PRODUCTION
PRODUÇÃO

Risk management for companies focused on innovation processes

Ana Paula Beck da Silva Etges[a]*, Joana Siqueira de Souza[a], Francisco José Kliemann Neto[a]
[a]Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil
*anaetges@producao.ufrgs.br

Abstract

Risk is inherent to the activities of technology and innovation companies and to manage them represent an opportunity to improve the company capability to achieve its goals. The use of ERM models has been studied since the Committee of Sponsoring Organizations of the Treadway Commission guides. This article adapted the MIGGRI model for the context of an innovation company from a TSP in Brazil. Using a case study and a review from previous ERM literature, the article show that is possible to measure the risks that an innovation company faces, and that they may be managed with a view to supporting a company's strategy. Were applied an economic analysis based on a MCS and an indicator of CFaR were applied to measure innovation risks. A strategic performance model for innovation companies are proposed and the benefit to implement Risk Management practices in innovation organizations was validated.

Keywords

Enterprise Risk Management. Monte Carlo Simulation. Economic risk analysis. Innovation management. Strategic performance.

How to cite this article: Etges, A. P. B. S., Souza, J. S., & Kleimann Neto, F. J. (2017). Risk management for companies focused on innovation processes. *Production*, *27*, e20162209. http://dx.doi.org/10.1590/0103-6513.220916

1. Introduction

The market of development of technology and innovation has been seen to be gaining, year-by-year a greater and greater share of the US economy, its differential in relation to the industry being the fact that it consists of a large volume of small companies (Trott, 2012). This country, together with others with a more developed economy, has a great deal of research related to this topic, while the volume of such studies in developing countries is limited (Nagano et al., 2014).

In the Brazilian context, the market of innovative companies has been growing at a quickening pace (Nanda & Rhodes-Kropf, 1999; Nagano et al., 2014) and consequently Brazil is recognized as the Latin American country in which technology and innovation companies have developed most (Viana, 2012). One factor that has brought about this classification being a viable statement is that Brazil has innovation environments or Technological and Scientific Parks (TSP), which are easily related to the capability of transforming innovation into business opportunities (Giugliani, 2012). This tendency to develop environments conducive to innovation can be explained by the contribution made by Lazzari et al. (2014) and Tu et al. (2014), who concluded that the financial performance of companies try to push innovation is greater than those that do not invest in this area. However, they subject themselves to dealing with uncertainties vis-à-vis the consumer market that they will cover (Mortimer, 1995).

Due to the swift advance of this market as well as the volume of businesses regarded as innovatory, there is high degree of uncertainty about the internal evolution factors of development of innovative business, and external (macroeconomic and market issues) which stresses the real challenge inherent in the process to manage innovation (Bessant, 2003; Mortimer, 1995; Viana, 2012; Nagano et al., 2014). The uncertainty mentioned has been present ever since innovative companies were formed, which therefore sees to it that the activity of

analyzing and managing risks is part of innovation management (Garcia & Calantone, 2002; Bessant, 2003; Canongia et al., 2004; Hauser et al., 2006; Wong & Chin, 2007; Nagano et al., 2014).

Some models have been developed which seeking to bring into effect Management of corporate Risks. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) proposed steps for managing and controlling the risks related to a company making full use of the concept of Enterprise Risk Management (ERM). This enables all the risks to which the company is exposed to be seen (Committee of Sponsoring Organizations of the Treadway Commission, 2007). Similarly, ISO 31000 which was published in 2009 also focused on structuring the Risk Management process (International Organization for Standardization, 2009). Souza (2011), based on previous models, put forward the Model for Identifying and Managing the Degree of Risk in Companies (MIGGRI, in Portuguese). This differed from its predecessors because it linked tools that make achieving this goal viable to the steps proposed for Managing Corporate Risks. At the same time, the model is still restricted to being applied in only one large civil construction company, although the author recommended that it be applied in other industrial sectors. Therefore, what stand out is the absence of models which cover the level of corporate risk management in innovative and technology companies (Bandyopadhyay et al., 2006), all that is found in the literature being models that seek to analyze risk of concern to Information Technology projects, such as Original Spiral Model, ProRisk, Riskit, or to project management: SERIM, SRAM, BRisk and OBRiM (Miorando, 2010).

Crossan & Apaydin (2010) discuss the need for in-depth studies that succeed in analyzing, using monetary measurement, the impact of innovation corporately on financial performance in innovative enterprises. There is a noticeable a gap in the literature and in practice in the context of innovation: a market of companies exposed to risks due to high uncertainty and the lack of appropriate methodologies for small innovative companies present in Science and Technology Parks (TSP). This lack start a necessity to research and develop methodologies that can be used by small innovative companies to improve its performance. Small innovative companies must receive this research attention in function of the high risk and uncertainty exposure that this market represent and those risks impact that can affect its financial structure.

Considering this context, this research start to look for the answer: How innovation companies from Brazil can use and apply ERM? What is therefore set as the main objective of this study is to apply MIGGRI to the context of a company located in an incubator of a TSP which has a wide impact throughout Brazil. The specific goal is to analyze the possibility of linking the model applied to the strategic management of the company.

Achieving those objectives, this research helps to turn clearer for entrepreneurships and innovative employees risk management model implementation practices. The traditional risk management models, started in the financial market, are translated in an operational and practical language to orient its implementation by different employees. In addition, the academy receives a new approach for risk management, valuing its application in other business environments.

Among the limitations of the study, the lack of statistical tools based on historical data stands out. This is due to the thinness of the database in the company analyzed and to the proposal of adaptation as a prototype model since this study will be based on only one practical example. It is believed that to validate a generic model of Risk Management for innovative companies, the application needs to be extended to a larger number of companies.

This paper is fragmented in five sections. During the first, the research problem, the theme and objectives were presented. The next section presents the theoretical background, followed by the methodology. The results were presented fourth section and, at the end, we have the conclusions and limitations.

2. Theoretical background

The theoretical framework of this study breaks down into innovation concepts and their relationship with risk management, how the MIGGRI model is detailed and the importance of assessing Risk in innovation environments.

2.1. Innovation and risk management models

The concept of innovation has been approached in different ways in the literature (Crossan & Apaydin, 2010). Hansen & Wakonen (1997) conceptualize innovation as something new: a new asset or a new process. Pittaway et al. (2004) translate innovation into a need that companies have, or as an obstacle to sustained growth (Yang, 2012). With regard to the economic approach, Freeman & Soete (2008) translate innovation into a new combination of reources that affects commercialization.

How the literature has explored the theme of innovation has been expanding in recent years (Hauser et al., 2006; Crossan & Apaydin, 2010); however, Crossan & Apaydin (2010), after having made a search and found approximately 13,000 articles, of which they, effectively, analyzed 525, emphasize that, among their results, only 9% of the studies include an economic analysis of innovation. This can be justified because of the existing difficult in measure the creation of value based on innovation (Crossan & Apaydin, 2010). Therefore, an innovative product can be seen as a technological development that holds out a commercial opportunity, which prompts the need for an innovative organization to be efficiently connected to external markets (Nagano et al., 2014), given that whenever a company markets an innovative product, an increment is added to the consumer market (O'Connor et al., 2008).

