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THE MATURITY LEVEL OF INFORMATION TECHNOLOGY MANAGEMENT TO SUPPORT INNOVATION WITHIN RESEARCH AND DEVELOPMENT (R&D) CENTERS IN BRAZIL

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ABSTRACT

Innovation is an important factor for R&D centers, it is the goal to be achieved in the development of technological projects. IT plays a fundamental role in this process. This paper seeks to understand the maturity level of IT management to support innovation within R&D centers in Brazil.

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Keywords: innovation, R&D center, information technology, maturity, strategic planning.

1. INTRODUCTION

Innovation is probably one of the most important issues discussed in nowadays. This topic has been debated in academic and professional environment, because it has the ability to turn the economy and bring competitiveness for companies (NAGANO et al., 2014).

The Oslo Manual (2005), Third Edition, states that this is treated as central topic, widely accepted, for the growth of product and productivity. Grizendi (2012) defines innovation from a Latin word "innovatus" being "in" meaning "move into" plus the adjective "novus", new. He concludes the concept as "the motion to seek the new."

In Oslo Manual (2005), the definition of innovation is based on its own classification of types, that is, innovation is to implement a new product or improve it significantly, is a new process, a new marketing method, or an organizational method in organization or external relations. The "law of innovation" in Brazil, dated 2005, defined innovation as to introduce something new or any improvement in the productive or social environment that results in a new product, process or service.

Innovation rarely happens in isolation way, but with different actors involved in this process, the government works to encourage the system through investments in workforce training, tax incentives laws, opening foment publishing and providing resources for innovative projects. The university, beyond preparing people giving high education, develops basic research, science, working toward the state of the art and the enlargement of the frontiers of knowledge and the industry is responsible for bringing many of the inventions to market.

In this context, gains increasing importance the well known open innovation, expression created by Chesbrough (2003). According to him, companies began to rethink the way they generate ideas and took them to the market. The companies were proud to generate, develop and commercialize ideas internally, from its R&D.

This was the ideal way to get success and protect the intellectual property rights. Chesbrough (2003) called this process "closed innovation". However, two

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main things change the mind of industries: the knowledge worker and venture capital financial capital provided to early-stage, high-potential, growth startup companies. Some industries start a movement in order to reduce the cycle of innovation, they begin the commercialization of external ideas, make partnership with universities, other industries and research institute. The boundaries between companies and the outside environment starts to be more porous, enabling innovation happen in different ways (CHESBROUGH, 2003).

Within this setting there is an important actor, whose main reason is to foster and generate innovation, supporting organizations in the pursuit of added value for their products, services and processes, R&D centers (MULYANTO, 2014).

They may be both internal to the company, being a department that supports the research and development of new technologies, new functions or new processes, but can also be found externally, in this case R&D center is a partner, an institute, an university or even another company. Usually these centers come together in an R&D network in a joint effort to develop and research the best solutions to the problems of industries (FABRICIO et al., 2014).

In some cases, the direction and management of technological projects are responsibilities of R&D centers of companies that eventually assist in the flow of knowledge and technology transfer.

The R&D centers are constantly challenged because they work in state of the art and technique, developing and researching issues, most of the time, not yet discovered, invented or mature for marketing. And because of this scenario they need to count with a series of high-level factors. Its employees are people who have accumulated and accumulate knowledge throughout academic and professional life.

The infrastructure should be another differential, high-speed intranet and internet network, system and software to allow virtual work, ways to storage the knowledge, control and management of generated artifacts (design documents, source code, software libraries, and others). In addition, several emerging technologies that are part of the daily lives of employees, such as smartphones, cloud computing, tablets and others.

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Due to the complexity of actors and necessary level of information, it is clear that Information Technology (IT) and its management within the institutes and R&D centers are essential for them to achieve their purpose of innovation.

The goal of this paper is to contribute to the understanding of how the management of information technology is being treated and views within the R & D centers in Brazil, the maturity of this department as support to generate innovation, the perception of researchers, engineers, project managers and IT professionals working in these centers. In addition, this paper would like to understand if the IT acts strategically, if it adopts some kind of governance framework, if properly support knowledge management, configuration management, and if IT is prepared for emerging technologies.

