Recommendations for risk identification method selection according to product design and project management maturity, product innovation degree and project team

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Abstract

This paper deals with the choice of the risk identification methods in relation to maturity in product design and project processes, product innovation degree and project team. Product development projects involves risk taking, mainly in the product design phase since critical decisions are made with vague, qualitative and often insufficient information. In this context, risk management is fundamental because it deals with the project uncertainties. Risk management methods rely on risk identification. This initial process influences the results of the other risk management processes. Several methods for risk identification are available in the literature and each one has its own approach to risk identification. Product design as well as project processes systematization level is fundamental to the successful implementation of some risk identification methods.

The essence of product innovation is to create or establish something new. However, different product innovation degrees demand different risk identification methods. The more innovative the product, the greater the need for methods that motivate risk identification. The project team plays an important role in the risk identification. They are the people most qualified to identify the risks. However, depending on the characteristics of the risk identification method to be used, more or less of the project team knowledge and involvement are needed. Therefore, the type of risk identification method selected depends strongly on the product design and project maturity levels, product innovation degree and project team. In this paper, a maturity model for the product design and project management as well as a typology for risk identification methods are presented. Some recommendations for the choice of risk identification method, considering the product design process and project management maturity, product innovation and project team, are then proposed. To conclude, the need for a new risk management methodology is discussed.

Keywords*: risk identification, maturity, product innovation and project team.*

Introduction

New product development (NPD) is an important activity for companies, due to high competitiveness and customer requirement. However, product innovation is extremely complex and involves implementation of product development practices, as well as project management activities.

Despite the broad adoption of project management (PM) tools and practices across different industries, companies are often confused or uncertain, and have difficulties locating their current level of application of project management (Kwak and Ibbs, 2002). The same occurs with the NPD practices. Difficulties resulting from a lack of understanding of concepts and methods relative to product design and PM, on the part of the project team are common (Lyons and Skitmore, 2004; Cooper, 2003). In this regard, the project maturity level may be used as a measure of the company's ability to use NPD and PM practices (Andersen and Jessen, 2003). Many maturity models are proposed in the literature to assess and improve, step by step, a company's processes and practices (Fraser, Moultrie and Gregory, 2002).

Product development projects are rarely executed as planned (Ulrich and Eppinger (1995); Vargas (2002); Deyst (2002). This is partly due to the existence of risks, mainly in the initial phases of the product design which commonly involve vague, qualitative and often insufficient information (Ferreira and Ogliari, 2005). All product development projects carry uncertainty and risk. Risk can never be eliminated entirely but it can be actively managed and resolved (Coppendale, 1995). In this context, risk management in product design and PM processes are fundamental to reaching project objectives. A failure in one of these processes implies that they are identified as well as in some way formalized. Project formalization is, therefore a prerequisite to risk management in projects (Gidel and Zonghero, v.2, 2006).

The first process of risk management is risk identification. It is a very important process because it will influence all of those which follow. Several methods are presented in the literature for risk identification. Each one presents different characteristics with regard to complexity, need for expertise, etc.

Project innovation degree is also a decisive factor in risk identification. Risk is an essential characteristic of product innovation. Innovative projects require that the project team make some assumptions based on incomplete information (Cooper, 2003; Smith and Merritt, 2002). Such a situation carries additional elements of risk and the more innovative the product the greater the risks.

The quality and the success of a project depend on the people involved in it (ISO 10006, 2006). The project is carried out by a team, and each team member must be helpful to the group, sharing the project risks and successes (Gidel and Zonghero, v.1, 2006).

In the risk identification, the people involved in the product design play a fundamental role, because these are the people most qualified to identify what can go wrong due their competences. However, the need for the project team experience and knowledge varies according to the characteristics of each risk identification method. Thus, it is essential to consider the profile of the project team in the choice of the risk identification method.

This paper present some recommendations for the choice of risk identification methods according to the product design process and project management maturity levels, also taking into consideration the product innovation degree and project team. This information will allow companies to choose the most appropriate risk identification method, according to their current situation, as well as facilitate its application.

Selection criteria for the choice of the risk identification method

No method can guarantee that everything will go to plan. However, a formal process or mandatory procedures for managing risk will dramatically reduce the likelihood that something unexpected will cause serious problems on a project (Coppendale, 1995). Analyzing the various risk identification methods shows that these methods require different product design processes and PM maturity levels.

