defines the place that the market test will be done, according to the specifications of the product. The product is analyzed by the consumer market of the place chosen to predict its acceptability. Based on that, the company makes the necessary changes in the product or remove from the market, if there is not the expected return.

Despite the suggestions of stages that guide the designer in the implementation of a project, basis for all product development, until implementation and distribution, it is worth remembering that the quality of the final product depends on the performance of this process. It is therefore critical that PDP has efficient management (Lourenzani et al., 2002). After all, the PDP performance is directly related to its maturity level.

2.2 Maturity process

Helgesson et al. (2012) state that mature organizations develop their activities in a systematic way, while immature achieve their results through the heroic efforts of individuals using intuitive approaches. A mature process is defined, managed, measured, controlled and effective, whose organizations achieve quality objectives, deadlines and costs in a consistent and effective. Immature organizations create goals, but often the quality is not the desired and the time and cost may be higher than planned. Mature organizations have systematized processes and documented methods to perform their activities, with data collected systematically and used to analyze, control, predict and plan their performance. Immature organizations do not think in terms of process and methods, vary according to the circumstances and the people who perform the tasks. Thus, the results are unpredictable and inconsistent. This reflects the assertion of Rozenfeld et al. (2006), which relate the degree of maturity of a company by how it applies best practices to develop quality products. For them, the level of maturity also influences the volume of incremental improvements and changes in processing.

To Quintella & Rocha (2007), the maturity level is an evolutionary stage, with goals defined process that provides foundations for improvements to be undertaken in the next stage, guiding the growth process capability of the organization. So that the company can locate where and as it is, makes use of a maturity model, which is a guide for the organization to obtain a diagnosis and plan to reach a better maturity level (Oliveira, 2005).

One of the earliest models of maturity levels emerged in the 1970s, called "Quality Management Maturity Enhancement," which measured five evolutionary stages of the company: Uncertainty, Awakening, Clarification, Wisdom, and Certainty. These principles were adapted by SEI in Carnegie Mellon University in 1986, resulting in the CMM (Quintella & Rocha, 2007). Based on this model, others have been developed, resulting in the CMMI in 1990, which further shows the characteristics evaluation of repeatability and predictability of the process, considering aspects of integration between activities (SEI, 2010). CMMI is a maturity model for the development and maintenance of software and services, covering the entire product lifecycle, from conception to delivery, and maintenance (Morgado et al., 2007).

After December 2011, the SEI considers the CMMI-DEV 1.3 version (Valle et al., 2010). According to the authors, this version does not have an explicit issue about "integration", called for IPPD (Target Specific Practices), that provides all that company must meet related to Integrated Product and Process Development, like the previous versions (SEI, 2010). However, integration is still considered through the practices of other items evaluated, like the OPD (Organizational Process Definition) and IPM (Integrated Project Management), for instance.

2.2.1 CMMI fundamentals

The CMMI is based on the concept of maturity levels, in the context of management systems of software development process, in order to guarantee the sale of more reliable products. As a company grows in terms of maturity, its development process is institutionalized through policies, standards and

organizational structures, which generate an infrastructure and a culture of support for development methods and procedures (Mazzola, 2010).

The CMMI provides an organized structure in evolutionary stages; there are five levels of maturity, organized in process areas, conducting for the continuous improvement. Process Area (PAs) is a group of practices related to a particular area that, when executed, satisfy a set of goals considered important for a specific area. The five levels of maturity are the following:

a) Level 1 - Initial- Corrective activities: the organization does not provide a stable environment for the development of processes, nor has well-established management practices. It has inefficient planning and compromises are always reactive;

b) Level 2- Managed: the projects have the requirements, products, and services managed and that processes are planned, performed, measured, and controlled. The status of products and services is visible by management at specific points. Practices are maintained during times of crisis, with projects performed and managed according to the documented plans. Commitments are made as required and products are reviewed to verify that requirements are being met;

c) Level 3- Defined: the processes are well characterized and understood and described according to standards and procedures. Processes are established, documented, integrated and improved over time. Management establishes objectives based on standard processes and ensures that these are followed, and that training is provided as required;

d) Level 4 - Quantitatively managed: the organization sets quantitative product quality targets and process performance targets. It uses as a management criterion the quantitative objectives based on the needs of the clients, end users, and the organization itself. The productivity and quality of project activities are measured and form the basis of process and product appraisals. Projects include statistical control of products and processes and are managed throughout the life of a process. The risks associated with the application in a new domain are known and understood;

e) Level 5 - Optimization: Focus on continuous improvement of process performance, measuring objectives established and revising them to reflect the business changes, being used as a criterion for management improvement. Lessons learned are disseminated to other projects and process improvement becomes part of everyone's activity, leading to a cycle of continuous improvement.

To check the overall maturity level of the company, the CMMI uses the "staged representation." However, when the intention is to assess the maturity of a specific area, it is used the "continuous representation". Considering that the focus of this work is to approach the overall maturity of the process, only the "staged representation" will be addressed in this review.

The staged representation presents five levels of maturity previously described. For the company reaches a certain level, you need to check if the company is servicing a set of Process Areas belonging to a certain level review, including its goals and practices. Chart 1 shows what combination of goals and practices are necessary to be accomplished to gain the evolution from the level 2, to 3, 4, or 5. In total, the CMMI considers 22 PAs, formed for a lot of goals and practices.

Each PA has several Specific Goals (ME), which refer to the execution of several Specific Practices (PE). In the process, they are also considered as Generic Goals (MG) and Generic Practices (PG). A Process Area is evaluated as "satisfied" only if all "crossings" between each Specific Practice and Generic Practice is "satisfied". If one crossing will be evaluated as "unsatisfied," the respective PA will be considered "unsatisfied". The enterprise needs to reach all PAs from determined level to reach this specific level and all levels precedents need to be attended as well (SEI, 2010). If the company meets all crossing of level 3 but miss some crossing from level 2, it will continue to be level 1. Figure 1 shows a structure linked to the Process Areas belonging to evaluation 2, considering how these crosses are formed to promote the evaluation. In order to reach a level, the previous levels must be completely satisfied, and not only the variables required in the level involved. Figure 1 shows the structure linked to the Process Areas pertaining to the level 2 assessment, considering, in a schematic way, how these crossings occurs in the assessment, highlighting them with a circle.