To achieve this purpose, it was done a literature review about R&D centers, focusing mainly on three areas of management: knowledge management; Configuration management; and the management of emerging digital technologies, big data and analytics, cloud computing, tablets, smartphones. Further, this paper made a survey with professionals working in R&D centers in Brazil to compare theirs opinion and perception with the literature review.

2. LITERATURE REVIEW

Information technology and management are critical success factors for innovation management (RAMPERSAD, 2012) and therefore essential for the purpose of R&D centers.

Manage the information technology within the R&D centers involves at least three management areas:

- Manage the knowledge, based on promoting ideas, inventions and get innovation, through socialization, externalization, combination and internalization (GARCIA-ALVAREZ, 2014);
- Manage the artifacts and the large amount of data created (configuration management) within the technological projects from the various partners and employees involved, requiring a fast, responsive, and controlled management (LINDKVIST, 2013);

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- And manage emerging technologies such as, big date and cloud computing (HASHEM et al., 2015).

To reach the target to management those three areas, R&D Center needs the support and directions from information technology.

3. R & D CENTERS

Lee (2014) pointed out in his work that R&D has been considered essential for the growth and survival of modern industries, mainly by constant and rapid technological change and the fact that knowledge is dispersed.

R&D centers have a key role in the innovation system of a country, they are an important actor that can assist organizations in the relentless pursuit of added value for products, services and process. Bergerman (2004) points out that R&D centers have the main requirements as innovation actors, multidisciplinary and high-level staff, quality certifications, professional project management, training of staff in graduate levels, master's and doctoral and multiple clients national and international. Bergerman (2004) argues that R&D Centers are one of the most solid pillars to build a virtuous cycle of research and innovation in a country.

All infrastructure around the R&D centers must be supported by information technology to ensure good communication, share of knowledge and improvement on productivity.

There are several needs of R&D centers for the management of IT, however, this article will focus on three basic points: knowledge management, configuration management and the management of the new emerging digital technologies.

Bergerman (2004) argues in his virtuous cycle of research-innovation that innovation and the creation of more wealth is based on the research and knowledge generation. The knowledge will lead researchers to develop something new. The basis for innovation is the knowledge, thus to know how to manage it is essential within a complex environment.

In this context, Nonaka and Takeuchi (1995) indicate that the process of knowledge management should be based on knowledge spiral:

- Socialization (tacit knowledge transmission from person to person through interaction)

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- Externalization (transformation of tacit knowledge into explicit through language or other representative form)
- Internalization (movement against the externalization is the transformation of explicit knowledge into implicit)
- And the combination (it is the combination of different explicit knowledge that results in the creation of more knowledge)

According to Garcia-Alvares (2014) to obtain better results with knowledge manage is relevant the use of information technology. In a case study, the author found that the use of IT allowed that the knowledge could be encoded and transmitted to a larger number of people, thus generating greater innovation capacity.

For each of the spiral stages the author proposed an IT tool that supports the process and at all stages the technology had a positive effect on the studied company, which brought productivity gains and facilities in the decision-making process.

A center of R&D requires a server infrastructure and internet network that facilitates the integrated work of the various partners. The development of complex projects and the involvement of various parties will require a configuration management that is able to make the traceability of changes made, check where possible problems occur, diagnose them and to recover when necessary (LINDKVIST, 2013). Using technology is possible for the company to adopt a particular change, check a baseline that led to a major project delivery, produce reports on the development, to recover from certain serious problem wrongly included in the system (XU, 2013).

Finally, the high-level R&D centers need to manage the new digital technologies. Oldham and Silva (2013) argue that the computing devices have the potential to contribute to creativity and idea generation of employees of an institution and therefore assist in the innovation process. According to the authors, as more devices are exposed to the developer more employees feel supported and more they will be able to connect to other internal and external partners, improving the quality of the ideas they generate.

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Oldham and Silva (2013) list some of these devices, for example, communication tools such as email, instant messaging, voice messaging; electronic conferencing tools such as data conferencing, voice conferencing, discussion forums; collaborative tools such as file sharing, group calendars; and social networking tools such as Facebook, Yammer and Chatter. The counterpoint are the risks related to large exposure of employees to various computing devices, including the huge amount of information, which can brings together with stress, difficult for combination and collection and the reduction of casual conversations face to face, all these risks should be managed, observed and investigated (OLDHAM; SILVA, 2013).