The maturity concept is related to the notion of development from some initial state to some more advanced state (Fraser, Moultrie and Gregory, 2002). Implicit in this, is the notion of evolution, suggesting that the subject, in this case the product design and PM, may pass through a number of intermediate states on the way to maturity. Different maturity models have been developed. They propose a systematic and incremental approach from an unsophisticated level to a sophisticated maturity level (Kwak and Ibbs, 2002).

Maturity approaches have their roots in the field of quality management. One of the first Crosby's Quality Management Maturity Grid (Fraser, Moultrie and Gregory, 2002). Perhaps the best tool derived from this approach is the Capability Maturity Model (CMM) developed by the Software Engineering Institute - Carnegie Mellon University, Pittsburgh which has conducted extensive research on improving of the quality of the software development process (Fraser et al., 2002; Dooley et al., 2001).

The CMM concept – of the maturity divided into levels, where the last one is a condition of continuous learning and improvement – inspired the development of other models such as that developed by Rozenfeld et al. (2006) destined for the study of NPD maturity, as well as the Project Management Process Maturity $(PM)^2$ Model level (Kwak and Ibbs, 2002). To evaluate the maturity of both product design and PM we decided to use a combination of those two models level (Kwak and Ibbs, 2002; Rozenfeld et al., 2006). They summarize the characteristics found in most of the maturity models adapted to product design and project management.

The model proposed by Rozenfeld et al. (2006) is represented in Table 1, in the second column called *Product Design*. This model is subdivided into five maturity levels in which the following dimensions are considered: whether the activity has been accomplished, whether the company uses appropriated methods or tools and at which stage the company lies in the incremental evolution level. The $(PM)^2$ Model is also represented in Table 1, but in the three last columns called *Project Management* (Key PM Processes, Key Focus areas and Organizational) also distributed across five levels of maturity.

After evaluating its maturity level, the company should define which is the new maturity level to be reached. This evolutionary process of maturity increment is not linear, but cyclical, because it is always necessary to apply the following stages: understand the improvement motivation, analyze the current situation, define actions and implant them in the search for the evolution Rozenfeld et al., 2006.

Table 1. Maturity Models adopted.

Maturity level	PRODUCT DESIGN (Rozenfeld et al.,2006)	PROJECT MANAGEMENT – (PM)^2 (Kwak and Ibbs, 2002)		
		Key PM Processes	**Key Focus areas**	**Organizational**
Level 5	Transformation cycle of the product design process integrated into the cycle of incremental improvement, the change management and the project planning.	PM processes are continuously improved PM processes are fully understood PM data are optimized and sustained	Innovative ideas to improve PM processes and practices	Project-driven organization Dynamic, energetic, and fluid organization Continuous improvement of PM processes and practices
Level 4	Control of all activities with a base in the indicators and actions is integrated into the processes of the changes management and incremental improvement. The management of the critical parameters and robust project is applied (Tagushi Method)	Multiple PM program management PM data and processes are integrated PM processes data are quantitatively analyzed, measured and stored	Planning and controlling multiple projects in a professional matter	Strong teamwork Formal PM training for project team
Level 3	There are performance indicators of all activities.	Formal project planning and control systems are managed Formal PM data are managed	Systematic and structured project planning and control for individual projects.[	Team oriented (medium) Informal training of PM skills and practices
Level 2	Use of functional modeling, definition of principle solutions, DFx, alternative conceptions, application of QFD. Application of FMEA, CAE, integration supply chain and specification of the production process and assembly, use of CAPP and PDM.	Informal PM processes are defined Informal PM problems are identified Informal PM data are collected	Individual project planning	Team oriented (weak) Organizations possess strengths in doing similar work
Level 1	Definition of requirements in a non systematic way, conception, structures, drawings, use of CAD, product requirements, analyzes life cycle analysis, process macro planning, talks with suppliers. Adoption of simple approval of phases (gates).	No PM processes or practices are consistently available No PM data are consistently collected or analyzed	Understand and establish basic PM processes	Functionally isolated Lack of senior management support Project success depends on individual efforts

The (PM)[2] Model breaks down PM processes and practices into nine PM knowledge areas (integration, scope, time, cost, quality, human resources, communications, risk and procurement) and five PM processes (Initiating, Planning, Executing, Monitoring and Controlling and Closing) by adopting the PMI's PM Body of Knowledge (Kwak and Ibbs, 2002; PMI, 2004). According to the authors this allows a company to determine the strengths and weaknesses of current PM practices and focus on the weak one to achieve higher PM maturity using a systematic and incremental approach. Thus, each PM maturity level contains key PM processes, focus areas and company characteristics.