The difficulty encountered for a full staged evaluation with CMMI is the number of variables involved in the analysis, since the number of crosses between "Specific Practices" (PE) and "Generic Practices" (PG), demanded to evaluate all maturity levels, is 2665. Considering only the evaluation level 2, where is most of the organizations, including those certified by ISO, means 570 variables to be verified. That is, a measurement of this nature involves consultant time and from those involved in the company process, becoming difficult the conclusion of this research

Chart 1. Process area involved to reach a certain maturity level (Adapted of SEI (2010)).

Maturity Level	Process area (PAs)	Definition
2	Project Planning	It establishes and maintains the plans that define the project activities.
	Project Control and Monitoring	It provides an understanding of the process used in a project, in such a way that corrective actions can be taken when its performance deviates from the established plan.
	Suppliers Contract Management	It manages the product purchasing from suppliers, including a formal contract.
	Requirements Management	It manages the project requirements and identifies the inconsistencies between the initial requirements and those implemented throughout the process.
	Configuration Management	It establishes and maintains the integrity of the results of the work performed using identification, control, status and auditing of the configuration throughout the life cycle of the project/product.
	Quality Assurance of Product and Process	It guarantees the delivery of high-quality products and services by assessing the quality of the development process.
	Measurement and Analysis	It develops and provides measurements to support the management of the required information.
3	Focus on Organizational Process	It plans and implements improvements in the organizational process through the understanding of the positive and negative aspects of the company's processes.
	Definition of Organizational Process	It establishes and maintains a set of organizational process items that can be used across the organization. These items include the process description, the process tasks and activities, the description of life cycle models, the process execution guide, as well as data, and process documentation.
	Organizational Training	It operates with the employees' development of the skills and knowledge in such a way that they can carry out their work effectively and efficiently.
	Integrated Project Management	It establishes and manages the design and commitment of relevant stakeholders (individuals or groups involved with the project — suppliers, customers, users and others), according to a defined and integrated process based on the company's standard processes.
	Risks Management	It identifies the potential problems before they occur, through the planning and execution of specific activities in risk situations, in order to mitigate the adverse impacts that may influence the achievement of the objectives.
	Development of Requirements	It produces and analyzes the customer's requirements, as well as the requirements of the product and the product components, in such a way that they meet the needs of the people involved in the project.
	Technical solution	It designs, develops and implements the solutions to meet the requirements, in order to cover products, components and by-products of the process life cycle, either individually or in combination.
	Integration of Product	It brings together all the product components and ensures that, when integrated, the product works well.
	Verification	It ensures that the work products meet the specified requirements
	Validation	It demonstrates that the product or its components meet their intended use when kept in a specific environment.
	Resolution and Analysis of Decision	It analyzes decisions using a formal process that assesses the possible alternatives and establishes criteria.
4	Performance of Organizational Process	It establishes and maintains a quantitative understanding of the ability of standard processes in supporting the quality and performance objectives in order to collect the data necessary for the quantitative management of the company's projects.
	Quantitative Management of Project	It manages the process defined for the project in a quantitative way, aiming at achieving the quality and performance objectives established for the project.
5	Organizational Development and Innovation	It allows the selection and orderly distribution of improvements (either incremental or innovative) to increase the company's ability to achieve its quality and process performance objectives.
	Resolution and Analysis of the Causes	It analyzes the causes of defects and other problems and takes action in order to avoid them in the future.

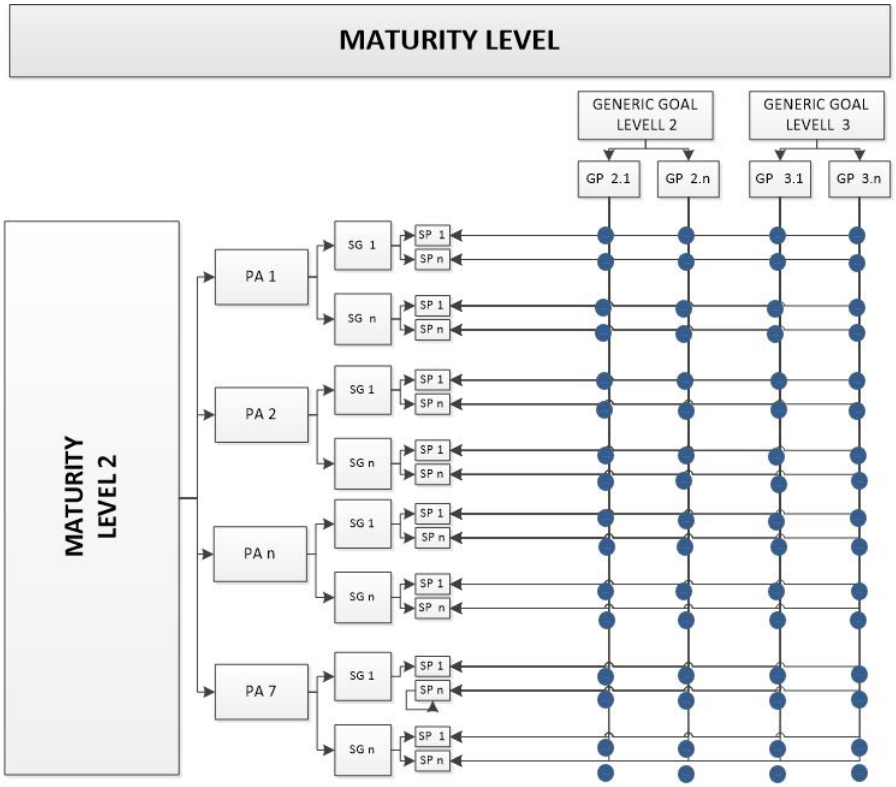

Figure 1. Variables evaluated to satisfy the maturity levels (Estorilio et al., 2015).

based on the researcher's time limitation. Therefore, in this work we chose to use the CMMI adapted by Quintella & Rocha (2007), which contemplates fewer questions to be verified in the company.

