

A RESEARCH, DEVELOPMENT AND INNOVATION MANAGEMENT SYSTEM FOR SMALL AND MEDIUM ENTERPRISES

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ABSTRACT

In an increasingly competitive market, innovation plays an extremely important role in organizations, since it enables them to produce goods or services that are more valuable to their customers than what their competitors have to offer. For this reason, many organizations develop processes that support innovation. In Portugal, the Portuguese Standard 4457:2007 (NP4457), which defines the requirements for a Research, Development and Innovation Management System (RDIMS), was introduced in 2007. These requirements act as guidelines for organizations that recognize the importance of innovation. The purpose of this paper is to present a RDIMS that supports the management of innovation in the company Gelado Colorido, based on NP4457. A case study was carried out in a business environment with a duration of 6 months. After analysing the reality of the company an Innovation Support System was presented divided in: Strategic Definition, Innovation Process and RDIMS Evaluation. Although it was created for a specific firm, it is based on generic references and it doesn't involve specific activities or characteristics of the organization or industry for which it was intended, which makes it possible to adapt it to other SMEs that are interested in improving innovation management performance and/or in the NP4457 certification.

INTRODUCTION

The ability to innovate allows companies to differentiate themselves from their competitors by improving their processes or by being able to produce goods or services more valued than their competitors (Leite, Albuquerque and Leal, 2007). Innovation is often associated with technological advances, but this is a limited vision, as innovation is present in another areas than technology within organizations. Innovation is inherently uncertain, somehow disordered, made up of some of the most complex systems and subject to change of various types. Moreover, it is also difficult to measure and requires close coordination of adequate technical knowledge and

excellent market-critical ability to satisfy all constraints simultaneously (Kline and Rosenberg, 1986). Despite being popularly described as a process without rules or plans, studies have shown that successful innovators have clearly defined strategies and management processes for innovation (Schilling, 2005).

In 2007, based on the Chain-linked Interactive Model, the Portuguese Quality Institute created the Portuguese Standard 4457:2007 (NP4457). The Standard presents the necessary requirements for a Research, Development and Innovation Management System (RDIMS), and aims at the certification of organizations, ensuring the recognition of the necessary technical skills for the management of innovation.

Due to their size and their characteristics, small and medium-sized enterprises (SMEs) feel that the innovation process is often hampered. The correct application of the standard in SMEs allows a systematic planning of the innovation process, thus helping to more easily recognize the opportunities and threats to which the organization is exposed, taking more advantage of the innovation process. In addition, the standard implies a continuous evaluation of the innovation process, which may act as a reflection for the organization on its own innovation processes.

The objective of this study, which adopted a qualitative and exploratory approach, was to define procedures and practices for innovation management that are best suited for a small enterprise in the food sector, making its innovation process more agile and that can serve as a basis for a future implementation of the NP4457. The study proposes an integrated system of innovation management, comprised of several phases, which were designed having in mind the characteristics of a resource constrained SME, and that will hopefully improve and facilitate the proper management of innovation in this category of organizations.

LITERATURE REVIEW

Innovation Definition

Innovation is nowadays a very common word in the world of organizations, but its definition remains somewhat elusive. Innovation is often associated with cutting-edge technology, but that may be a reductive

view. Often, it is less a question of technology and more a way of thinking and discovering creative solutions within organizations (Amabile, 1988; Hidalgo and Albors, 2008), by adapting their knowledge and skills in their offerings or in the way their products or services are delivered (Tidd et al., 2005). Innovation occurs in an abstract way within organizations at a technological, marketing or organizational level, generating different results from case to case, and may involve various types of innovation (product, process, marketing or organizational). In fact, the successful innovations result from a good combination of the various organizational competencies (Caraça et al., 2006).

Innovation can then be seen as a tool for entrepreneurs, that is, the way through which they can exploit change as an opportunity for a different business or service (Drucker, 1985). The adoption of innovation allows organizations to adapt to the environment in which they are inserted or anticipate changes in order to increase or maintain their effectiveness and competitiveness (Damanpour and Gopalakrishnan, 2001). Innovation is what agile companies do, that is, they constantly reinvent themselves in terms of their solutions to the riddle represented by the threats and opportunities in their environment. This may mean adopting new technologies, or own generation (Bessant, 2003).

This study adopts the definition given in 2005 by the Organization for Economic Co-operation and Development (OECD), which defined innovation as "the implementation of a new or significantly improved product (good or service), process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." (OECD, 2005, p.46).