No other type of project is in greater need of risk management than product development projects (Smith and Merritt, 2002). This is due, largely, to the innovative[1] profile of such projects and, consequently, of the involved risks. Therefore, it is known that the presence of risks is a characteristic inherent to innovation. Thus, the product innovation criteria assume a fundamental role in the choice of the risk identification method to be used in product design. In this paper, the product innovation classification model that will be used is that proposed by Pahl et al. (2005), presented in Table 2.

The essence of product innovation is to create or establish something new. Since this process necessarily involves risk, innovative companies require a strategy not of risk avoidance, but of early risk identification and management (Keizer et al., 2002). Generally, the greater the product innovation degree, the greater the time or effort needed to develop the product and the higher the research costs. Thus, the adoption of risk identification methods is fundamental.

The project team also plays a very important role in the NPD risk management. The project team members, though their work, behavior, organizational interaction and imperfections, are one of the greatest sources of uncertainty and risk in any NPD. But at the same time they are also one of the most important resources for reducing risks due to their competence and experience (Skelton and Thamhain, 2003).

Therefore, the team members should be involved in the risk management processes, because these are the people most qualified to identify, analyze, respond to and control the risks. However, depending on the characteristics of the risk identification method used, more or less of the project team knowledge and time are needed.

Table 2. Degree of product originality (Pahl et al., 2005)

Project Type	Characteristics
Innovative	New tasks or problems are assisted by a new principle solution or a new combination of a family of principle solutions. It is worth pointing out the difference between invention that is truly treated of a discovery that is often based on the application of new scientific knowledge. With innovation, new functions and new characteristics of a product are materialized. This can occur perfectly through a recombination of a family of solutions.
Adaptable	The principle solution is preserved and only the configuration is adapted to the new peripheral conditions.
Alternative	The size and/or the arrangement of components or subgroups is varied, which is typical of series constructive and/or modular systems.

[1] In this text, innovation is understood as the degree of product originality

In this regard, the recommendations for the selection of the risk identification method, in product design, will be based on the three criteria presented above: product design and project management maturity levels, product innovation degree and project team. However, a typology for risk identification methods will first be presented, which will be used later.

Typology of risk identification methods

Risk management follows, generally, four major processes: risk identification, risk evaluation, risk response and risk control. The main differences between the risk management methods are the risk identification and risk evaluation processes (Chapman, 1998; Verdoux, 2006). These two phases are decisive because they lead to the decision and implementation of preventive and/or corrective actions. The literature reports several risk management methods specific to these processes. We are particularly interested in the risk identification methods, since risk management relies on risk identification. Gidel and Zonghero (v.1, 2006) present a typology for risk identification methods according to three approaches: analogical, heuristic and analytical.

The analogical approach is based mainly on the experience acquired in the management of previous and similar projects. Since this experience has been formalized, it is possible to proceed through comparison using, for instance, checklists. An advantage of this approach is that its application is usually fast and simple. A disadvantage is that the project team may focus on the checklist and forget to explore other risks that are not present on the list.

The heuristic approach consists of the use the project team creativity and/or expertise, for example, through a brainstorming meeting with specialists. This approach is efficient in terms of risk identification, since it is applied following strict rules and principles. For instance, the right expert must be selected and involved to insure their active participation. This approach allows an enhancement of the project team's ability to visualize the risks which they may encounter and to incorporate this culture into the company. This is extremely important, since the risk management motivates the company to visualize the future and try to predict what may go wrong (Kerzner, 2002). It is recommended to include in the session internal specialists as: commercial manager, R&D manager and even the main partners as well as the project team (Gidel and Zonghero, v.1, 2006).

Finally, the analytic approach is the most known and currently used in the industry for the study of technical risks (Gidel and Zonghero, v.1, 2006). This approach is based on the Failure Mode and Effects Analysis (FMEA) method, an item of the norm NF X 60-510 that gives procedures applicable to PM. In this method, the analysis is focused on the project processes, having identified the failure possibilities, the internal or external causes of failures and imperfection, and their effect on the output elements (that frequent constitute the input elements of the next process).