2.2.2 Method adapted from CMMI

Quintella & Rocha (2007) propose a method to determine the level of maturity of the organizations, composed of questions to be evaluated in the company, which verify the fulfilment or satisfaction of the generic and specific goals of several processes' areas related to the respective levels of maturity based on CMMI concepts. This method is hypothetical-deductive, that is, the knowledge gap on which the hypotheses are formulated is followed by deductive inferences, testing the prediction of the occurrence of phenomena covered by the hypothesis. The central hypothesis, tested in the industrial field, was the following: In search of strategic positioning and maintenance of its competitiveness, companies in the automotive industry maintain a structured method for the product development, which has the potential to guarantee the consumer's acceptance and the financial flow resulting from the products commercial success. This method is composed of 27 questions, divided into four groups, identified as key issues. Each group of questions represents the goals that the company must meet to be at a certain level of maturity. This method was adapted for this research and is found in the item 3.

When talking about Quality Certification, this level of verification changes, that is, the analysis of its form of evaluation within the company shows that that the main point is the planning and standardization of processes, demanding consistency with their execution and management. However, a brief review will be presented, aiming at a better understanding of this topic.

2.3 Quality Certification

The Quality Certification is an indicator to consumers and businesses that the product, process or service meets pre-set minimum quality standards. To do so, it follows an international standard, known as the International Organization for Standardization (ISO), which consists of a series of technical norms which address different themes. Among them, we have the ISO 9000 series, which addresses guidelines to be considered in an organization's Quality Management System (Carvalho & Paladini, 2013).

According to Cerqueira (2006), the ISO 9000 series consists of three main norms: the NBR ISO 9000 - Fundamentals and Vocabulary of the Quality Management System, which establishes a starting

point for understanding standards and defines the fundamental terms used in the ISO 9000 Family. The NBR ISO 9001 (ABNT, 2008) - Quality Management System Requirements, which defines requirements to meet customers and regulations, and the NBR ISO 9004 (ABNT, 1993) - Guidelines for Performance Improvement of the Quality Management System, measured by means of customer satisfaction and other stakeholders.

ISO 9001 certification is recognized worldwide in several productive sectors. To obtain this certification it is necessary to document the quality system and then to execute the work processes according to the documented procedures. Periodic audits (internal and external) are required to verify if the company continues to operate according to the previously documented procedure (Mott, 2001).

ISO 9001 is structured in 09 (nine) sections that can be divided into 02 (two) parts: General and Requirements. The first part, "General", describes the overall content of the standard, its application, definitions and others. The second part, "Requirements", defines the requirements necessary for the implementation and maintenance of a Quality Management System. These requirements are within five specific sections, according to the numbering presented: 4. Quality Management System; 5. Management responsibility; 6. Resource Management; 7. Product realization; 8. Measurement, Analysis, and Improvement. Like can be seen, only the Section 7 addresses the activities related to the "product development process" and, therefore, will be the only item to be detailed (Tonini et al., 2008). Considering the two parts, the "Requirements" refer to the part that the company must satisfy during and after the implementation of the certifying standard.

Section 7 is divided into six requirements: 7.1 Product Planning and Realization; 7.2 Processes Related to Customers; 7.3 Design and Development; 7.4 Acquisition; 7.5 Production and provision of services and 7.6 Control of monitoring and measuring equipment. Of these, requirement 7.3 details the items required in a "Design and Development", emphasizing that the organization must plan and control product design and development, manage interfaces between different groups involved in design and development, ensure effective communication and clearly assign responsibilities. In addition, the company must also determine the internships, critical analysis, verification and validation appropriate to each stage, as well as determining responsibilities and authority in design and development (Tonini et al., 2008).

In the current ISO 9001 version (2015), these requirements have been restructured into seven sections: 4. Organizational Context; 5. Leadership; 6. Planning; 7. Support; 8. Operation; 9. Performance Assessment and 10. Improvement. In the new standard version, the requirement that addresses the activities related to the product development process is the Operation requirement — 8. Operation (ABNT, 2015).

Section 8 is divided into seven requirements: 8.1 Operational Planning and Control; 8.2 Requirements for Products and Services; 8.3 Project and Development of Products and Services; 8.4 Control of Processes, Products and Services Provided Externally; 8.5 Production and Service Provision; 8.6 Products and Services Release and 8.7 Control of Non-compliant Outputs. From these, the requirement 8.3 details the necessary items in "Project and Development", emphasizing that the organization must plan and control the product project and development, manage interfaces between different groups involved in the project and development, ensure effective communication and clearly assign the responsibilities. In addition, the company must also determine the stages, critical analysis, verification and validation appropriate to each stage, as well as determining responsibilities and authority in the project and development (Carvalho & Paladini, 2013; ABNT, 2015).

Finally, as can be seen, the standard has guidelines that indicate that the company must plan, control and manage some activities, as well as ensure communication and assign responsibilities, but does not address operational details, which involve how the company should develop and operationalize information during the project, as CMMI and its derivative approaches addresses (Mott, 2001).

Therefore, according to Mott (2001), the conformity of the standardization of good process practices will not be different from the standardization of the practices of a bad process. As it turned out, for a company to guarantee its customers that its products are reliable, it certifies itself. However, "Certification" is not always synonymous with quality products. After all, good product means good process or mature processes and to accomplish that, it would be require a diagnosis of where the enterprise is and what it is necessary to do to improve, according with its goal. This could be provided by methods of the CMMI type, as previously mentioned.

3 Methodology

In order to accomplish the main goal, this study started with the bibliographic review previously presented. Aiming to understand the maturity level of the PDP process in the food sector, as well as the compatibility with the situation of its Quality Certifications, it was necessary to proceed with an investigation in an industrial field, and the food sector was the chosen area. Considering the existence of several companies of this sector and the possibility of their participation, it was conducted a multiple cases study (Yin, 2015).

According to Yin (2015), this method falls within as a qualitative approach and is used to

collect data in the field of organizational studies. This methodology can also be applied, according Donaire (1997), when require broadening the knowledge on certain issue, which in the case of present survey, that aims to identify the correlation between the level of maturity of the PDP and the ISO 9001certification process.