In addition to the mentioned devices and technologies, many others appear constantly, which requires recycling from IT staff in order to handle with the diversity of technologies. The retraining of IT team will help it to analyze scenarios and critically add some tool or system that allows the reduction of costs within of R&D centers.

An examples of possible cost reduction is the emergence of cloud computing, it can reduce or even eliminate the need for maintenance of computer hardware, dedicated physical space and management software (HASHEM et al, 2015). The big data is another emerging technology that, not only requires appropriate tools to process the volume and the variety of generated data, but also need new profiles of IT professionals who can work with new tools related to this topic. The combination of cloud computing with big data is already a reality that has been studied (HASHEM et al., 2015).

4. METHOD

To understand the maturity and strategies adopted in the management of information technology as support for generation of innovation in R & D centers in Brazil, it was chosen the use of quantitative method, through a survey.

The variables used in this survey are related to the maturity of IT to support innovation and whether IT is actually being used strategically by R&D centers.

A major factor for the survey is the search for a varied sample that considers not only IT professionals working in these centers, but also include the opinion of those that are supported by IT management, as researchers and engineers, project managers, decision makers and R&D directors.

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This research is descriptive, in other words, it seeks to identify opinions of a population in order to confirm the literature review about the importance of IT for R&D centers and if IT is being used as strategic for generation of innovation.

The sample was obtained through non-probabilistic method by convenience. The participants were chosen to be available, combined with the method of networks ("snowball"), it means that some key participants are identified and added to the sample. From them, it is asked if they know other people to help in the collection of opinions, when then, these others are also included in the sample (SAMPIERE, 2013).

Although the sample size definition is complex and difficult to measure, it was decided to follow the suggestion of Sampiere (2013) when he says that the minimum sample size suggested for observations is around 30-50 cases.

A Likert scale was used for responses from participants.

5. RESULTS AND DISCUSSION

This section of the paper presents the results of the survey with different professionals working within the R&D centers in several Brazilian companies. The goal was to understand if the perception of them confirms the aspects defended by authors from the literature review, if IT has a key role to generate innovation. Moreover, the paper sought to assess the maturity of IT within these centers, if it is treated as strategic, if IT professionals are prepared for the new trends and difficulties faced by IT to support the innovation process.

The first observation of this survey was concerned to the selection of the sample. Although it was not probabilistic, the intention was to get advice from different professionals of different levels (strategic, tactical and operational). In addition it was considered the opinion of those employees who are directly involved in IT management. Participants were diversified, containing five (5) researchers, five (5) engineers, three (3) project leaders, seven (7) project coordinators, eight (8) project managers, three (3) R & D directors five (5) IT engineers, seven (7) IT analysts, one (1) IT manager and one an IT director. The sample had 45 participants and no disposal.

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When asked if IT is strategic to the process of innovation, the sum of responses that agree or strongly agree exceeded 70%, which demonstrates a clear perception of professionals working in R&D centers of the importance of making a good IT management and it should be aligned with the company's business strategy. This confirms the literature review about correlating IT with innovation (GARCIA-ALVAREZ, 2014; RAMPERSAD, 2012; LINDIC, 2011).

The questions related to the potential of IT to transform the way people work, most responded agree or strongly agree, and largely agreed with the importance of IT to the business today, three years from now and five years from now.

As innovation and knowledge are intrinsically linked according to the literature review, the survey asked whether the knowledge management technologies had some impact on the work of R&D centers and most of 76 % said yes, the technologies used in knowledge management impact the current job, no surprises and it confirms the studies.

In contrast to this view that IT is strategic to the process of innovation, the results show that IT is not treated with proper care and maturity, because when asked if the institution had a clear and coherent IT strategy to support R&D the sum of the responses disagreed or totally disagreed was 42%. Including those who responded that neither agree nor disagree, this number increases to 66%. However, 31% of the result agree that their institutions have a clear and coherent strategy for IT to support R&D activities.