The FMEA method has the advantage of proposing an exhaustive approach, however this advantage causes a relatively heavy application that frequently needs the use of a computer science application for the data processing. Another limitation of this method is that it does not allow the study of the failure combinations (Courtot, 1996).

Ferreira and Ogliari (2005) present an extensive list of methods that can be used in risk identification in product development projects, and some of them are grouped according to the classification proposed by Gidel and Zonghero (v.1, 2006) in Table 3.

It is worth pointing out that, although each method is classified into a specific approach, it can, and frequently does, present characteristics of another approach. For example, the checklist approach must be associated with creativity techniques, since each project is unique. Herein, we classify the methods according to the predominant approach.

Recommendations for risk identification method selection according to the product design process and project management maturity, product innovation degree and project team

Based on the risk identification method typology above, we present some recommendations on which one to use according to three criteria: maturity level, product innovation degree and project team (Table 4).

For the correct implementation of the analogical methods, the level of product design and PM maturity recommended corresponds to at least level 3. Although the application of the analogical methods is fast and easy, they consist of a systematic and wide form of risk identifying that needs formalized information about the product design and project management for their elaboration or expansion (Riek, 2001).

In relation to the product originality level, the analogical approach is more appropriate for alternative and adaptable projects, since the methods that use these approaches are based on experience and comparison with previous projects (Smith and Merritt, 2002; Riek, 2001). For instance, checklists present a list of standardized risks and thus their application is more appropriate for projects that have similar characteristics, that is, alternative and adaptable projects.

Having examined fifteen case histories of risk management in NPD, Riek (2001) suggested that the project teams should be cautious in the use of the methods that follow this approach, no matter how well they have been developed. They can aid in avoiding simple oversights, but must be used in a discussion mode to assure that analogous or related items are identified. Therefore, these approaches can be used as a starting point and must be customized for each project.

In the analogical approach, it seems that the project manager's responsibility is simplified. Also, it is essential to reflect on potential events that are not present in the methods, but could appear. The main drawback with regard to this approach is that the project manager may be comforted by a false security and reduce the monitoring of the new risks (WEKA, 1999). The application time that the analogical approach requires for its adequate application is shorter when compared to the other approaches, because the simplicity of the methods.

Table 3. Classification of the risk identification methods

Analogical approach	Heuristic approach	Analytic approach
Checklist	Brainstorming	FMEA
Analogical comparison	Delphi Method	Fault Tree
Risk category	SWOT	

Table 4 - Classification of the risk identification approach for the selection of the methods

CRITERIA / TYPOLOGY	PRODUC DESIGN AND PM MATURITY	PRODUCT INNOVATION	PROJECT TEAM
ANALOGICAL	3+	Adaptable/Alternative	+
HEURISTIC	1+	Innovative/ Adaptable	++
ANALYTIC	3+ Product design and $(PM)^2$ - Key PM Processes and Focus Areas	Innovative	+++
	4+ $(PM)^2$ - Organizational		
+++: very important ++: important +: less important			

The analogical approach complemented of the cumulative experience of the project team it is a great aid to inexperienced project team leaders. The use of the team's experience in combination with the checklist items to remind its members of the types of issues that may arise is recommended (Riek, 2001).

As the heuristic approach is based on the exploitation of the participants' creativity for the identification of the maximum possible risks, the level of maturity advisable for the successful application of these methods is level 1, since it is thus assured that all the project team members have understood the product design problem and are familiarized with the project context. This approach is best used when a problem is well defined, the major issues involved in the problem have already been identified and there is no need to explore the problem further. It is also important to consider basic rules for the successful application of this approach. In the case of the brainstorming method an essential condition is that in the risk identification meetings it is not recommended that the risks be quantified and measures defined to minimize them simultaneously. Not only would this lead to more time being spent, but significant risks could be discarded precipitately (Riek, 2001).

The heuristic approach is more suitable for innovative and adaptable projects. These project types require the stimulation of the project team to identify new risks, mainly in the case of the innovative projects due to their high degree of originality in terms of product, project management etc. For instance, brainstorming sessions are an effective way of channeling natural creativity into identifying what can go wrong on the project. One person's idea can trigger someone else's (Coppendale, 1995).