To apply the case study, Yin (2015) suggests developing it in six phases, executed in the following way:

1) Choice of the theoretical background: this research focused on the food sector because it has representativeness in the national economy and is the specific area of expertise of one of the authors of this study. The "maturity and certification" topic was the central theoretical background, according to the objective of this research;

2) Case selection: From the 117 food and beverage industries of Paraná (FIEP, 2007), 15 were located in Curitiba (city where the authors were, facilitating their access to the locations), but only five industries accepted to participate in this research project;

3) Design of the Data Collection Protocol: the method used to collect data was the simplified version of CMMI, proposed by Quintella & Rocha (2007), plus the following questions about Quality Certification: Q1) Does the organization have Quality Certification? If yes, Q2) when and by which company was the organization certified? Q3) Does the organization intend to obtain Quality Certification in the next years? If so, how long? Q4) Does the company export its products? If so, how many of its products and to which countries?

In order to test in the industrial field, the questionnaire proposed by Quintella & Rocha (2007), a pilot test was conducted in Company A, initiating a new version, more familiar and direct in terms of the industrial environment of product development, as shown in Chart 2. The maturity levels are as follows: 1- little controlled and unpredictable; 2 - can repeat some tasks; 3 - well-understood and typified process; 4 - measured and controlled process and 5 - focus on continuous improvement. It is important to highlight that the questions presented in this table were based on those suggested by Quintella & Rocha (2007); however, they suffered minor changes after the pilot test conducted in the first case studied. These changes were mainly related to sentence reduction and vocabulary simplification. Chart 2. shows the questionnaire used to collect data in all other cases that will be presented at a later stage.

As can be seen, the questions aim to understand how the company presents structured methodologies to develop its projects, how much control they have over their projects and manufacturing processes, and how they are able to absorb the lessons learned from previous projects, aiming to avoid the occurrence of repetitive errors.

4) Conducting the case study: initially, it would be necessary to have an explanatory follow-up of the entire flow of the company's PDP process, in all cases studied, from design to manufacturing, including the input procedures and control of raw materials involved. After this phase, the collection took place through interviews with managers, production supervisors and people who had knowledge of the whole production and company, after a previous explanation of the research objective. These questions sought to assess the achievement of goals in the areas of maturity levels processes, in a scale of evolutionary steps (from one to five) and verified the existence of certification in the institution or the desire of acquiring it, including the situation of its goods exports. Among the five companies surveyed — here named A, B, C, D and E — is included the company that served as a pilot test. Companies A, B and C are large companies; company D is Small Business and company E is Medium-Sized Company, according to the SEBRAE classification (SEBRAE, 2013), where Small Businesses have 20 to 99 employees, Medium-Sized Companies have 100 to 499 employees and Large-Sized Companies have more than 500 employees. The number of respondents in each company was as follows: Company A (1 respondent); Company B (2 respondents); Company C (1 respondent); Company D (2 respondents) and Company E (1 respondent). The number of respondents chosen varied according to the availability offered by the company and to the process vision of the respondent in question;

5) Written development of a report: After conducting the interviews in each company, this study calculated the median of each group of questions, related to key questions and in accordance with the methodology presented by Quintella & Rocha (2007). According to the authors, we

Chart 2. Questions to determine the maturity level (adapted from Quintella & Rocha, 2007).

	Issues used to verify compliance with goals and practices in the evaluated process
level 2	1) Are the projects of new products planned, with the participation of stakeholders (including suppliers), and are their developments monitored and controlled, based on their planning? 2) Are the corrective actions established when product development (PD) of the project is not taking place as planned? 3) Are the requests for the project collected, updated and accessible, providing traceability from the customer to the final product? 4) Is the documentation required for the PD maintained, identified, controlled and audited? 5) Do the PD details have their performance assessed according to the initial planning, transferring the information to the project team so that this group can accompany it? 6) Do all the company's projects have their requirements, products and services managed and the processes planned, executed, measured and controlled? Is the situation of products and services visible to management at specific points of control? 7) Are the PDP activities, situation and results reviewed together with the top management?
level 3	8) Is the information related to the PDP planning and execution (metrics and expected results) collected in order to understand the strengths and weaknesses of the used processes, so that the continuous improvements are planned and implemented? 9) Are standard organizational processes established and kept, based on the company's needs and objectives, including the process descriptions and detailing, guidance documents and other documentation? 10) Are the company's training needs identified, as well as the common tactical needs between projects and support groups, achieving or developing the skills required to execute the company's standard processes? 11) Is there a training program able to ensure that the development staff and managers achieve the knowledge and skills necessary to fulfill the roles assigned to them? 12) Do all those involved in new product development (DNP) have a shared vision of the project, becoming involved in it, identifying, negotiating and monitoring the existing interdependencies, in order to solve the problems that may arise? 13) Are the integration and collaboration among all those involved in the DNP encouraged, recognized and/or rewarded, promoting the individuals and team excellence? 14) Are the development risks associated with cost, as well as the project resources, schedule and technical aspects identified, assessed, documented and possible responses to these situations identified? 15) Are customer's needs identified? If so, are they translated into design requirements, including those metrics that monitor the expected performance for each requirement? 16) Are such requirements converted into product concepts, and subsequently into the layout and project of product details, using methodologies and assessment methods that consider the product type, performance requirements, costs, and deadlines for development? 17) Is there a procedure to ensure that the developed product of the company meets the delimited requirements, from the initial PDP to the final product testing? 18) Is the customer involved in this verification process, validating it? 19) Are the processes well characterized, understood, and described according to standards, procedures, tools and methods? Are the standard development and maintenance processes, adopted throughout the organization documented, including management standards? Are these processes integrated into a coherent whole?
level 4	20) Are the company's business objectives broken down into quantitative objectives, in order to plan the quality and performance of the processes, resulting in indicators to assess the process performance? 21) Are such quantitative objectives based on the needs of customers, end users, process implementers and the organization itself? 22) Considering these quantitative objectives, are quantitative and statistical techniques of process and product performance management applied? 23) Can significant variations in the process performance be distinguished from random variations (noise) and identify specific product lines? Is the root cause of these variations identified and, where appropriate, corrected to prevent future occurrences? 24) Are the risks involved in the process of introducing a new product, technology or area of operation/application known and managed
level 5	25) Are the improvement proposals, aimed at getting the organization to achieve the quality and performance objectives, selected based on costs and benefits, as well as the availability for investment, involving a decision-making group, aligned with the company's values and objectives? 26) Do the company seek to understand the common causes of variation inherent in processes and to achieve ways to remove them from these processes, using this knowledge and lessons learned to continuously improve the company's processes, and disseminating them to other projects as well? 27) Is the entire organization concentrated on the continuous improvement of the process performance, by either incremental (continuous) improvement or technological innovations (including fault prevention)? Are the measurable objectives of process improvement established and continually revised to reflect changes in the business objectives and used as criteria to improve the management process?