Tonelli (2014) proposes the use of the Balanced Scorecard (BSC) as a method to make the alignment between the strategic planning of IT and strategic priorities of the company's business. He says that with the use of the BSC was possible to obtain the support and involvement of relevant stakeholders outside the IT functions, so expanding the boundaries of IT. This can be a solution to be adopted by companies that feel they have no clear and coherent IT strategy to support R&D activities.

Do not have a well-defined strategy to support R & D activities may explain part of the sample discontent with the support that IT is giving them currently. Only 18% agree or totally agrees with the support that IT provides in nowadays to their activities.

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This also explains why the majority understand that the leaders do not encourage the pursuit of innovation related to IT that can improve the work. Only 16% of respondents agree or totally agree on encouraging leadership for innovation in IT.

Asked about the impact of new digital technologies as smarphone (mobile), collaborative and social technologies, analytical data (big data) and cloud computing, most replied those emerging technologies has impact or much impact. In the case of mobile 66% answered that has impact or much impact, for collaborative and social technologies 58%, for cloud computing 55% and 49% said that analytics and big data has impact or much impact. Those answers are according to the literature review.

Whereas many emerging technologies, the survey also had the interest to know if the IT staff would be prepared to deal with so many new and would be ready to respond to new trends. Most of response was no, they are not confident that the IT team is prepared to deal with emerging trends and technologies, 51% said they disagreed or totally disagree totally with the statement. And if added those who neither agree nor disagree, the number goes to 69%.

The answer to that question is at least curious when contrasted with the responses of the use of emerging technologies of mobile, collaborative and social data and analytics and cloud computing. If the IT staff is not ready for new trends, who is responsible for new emerging technologies? This leads us to believe that the team of researchers and engineers work together with IT or even that they work by themselves on a solution to meet their needs within the project. This is a point that needs to be explored qualitatively within R&D centers, however the next two questions may help to clarify.

The survey asked about which levels are effectively involved in the management of IT resources. The result shows that there is an involvement of strategic, tactical and operational level. In this issue 9% said that the president is directly involved with the management of IT resources, 4% indicated the vice-presidency, 44% the board, 69% management, 56% operational staff and 5% said they did not know.

Also, the survey asked how the company implements new IT services. The result shows that there is no single way, several experiments are performed and

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research groups appear to be involved as well. The responses obtained from this question were: 67% said the implementation is top-down, coming from a group of senior leaders of the organization, 22% indicated bottom-up, coming from different groups within the organization, 24% state that the implementation is part of a pilot projects or experiences and 11% said they did not know.

The survey still investigated if IT management used any framework for managing information technology. 47% answered no, but it is noted that the main frameworks (Information Technology Infrastructure Library - ITIL, Control Objectives for Information and Related Technology - COBIT, International Organization for Standardization / International Electrotechnical Commission - ISO / EIC, Project Management Body of Knowledge - PMBOK and eSourcing Capability Model for Service Providers - eSCM) appeared in the survey, demonstrating that R&D centers use IT governance in their daily lives.

Finally, to complete this discussion about the result of survey, it was asked which are the greatest obstacles preventing the IT to be more active and innovative, for each of the respondents were asked to select at least three obstacles. The most frequently mentioned items were the lack of political and well-defined strategy, cost and lack of agility of the organization.

6. CONCLUSION

This article aims to explore the importance of information technology and its management as support for the generation of innovation in R&D centers through a literature review and the perception of the people working in these institutes. What became evident was that in fact the information technology is an important factor to ensure the good work of R & D centers and should act on knowledge management, configuration management and management of emerging technologies. Those three management should be supported by IT in order to facilitate and engage R&D team.

Although it makes extensive use of information technology, it was found that there is still much room for improvement. Some answers demonstrate that IT is not fully aligned with the business strategies of the R&D team, the IT is seen as mere support, when it should be strategic and support the plan of the company incisively. Studies propose the use of Balanced Scorecard to improve this item and can help

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R&D centers to make an alignment between business strategies and Information Technology.

It is observed the growing demand for new work processes and new tools that are able to innovate the way the research and development of technological projects can be done and for this, to have a qualified IT staff and able to meet those demands can be the difference for these institutes.

The conclusion is that IT is important for the purposes of R&D centers, but it should be strengthened with the participation of the strategic planning discussion and tracing its goals in accordance with the guidelines defined for whole institution.

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