As the base of the heuristic approach is concentrated on the identification of a great amount of risks, without initially being concerned whether they are pertinent to the project, the presence of specialists who are sufficiently creative is fundamental to obtaining good results. The person who leads the process, the project manager or an external facilitator, must maintain a neutral position in relation to the ideas that are generated and questionnaires that are elaborated, in order to avoid that certain tendencies are privileged (Riek, 2001).

Particular attention must be paid to the constitution of the project team that will be involved in the risk identification, mainly, when the brainstorming and SWOT methods are adopted. The presence of members who possess certain prestige or authority can prevent the generation of certain ideas through diverting them. In such cases, it is recommended that these specialists are consulted separately. For the brainstorming method, the size of the group will have a direct impact on the quality of the data obtained (Chapman, 1998). The maximum number of specialist recommended in a brainstorming session is 6 and a session should last a maximum 3 or 4 hours (Riek, 2001). The same can be extended to the SWOT method since this also includes the generation of other items such as opportunities and weaknesses, and it can become tiring. One way to prevent these group effects is to collect potential risk factors individually from each member and then evaluate these factors the same way (Keizer et al., 2002). The method Delphi also involves specialists but they are consulted individually so that hierarchies and individual reputations do not affect the application of the method. Here, the number of specialists does not matter since the company can manage the information which is generated. This method requires more work from the facilitator and much more time than the other two methods (brainstorming and SWOT) due to the great volume of information that can be generate (Chapman, 1998). Depending on the importance of the project to the company, it may not be possible to pass on many details of the project to external specialists. This can result in superficial and limited risk identification. On the other hand, it is less common for companies of today to perform all of their critical development activities in-house. Alliances of some form or another are created to fill competency gaps deemed absolutely critical to the success of the project, yet not available in-house (McDermott and O' Connor, 2002). The project partners must participate in the Delphi session. They are the people most suitable to identify the risks and to reduce them with less information restrictions since all of them have an interest in the project success.

For the analytic approach it is recommended that the maturity level of the product design and PM (Key PM processes and Key focus areas) is equivalent to at least level 3. The higher the maturity level of the company in relation to the product design and PM, the better will be the results of the elaboration and application of the analytical approach. The volume of information generated by the methods which use this approach requires that the company is in a situation to manage it. Also, often the project team needs to analyze in details the project planning and the product design process to define more adequately the types of failures that can occur, the effects and possible causes of failures, in the case of FMEA. Thus, a structured product design process and formal project planning are essential.

The FMEA method is based on team work as well as on each member obtaining experience (Verdoux, 2006). During its whole application it is necessary to strictly delimit the topic under study. Sometimes it is a difficult phase, but it is essential for the success of the project. The same can be expanded to the other methods which use this approach.

The analytic approach is very appropriate for innovative projects, because this type of project presents a lot of new situations, with associated risks, which must be identified and analyzed in details.

With regard to the project team, the analytical approach needs a minimum of experience to develop, for instance, the failure tree, as well as specialists from different domains of the project to identify the failure modes, causes, etc (Courtot, 1996). Maturity level 4 for the criterion project team is the most adequate, which suggests strong teamwork as well as formal PM training of the project team. To achieve success in the application of the methods it is essential that the project manager or facilitator has an excellent knowledge of the methods that use this approach, and it is very important that the project team understands the procedures that form the methods. Experience is not always a prerequisite for this approach. Experienced project teams may feel blocked in the identification of new risks. Moreover, it may be that in their perception they dominate the project and see no risks related to the project. The application time for this approach is much longer than that of the others, because of its complexity.

Discussion and conclusions

This paper will allow companies to place themselves in relation to the selection of the most appropriate risk identification approach considering the product design and project management maturity levels, product innovation degree and project team. The application of a risk identification approach tends to become simpler, since the company will adopt the method that it has more capacity to implement, in other words, the method which is most viable for the organization to adopt.

Through the appropriate selection of the risk identification approach and considering the procedures outlined above, it is hoped that companies will increase the quantity and quality of risks which are identified, as well as develop a pro-active culture within the company

However, the continuous improvement of the company global performance should be a permanent objective. The company must search for the continuous improvement of the processes. With regard to the risk identification approach adopted, the company must constantly evaluate it and verify whether it is consistent with the needs of the product design and project management processes, as well as the project team expectations. If this is not the case, another approach which the company is in a situation to apply, must be adopted.

