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SME'S INNOVATION CAPABILITY AS A RESOURCE TO MEET FUTURE LOGISTICAL DEMANDS OF BRAZILIAN OIL INDUSTRY

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ABSTRACT: The aim of this study is to systematize the knowledge related to the innovation capability of the small and medium enterprises (SMEs) operating in the exploration and production (E&P) of oil and natural gas in Rio de Janeiro state (Brazil). This systematization consists in the early stages of a larger study, which aims to formulate a reference model oriented to the evaluation of the innovation capability of these SMEs, focusing on a maturity trajectory. This model can guide innovation efforts of these companies in order to meet future technological and logistics demands of oil E&P in the Brazilian offshore.

KEYWORDS: Innovation, capability, SME, Oil and natural gas, Brazil, Logistics

INTRODUCTION

The petroleum was, throughout the twentieth century, the main source of energy in the global energy matrix. And its prominent position tends to remain, at least during the first decades of this century. Although losing ground to cleaner and renewable energy sources, oil and natural gas will still be a majority in the energy scenarios as mentioned by [1].

According to [1], a study made by the International Energy Agency (IEA), between 2006 and 2030 there will be a 45% increase in global energy demand. Oil will lose its share by about 4% in the world energy matrix, but global consumption will grow from 80 million (2006) to 106 million (estimated for the year 2030) barrels per day (bpd). In Brazil, the situation will be similar. There will be a decrease in oil demand from 36% (2008) to 27% (2030). However, in the same period, consumption will increase from 1.95 million to 3.0 million bpd.

The same study indicates that, considering only existing producing oil fields and its natural decline, a world production is projected for the year 2030 of 31 million bpd. With an estimated global demand of about 106 million bpd, the deficit of 75 million bpd could be partly supplied by the improvement in recovery factor from existing fields.

Still, the greatest increase will occur through the incorporation of new oil discoveries, with volumes able to meet the anticipated demand. Brazil hopes to meet part of this deficit through the exploitation of the reserves located in the region of the "pre-salt" layer [1]. Thus, it is observed that the discovery of oil in this region becomes relevant not only nationally but also in the global scenario.

In Brazil, it was agreed to call "pre-salt" to a group of rocks located in the marine portions of most of the Brazilian coast of because these are a rocky range that extends beneath an extensive layer of salt. The region of the pre-salt's oil province is located in the Brazilian Continental Shelf and extends from the coast of Espírito Santo to Santa Catarina, an area of approximately 149,000 km². Its area of occurrence, whose oil potential does not equal to any other so far discovered in Brazil, represents around 2.3% of total sedimentary basins (land and sea), totaling 6.4 million square kilometers [2].

Total reserves of the pre-salt layer are not fully known. However, considering solely the potential volumes announced and yet not fully quantified, a volume of oil is estimated that is capable to double current Brazilian reserves. These fields can produce more than 1.8 million barrels per day (current production is about 2.0 million) until the year 2020. In that same year, the total production of the country should be around 4.0 million bpd [1].

However, oil and gas exploration in this region constitutes a complex problem. There is a huge range of logistical and technological challenges that must be overcome [1]. It will take high financial resources for the implementation of production projects, training of manpower, qualification of the

service sector, and, finally, for the technological improvements focused on cost reduction and economic feasibility of exploration and production (E&P) of the oil and gas in the pre-salt region [3].

LOGISTICAL CHALLENGES IN THE E&P OF PRE-SALT LAYER REGION

The offshore exploration, development and production of oil and natural gas are a reality of the Brazilian oil industry [4]. However, exercising these activities in ultra deep waters is still a challenge. With the exploitation of pre-salt, the situation is even more challenging. Among the technological and logistical challenges related to the exploitation and production of oil and gas in this region, some of the most significant are: to overcome the distances between the location of the discoveries and the shoreline (on average approximately 300 km) to reach the depths of the reservoirs (between 5000 and 7000 meters); and to overcome the thicknesses of the water depth (between 1500 and 3000 meters) and the salt layer (of approximately 2000 meters), besides the high concentration of CO₂ in the region [2]. A representation of some of these challenges is shown in Figure 1 [1].