Source: the authors.

considered the following rule: the organization belongs to the highest level when the medians of all responses are greater than or equal to four (which means "often" or "always"). In this work, we used the scale of 1 to 5, which indicates: 1 (never), 2 (rarely), 3 (sometimes), 4 (often) and 5 (always). In a group of questions, any median response less than four means that the goals are not met in the company considering the level of the issues analyzed, even if the group median is four or five. If, for example, in the group of questions 1 to 7 (which inserts PDP as level two), only one question achieves a response lower than four, the PDP does not correspond to level 2, even though the group median reaches the value four, but rather to the previously lower level which, in this case, would be level 1;

6) Standardization and Theoretical Modification: After the case study, it was performed the analysis of information obtained in each company. Afterwards this information was compared aiming to understand the sector status. However, it worth to point out that because of low number of respondents, these data cannot be generalized for the sector; valid only as an indicative of the status in the Metropolitan Region of Curitiba.

4 Case studies

The results are presented in the following sequence: the first table for each company presents a "brief history of the company, with the identification of the respondents, including the groups of questions that delimit the maturity levels with the answers and medians obtained" and, following, the table complements the company information with responses about "Quality Certification". The Companies and Charts with their information are as follows: Company A (Charts 3 and 4), Company B (Charts 5 and 6), Company C (Charts 7 and 8), Company D (Charts 9 and 10), and Company E (Charts 11 and 12). It is important to point out that these studies were conducted in the years 2008 and 2009.

4.1 Case study: company A (Pilot Test)

The company A, utilized to perform the pilot test, starts with the comprehension of the entire PDP, aiming to obtain the general overview of the company and its resulting products. Founded in 1977, is a large company located in Curitiba, south of Brazil, and it process pork meat and milk. The company is present in more than 20 countries and, in Brazil, is ranked in outstanding position among major food industries in the country. In this survey, the data collection was carried out with the manager of the Quality System Management. Results obtained through the questionnaire are presented in Charts 3 and 4.

Chart 4 presents the results related to the Quality Certification.

Chart 3. Results from the questionnaire of company A.

GROUPS OF ISSUES THAT DEFINE THE MATURITY LEVELS AND ITS ANSWERS	Medium
It seeks to identify if the PDP is in Level 2 of the CMMI (issues 1 to 7) **Answer:** No, despite having obtained a median 4 in the group, the respondent indicated that the projects and processes are not measured and controlled, and the results do not have a Management review process (answer level 3, issue 7).	4
It seeks to identify if the PDP is in Level 3 of the CMMI (issues 8 to 19) **Answer:** No, the issues 8 and 12 demonstrate a low level of maturity (answer level 1). These items are related to the planning and execution of processes for improvement; this data is collected, but not documented. Integration and collaboration among those involved in new product development do not officially have an integration-oriented metrics and the medium is less than 4. Another issue that demonstrated low level is related to customers, whose are not involved in the verification process; only give their feedback after the occurrence (answer level 2, issue 17).	3,5
It seeks to identify if the PDP is in Level 4 of the CMMI (issues 20 to 24) **Answer:** No. Although the median is equal to 4, process and product performance management techniques, that are quantitative and statistical, are not applied. According to the respondent, the board does an only qualitative analysis. Process variations are not previously identified and are not documented. They solve problems only at the moment they occur, without preventing future recurrences (answer level 2, issue 23).	4
It seeks to identify if the PDP is in Level 5 of the CMMI (issues 25 to 27) **Answer**: No. Respondent stated that proposals (innovative and incremental improvements) for the organization to achieve process quality and performance objectives are selected on the basis of benefits and costs, not including documentation or controls (answer level 1, issue 25). Moreover, the enterprise presented medium less than 4 in the answers.	2

Source: the authors.

According to the results obtained, the company A is in the level 1 of maturity, has no Quality Certification and does not export products, but demonstrated the intention to certify in short time. Despite the company A presented level 1 of maturity, it presents strengths such as Planning of product integrated development and develops the documents requires, such as information about designs and specifications. However, the company presents some weakness that should be improved to reach the sufficient and necessary maturity level to obtain the quality certification.

Among the main lacks, can be listed the following: the company does not present metrics, measurements or assessment of the performance of planning and execution of the new products development process. Also, it presents a lack of shared vision of persons involved in the project to accompany the inter-dependencies existing in this process.

Considering that this company was the first, the questionnaire was adjusted, aiming better comprehension of other companies.

4.2 Case study: company B

The company was founded in 1968, keeping the commitment to invest in technology research and development in the food sector. The company produces dehydrated vegetables and fruits, cereal bars, and other products of this nature. In 2001, the company implanted the Balanced Score Card (BSC), whose method aims to establish the company strategies, considering four perspectives: finances, clients, internal processes, and learning. Has the branch in Arceburgo, in the South of Minas Gerais - Brazil. It operates with 650 collaborators in Curitiba.

To survey the maturity level of the company "B", the data collection was carried out with the Manager of New Products Development Process and with the Manager of the Quality Management System.

Chart 4. Results on questions related to the Company A.

QUESTIONS RELATED TO CERTIFICATION	
QUESTIONS	**ANSWERS**
Q1: Has the Quality certification?	Among 5 unities in Parana, 2 are certified. The company interviewed do not have certification.
Q2: When was certified and by which company?	Not certified
Q3: Intend to get a Certification? If yes, until when?	The company seeks to certify in short time and already is preparing for it.
Q4: Does enterprise export products? If yes, how much and to which countries?	This unity does not export products due to limitations of transport, warehousing and the variety of products.

Source: the authors.

Chart 5. Results of questions related to the Company B.