Innovation Management

Innovation can be seen as a process involving the invention of something and the exploitation of its results (Roberts, 2007). The task of managing this process is then to create specific routines for the company. Routines represent the approaches that a given organization makes to meet the challenge of innovation. Innovation routines are increasingly recognized for their contribution to competitive advantage, and can't simply be copied from one context to another, they need to be learned and practiced over a sustained period of time (Bessant, 2003). Following are some of the areas that should be managed to facilitate innovation. It is necessary to consider that the management of these areas should be done in a joint way, creating routines, and not individually.

- Innovation strategy - managing the innovation strategy requires understanding the what, why, and when of the innovation activity. This means developing, reviewing and updating an innovation policy and strategy consistent with the organization's mission and setting innovation goals in the short and long term (Adams et al., 2006; Hamel, 2006; Cooper, 2011).

- Portfolio Management - involves the definition of a diversified portfolio that encompasses different types of innovations. Choosing the right innovation projects isn't always easy, it is necessary to recognize the lack of information that exists in the initial phases and adapt selection criteria that are more broad than the financial indicators, including criteria like business opportunity or technical feasibility according to the projects (Adams et al., 2006; Cooper, 2011, 2013; Mitchell et al., 2014).
- Project management - a project can be defined as a unique enterprise, represented by a sequence of activities, limited in time, to achieve the objectives determined within a given budget. Due to the high level of uncertainty, the application of project management methodologies allows organizations to obtain the best results during its execution (Igartua et al., 2010; Miguel, 2013)
- Innovation process - innovation development is managed and improved through a clear process, using a structured step-by-step logic to guide and manage innovation (Igartua et al., 2010; Cooper, 2011).
- Leadership and organizational culture - Organizations can provide enough freedom to allow the exploration of creative possibilities, but they also need control over the innovation process to manage it effectively and efficiently. Innovative organizations must adopt contrasting structures and attitudes as they move from initiation to the stages of implementation of innovation (Adams et al., 2006; Cooper, 2011).
- Resources – Resource management for innovation means providing adequate resources for people to explore ideas, and ensuring that people have the resources and space to develop opportunities of innovation (Igartua et al., 2010; Cooper, 2011).
- Human Resources - attract, recruit, motivate, reward and develop individuals are the backbone of effective resource management for innovation (COTEC, 2010).
- Knowledge management and intellectual property - knowledge management is concerned with identifying, translating, sharing and exploiting knowledge within an organization. Intellectual property is intended to protect the intangible goods created by the intellectual activity of the human being, and are owned by the companies or persons who create or own them (Teece et al., 1997; Tidd et al., 2005).
- Technology - organizations must be aware of technological developments since they can't always create their own solutions. Clearly, technology solutions may already exist elsewhere, and an innovative organization can simply adopt or adapt them through simple modifications to a new purpose (Roberts, 2007; Teece, 2007).
- Market connection - connecting to the market can make the difference between a good idea and a successful product, since without marketing and sales, a product innovation or a new service wouldn't attract the interest of customers (Igartua et al., 2010).

- External networks - the creation of innovation networks allows companies to reduce the costs or risks involved in developing new technologies or entering new markets, achieving economies of scale, reducing the time to develop and sell new products and to promote the exchange of knowledge (Tidd et al., 2005).
- Performance measurement - as with any other management aspect, innovation management requires adequate measurement systems to enable managers to calculate the impact of innovation activities on company performance (Adams et al., 2006; Saunila, 2016).

Innovation Management Standard

In Portugal, according to the Community Innovation Survey 2014, the SMEs were the companies that showed the lower rate of innovation activities and innovation results when compared with large companies and this survey also showed that they had more obstacles to innovate (DGEEC, 2016). To facilitate the innovation management process, the Portuguese Quality Institute created the Portuguese Standard 4457:2007 (NP4457) in 2007. The Standard presents the necessary requirements for a Research, Development and Innovation Management System (RDIMS). These requirements act as guidelines for organizations that recognize the importance of innovation. The standard is based on the Chain-linked Interactive Model, it is applicable to any organization, to any type of innovation and it is oriented towards continuous improvement (IPQ, 2007).

The NP4457 is divided into four sections. In the first section - Management Responsibilities, it is necessary to establish a Research, Development and Innovation (RDI) policy that guides the entire organization, and which must be aligned with organizational strategy. The RDI policy must be deployed in measurable objectives, to which are given responsibilities and methodologies for its implementation, so that later the organization's situation can be reflected and re-evaluated in the face of the results.