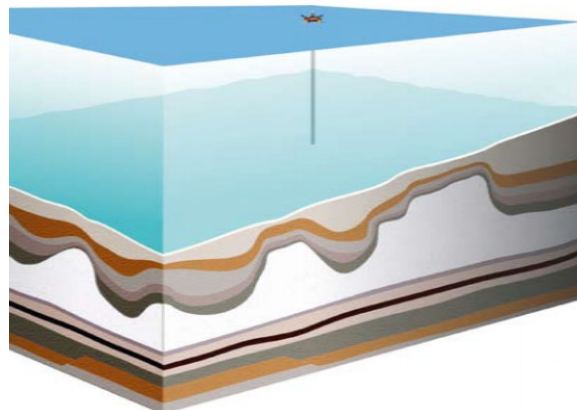


Figure 1 - Graphic representation of Pre-Salt scenario

The State of Rio de Janeiro plays a central role in any discussion of the exploration and production (E&P) of oil and natural gas in this region mainly due to two reasons. Firstly, because it is an economic issue, since the growth of the State of Rio de Janeiro has been strongly driven by oil and natural gas [5]. In 2009 the State of Rio de Janeiro was responsible for the production of 85% oil and 54% of natural gas in Brazil [6]. These volumes come from the region called Campos Basin, located on the northeast coast of Rio de Janeiro State [5,7]. Small and medium enterprises (SMEs) installed in this region are located in Brazil's most important oil region and constitute a network of service providers to support the sector. These companies are found in the final phase of the productive chain of the oil industry, primarily developing intensive services in engineering and technical activities, such as systems and complex components integration; equipment and operating systems maintenance; and services associated with the development of offshore activities as well logistical and supply chain partners [8].

Secondly, because it is a logistic issue. It should be noted that even though the logistical and technological "macro challenges" of pre-salt have already been mapped, it is not entirely clear what the role of the industrial cluster of Campos Basin in this scenario will be. The region has over 30 years of experience in offshore E&P, and the major operators - especially PETROBRAS - have a long history of overcoming great difficulties, especially when related to the water depths.

In this sense, Campos Basin's oil and gas industrial agglomeration has emerged as the most probable origin of the companies that possess the know-how for the development of logistical and technological capabilities necessary for the exploration of pre-salt. However, the SMEs providing services to the sector are traditionally seen as mere consumers and importers of technology. The sector is not considered innovative and has been viewed as generally developing improvements or small incremental innovations. However, the scenario of the pre-salt will require a new technological dimension in Brazilian E&P.

Associated with this perspective, a range of difficulties and challenges for the SMEs will arise. It will take not only new technologies, but also new products, processes, logistical and supply chain management methods as well organizational structures. This new era in the E&P can also bring opportunities for a competitive leap ahead of the Brazilian oil industry to the international market.

On the other hand, when dealing with major operators in the industry, it is known that there is a great hub of technological development located in the Technological Park of Rio de Janeiro Federal University (UFRJ), in the city of Rio de Janeiro. This technology center has provided a large amount of knowledge for the oil sector through the generation of new technologies, patents, products and processes, and also through academic and technical productions. But there are still few and incipient studies linking SMEs from the oil and gas sector of Campos Basin with innovations - whether technological or of any other nature. As a result, little is known about the current state of innovative capability of SMEs located in the Campos Basin facing these challenges.

THE INNOVATION CAPABILITY IN THE CONTEXT OF SMEs

Innovation has currently been widely disseminated as a great competitive advantage, for large and small or medium companies. This has been even more pronounced for those which are - or want to be - inserted in a global economy increasingly based on knowledge [9]. We adopt the definition that "Innovation is the multi-stage process whereby organizations transform ideas into new/improved

products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace” [10].

However, innovation in SMEs has traditionally been treated by the literature in two ways: (i) essentially discarded or neglected [11, 12], based on the questionable assumption that SMEs do not innovate - whether by choice, by market constraints (and competitiveness) or intrinsic limitations inherent in these organizations. Or, more commonly, (ii) indirectly and scarce [13, 14], addressing it in a reductionist and limited approach.

Given these prospects, we believe that studies of innovation in SMEs remain fragmented and are generally focused on individual case studies. Little attention has been given to sectors or industries where innovation factors are studied in these companies [12].

Both aspects described have caused myopic views on innovation in these types of organizations. This has occurred especially when the approach is limited to trying to measure, quantify or determine the degree of innovation in an SME using quantitative indicators classically associated with technology-based innovation derived from internal research and development (R&D) process (as the production of patents, for example). However, in more recent texts, the idea of the practice of R&D as a factor inducing innovation has been questioned and minimized.

Given these statements, we understand that innovation (in a broad sense), when considered as a process - i.e., something that can be presented as a discipline, be learned and practiced [15] - has traditionally been driven by mechanisms associated with “Innovation Management”. This body of knowledge has gained increasing strength and impact in the literature of engineering, management and economics, since innovation is no longer understood as something chaotic, unexpected, occasional and sporadic, to become a rational, continuous and manageable process by the organization - like others already widely consolidated - such as quality management, human resources policies and strategic planning [16,17].