The results of this study provide insights into some common procedures that must be adopted during the implementation of the risk identification independent of the product design and project management maturity levels, the product innovation degree and the project team.

The people involved in the risk identification must have a clear and objective understanding of the design problem and project context. In addition, the risk management relies on the competence of specialist related to the methods to be used, in order to apply then correctly (Gidel and Zonghero, 2006; Verdoux, 2006) regardless of the complexity level. An outside risk facilitator has the advantage of relative independence and freedom from bias. Project team members will be more likely to reveal their worries to such a facilitator. The responsibility for the risk identification and the other processes, however, should remain with the project leader (Keizer et al., 2002).

However, the specialist in the method cannot diagnose the project risks in an isolated way. It is indispensable to work in a team, following a method, to identify and to deal with the project risks. The objective is to obtain a result from the project team competences, regardless of the approach that is used. In this regard, it is fundamental that the project team also receives training on the method to be used. A properly qualified and configured team can make more precise and opportune decisions in relation to risk identification.

The project team sensitization in relation to the importance of the risk identification is also a factor essential for the project team learning and gaining of knowledge within the company. The experience and knowledge capitalization is made through the formalization of specific documents, such as, lists of identified risks, risk management plan and reports that assure the use of the acquired experience in future projects (Verdoux, 2006). In this way, for each project it is possible to extract lessons that represent an improvement in the NPD and in the identification, analysis, response to and control of the project risks.

This paper highlights a number of important issues regarding the nature of the risk identification approach selection. More research in this area has been developed.

Ferreira and Ogliari (2005) proposes a risk management methodology that includes the identification, analysis, risk response planning and risk control applied to the activities of the product design process. However, it was identified that there is a need to first define principles with relation to the product design and project management to be adopted by the company for the successful implementation not only of the risk identification process but also of the other risk management processes.

Subjects of importance are the specialists' involvement in each risk management process, formalization of the product design and project management, definition of the company's tolerance of the risks, guidelines for effective communication in the risk management process and a pro-active attitude are discussed and defined considering all the processes of the risk management, not only the risk identification process.

Through the consideration of these principals, companies are provided with an infrastructure that will make the risk management processes more structured and applicable. Incipient companies will also be in a situation to have conditions of implement not only the risk identification but the other processes of the risk management in their product development projects.

Recently, Ferreira and Ogliari (2005) defined recommendations of how to identify new risks in the product design activities. Also, the risks related to the results of each product design phase, the risks of passing to the next phase and the project management risks, including the areas of knowledge of the Project Management Institute (PMI, 2004), are considered. Through this methodology it is intended to promote conditions within the company whereby it can identify risks, even when the project team does not have experience in managing risks in the product design process. This methodology is also recommended for innovative projects because it deals with of how to identify new risks, and which aspects should be addressed in the consideration of each activity of the product design to identify new risks.

It is recommended that interactions between the different risks are considered (ISO 10006, 2006) and little previous work has examined the relations between risks (Ferreira and Ogliari, 2005). In the risk identification the use of the DSM – Design Structure Matrix is proposed to identify the relations between such risks, in other words, to identify possible combinations of the product design activity risks. The advantage of this method is the possibility to study the risk interactions and connect the technical and project management risks related to each activity, since a risk never exists in isolation, and thus the cause and effect relationships are identified (Ferreira and Ogliari, 2005).

The risks are then analyzed by the intermediary of the Bayesian nets that allow the analysis of united probabilities providing a more accurate and detailed information base for the decision-making. With the Bayesian nets it is possible to identify the relationships of cause and effect between variables. This is an important aspect in the product design due to the great number of relationships of interdependences between activities and phases.

In the risk response, planning guidelines are presented for the development of actions for the risks identified and analyzed. The objective is to help the project team to elaborate strategies for each new risk.

Finally, in the risk control process essential information is stored for the monitoring of the risks throughout the project. The creation of a system to register and analyze the information of the project is recommended. This information system must not only be used for monitoring and control of the risks but also for the continuous improvement of the risk management.

This risk methodology will give support to companies in the implementation of risk management processes in the product design process. With its adoption it will be possible to integrate the product design process and risk management; develop a favorable environment for the application of the risk management processes; identify and analyze the risks considering their dependence relations as well as causes and effects and finally predict the possibility of a project failure taking into consideration the current and future conditions.

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