The RDI planning section involves planning for the detection of threats and opportunities through the interfaces, how you will capture and evaluate the ideas or opportunities arising and the management of the resulting projects.

The third section encompasses the implementation and operation of the RDIMS. At this point, RDI management activities that must be carried out by organizations, such as portfolio management and idea management, are identified by the standard. The organization shall also ensure the establishment of appropriate external and internal communication procedures, as well as registration and control of all documentation relevant to the RDIMS.

The fourth section refers to the evaluation of results and improvement and indicates that the organization should implement procedures to evaluate the results of the innovation process. One requirement of the standard is

that internal audits must be conducted, by people who aren't auditing their own work.

RESEARCH METHODOLOGY

This study aims to create a set of proposals that support the management of innovation in the company Gelado Colorido (which means Coloured Ice Cream), based on the NP4457 standard. This is a small company, belonging to the food industry. It was created in 2012, with the intention of offering its customers functional ice creams (an ice cream that has some health benefit). Given the high level of RDI associated with this type of products, the company intended to structure a RDIMS to facilitate the innovation process.

During the study, the perspective adopted was essentially positivist and the nature was essentially exploratory, insofar as it was based on established concepts and theories, although the approach is predominantly qualitative. In this case study, the collection of data mainly involved documentary analysis. The documentary analysis included the selection, treatment and interpretation of existing information in documents and was carried out in a systematic way and it was fundamental for the creation of the proposed system. This analysis mainly involved the NP4457, COTEC's guide to good practices for innovation management, the RDI activities manual by COTEC and the strategic analysis of the organization. Since the investigation took place in a business environment, and as a way of completing or confirming the information gathered in the documentary analysis, participatory observation and unstructured interviews were used. Participatory observation allowed to analyse the routines and procedures currently developed in the organization, while unstructured interviews allowed to understand the perception that employees had about innovation in the organization, specially the administration and the quality department.

THE INNOVATION SUPPORT SYSTEM

After analysing the reality of the company, an Innovation Support System was presented, divided into three components: Strategic Definition, Innovation Process and RDIMS Evaluation. This system is based on the Stage-Gate Model, on the Chain-linked Model and on selected recommendations and adjustments of the NP4457, which were deemed more adequate to the small firm under study. The Strategic Definition defines all the guidelines to the innovation process according to the organizational strategy. The Innovation Process includes four phases: Interface Management, Idea Management, Project Evaluation and Selection and Project Management. The phases aren't sequential, since the interfaces represent all internal and external communication of the organization's knowledge, and function as support elements to the internal process of innovation. The different phases are divided into several stages and control points/gates, which must be established during the Strategic Definition phase. The

stages represent the work done, while gates represent the decision making, which ensures compliance with the requirements necessary to move to the next stage. Given the high level of uncertainty to which innovation projects are associated, these divisions can mitigate uncertainty and control costs and time during their implementation. The number of stages and gates must be adapted accordingly with the uncertainty associated with the projects. Finally, the RDIMS Evaluation aims to detect all the failures and suggesting improvements, working as an input to the Strategic Definition. The following sections will define more clearly each phase, which were designed to address specific difficulties that a small firm faces and that can contribute to improve substantially the management of innovation in resource constrained firms.

Strategic Definition

The Strategic Definition delimits the scope of RDI activities and should have a reach not only in the short term but also in the long term. In order to make the system work, an RDI policy must be established and documented to help ensure the alignment of RDI activities with the organization's strategic objectives. In addition, the organization must define the RDI objectives. These objectives should be consistent with the RDI policy and should be SMART (SPI, 2013), specific, measurable, achievable, realistic and time-limited. The RDI policy and objectives should be regularly reviewed and updated, communicated and understood by the entire organization (COTEC, 2010).

The Strategic Definition also has the purpose of delegating the responsibilities of those involved in innovation, who need to ensure that all activities are carried out in accordance with the strategy established for the success of innovation in the organization. In addition to the person responsible for RDI, the evaluation committee should also be defined, which will be responsible for decision making during the innovation process.

The Strategic Definition should include the definition of strategic axis, so that the RDI portfolio isn't limited and can guide the employees at the time of suggesting ideas. The choice of strategic axis helps to delimit scope and can vary, for example in relation to the type of innovation, the degree of novelty or the level of risk/uncertainty. During the selection of the strategic axis, the resources must be allocated to each one of them, as well as the control points and their criteria and methods for selection should be defined. The criteria need to consider the type of projects it is evaluating, because not all projects are technology-based innovations or market related.