Regarding the complexity inherent in this segment, it is considered that the success of innovative business depends invariably on its acceptance by consumers, it being necessary for the target consumer market to be at a level of demanding innovations. In other words, the consumer must have a culture that wishes what is new and different, so that companies can achieve the result desired in their projects (Hauser et al., 2006). There is a noticeably extensive challenge associated with managing innovative businesses, which extends strongly to the external environment, thereby increasing the level of uncertainty associated with this market (Bessant, 2003; Nagano et al., 2014).

Having accepted that uncertainty is inherent in the innovation environment, and given the definition proposed in NBR 31000, in which risk is conceptualized as the effect of uncertainty on objects, uncertainty being the state of the shortfall in information related to an event (International Organization for Standardization, 2009), the presence of risk in innovative enterprises is confirmed. The analysis and management of such risks can be translated into activities that aim to assist the capacity of such companies to anticipate how they will deal with the uncertain environment of the market analyzed, by fostering actions that may well come to contribute to the company's bottom line (Mortimer, 1995). O'Connor et al. (2008) indicate that the advance of innovations demands that companies be encouraged to deal systematically with the risks to which they are exposed, with a view to reconciling the high degree of uncertainty and dynamic and flexible environments that enables innovation to make successful advances.

The Risk Management process aims to help companies analyze their risks. Risk Management, in a synthetic way, the guides companies on how to take correct attitudes about which risks they must face up to, which they should ignore, which need to be hedged or eliminated and which should be exploited in order to maximize the organization's performance (Damodaran, 2009). Frigo & Anderson (2011) stress the importance of making Risk Management fit for purpose and analyzing it at the corporate level. They point out that when it is applied only in order to analyze the feasibility of projects, it only gives an individual analysis and thus does not represent the generic panorama of the exposure of company's business to risks. As pointed out in the introduction of this article, there is a shortage of Risk Management models at this level of coverage in the market of innovative companies.

The time between the emergence of an innovative idea and product launch itself becomes another factor that throws the importance of Risk Management into relief. This is because the importance of the risk element is directly related to the length of the project element (Kliemann, 2010). The importance of considering the time difference between the conception of the idea and a new development actually being launched in the market has become an important and motivating issue as to using analytical practices and Risk Management (Damodaran, 2009). Among the main models of Risk Management, on which structuring the MIGGRI model is based, are the COSO methodology (Committee of Sponsoring Organizations of the Treadway Commission, 2007), PMBOK (Project Management Institute, 2008) and the standards AS/NZS 4360 (Standards Association of Australia, 1999) and ISO 31000 (International Organization for Standardization, 2009), from Australia and Brazil respectively.

What COSO methodology (Committee of Sponsoring Organizations of the Treadway Commission, 2007) sets out to add to the Risk Management process is a focus on the corporate risks of organizations. It is defined as a process which is applied to the company's strategy and which sets out to identify events with the potential to affect its enterprises and gave rise to the concept of Enterprise Risk Management (ERM). To achieve this objective, COSO put forward a new system of Risk Management that makes use of ERM as an essential tool for creating and preserving the business value of companies (Hayne & Free, 2014). ERM can be defined as a structure that enables all the risks to which an organization is exposed to be viewed, including risks at the corporate level risks and for each business unit by using an ordered framework and proposes that risk management be integrated, continuous and systematic. The Brazilian standard for Risk Management, NBR ISO 31000: 2009, based on ERM and the earlier Australian Standard AS/NZS 4360 (Standards Association of Australia, 1999), seeks to assist the development of continuous and systematic control processes and Risk Management in organizations.

The methodology present in PMBoK – the Project Management Body of Knowledge - discusses how to structure a management process based on the management of risks, priority being given to projects (Project Management Institute, 2008). Despite the widespread application of PMBoK between companies, some researchers criticize it due to the absence of the concept of how value flows to a project (Koskela & Howell, 2002). These authors conclude that non-traditional project management methods, which consider the flow of activities that do not add value in their plan, unlike that of PMBoK, already applied to the software and the construction industry, can significantly reduce risks because they allow possibility of working with uncertainty as it emerges throughout a project.

2.2. Model for identifying and managing companies' degree of risk

The introduction of the concept of corporate Risk Management prompted the advance of a new degree of coverage in the literature on and the practice of risk management which hitherto had been restricted to the level of projects (Hayne & Free, 2014). Souza (2011) sought to deepen the concept and the existing methodologies, by proposing tools that were appropriate for implementing a systematic approach to risk management at the corporate level.

To do so, she sought a theoretical foundation in the literature so as to be able to give a detailed account of each stage of the model. Among the main differentials vis-à-vis what had already been proposed, what stands out is that MIGGRI, on using the tools she suggests, enables a global indicator of risk into which the company fits to be generated. This takes the impact of quantitative and qualitative risks on it into consideration. In addition, the model proposes that a cross-check be made on the degree of risk to which the company is exposed and the desired degree of exposure that it should reach, in accordance with the risk profile into which the company fits. The steps proposed in the MIGGRI model are shown in Figure 1.

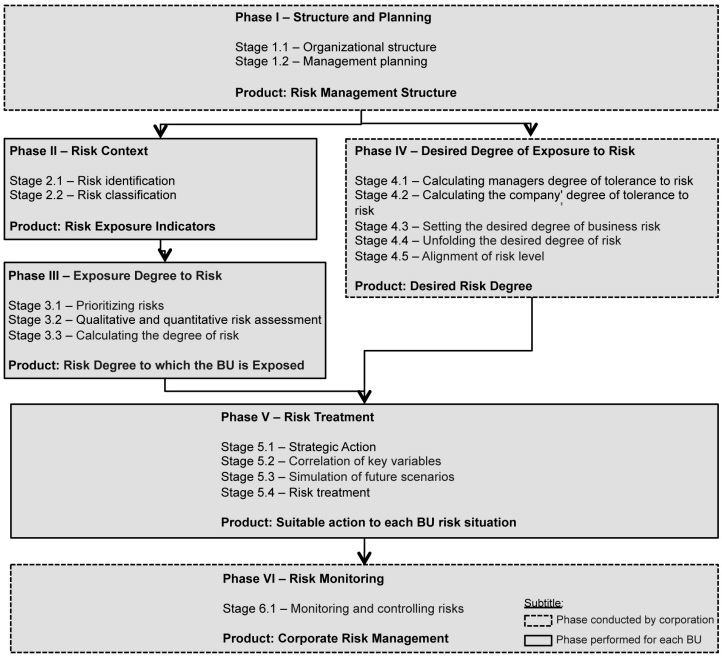

Figure 1. Phases, Stages and Products from MIGGRI model. Source: Adapted from Souza (2011).

Among her recommendations for using the model with excellence, based on experiences of other authors and on the preliminary application of MIGGRI, Souza (2011) recommends structuring a directorate of risks in order to facilitate implementing the concepts of the Management of Corporate Risks in a company. On adapting the model to the context of smaller companies, it is known that is not feasible for such a company to make a professional of this order available because of the impact on cash flow. Thus, it is fundamental that the managers

of small companies have a thorough knowledge of financial and economic analysis, besides strategic vision for the company. This knowledge is needed with greater intensity in the phases to do with calculating the Degree of Exposure to Risk and the Desired Degree of Exposure to Risk, which require a Monte Carlo Simulation (MCS) to be used.