The tools, mechanisms and processes associated with innovation management brought major contributions to the understanding of this field of study. But they also have some limitations which are more striking in the context of SMEs. Among them are two essential premises:

- a) *Understanding innovation as a process:* The central premise of innovation management is the fact that innovation should be understood as a rational and continuous (not sporadic) process which is continuously managed within the organization, in order to generate results. Despite the clear benefits from this approach, such as management mechanisms focused on fostering, selection and implementing ideas and knowledge, this premise assumes that the organization is innovative - or at least, is able to innovate. Therefore, it isn't attractive to SMEs that are unable to establish an internal and formal process of research and development or whose businesses are not based on products and processes highly dependent on complex technologies.
- b) *Assume the existence of a portfolio of innovations:* This issue is a natural consequence of the first premise. Once the organization has innovated (or is able to innovate), and this process is continually pursued and managed, it is safe to assume that this organization has a portfolio of innovations that should also be managed. Again, this type of approach also reveals not very coherent with the reality of the SMEs located in the Campos Basin industrial cluster. Even for those who innovate in an objective way - but occasionally - to consider the existence of a portfolio of innovations, and as a consequence, the need for management of it, may be somewhat unrealistic.

Therefore, taking into account the issues raised, we define innovation capability “as an organizational property that underpins an ample flow of multiple, value-creating and novel initiatives” [18]. Although there is a potential difficulty in distinguishing between innovation efforts that are not based formally on R&D and daily activities of these companies [13], we believe that SMEs - even those little intensive in R&D - are able to innovate. Furthermore, we assume that a consistent approach to innovation capability - in detriment of “innovation management” - is a more appropriate perspective when we intend to study innovations in the context of SMEs.

A possible solution to the standoff between the perspectives of “innovation management” and the acquisition of “innovation capability” - the second suggested here as a predecessor of the first - can be found originally in [13]. This work seeks to identify the types of innovation and the innovation capability factors in enterprises, focusing on SMEs of both manufacturing and service industries as well in logistical processes. It also minimizes the importance of R&D as a factor inducing (or as a necessary condition) for the development of innovations in these organizations [13].

ASSESSING THE INNOVATION CAPABILITY IN SMEs

Traditional perspectives have been adopted in studies and research aimed at preliminary assessments of the degree of innovation, or of the innovation capability of organizations. Generally, these perspectives seek to draw a diagnosis of an organization current capacity to innovate, with a focus on structuring an environment conducive to expansion of this capacity and, in a given time horizon, the management of innovations arising from this expansion [16,17].

Here we make a distinction between the meanings of “capabilities”, “resources” and “capacity” of an organization. Resources are stocks of available factors owned or controlled by an organization, whereas capability refers to the ability to implement these features [13]. Thus, the capabilities are critical in the provision and maintenance of competitive advantage and strategy implementation in organizations. As a result, the capabilities are introduced as a transformative ability between resources and objectives of innovation [13].

We can see a historical trend in the identification of “dimensions” that are supposedly capable of representing the innovation capability of an organization [17,18,19]. These dimensions are usually associated with a traditional and compartmentalized view of the organization. Below is a list that the dimensions that most appear in the literature: Strategy [16,17,19,20,21,22,24]; Processes [4,16,17,19,20,21,22,24,25]; Structure [4,16,17,20,21,22,24,25]; Culture [10,16,19,21,26]; Relationships [4,5,16,17,25,27]; Leadership [16,19]; Learning [10,16,17,22,24,26]; People [4,5,8,10,16,24,25,26,27]; Finances [4,5,12,16,22,25,27,29] and Market [8,12,22,24,28,29].

The vision of dimensions presents two basic problems: the first, it is the compartmentalized view of the organization, where each dimension represents, usually, a department. The second is the fact that the idea of evaluating innovation through these dimensions is also associated with a linear and traditional view of the innovation process, which, as we have previously shown, is not very suitable for SMEs little intensive in R&D activities.

Recently, new perspectives and more adherent to the reality of SMEs have been adopted, focusing on multidimensional innovation capabilities. According to [30], the lack of multicultural competence and multicultural sensitiveness also impacts in leadership and organizational success. The sensibility to the cultural dimension, for example, helps understanding many crucial factors concerning business around the world [31]. In this sense, according to [32], based on a multicultural perspective, decision-making for a variety of business areas and services, including innovation, depends on different assumptions among countries and cultures. Table 1 indicates, a summary of some parameters related to the innovation capability [13,26,33].