Innovation Process

Interface Management

The first phase aims to manage the different interfaces presented in the Chain-linked Interactive Model, to

ensure the circulation of knowledge between the organization and the environment that surrounds it. This analysis seeks to identify the agents of the external environment (macro and micro) that interact with the organization for the production of knowledge, as well as to detect the opportunities and threats that the organization faces. During this analysis it is also necessary to define which activities are crucial for the exchange of information, ensuring that these are planned, implemented, maintained and updated. Finally, it is important to establish procedures for collecting, documenting, analysing and treating, disseminating and valuing information.

The Chain-linked Interactive Model presents three distinct interfaces (technological, market, organizational) for capturing knowledge, and the organization should define the activities for each of them. The activities chosen for Interfaces Management will act as support activities for the internal process of innovation.

The Technological Interface encompasses all the activities used to guarantee Technological Surveillance, Cooperation and Forecasting. Technological Surveillance consists in the systematic observation of the surroundings with respect to the existing technology in the market and the technological advances. Technological Cooperation encompasses partnership activities with other institutions and organizations, with a view to sharing technical and scientific information and joint development of products and processes. Finally, the Technological Forecast consists of prospective activities focusing on the development of technologies of potential economic interest.

The Organizational Interface defines the activities or tools necessary to guarantee the creation or exchange of organizational knowledge, through Internal Creativity, Organizational Capacity and Knowledge Management. Internal Creativity includes the practices of harnessing and stimulating the internal creativity of the innovative company. Organizational Capacity refers to the design strategies for innovation. Knowledge Management consists of the practices of generation, validation, codification and diffusion of existing knowledge in the innovative company and management of external knowledge needs.

The management of the Market Interface consists in the identification of Internal and External Analysis activities, Intellectual Property and Analysis of New Clients, to ensure the necessary knowledge about the market. The Internal and External Analysis consists of analysing the internal and external context of the innovative company and its positioning considering relative strengths and weaknesses in the environment. New Customer Analysis covers observation and analysis of potential customers and new user markets. Finally, Intellectual Property refers to the management of the possibilities offered by intellectual property regimes for the protection, exploitation and dissemination of the results obtained in the innovation process.

Idea Management

The Management of Ideas comes from the Interface Management, that is, many of the ideas proposed arise through threats or opportunities detected in the environment in which the company is inserted. In an innovative company Internal Creativity must be encouraged, and therefore everyone must have the opportunity to give their opinion, as well as to receive feedback on ideas submitted. Initially the employees should register all their ideas, so they can be collected. The collection of ideas should allow the creation of a database or a repository which, in turn, will allow evaluation and selection based on the same criteria, and hence constituting pre-projects. The creation of the idea repository makes it easier for the organization to collect data needed for the evaluation of the RDIMS. At this stage, the criteria for the evaluation must be wide-ranging since there isn't much information about the idea. The criteria may be related to the strategic framework, the opportunity that the idea can give to the organization or the adequacy of the organization resources to the idea.

Project Evaluation and Selection

The Project Evaluation and Selection phase precedes the development of the innovation and should confirm the attractiveness of the project before there is a greater investment. This phase begins with the division of ideas into the strategic axis, so different types of projects can be separated and follow their paths according to the Strategic Definition. During this phase business plans should be created, which must translate the customers' needs into technically and economically viable solutions, for product innovations. Innovations that aren't product related should present their advantages to the organization considering the criteria defined for their selection, focusing on technical and economic feasibility. The selection of the projects must be made according to the strategic axis. The use of scoring models is recommended, once it allows a broader assessment, according to strategic objectives, than evaluations that are made only based on financial indicators. With the use of a scoring model, the selection criteria in the different axis can be adjusted to the characteristics of the innovations to which they refer. But pre-projects that are on the same axis should be compared according to the same criteria. The selection of the projects also depends on the resources that are available for each of the axis, as well as the number of pre-projects that are in each one. If there are no pre-projects on one axis, or the existing pre-projects don't spend the resources available, those resources can be transferred to another axis.

Pre-projects passing Project Evaluation and Selection will now be called RDI projects. At this stage it is still necessary to define the acceptance criteria for approval in the next phase/stage, as well as the role of project leader. Pre-projects that don't pass this phase are archived.