The MCS enables finding the distribution of values that best describes the behavior of the data being analyzed (Jorion, 2010), and takes hundreds of scenarios into consideration in such analysis, which is limited in methods such as scenario analysis and decision trees. Moreover, among the indicators that can be calculated based on their response is Cash Flow at Risk (CFaR), or cash flow at investment risk. The usefulness of this indicator is assured by the fact that it succeeds in measuring the potential gain or loss of the money invested (Damodaran, 2009), besides adding value quantitatively to the Risk Management process (Jorion, 2010). That is to say that the CFaR enables both the opportune and the dangerous side of risk to be analyzed: how much the investor risks gaining ($CFaR^{+}$) and how much the investor risks losing ($CFaR^{-}$) in relation to the expected scenario, and taking the interaction of hundreds of scenarios based on input data into consideration. The CFaR is an example of an indicator that can be used as a result of the Degree of Risk of organizations which allows regular updates to be made.

The second indicator suggested in MIGGRI model concerns the Global Indicator of Risk: $I = (R_i;k_i)$, Equation 1, proposed by Souza (2011) as the answer to one of his goals with the model, quantifying the degree of exposure to risk. This indicates the variation in relation to the expected result, Equation 2, and the tendency of the risks, Equation 3, in each unit or line of business, thus allowing the manager to analyze what the ambit of the company's activity is that is impacting the overall expected result, the most strongly.

$$I_i = (R_i; k_i) \tag{1}$$

$$R_i = \frac{CFaR_i^{+A} - CFaR_i^{-A}}{\mu_i} \tag{2}$$

$$k_i = \frac{CFaR_i^{+A} + CFaR_i^{-A}}{CFaR_i^{+A} - CFaR_i^{-A}} \tag{3}$$

where: I = degree of risk of the business unit; R = degree of dispersion of the potential values of the business unit; k = an index shows the ratio between positive and negative risks of the business unit. This sub-index will assume values between -1.0 and 1.0, where -1.0 indicates that the company is subject only to negative risks, and 1.0 that the company is subject only to positive risks; i = business unit assessed.

2.3. The importance of evaluating the innovation risk

Among the benefits of exploiting risk is the need to have an advantage over competitors who are exposed to the same risk (Damodaran, 2009). In the innovation environment, where risk is encouraged by the characteristics of intangibility, globality and the potential of capital (Giugliani, 2012) and also by the need to monitor the market closely (as to securing and meeting needs and reaching and holding the consumer) (Hauser et al., 2006), the maximum amount of information should be sought from the external environment (monitoring the market) and from the internal one (processes) in order to establish what the speed of response to risk is (Damodaran, 2009). From this point of view, note that the application of Risk Management models can be used as a data source so that managers can make decisions strategically which are aligned to the company's objectives. Therefore, the use of performance systems based on the data generated in models like MIGGRI has the potential to generate information that is important for managing strategy.

Performance management systems showed an exclusively financial perspective until towards the end of the 20th century. Since then Kaplan & Norton (1996) deepened their studies and developed the methodology called Balanced Scorecard (BSC), which associates an analysis of the company's performance analysis to its strategic objectives in order to represent the respective strategy that ensures its market success. Therefore, the authors proposed structuring the model in four perspectives; Financial, Customers, Internal Processes, Learning and Growth. The BSC has spread very widely in industry but the literature shows it has faced some criticisms.

In the innovation literature, the current difficulty of seeking to measure innovation is noted (Smith et al., 2005). Jong & Marsili (2006), from an analysis of 1,234 small companies, consolidated variables that indicate there is an orientation to the innovation of the company: innovation outputs; innovation inputs; innovative

resources; innovative planning; and external relations. When seeking to measure the performance of innovation, the difficulty increases and, accordingly, Zeng et al. (2010), on studying a Chinese TSP, proposed 21 indicators, of which 10 are for innovation of the organization, and the objective of is to fill this gap. Among them those hat sand out are: the growth of R&D teams, the growth of innovative value added to the region, the rate of exportation of technology in relation to industrial exportation and the development of innovative products per capita.

Among the factors that drive the development of innovation, what stand out are innovation environments, such as the Scientific and Technological Parks (TSP). TSPs are often associated with environments fit for transforming innovation into business opportunities (Giugliani, 2012) and creating e competitive, effective and dynamic benefits (Gaino & Pamplona, 2012). The search for innovation environments such as TSPs is prompted by the fact that companies that invest with the intention of innovating tend to have greater financial performances (Lazzari et al., 2014). However, taking on an innovative approach leads back to exposing uncertainties, both technical and market ones (Hauser et al., 2006; Freeman & Soete, 2008). Thus, practices that allow risks to be analyzed and managed in order to attain a good economic performance are required. However, models and tools that allow the corporate management of risks are still oriented towards traditional management environments (Bromiley et al., 2015).

It is noted that there are systematic approaches to monitoring performance from different perspectives in the literature. Furthermore, the use of information provided by risk analysis as a feed source of a system for monitoring performance is among the recommendations made by Souza (2011). Thus, it is believed that the use of the innovation indicators proposed in the literature together with indicators that make it feasible to monitor critical risks, i.e., that may impact the company's expected performance, may be useful for the innovative companies. In addition to the benefits already highlighted on the use of analysis and risk management, one has to use the information from this analysis and to assess the impact of each business unit is within the company and thus fuel prioritization analysis models performance. Souza (2011) suggests that the use and monitoring of performance models such as the BSC and Risk Management may be of considerable value to aid decision making strategically.

3. Research methodology

This study began by drawing on the conclusions reached by Etges & Souza (2014), who applied a semi-structured interview in thirteen innovative companies operating in the TSP of the Pontifical Catholic University of Rio Grande do Sul (Tecnopuc) in order to examine to what extent the responses fitted in with the theme of the Management of Corporate Risks. A company was then selected which had a profile that was suited to applying the MIGGRI methodology. It is worth noting that the use of the TSP Tecnopuc is justified by the fact that it is one of the three well-established TSPs in the South of Brazil, has a self-sustaining structure, and the National Association of Promoting Entities Innovative Enterprises (ANPROTEC) has twice given it the award of Best TSP in Brazil

During the interviews, it was pointed out that the previous study by Etges & Souza (2014) had noted the companies' unanimous interest in the theme of the Management of Corporate Risks. In order to select the company in which it would be feasible to apply the study with greatest effect, some of its fundamental characteristics had to be closely examined in order to examine risks. Those the following were considered: its level of technology (how much the company invests in innovation and development of technology), its maturity (the financial structure of the company), its interest in and profile of risk as important characteristics so that the quantitative analysis of the financial impact of the risks identified would be viable. Therefore, the criterion of maturity is important due to the demand for an appropriate financial management structure.