GROUPS OF ISSUES THAT DEFINE THE MATURITY LEVELS AND ITS ANSWERS	Median
It seeks to identify if the PDP is in Level 2 of the CMMI (issue 1 to 7) **Answer:** No, despite the company possess the median equal to 4, demonstrated that the design requirements do not possess traceability and are not maintained, identified, and controlled. Besides, documents required to develop the design are not audited (answer level 3, issue 4).	4
It seeks to identify if the PDP is in Level 3 of the CMMI (issue 8 to 19) **Answer:** No, despite the group of questions presented the median bigger than 4, the respondent indicated that there are difficulties to identify the clients' necessities. So that, they also do not succeed to convert these necessities in the product requirements, not ensuring that these requirements can be attended (answer level 2, issues 15 and 16; answer level 3, issues 17 and 18).	5
It seeks to identify if the PDP is in Level 4 of the CMMI (issue 20 to 24) **Answer:** Besides, the group of questions did not present the median bigger than 4, the respondent indicated that the quantitative objectives of the quality are not based on the clients' necessities. Beyond that, the company does not apply management techniques for process performance, that means, the risks involved in the new product introduction, technology or the sector of actuation are not known, nor managed. (answer level 3, issues 21, 22 and 24).	3
It seeks to identify if the PDP is in Level 5 of the CMMI (issue 25 to 27) **Answer:** No. Besides the median be lower than 4, the company does not search to understand the common causes of variation, inherent to manufacturing processes, and to find the ways to improve or correct (answer level 3, issue 26).	3

Source: the authors.

Results obtained through the filling of questionnaire are presented in Charts 5 and 6.

Chart 6 presents the results related to the Quality Certification.

The company B is in the maturity level 1 and does not have quality certification. The company does not seek certification at moment and export some products to Japan and Africa. The company has the PDP well delimited, controlled, and focus on continuous improvement. Despite these positive characteristics, the company is maturity level 1 because its inefficiency in the informational design phase; it doesn't have a methodology to identify the client's requirements, to convert into product technical specifications. Including, the company itself reported the consequence of this inefficiency, presenting a product which was rejected by consumers and forced to withdraw from the market in the past.

4.3 Case study: company C

Located in the Araucaria city - Parana, the company C operates with 450 collaborators, therefore, is a large company. The company operates in several sectors of byproducts of soybean, since the reception, warehousing, and grinding of soybean, to the production of the lecithin, production and fill out of refined oil, production of protein concentrated bran (SPC), and alcohol. To survey of the maturity level, the data collection was carried out with the Manager of Quality System Management. Results obtained through the questionnaire filling are presented in Charts 7 and 8.

Chart 8 presents the results related to the Quality Certification.

The company C is in the maturity level 2. It possesses the quality certification in the last 10 years ago and exports 90% of its products to Europe. After all, it can be said that despite the company presented the maturity level 2, possess strengths such as: a well delimited and controlled PDP and focused on continuous improvement; performs corrective actions when process variations are identified and possess characterized processes, comprised, maintained, and controlled. Although the company shows little integration among the teams, the PDP sector presents feedback practices with stakeholders about the problems and difficulties that occur during

Chart 6. Results of questions related to certification of Company B.

QUESTIONS RELATED TO CERTIFICATION	
QUESTIONS	**ANSWER**
Q1: Has the Quality certification?	No
Q2: When was certified and by which company?	Not certified
Q3: Intend to get a Certification? If yes, until when?	Not for a while
Q4: Does enterprise export products? If yes, how much and to which countries?	Some products as flour and refreshment. Export to Africa and Japan.

Source: the authors.

Chart 7. Results of questions related to Company C.

GROUPS OF ISSUES THAT DEFINE THE MATURITY LEVELS AND ITS ANSWERS	Median
It seeks to identify if the PDP is in Level 2 of the CMMI (issue 1 to 7) **Answer:** Yes, because the respondent indicated the existence of such characteristics in the PDP of the organization.	4
It seeks to identify if the PDP is in Level 3 of the CMMI (issue 8 to 19) **Answer:** No, despite the group of questions presented the median bigger than 4, the respondent indicated that are not collected information related to the PDP planning and execution (answer level 3, issue 8). Also, the people involved in the new products development does not have the shared vision of the design (answer level 2, issue 12) and there is no integration and collaboration among the people involved (answer level 2, issue 13).	4
It seeks to identify if the PDP is in Level 4 of the CMMI (issue 20 to 24) **Answer:** Besides the group of questions does not present the median bigger than 4, the respondent indicated that the quantitative objectives of the quality are not based on the clients' necessities. Beyond that, the company does not apply management techniques for process performance, that means, the risks involved in the new product introduction, technology or the actuation sector are not known, nor managed (answer level 3, issues 21, 22 and 24).	4
It seeks to identify if the PDP is in Level 5 of the CMMI (issue 25 to 27) **Answer:** No. Besides the median be lower than 4, the company does not search to understand the common causes of variation, inherent to manufacturing processes, and do not identify the ways to remove (level 3, issue 26).	4

Source: the authors.

the PDP processes. In addition, the company has some weaknesses such as lack of incentive in the integration and collaboration among those involved in the new products development.

4.4 Case study: company D

The company is in charge of fabrication of products derived from cocoa-bean and of the chocolate. Operates in all national territory and does the sale only by with 23 distributors. The manufacturing plant is located in Piraquara - PR with 55 collaborators, it is a Small Company. The data collection was performed with Processes manager and the Director of the Company. Results obtained through the filling of questionnaire are presented in Charts 9 and 10.

Chart 10 presents the results related to the Quality Certification.

Chart 8. Results of questions related to Certification of the Company C.

QUESTIONS RELATED TO CERTIFICATION	
QUESTIONS	**ANSWERS**
Q1: Has the Quality certification?	Yes. ISO 9001:2000/ APPCC (Analysis of Dangers and Critical Points of Control) / GMPB 2 (good manufacturing practices/ Bran (APPCC international for animal products - export)
Q2: When was certified and by which company?	2003. BRTUV
Q3: Intend to get a Certification? If yes, until when?	The enterprise has certification
Q4: Does enterprise export products? If yes, how much and to which countries?	Yes. 90% of products: soybean oil, lecithin and soybean bran. Europe.

Source: the authors.

Chart 9. Results of questions related to the Company D.