Project Management

Project Management involves all the activities that go from the initiation phase to the closing of the project. It is at this point that most of the project's resources are going to be spent. Each project is unique so the criteria to the gates must be adjusted to the projects. The initiation takes place during the project selection, with their approval. After initiation the project plan must be defined. According to the NP4457 each project plan must contain:

- description of the project, including identification of the problem to be solved, improvement, competitive advantage or anticipated benefits;
- identification of the team, necessary resources and estimated timeframes for the accomplishment of the project mentioned in the expected results (milestones);
- verification and validation activities, including, when appropriate, criteria for review, selection and approval of result;
- methods of controlling changes;
- identification of expected results;
- documentation of intellectual property necessities.

After planning, it comes the execution. Any kind of change that occurs in the project will require re-planning so that it is possible to analyse the impact it has on the project. Monitoring and control activities should be put in place to avoid as much as possible deviations. At the end of the project lessons learned should be presented, which should include a project performance analysis in relation to planning, considering the objectives, time frame and budget.

The stages recommended for this phase are represented by Development, Validation and Implementation or Commercialization. The Development, as its name implies, encompasses the development of innovation and it may include updating of marketing plans and financial analysis and resolution of legal issues. The Validation tests all feasibility of the project and it opens the door to the Commercialization or Implementation of the innovation, but there is still the possibility of the project failing or returning to Development. Lastly, the Implementation or Commercialization of the innovation.

RDIMS Evaluation

The purpose of the RDIMS evaluation is to verify the benefits achieved with the implementation of the innovation system, as well as the identification of proposals for improvement in the various processes, since the system isn't static and should be adapted according to the reality of the organization.

The organization should establish procedures that allow to evaluate the innovation system, as well as the results from each RDI project. In relation to the evaluation of the innovation system, the organization should ensure that there are methodologies for regularly documenting, monitoring and evaluating RDI activities and outcomes. It is necessary to understand if the RDI policy was

understood and followed, and the RDI objectives were achieved.

For the evaluation to be implemented effectively, it is advisable to evaluate the tools used, as well as to define metrics and indicators of innovation that help to perceive the state of innovation and the expected results in relation to the objectives initially proposed. When defining the metrics, it is necessary to consider the whole process.

According to NP4457, the organization should perform internal audits at planned intervals to determine if the RDIMS follows the provisions outlined and is maintained effectively. The organization should define those responsible for audits and ensure that they aren't evaluating their own work, and the selection of auditors should ensure objectivity and impartiality to the audit process. The auditors should prepare a report that should include corrective actions for detected nonconformities and their causes, as well as the deadlines for their implementation. After the audit and according to the established deadlines, the results must be verified and reported. Audits play a key role in the analysis of RDIMS, and its results should be included in the evaluation of results. The results can be divulged to demonstrate the progress made by the organization in this area.

CONCLUSIONS AND FURTHER RESEARCH

The innovation system created here is a starting point for the organization, and it must be adapted over time. The systematization of the innovation process can contribute to the growth of the company and its continuous improvement. Some of the advantages that stand out are: the better capture of ideas and valorisation of knowledge, the direction of innovation activities according to the established strategy and a better control over the various phases from the generation of ideas to the projects and the respective results. These are all aspects that are generally not properly managed in SMEs.

To make the most of this type of system, it is recommended to follow a set of best practices. Cooper and Edgett (2012), using studies carried out to companies in different areas on the best ways to manage the process between the generation of ideas and the launching of new products, suggest that: the process must be documented and actually used, should be made available all necessary resources to carry out the projects, compliance checks should be applied to confirm that the process is followed and the process should be adaptable. The decision makers should be defined, vary according to the risk associated with the decision and should prepare and be present at the meetings to contribute to the decision making. To improve the efficiency of the process, criteria must be defined for decision making, as well as the deliverables at each stage and the decisions taken must be supported by facts.

The system proposed here, although it was created for Gelado Colorido, is based on generic references and doesn't involve specific activities or characteristics of the

organization or industry for which it is intended, which makes it possible to adapt it to other SMEs that are interested in improving innovation management performance and/or in the NP4457 certification.

Due to the wide scope of the innovation theme there are several areas that could be further elaborated for the purpose of improving the RDIMS. Among the several areas that can be highlighted for future work are project management, with the implementation of a more elaborate methodology, covering all areas of knowledge allowing a greater advantage of the projects, as well as defining the best ways to create an innovative culture within an organization, in order to encourage the whole organization to participate in the innovation process.

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