Therefore, the level of technology, maturity, interest and risk profile were considered as criteria. As alternatives the companies in which interviews were held in the study by Etges & Souza (2014) were used. To select the company that was the focus of this study, the Analytical Hierarchy Process (AHP) was used, with the responses obtained in the study of Etges & Souza (2014) being taken into account. Table 1 shows the results of applying the AHP to thirteen companies considering all four criteria, with a consistency ratio smaller than 9.3% for all matrices created to do it. All the replies supplied by the two researchers who used the AHP. It is important to highlight that the two researchers did the paired comparisons among alternatives for each criteria.

The analysis of Table 1 was the underpinning used to select Company F for the application of the model. It emphasizes the great importance of the criterion of maturity is emphasized, which is due to the demand for a financial management framework to implement the MIGGRI model. The selected company was found to have detailed cash flows and the managers' knowledge of tools for economic projections and strategic

planning was good. Considering this research context, it is possible to classify this study like a case study, which practical applications oriented to solve a real problem for a small innovative company from a TSP were applied by the researchers and the organization. Applying this case study with this new problem, is being developed a contribution for the literature that doesn't present a consolidated framework to apply risk management in innovative companies. This can be suggested because this research is answering a solution (how?) for a problem (what?) that is important for the actual economy (why?) and designing who must be involved (who?) (Whetten, 2003). The use of case studies to contribute with the literature capability to solve real problems is suggested by methodology researches, like Boer et al. (2015).

Table 1. Main matrix of the AHP.

	A	B	C	D	E	F	G	H	I	J	K	L	M
Technology level	0.4L3	0.72	0.72	0.72	0.14	0.72	0.43	0.14	0.72	0.72	0.72	0.14	0.43
Maturity	0.43	0.72	0.14	0.14	0.43	0.72	0.72	0.14	0.14	0.14	0.43	0.72	0.43
Interess	0.43	0.72	0.43	0.14	0.14	0.72	0.43	0.72	0.14	0.14	0.43	0.43	0.14
Risk Profile	0.72	0.14	0.72	0.72	0.43	0.14	0.14	0.72	0.72	0.72	0.72	0.72	0.14
Total	2.03	2.17	2.03	1.74	1.16	2.32	1.74	1.74	1.74	1.74	2.17	2.03	1.16

Company F was set up in Tecnopuc two years ago. Among the features that made it viable to open the company in this environment, what stands out is the constant search for new solutions being present in its raison d'être. The company examined operates in hospital services, which includes processes for calibrating equipment. This is regarded as innovative vis-à-vis what is already on the market, therefore allowing for agile and high quality results. In addition, the company is not opposed to items of equipment that are already commonly available in European and North American markets coming into circulation in Brazil. It maintains continuous monitoring activities of the external market, thus seeking to bring solutions to Brazil that will contribute to restoring and maintaining the health of patients treated in Brazil. Thus, the intense search for innovation which is part of the company's strategy made it viable, in conjunction with the relevant features highlighted in the method, to apply the model at this location.

The MIGGRI model was adapted to the context of the (small-scale, innovative product and services) company selected. This was followed by applying it on site in conjunction with the company. Figure 2 highlights, by means of a check mark, the steps of the MIGGRI model that were used.

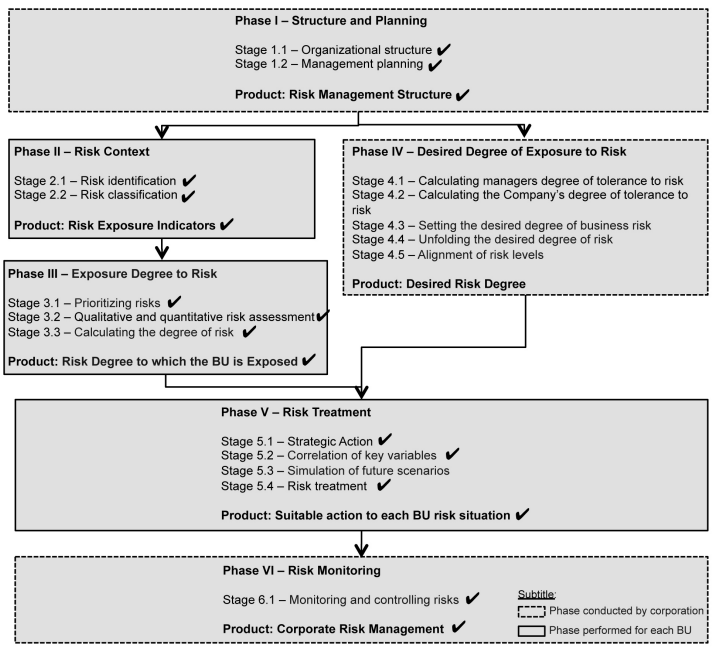

Figure 2. Method of Work proposed.

On looking at Figure 2, it can be seen that a few steps of the MIGGRI model were not followed in the company under study. This limitation stems from the company's lack of knowledge with respect to risk management practices. The limitations worthy of note were the complete exclusion of Phase IV of the model, regarding Desired Degree of Exposure to Risk. Since the company in question had not conducted a survey of its risks in earlier periods, it is difficult to have managers at this first moment fully grasp the notions of desired degree of exposure to risk. Therefore, it is understood that this step is best suited to companies with a greater understanding of their associated risks. The qualitative Assessment of Risks, as well as the Simulation of Future Scenarios, were also steps that were also excluded in this first application of the MIGGRI model, which therefore had to be adapted because of the lack of depth of the managers' knowledge. However, it is understood that the model as a whole is applicable to companies belonging to the innovation environment, and the objective of this application was to support such a claim.

4. Results and discussion

The implementation stages of the MIGGRI model for this company will be presented in chronological order and the results discussed below.

4.1. Structuring and planning

Considering the demands of future economic analysis for the analysis and Management of Risks, the need to develop some activities still missing in the company's structure was noted, including segmenting the cash flow into Business Units (BUs). The company chosen operates with two business fronts: services and the resale of hospital products. With regard to services, it supplies: more accurate calibration for hospital equipment to what is already on the market as a result of the innovation developed by its managers as to calibration methods (A); hiring hospital equipment (B) and maintaining hired equipment (C). Among its commercialized products, the company imports and re-sells two products (D and E) that are not otherwise available in the Brazilian market, with unit D being aimed at individuals and hospitals and unit E only at hospitals. The objective of structuring the cash flow of each BU latches onto the need to project profits (revenues - R) and expenditures (costs - C) for each BU, with a view to identifying, using robust tools, the projected variation in profits (L = R-C), by measuring the impact of risks that permeate each specific business of the company.

To structure the cash flow and its future projection, the ABC (Activity-Based Costing) method was used (Cooper & Kaplan, 1991), which is based on defining the cost drivers so as to distribute them. Thus, for payroll, for example, the driver of Attention Index was used for the rent per m^2 demanded by each BU, and the infrastructure costs were distributed uniformly. Moreover, amounts with respect to bills for water, electricity, telephone and gas were included as overheads in the CF. The direct costs and revenues were estimated in accordance with the demand forecast for the company's services and products. It is noteworthy that, given that the company has been on the market for two years, it was assigned a forecast horizon of only one year. With regard to taxes, tributes due were included in accordance with the business fronts: services 11.4% of revenue, products of unit E 7.6% on turnover and product unit D 12% of turnover. Table 2 illustrates the Cash Flow projected for the next Financial Year, which will be used to conduct the probabilistic analysis of the risks.