GROUPS OF ISSUES THAT DEFINE THE MATURITY LEVELS AND ITS ANSWERS	Median
It seeks to identify if the PDP is in Level 2 of the CMMI (issue 1 to 7) **Answer:** No. Despite the median presented the value bigger than 4, the respondent indicated that the designs of new products are planned with the involvement of interested part but are not measured and controlled (answer level 3, issue 1). Products and services are not managed, and the processes executed are not measured or controlled (answer level 3, issue 6). However, in further questions of this group (2, 3, 4, 5 and 7) the company presents a status of continuous improvement (level 5), with characteristics such as: establishing corrective actions when the activities do not follow the plan; designs information necessary to the development of product are maintained, identified, and controlled and all company activities are accompanied by the top manager.	5
It seeks to identify if the PDP is in Level 3 of the CMMI (issue 8 to 19) **Answer:** No. Despite the group of questions presented the median equal to 4, the respondent indicated that there are difficulties to guarantee that persons involved in the design have knowledge and abilities to accomplish their roles. The company also has no stimulus to the new products development team and there is no integration among collaborators (answer level 1, issues 11 and 13). The company does not utilize methodologies or methods to convert the client's needs in the design technical requirements (answer level 3, issue 16).	4
It seeks to identify if the PDP is in Level 4 of the CMMI (issue 20 to 24) **Answer:** No. The group of questions presented the median bigger than 4, but the company does not have management techniques for processes and products performance (answer level 3, issue 22).	5
It seeks to identify if the PDP is in Level 5 of the CMMI (issue 25 to 27) **Answer:** No. Although with the median bigger than 4, the company is not entirely focused on the continuous improvement of process performance (answer level 3, issue 27).	5

Source: the authors.

Chart 10. Results of questions related to certification of the Company D.

QUESTIONS RELATED TO CERTIFICATION	
QUESTIONS	**ANSWERS**
Q1: Has the Quality certification?	No
Q2: When was certified and by which company?	Not certified
Q3: Intend to get a Certification? If yes, until when?	Yes, however without time limit
Q4: Does enterprise export products? If yes, how much and to which countries?	Yes, to Paraguai – covering and granulated

Source: the authors.

The company D is in the maturity level 1 and does not have the Quality Certification. The company searches for certification, but it doesn't have a deadline to accomplish that. It can be said that despite the company D presents level 1, it possesses strengths such as: operates with direct contact with clients, identifying the real necessities. However, the company presents some weakness: Lack of integration among persons involved in the PDP; Lack of training for the required abilities for design; lack of support methodologies in some design activities and lack of identification of roles of each person involved in the PDP.

4.5 Case study: company E

The company started the production in Brazil in 1971, located in Curitiba. The company has more seven branches in the south of Brazil. The company operates with 155 direct collaborators, therefore a Small Company, with activities of processing and commerce of cereals. For this survey, the data collection was carried out with Food Engineer, in charge of all processes in the Curitiba´s branch. Results obtained through the filling of questionnaire are presented in Charts 11 and 12.

Chart 12 presents the results related to the Quality Certification.

The company E is in the maturity level 1 and does not have the Quality Certification, but there is a preview of obtaining it in the next 5 years. The company does not export products to abroad. Although the company presents level 1, has strengths such as new products planning, with measurements and performance assessment, and to take corrective actions when required, supported by the Top Manager. However, the company presents some weakness: Lack of integration of persons involved in the PDP and lacks methodology for the design phase, particularly, to develop the informational design, aiming to identify the clients' requirements and to convert into the design technical requirements.

4.6 Result analysis

Among five companies surveyed, all have a low maturity level, with the processes little controllable and, in some points, unpredictable. The company C had the maturity level bigger compared to others, being able to repeat some PDP tasks, but, still is considered immature as can be seen in the Chart 13. This company is sole that has the Quality Certification. The others (companies A, D, and E) still plan to apply to get the certification and the company B still has not foresight. Regarding the products exportation,

Chart 11. Results of the questions related to the Company E.

GROUPS OF ISSUES THAT DEFINE THE MATURITY LEVELS AND ITS ANSWERS	Median
It seeks to identify if the PDP is in Level 2 of the CMMI (issue 1 to 7) **Answer:** No, the median be bigger than 4, the requirements for design have no traceability and the documents required to develop products are not controlled (answer level 2, issue 3; and level 3, issue 4).	5
It seeks to identify if the PDP is in Level 3 of the CMMI (issue 8 to 19) **Answer:** No, besides the group presented the median lower than 4, the standards processes are not established nor maintained. The integration and collaboration among persons involved in the new products development process are not stimulated. Customer needs are not identified, so there is also no translation into technical design requirements (answer level 1, issues 9, 13, 15, 16 and 18).	3
It seeks to identify if the PDP is in Level 4 of the CMMI (issue 20 to 24) **Answer:** No. Besides, the group did not present median bigger than 4, the company does not have guidelines to plan the processes quality and performance, that means, are not applied management techniques of process performance. The guidelines of quantitative quality are also not based on the clients' requirements (answer level 1, issues 20, 21 and 22).	1
It seeks to identify if the PDP is in Level 5 of the CMMI (issue 25 to 27) **Answer:** No. In spite of the median be 4 and the questions obtained are bigger or equal to 4, does not correspond to the level 5, because do not attend some previous questions.	4

Source: the authors.

Chart 12. Results of questions related to the Certification of Company E.

QUESTION RELATED TO CERTIFICATION	
QUESTIONS	**ANSWERS**
Q1: Has the Quality certification?	No
Q2: When was certified and by which company?	Not certified
Q3: Intend to get a Certification? If yes, until when?	Yes, within 5 years
Q4: Does enterprise export products? If yes, how much and to which countries?	No

Source: the authors.

companies B, C, and D export their products and companies A and E not yet.

Making an analysis-synthesis of all cases can be highlight some aspects that the companies require achieve to improve their maturity levels. In another hand, despite not presented high maturity level, companies have some aspects related to the high maturity performance (See Chart 14).

From the results obtained, it has noticed that the company A did not attain the maturity level 2 due to the metrics lack, performance assessment on planning and execution of the new products development,

Chart 13. Demonstration of results of companies analyzed.

Companies of the food Sector	Level of Maturity	Actual Certification	Perspective of Certification	Export of Products / Countries
A	1	NO	YES	NO
B	1	NO	NO	YES / Africa and Japan
C	2	YES (ISO 9001:2000/ APPCC / GMPB 2) since 2003	Has certification	YES / Europe
D	1	NO	YES	YES / Paraguay
E	1	NO	YES	NO

Source: the authors.