Table 2 - Innovation Capabilities

	Reference		
	[33]	[26]	[13]
Innovation Capabilities	<ul style="list-style-type: none"> <input type="checkbox"/> Meaningful work; <input type="checkbox"/> Risk-taking culture; <input type="checkbox"/> Customer orientation; <input type="checkbox"/> Agile decision-making; <input type="checkbox"/> Business intelligence; <input type="checkbox"/> Open communication; <input type="checkbox"/> Empowerment; <input type="checkbox"/> Business planning; <input type="checkbox"/> Learning organization; 	<ul style="list-style-type: none"> <input type="checkbox"/> Company culture; <input type="checkbox"/> Learning organization; <input type="checkbox"/> Human resource; <input type="checkbox"/> Idea generation; <input type="checkbox"/> Knowledge management; <input type="checkbox"/> Technology focus; <input type="checkbox"/> Cross-functional integration; <input type="checkbox"/> Knowledge dissemination; 	<ul style="list-style-type: none"> <input type="checkbox"/> Capabilities for knowledge exploitation; <input type="checkbox"/> Entrepreneurial capabilities; <input type="checkbox"/> Risk management capabilities; <input type="checkbox"/> Networking capabilities; <input type="checkbox"/> Development capabilities; <input type="checkbox"/> Change management capabilities; <input type="checkbox"/> Market and customer knowledge;

As a part of the research currently underway, we are seeking a way to integrate the perspectives of both dimensions and capabilities. The fundamental premise adopted is the proposition that the dimensions are associated with a classical view of large organizations and their innovation processes (associated with innovation management), while the second reveals a reality more adherent to the context of innovation in SMEs (the acquisition of innovation capabilities).

For this we are developing a set of indicators able to translate the “requirements” of each dimension into innovation capabilities. The starting point (conceptual base) are these dimensions, and from there the whole process of indicators construction is “mediated” by the characteristics and nature of SMEs’ innovation capabilities [13,26,33]. Thus we integrate two strands of literature that, although not completely different, are not entirely compatible.

Simultaneously, we are mapping the particular characteristics of SMEs located in the Campos Basin region and engaged in the oil and natural gas E&P. After identifying the profile of these companies, we can adapt the reference model which will be proposed. The idea here is to understand how the technological and logistical difficulties related to pre-salt layer E&P will impact the reality of SMEs that will operate in this sector. Also, it is important to understand how those organizations deal with multicultural challenges that emerge concerning the scenarios in which they develop their activities. Within this framework we can understand the challenges facing these companies and propose a course of evolution and a maturity trajectory in their innovation capabilities so they will be able to overcome them in the future.

CONCLUSIONS

The theme of “pre-salt” will be recurring in the Brazilian academic literature in the coming years. However, it should be treated with caution. Given this warning, this study aspired to contextualize the reality related to the technological and logistical challenges associated with E&P in the pre-salt layer through some delimiters parameters. The main delimiter parameter here is the idea

that understanding the “drivers” of innovation capability of SMEs may be an important tool in the process of overcoming these challenges. This perspective gives us advantages and disadvantages.

The main disadvantage is the inability to approach the problem from an extremely technical viewpoint. On the other hand, this same disadvantage constitutes the main feature of the research, and as a consequence, in its contributions to the literature. Firstly, this research breaks a common academic paradigm (especially in Brazil) when associate the SMEs of Campos Basin with the theme of innovation and technological development. It also proposes an expansion of the discussion (still considered underexplored in Brazil) on the issue of innovation capability and on multicultural organizational competence.

We suggest a more extensive and profound study on the subject. The literature has showed that there is still room in the literature for a detailed search for a definition for innovation capability that is more adherent to both: i) the perspective of the disciplines of innovation and technological development in high-technology companies and/or practitioners of internal R&D; and ii) the perspective of innovation in SMEs, since their realities are quite diverse and heterogeneous, especially when compared to the large innovative organizations, linking that issue to multicultural sensitivities.

Another question that remains open is referred to the relevance (or not) of the reference models for the innovation capability. There are several in the literature, like those presented in [18,34,35,36], and this leads us to question whether these models are really useful or practical. Or, if they are feasible but do not bring significant results to organizations that use them.

This concern has permeated all the research that is being developed. It is our intention to find a common link throughout the reference literature, incorporating the qualities and advantages of available models. A very important issue since the beginning of the study was the fact that we consider counterproductive to provide “just one more” model for the literature, which is filled with many others. So, in this article the term “reference model” was intentionally not blatantly used, since we know that our work, still in the initial phase, will require a complex and detailed validation process. We understand that the term “reference model” has been used indiscriminately, often losing its own meaning. Therefore, we use this terminology quite cautiously, recognizing that our work is still in development.

However, we can already say that in a more practical sense, innovation capability is a collection of resources that can lead to innovations, as having the ability to produce does not mean that the capacity is used. In other words, we agree with [37] when the author states that innovation capability is important because it is necessary, but not sufficient, for innovation to happen.

As questions still open and proposals for future work, we suggest two approaches to be explored: the understanding of how innovation capabilities vary across different levels of maturity and life cycles of SMEs, and understanding the extent to which the innovation capabilities are different between SMEs and large enterprises, with especial attention to the oil industry. We believe these issues are relevant to the construction of a maturity trajectory associated with the innovation capability of SMEs.

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