Table 2. Projected Cash Flow for the following Financial Year.

Annual	A	B	C	D	E	Total
Gross Income*	109,800.00	198,518.33	542,607.69	301,923.08	197,689.65	1,038,875.96
Taxes	16,272.36	29,420.42	80,414.46	44,080.00	28,461.74	
Net Income	93,527.64	169,097.91	462,193.23	257,843.08	169,227.92	1,151,889.78
Product Cost*	50,506.00	11,000.00	77,933.75	129,950.00	101,451.04	185,420.40
TCM	43,021.64	158,097.91	384,259.48	127,893.08	67,776.88	781,048.99
Employees*	84,358.04	85,847.30	86,118.81	90,453.39	81,439,55	428,217.10
Structure*	12,000.00	12,000.00	12,000.00	12,000.00	12,000.00	60,000.00
Rent*	3,709.09	1,854.55	2,781.82	927.27	927.27	10,200.00
Unit Profit	**(57,045.50)**	**58,396.07**	**28,358.85**	**24,512.41**	**(26,589.95)**	**282,631.89**
Expenses	-	-	-	-	-	117,187.88
Total Profit	-	-	-	-	-	**165,444.01**

*Will undergo probabilistic variation when the Monte Carlo Simulation is used.

In a brief description of the results expected from the projection, it is seen that units A and E will not produce net profits but according to the managers, they are important because they reach the clients of units B, C and D. Units A and E are seen as a way to open the door to new consumers for the subsequent sale of units B, C and D. In other words, despite the unit being the reason for the opening and the location of the company in a Technological Cluster, it is noted that it currently runs at a loss, it being unit C that is responsible for the good projected result of R$ 165,444.01 at the end of the next Financial Year.

4.2. Context of risk

The Risk Breakdown Structure (RBS) proposed in the COSO methodology (Committee of Sponsoring Organizations of the Treadway Commission, 2007) enables managers to relate the risks to which the business is exposed, by classifying them according to their origin (internal and external) and their class (infrastructure, personnel, process, technology, economic, technical, social, political and environmental), thus facilitating a strategic analysis on how to act with respect to them (Hayne & Free, 2014). In the context of the company under analysis, managers mentioned that they did not dedicate time to analyzing risks in a structured way when the company was formed. Thus, brainstorming sessions were held with company managers to draw up RBS, with the existing risks being related to the BUs and to the variables that they potentially will have an impact on. The relationship established enabled the perception of a large volume of risks inherent to the business and the impact on all BUs from some risks, thus indicating that attention should be given to them. In addition, it was noted that the variable of gross revenue is the one with the largest volume of associated risks, therefore indicating in a qualitative way that it represents the variable of highest exposure to risk. An illustration of several risks listed in the BU is in Table 3.

Table 3. Partial RBS of the company.

Risk	Origin	Classification	Impact	A	B	C	D	E
Physical Change in Space	Internal	Infrastructure	Rent	x	x	x	x	x
Delivery date products and equipment	External	Technical	Income				x	x
Important delay	External	Technical	Income				x	
Dibbing	External	Economics	Income			x	x	x
Quality of workmanship	External	Employees	Employee	x	x	x		
Technology Changes	External	Technological	Structure			x		
Ill-use	External	Technical	Income	x	x	x	x	x
Process Management	Internal	Process	Structure	x		x		

4.3. Degree of exposure to risk

From the breakdown of the risks of qualitative way, the next step was to conduct a probabilistic analysis of the impact of risks on the company's cash flow. Because of the shortage of long-term historical data that would have allowed the use of statistical distributions based on historical data, estimates were made of triangular probability distributions to analyze the impact of the risks on each variable of the cash flow. The use of triangular distributions can be found in the context of risk in studies by Souza (2011), Zouggari & Benyoucef (2012) and Miorando et al. (2014) and, also, in portfolio optimization (Dutra et al., 2014). For this estimate, the basis is managers' knowledge and opinions on the progress of their business.

The process of making a survey of the distributions began from identifying the risks that affected each variable, followed by an estimate of the impact that each risk could cause them. Due to the presence of more than one impact on each variable risk, the need to combine the individual distributions of impact of a risk in one variable was noted. Given that the risks are independent, that is, the occurrence of one event is not affected by another (Pinheiro et al., 2012), statistics were used that are founded on Bayes' Theorem, the Total Likelihood Principle, Equation 4, in order to combine the distributions and to achieve the scenario of a final distribution stage for each of the variables included in the Cash Flow (Gross Revenue, Structure, Rent, Cost of Product and Personnel).

$$P(B) = \sum_{i=1}^{m} P(BIAi) * P(Ai) \quad (4)$$

where: A_1, A_2, ..., A_n = part of a sample space; B = any other event of this space.

It also considered a correlation of 0.8 between the variables of cost and revenue, since the largest share of costs is concentrated on highly skilled people and on variable costs. Thus, the cost increases as the demand for the services grows. Table 4 illustrates the triangular distributions of each variable defined in the BUs. It is noteworthy that for the variable of Expenditure on Personnel there is no distribution associated with units D and E, as they represent products, which according to the managers are not affected by the risks involved with this variable.

Table 4. Probability distributions of entry and calculation of the Degree of Risk.

Incoming	Business Line				
	A	B	C	D	E
Incoming (min)	50%	63%	25%	33%	47%
Incoming expected	100%	100%	100%	100%	100%
Incoming (max)	136%	155%	140%	112%	140%
Product Cost	A	B	C	D	E
Cost (min)	70%	65%	75%	95%	42%
Cost expected	100%	100%	100%	100%	100%
Cost (max)	125%	117%	125%	127%	136%
Rent	A	B	C	D	E
Expenses - rent (min)	100%	100%	90%	80%	90%
Expenses - rent expected	100%	100%	100%	100%	100%
Expenses - rent (max)	120%	120%	110%	110%	110%
Structure Cost	A	B	C	D	E
Expenses - structure (min)	86%	95%	77%	90%	95%
Expenses - structure expected	100%	100%	100%	100%	100%
Expenses - structure (max)	115%	105%	115%	105%	105%
Employees	A	B	C	D	E
Expenses - employee (min)	100%	100%	100%		
Expenses - empolyee expected	100%	100%	100%		
Expenses - employee (max)	110%	110%	110%		

From the triangular distributions defined, and along with full details of the cash flows and projections for the year under analysis, @RISK software was used to perform a Monte Carlo Simulation (MCS). As a result, the probability distribution of the outcome variable of the cash flow was generated, i.e. of the expected profit in this study, fragmented by BU, thus facilitating the analysis on the impact of each business line in the company's results as well as giving priority to actions that may be used to monitor it and minimize it. Therefore, an MCS was used that considered 200,000 interactions.

From the results generated, it was possible to calculate the indicators $CFaR^{+}$, $CFaR^{-}$ and the Global Indicator of Risk ($I_i = (R_i; k_i)$), suggested by the MIGGRI model to estimate the Degree of Risk involved in the company's business (Table 5). It is noteworthy that there is coherence between the findings. That is, the distribution of values that best describes the behavior of the data is consistent with the guidelines of the triangular distributions initially inserted into the software, with emphasis on the potential use of the tool to aid orientation towards a system for performance based on the information that managers have.