Chart 14. Comparison of results found in the Companies surveyed.

Company and level	Main failures in the PDP	Main Strong points in the PDP
Company A Level 1	• The company does not present metrics, measurements or assessment of planning and execution performance of the new products development process; • There is a lack of shared vision of the involved in the projects for an accompaniment of the interdependences existing in the process.	• To plan for product integrated development; • To develop required documents, such as information of projects and specifications; • To execute corrective actions when occurring process variations; • To apply methodologies to convert the clients' requirements into concepts of products.
Company B Level 1	• There is a gap in the informational design phase, related to the identification of the clients' requirements; • There is a lack of methodologies to convert the clients' requirements into product specifications.	• To have a PDP well delimited, controlled and with focus on the continuous improvement; • To utilize the Stage-Gate structure (Systematic process for the assessment at the end of each phase of the PDP); • To utilize their own design methodology, although fails on some specific points.
Company C Level 2	• There is a lack of the team integration related to the PDP; • Problems with integration activities.	• To have characterized processes, comprised, maintained, and controlled. • A well-defined and controlled PDP, with a focus on continuous improvement; • PDP processes feedback with stakeholders; • Corrective actions performed when the process variations are identified.
Company D Level 1	• There is a lack of integration among the PDP members; • There is a training lack for required abilities for the project; • There is an identification lack of roles for the PDP members.	• To work close to clients, identifying its real necessities.
Company E Level 1	• There is a lack of integration among the PDP members; • There is a lack of methodologies to convert the clients' requirements into product specifications.	• To plan for new products, with measurement and performance assessment; • To take corrective actions when required and count with the Top Management participation.

Source: the authors.

Also, it is not promoting shared vision among the involved. The company does not possess the quality certification and doesn't have a perspective to obtain in short time. For that, it would require of their weakness's improvement, besides to maintain the planning activities of product integrated development with documentation to attain the maturity level 2, necessary to get the quality certification.

The company B did not attain the maturity level 2 and does not possess the certification but expect to get it in short time. Yet, the company exports products to Africa and Japan. This exportation is directed to the countries whose not demand ISO 9001 certification, differently in case of Europe, EUA, and others. The weakness of the company B is related to the lack of identification and survey on the clients' requirements in the informational design phase to unfold in the technical requirements. In spite of, it possesses a PDP well delimited and control its design development.

Company C has a maturity level 2, has been certified since 2003 and exports its products to Europe, which shows consistency with the initially identified research hypothesis. That is, the company with better maturity has been certified for more than five years and continues to maintain its certification and export of its products. This company presented well-characterized, understood, maintained and controlled processes, well-delimited PDP, focusing on continuous improvement and feedback of PDP processes with stakeholders. Considering the weaknesses of this company, it presents failures in delivering information to the project team, in order to monitor and review the project results; in establishing and managing corrective actions to resolve critical situations in the project development; in the search for continuous improvement and in the involvement and integration of people during the project.

The company D attained maturity level 1. Their weakness related to the integration of the persons involved in the PDP. Despite not possessing the certification, the company exports its products to Paraguay and intent to get the certification in short time. In this case, Paraguay also does not demand ISO 9001 certification. In spite the company operates in direct contact with clients, identifying their real necessities, has difficulties to identify the roles of each person involved in the PDP and does not promote training for required design abilities, aspects that hinder to improve the industrial maturity and makes difficult to obtain the certification.

The company E attained maturity level 1, as does not possess certification nor export products. The company performs measurements and assessment of performance in the new products planning but faces difficulties to collect clients' requirements and does not apply a methodology for that. Besides, the processes standardization is precarious, which is little controllable and unforeseen. Thus, the company faces difficulties to repeat tasks, hinder to get the Quality certification. Despite such difficulties, the company takes corrective actions when necessary, with the Top Manager participation.

It is important to point out that the problems related to the lack measurement and control during the products and services development, lack of identification and control of the documents required to PDP, integration problems among project teams, few processes standardization, methodologies lack to convert the clients' requirements in technical specifications are common failures among companies with maturity "level 1".

Ending this survey work, it has noticed that there is a coherence between the "PDP maturity" and "Quality Certification". Companies that certified more time possess more mature processes, considering that the maturity level 2 is the minimum required for the company to present some of the requirements demanded by ISO 9001 Certification.

5 Conclusions

This survey analyzed the maturity level of the company's PDP of the food industry and identified the compatibility with the status of their Quality Certifications. When analyzing the maturity levels of the industries surveyed, this study identified the deficit points of these industries, which contributed in guiding the company to better levels of industrial maturity, as well as preparing it to achieve the ISO certification.

Among companies surveyed, all showed coherence in their results, that means, 4 companies presented the maturity level 1 and do not possess certification and those that possess the maturity level 2, had already obtained the certification in 2003 and remained stable. This shows that a company requires a minimum maturity level of to get the ISO certification and this "minimum" means "maturity level 2". The level 2 means a managed process, a company that assures that the requirements, products and services being managed appropriately, and its processes planned, executed, measured, and controlled. Beyond that, the commitments are established according to the necessities, being the products revised for the assessment of the requirements accomplishment, standards, and objectives.

It is important to highlight that the companies seek certification, for this, they prepare themselves, generating standardizations and other requirements that also influence in the opposite direction, that is, they improve because of their maturity. As the years pass and the company maintains its certification, the increased maturity of the process appears to be a consecutive development. Therefore, mature

processes facilitate certification, but certification leads to a better level of maturity.

The diagnosis supplied by the method applied showed that the companies of food industry require several improvements, among them, can be pointed out the following: support methodologies for the product design phase and team competence to work better when inserted in the multidisciplinary groups. Besides these improvements, the paper proposes that food industry searches for specialists in design, especially, in the informational design phase, including methods utilized to identify the clients' necessities and unfold in the technical requirements, differentiating the mandatory from desired requirements. Beyond that, food industry shows a lack of documents and activities standardization, making difficult some control and the achievement of Quality Certification.

It is important to highlight that this study is limited to the food sector located in Brazil but, as a suggestion for future work, it could be reproduced in other industrial sectors.

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