Table 5. Indicators calculated based on SMC.

	A	B	C	D	E
Expected	(40,634.87)	114,215.80	247,842.80	(52,330.54)	(29,320.15)
CFaR-	(19,555.71)	(49,906.50)	(187,949.84)	(70,999.96)	(34,256.33)
CFaR+	17,897.78	55,638.00	158,950.30	47,069.96	33,326.71
I(R;k)	(0,92;-0.04)	(0.92;0.05)	(1.40l-0.08)	(2.26;-0.2)	(2.31;-0.01)

An example is in BU (C), which is the highest expected return, referring to a detailed analysis from this first finding. This BU generated a negative k_i index, which is explained by the strong risk of loss of income involved (25%), which made the $CFaR^{-}$ of this BU remain more representative than the $CFaR^{+}$. Thus, what stands out is the attention that should be given to the risks that cause an impact on the revenue of BU (C), thereby emphasizing

the potential use of information generated by the MCS for feeding performance systems that the company uses especially regarding the indicators of monitoring and control to guide improvement actions.

A similar analysis can be performed for the BU (D) that although prior to incorporating the risks shows a positive result, when risks are incorporated indicates attention because it has an expected negative result in Table 5 ($ 52,330.54). The warning sign is aggravated when analyzing the R_i index of 2.26. In other words, there may be a 226% variation compared with the expected return on this BU, tending to be oriented to the negative side (of loss of cash flow) due to the negative trend found in the k_i index of -0.20. It is emphasized that these results are being influenced by the input distributions where for the variable of income there is a negative representative risk (33%). Thus, risks related to the revenue of this BU should also receive priority in performance systems that aim at financial stability and the possible financial improvement of the company.

It is also perceived that units A, D and E, besides having a negative result when the risks are considered, tend to have negative variations (k_i -0.04, -0.2 and -0.01 respectively). Thus, despite the company using unit A, for example, to enter the customers and later sell other solutions, it is recommended that there should be a study on discontinuing lines of business which will potentially have negative results, by developing less costly alternatives and to incorporate new customers. Thus, the company would have a better overall result because it would no longer have losses from the sale of business units A, D and E, which when summed up represent in the scenario expected R$ 122,285.56. The results of the company after the consideration of risk would increase from R$ 239,773.04 to R$ 362,058.60, without considering that possibly the indirect costs of the structure could be reduced by discontinuing some solutions. Should the company choose this option, the impacts of risks shared between lines of business should be analyzed so as to make the correct decision and to measure the risk.

As a final analysis, based on the results of the MCS, the presence of the variable Revenue stands out among those that cause the greatest effect on the variation of the company's overall profits. Because of the innovative nature of the business under study, this affirmation needs to be checked against what the literature on innovation emphasizes: uncertainty is inherent in the innovation process (Garcia & Calantone, 2002; Bessant, 2003; Canongia et al., 2004; Hauser et al., 2006; Wong & Chin, 2007; Nagano et al., 2014) and is strongly influenced by the difficulty in confirming whether or not the innovative product or service has been commercialized (Cooper, 2003; Bessant, 2003; Wong & Chin, 2007; Trott, 2012; Nagano et al., 2014). This study confirms this difficulty and does so because of the presence of the negative impact of the risks associated with revenue, and moreover, the final results generated by the MCS which show this variable to be the one that has most impact, namely it causes the greatest variation in the company's overall results. It is noteworthy that the variable with the least impact is summarized in the rent, which had few associated risks and effects.

On returning to the risks linked to the variable of greatest impact (income), we can see one of the potential uses of the model: it enables the risks that should receive greatest attention in mitigation practices to be identified since they lead to a greater economic impact. Thus, the systemic use of the proposed model allows continuous management to be structured and brought into practice. This uses indicators that involve the critical risks found and these are detailed in the next section.

After conducting the MCS and analyzing the results found, the worth of using the MIGGRI model is realized as are the opportunities for analyzing in depth by applying it in segments by business units. By structuring its application in this way, the cash flow of whatever segment of the company has suffered the greatest impact can be seen and measured, thereby enabling managers to base their decision-making on whatever actions may be the most strategic for the company's results.

4.4. Treatment and monitoring

Having measured the risks in the BUs, the next step is to identify the critical risks and to deal with them. Therefore, indicators must be created. However, using indicators that make it feasible to monitor the innovation performance of a company set up in a TSP becomes challenging for managers. However, what is noted is the willingness to seek to monitor the progress of the raison d`être of such a company in this environment. Thus, it was proposed that the company use a performance system that makes it viable to monitor the innovative performance of the company, based on the indicators proposed by Jong & Marsili (2006) and Zeng et al. (2010) and which also allow precise monitoring of the critical risks that may happen to affect this performance.

When considering the potential of strategic analysis based on the findings in relation to the impact and the position of the BUs in the company's economic performance, the relationship existing between the analysis and the Management of Financial Risks and the Strategic Management of the company. This is present because on measuring the impacts and the respective risks related to the variables that may be pulling the company's profit positively or negatively, the manager is able to guide and prioritize decision making on the areas that demand

constant and detailed monitoring in order to mitigate risks and, consequently, to avoid losses. Furthermore, when periodically analyzing the risks to which the company is exposed, an internal analysis of the processes is made and an external one of the market. By using this analysis, managers dedicate themselves to making a strategic analysis of the company's position in the market in a systematic way.

Thus, with regard to monitoring and controlling risks, based on the analysis conducted, the recommendation was made to the company under study that it should start to use performance indicators related: to monitoring the risks associated with the variables of greatest impact on the company's profits; to the BUs which have the greatest financial representativeness; and to the BUs with greatest variation in relation to the expected average result. It was proposed that the indicators should be accessible to everyone involved in the process and displayed on the company's noticeboards, thus facilitating visual management, by making information transparent and by structuring action plans quickly on perceiving a drop in the performance of some area that is being constantly monitored.

An illustrative sample of the proposed system for monitoring the company's performance is shown in Figure 3.

Looking at Figure 3, can be seen that it follows a structure based on the BSC model, in which the indicators are classified according to the strategic prospects of the company. The indicators refer to important steps for the organization, such as Receivables overdue from customers. Using these measures, action plans should be drawn up to deal with critical risks and thereby to achieve the expected result. To facilitate the dissemination

KPI Dashboard -innovation dashboard (Jong and Marsili, 2006).

Indicator	BSC	Checked	Goal	Periodicity	Status
Innovations outputs	Internal Process	-	1	Annual	0
Innovation inputs	Internal Process	6	5	Annual	1
Innovation Planning	Internal Process	1	1	Annual	1
External relationship	Internal Process	3	5	Annual	0
Internal resources	Internal Process	2	5	Annual	0

Innovations dashboard (Zeng et al., 2010)

Indicator	BSC	Checked	Goal	Formula	Periodicity	Status
Growth of R&D team	Internal Process	3%	5%	((Team volume n)/ (team volume n-1))-1	Annual	0
Gross innovation income growing	Financial	12%	10%	((income innovation n)/(income innovation n-1))-1	Annual	1
Patents submitted by employees	Internal Process	1%	1%	Patents/Employees	2 years	1
R&D budget growing	Financial	12%	8%	((R&D busget n)/(R&D budget n-1))	Annual	1
Research capacity	Internal Process	15%	25%	Research time/capacity	Month	0

KPI Dashboard - critical risks

Indicator	BSC	Checked	Goal	Formula	Periodicity	Associated Risks	Status
Customers in default	Customers	12%	10%	inadimplences/total	Monthly	Received overdue	0
Effective contracts	Financial	90%	80%	Effectives/business	Monthly	Contracts Tender	1
Bidding perfomance	Internal Process	0%	80%	won/crowded	Monthly	Contracts Tender	0

Enterprise Risk Control

Risk	Business Line	Impact variable	Responsability	Actions	Actual context	Goal	Periodicity
Customers	e	Income	-	-	-	-	1
Licitation	b	Income					1
Argue Competition	a	Income					2
Concorrence	a	Income					3

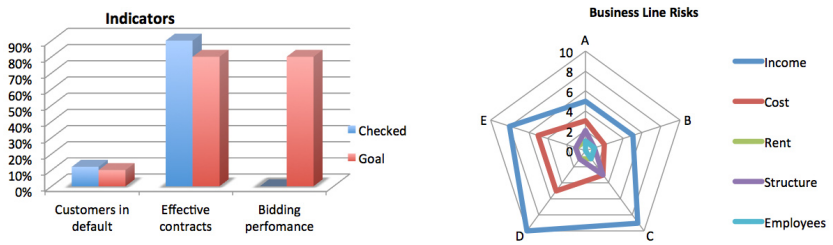

Figure 3. Sample of the proposed system for monitoring performance.

of information and its control, using dashboards with visual data helps, when managing and monitoring risks continuously. In the company under study, the dashboard was structured and is currently being implemented in full and so the data presented are by way of illustration only.

5. Conclusions

The innovation process is full of decision points that require swift and strategic actions in a dynamic environment, heavily influenced by variables external to the company (Cooper, 2003; Nagano et al., 2014). Internal processes, such as the management of risk and performance, which generate information about the company's position, are shown to be essential to sustaining the organization.

This study sought to apply the MIGGRI model proposed by Souza (2011) to the environment of small innovative companies of a TSP, and success was achieved by using this first study. The model was applied by implementing it together with a company of this segment, and the analyses of the findings enabled a proposal for constant monitoring to be structured based on designing a performance system that uses indicators. Thus, what is seen is the link between analyzing the risks to which the company is exposed, its origin and their relationship to decision making to manage the company strategically. In brief, the probabilistic analysis of the risks indicates the variables that cause the greatest financial impact, thus allowing their relation to the risks to which they are related, the decision making being funded on monitoring and controlling activities related to these risks.

The model adaption was tested and contributed with the company capability to manage innovation risks. With this result, is possible to affirm that the risk management model can be explored by other companies oriented to improve the risk management process and, in sequence, innovation performance. One objective was also attended and innovation managers and employees receive an orientation about how to implement risk management process previous focused in big companies or financial environment.

The academy received a new approach about risk management. Theoretical guides, and models model focused on stablish market were used to structure a model for small, new and not stablish markets. The managers are benefited with a technique that enable them to identify previously financial dangerous and, with this, to act proactively turning the innovation organization stainability more likely.

The MIGGRI model, calculating the desired degree of exposure to risk was disregarded for this first analysis, due to the length of time the company has been in the market. However, the inclusion of this phase is recommended in future analyses in companies located in innovation environments. In addition, a new application is recommended for future use in this company to compare the findings and to identify whether it is worthwhile using indicators and actions that target the risks which represent the greatest impact on the company's performance.

This research is limited by the region. The case study is from Brazil and can't be assumed like a globally conclusion. In the same way, how was used only one case, those findings are specific for this company and its business sector. Future applications in different companies, countries and business sectors can contribute for the advance in this proposed model.

Finally, due to the repetitions of risks between the companies already in the innovation market, in-depth studies with a larger number of companies and investors in this market on the theme of risk management are proposed to homogenize groups of risk factors for the innovation ecosystem. On achieving this level, a system that analysts and company managers find easy to use can be proposed. They will thus have a homogeneous starting point, and their responsibility will be to reflect on the presence of the impact of all the groups of risk on their business and to the tools recommended for managing risk. When there is a higher volume of business replicating the MIGGRI model, benchmarking the risks and the respective risk management in innovative TSP environments will be undertaken. Furthermore, it is suggested that the application is broken down into different forms of innovation: innovation in a radical or incremental product and innovation in a radical or incremental service.

References

Bandyopadhyay, K., Mykytyn, P. P., & Mykytyn, K. (2006). A framework for integrated risk management in information technology. *Management Decision*, *37*(5), 437-445. http://dx.doi.org/10.1108/00251749910274216.

Bessant, J. (2003). Challenges in innovation management. In L. V. Shavinina (Ed.), *The International Handbook on Innovation*. Oxford: Elsevier.

Boer, H., Holweg, M., Kilduff, M., Pagell, M., Smurfit, M., Schmenner, R., & Voss, C. (2015). Making a meaningful contribution to theory. *International Journal of Operations & Production Management*, *35*(9), 1231-1252. http://dx.doi.org/10.1108/IJOPM-03-2015-0119.

Bromiley, P., Mcshane, M., Nair, A., & Rustambekov, E. (2015). Enterprise Risk Management: review, critique, and research directions. *Journal Long Range Planning*, *48*(4), 265-276. http://dx.doi.org/10.1016/j.lrp.2014.07.005.

Canongia, C., Santos, D. M., Santos, M. M., & Zackiewicz, M. (2004). Foresight, Inteligência competitiva e gestão do conhecimento: instrumentos para a gestão da inovação. *Revista Gestão & Produção*, *11*(2), 231-238. http://dx.doi.org/10.1590/S0104-530X2004000200009.

Committee of Sponsoring Organizations of the Treadway Commission. (2007). *Gerenciamento de riscos corporativos: estrutura integrada* (2nd ed.). United States: COSO.

Cooper, R. G. (2003). Profitable product innovation: the critical success factors. In L. V. Shavinina (Ed.), *The International Handbook on Innovation*. Oxford: Elsevier.

Cooper, R., & Kaplan, R. S. (1991). Profit priorities from activity-based costing. *Harvard Business Review*, *69*(3), 130-135.

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: a systematic review of the literature. *Journal of Management Studies*, *47*(6), 1154-1191. http://dx.doi.org/10.1111/j.1467-6486.2009.00880.x.

Damodaran, A. (2009). *Gestão estratégica do risco*. Porto Alegre: Bookman.

Dutra, C., Ribeiro, J. L. D., & Carvalho, M. M. (2014). An economic-probabilistic model for project selection and prioritization. *International Journal of Project Management*, *32*(6), 1042-1055. http://dx.doi.org/10.1016/j.ijproman.2013.12.004.

Etges, A. P. B. S., & Souza, J. S. (2014). Estudo de Campo sobre Gestão de Riscos Corporativos em empresas participantes de um Parque Científico Tecnológico. In *Anais do IV Congresso Internacional de Conocimento e Inovación*, Equador.

Freeman, C., & Soete, L. (2008). *A economia da inovação industrial*. São Paulo: Unicamp.

Frigo, M. L., & Anderson, R. J. (2011). Strategic risk management: a foundation for improving enterprise risk management and governance. *Journal of Corporate Accounting & Finance*, *22*(3), 81-88. http://dx.doi.org/10.1002/jcaf.20677.

Gaino, P. A. A., & Pamplona, B. J. (2012). Abordagem teórica dos condicionantes da formação e consolidação dos Parques Tecnológicos. *Revista Produção*, *20*(10), 177-187.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management*, *19*(2), 110-132. http://dx.doi.org/10.1016/S0737-6782(01)00132-1.

Giugliani, E. A. (2012). *Governance model for science and technology parks: what are the STP's evolving into?* Tallin: International Association of Science Parks.

Hansen, S. O., & Wakonen, J. (1997). Innovation, a winning solution? *International Journal of Technology Management*, *13*(4), 345. http://dx.doi.org/10.1504/IJTM.1997.001668.

Hauser, J., Tellis, G. J., & Griffin, A. (2006). Research on innovation: a review and agenda for marketing science. *Marketing Science*, *25*(6), 687-717. http://dx.doi.org/10.1287/mksc.1050.0144.

Hayne, C., & Free, C. (2014). Hybrid professional groups and institutional work: COSO and the rise of enterprise risk management. *Accounting, Organizations and Society*, *39*(5), 309-330. http://dx.doi.org/10.1016/j.aos.2014.05.002.

International Organization for Standardization. (2009). *ISO 31000:2009: risk management: principles and guidelines 2009*. Geneva: ISO.

Jong, J. P. J., & Marsili, O. (2006). The fruit of innovations: a taxonomy of innovative small firms. *Research Policy*, *35*(2), 213-229. http://dx.doi.org/10.1016/j.respol.2005.09.007.

Jorion, P. (2010). *Risk management*. California: School of Business, University of California.

Kaplan, R., & Norton, D. (1996), *Translating strategy into action: the balanced scorecard*. United States of America: Harvard College.

Kliemann, J.F. (2010). A gestão de riscos como ferramenta para aumento da competitividade das empresas. In *Anais do XXX ENEGEP*, Rio de Janeiro.

Koskela, L., & Howell, G. (2002). *The underlying theory of project management is obsolete*. Pennsylvania: Project Management Institute.

Lazzari, F., Bampi, R. E., & Milan, G. S. (2014). Os esforços de inovação e sua relação com alguns indicadores de desempenho do negócio. *Revista Produção Online*, *14*(1), 58-83. http://dx.doi.org/10.14488/1676-1901.v14.i1.1428.

Miorando, R. F. (2010). *Modelo econômico probabilístico de análise de risco em empresas de TI* (Doctor thesis). Universidade Federal do Rio Grande do Sul, Porto Alegre.

Miorando, R. F., Ribeiro, J. L. D., & Cortimiglia, M. N. (2014). An economic-probabilistic model for risk analysis in technological innovation projects. *Technovation*, *34*(8), 485-498. http://dx.doi.org/10.1016/j.technovation.2014.01.002.

Mortimer, A. L. (1995). Managing innovation and risk. *World Class Design to Manufacture*, *2*(5), 38-42. http://dx.doi.org/10.1108/09642369310095210.

Nagano, M. S., Stefanovitz, J. P., & Vick, T. L. (2014). Innovation management processes, their internal organizational elements and contextual factors: an investigation in Brazil. *Journal of Engineering and Technology Management*, *33*, 63-92. http://dx.doi.org/10.1016/j.jengtecman.2014.02.004.

Nanda, R., & Rhodes-Kropf, M. (1999). Investment cycles and startup innovation. *Journal of Financial Economics*, (110), 1.

O'Connor, G. C., Ravichandran, T., & Robeson, D. (2008). Risk management through learning: management practices for radical innovation success. *The Journal of High Technology Management Research*, *19*(1), 70-82. http://dx.doi.org/10.1016/j.hitech.2008.06.003.

Pinheiro, J. I., Carvajal, S. S. R., Cunha, S. B., & Gomes, G. C. (2012). *Probabilidade e estatística: quantificando a incerteza*. São Paulo: Elsevier.

Pittaway, L., Robertson, M., Munir, K., Denyer, D., & Neely, A. (2004). Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews*, *5-6*(3-4), 137-168. http://dx.doi.org/10.1111/j.1460-8545.2004.00101.x.

Project Management Institute. (2008). *PMBOK: a guide to the project management body of Knowledge* (4th ed.). Pennsylvania: PMI.

Smith, K. G., Collins, C. J., & Clark, K. D. (2005). A behavioral theory of R&D expenditures and innovations: evidence from shipbuilding. *Academy of Management Journal*, *48*(2), 346-357. http://dx.doi.org/10.5465/AMJ.2005.16928421.

Souza, J. S. (2011). *Modelo para Identificação e Gerenciamento do Grau de Risco de Empresas – MIGGRI* (Doctor thesis). Universidade Federal do Rio Grande do Sul, Porto Alegre.

Standards Association of Australia. (1999). *AS/NZS 4360: risk management*. Strathfield.

Trott, P. (2012). *Gestão da inovação e desenvolvimento de novos produtos*. São Paulo: Bookman.

Tu, C., Hwang, S., & Wong, J. (2014). How does cooperation affect innovation in micro-enterprises? *Management Decision*, *52*(8), 1390-1409. http://dx.doi.org/10.1108/MD-07-2013-0388.

Viana, R. B. C. (2012). A estratégia na incerteza: explorando cenários para empresas recém-criadas no mercado brasileiro de tecnologia da informação. *Reuna*, *17*(3), 85-98.

Whetten, D. A. (2003). O que constitui uma contribuição teórica. *Revista de Administração de Empresas*, *43*(3), 69-73.

Wong, S., & Chin, K. (2007). Organizational innovation management. *Industrial Management & Data Systems*, *107*(9), 1290-1315. http://dx.doi.org/10.1108/02635570710833974.

Yang, J. (2012). Innovation capability and corporate growth: an empirical investigation in China. *Journal of Engineering and Technology Management*, *29*(1), 34-46. http://dx.doi.org/10.1016/j.jengtecman.2011.09.004.

Zeng, S., Xie, X., & Tam, C. (2010). Evaluating innovation capabilities for Science parks: a system model. *Technological and Economic Development of Economy*, *16*(3), 397-413. http://dx.doi.org/10.3846/tede.2010.25.

Zouggari, A., & Benyoucef, L. (2012). Simulation based fuzzy TOPSIS approach for group multicriteria supplier selection problem. *Engineering Applications of Artificial Intelligence*, *25*(3), 507-519. http://dx.doi.org/10.1016/j.engappai.2011.10.012.

Received: Sept. 9, 2016
Accepted: Apr. 26, 2017