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BARRIERS AND INNOVATIVE ACTIVITIES IN THE INNOVATION PROCESS OF SMES IN CEARÁ

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Abstract

While the impacts of innovation, the obstacles and the incentives to innovations successful implementation, have been amply studied in industrialized countries, this subject has been rather neglected in less developed nations. Therefore, this work has the general objective to describe and confirm the major barriers to innovation which affect innovative activities of SMEs in the Brazilian State of Ceará. In methodological terms, the analysis is based on a survey dataset provided by National Industrial Apprenticeship Service of the Regional Department of Ceará (SENAI) "Serviço Nacional de Aprendizagem Industrial". Statistically, we use descriptive statistics and confirmatory factorial analysis. The main results points that the most significant barriers that hinder the development of innovation are the high costs of innovation, followed by the lack of skilled workers and employees.

Key words: Barriers to innovation, innovative activities, SMEs

Introduction

Innovation is the continuous development and improvement of products and production processes. It has been widely recognized as an essential part in the development of companies to ensure their competitiveness in an increasingly global market (GALIA; LEGROS, 2004; STOREY, 2000). The importance of innovation in promoting economic growth and industrial development of countries is well emphasized in the literature (DAVELAAR; NIJKAMP, 1997; FRENKEL; SHEFER, 1997). It has become clear that innovation is a key aspect for the development of a country's economy (FREEMAN et al., 1982; NIJKAMP; POOT, 1997). In the recent decades, governments implemented policies to stimulate and enhance the innovation process, sometimes with limited success. Thus the study of innovation and barriers to their successful implementation are of great importance for efficient economic policies.

Although in certain cases barriers to innovation may act as stimulants for new developments it is widely accepted that barriers to innovation usually have negative effects on the economic performance and development of a company (HADJIMANOLIS, 1999). Public policy, that stimulates innovation projects, can help to improve the companies' competitiveness and their survival. The economic strength in turn directly impacts on country's job market and its economic viability (HADJIMANOLIS, 1999).

The globalization of the markets requires the adaptation of companies in order to survive. To stay competitive on an international competing market even small and medium companies continuously have to improve their productivity and quality by taking advantage of new technologies. Innovation is a difficult undertaking, especially for companies with little experience and limited resources (HADJIMANOLIS, 1999).

Hence, this study tries to advance in the understanding of the relationships between innovation activities and barriers to innovation. It aims to describe and confirm the major barriers to innovation which affect innovative activities of small and medium enterprises (SMEs) in the Brazilian State of Ceará. This study uses the descriptive analysis to find and characterize the major features of innovative activities and barriers to innovation and use confirmatory factorial analysis to classify the types of barriers.

This paper, after this introduction, is structured as follows. In section 1, concepts of innovation, innovation activities and barriers to innovation relevant to this study are presented. The methodology is described in section 2. Next, we present the results analysis. The conclusion close this paper with the main interpretation of the data results.

1. TECHNOLOGICAL INNOVATION

The major paradigm for technological innovation still used today was established by Schumpeter during 1950s (NELSON, 1982). This model is characterized by economic scarcity where ideas, innovation and technologies compete for resources (FRENKEL, 2003).

Schumpeter's concept of innovation, covers five situations:

a) the deployment of a new or substantially improved product;
b) the development or introduction of a novel or substantially improved manufacturing technique for an existing product;
c) the opening of a new market in which other companies from the same industrial sector are not operating yet. This market may have existed before or not;
d) the acquisition of a new phase inputs;
e) the establishment of a new industrial organization, either by creating a monopoly, or by fragmenting a monopoly.

Technological innovation involves mainly the improvement of products and processes i.e. the introduction of new or significantly improved products or the implementation of novel manufacturing techniques (FREEMAN; SOETE, 1997; OECD, 2005).

A vast amount of literature is devoted to the study of innovation in small and medium enterprises, but most of the results are related to barriers of innovation that companies face in developed countries. Several studies have shown that SMEs contributed considerably to the economic development during the last centuries (ROTHWELL, 1994). Thus, it is of great importance to analyze their influence on the economy of developing nations. SMEs have become increasingly competitive during the last decades due to their flat organizational structure and higher flexibility compared to large enterprises. This flexibility enables SMEs to react to fast market shifts and tie closely to their customers (ROTHWELL, 1994).

1.1 Innovation Activities

Innovative activities have to demonstrate the efforts of companies to innovate (CGEE, 2009). This mainly relies on creativity, cooperative efforts, organizational changes and new ways of market relationship (FALK, 2006). Following Oslo Manual (OECD, 2005) innovation activities are:

a) **Research and experimental development**: which can be subdivided into in-house R&D and acquisition R&D. In-house R&D are internal efforts undertaken by the company itself to increase knowledge and to develop new applications. Acquisition R&D means the acquisition of knowledge from other organizations;
b) **Acquisition of other external knowledge**: this type of knowledge is mainly related to the licensing of trademarks or patents;
c) **Acquisition of machinery, equipment and other capital goods**: in order to improve the product manufacturing process;
d) **Other preparations for product and process innovations**: activities which are correlated to product and process innovations, such as design;
e) **Market preparations for product innovations**: the introduction of new or substantially improved products (goods and services) on the market;
f) **Training**: professional qualification linked to the successful innovation implementation.

A general paradigm in literature on innovation in SMEs is that the smaller the company, the less likely it is to embrace innovative research and development by itself. The amount of money spent in R&D usually rises with company size (COHEN; KLEPPER, 1996). This relation between company size and investment in R&D suggests that there is an under allocation of R&D investment in SMEs. Acs and Audretsch (1991) however note, that small enterprises contribute more than twice as many innovations per employee than large enterprises do. Furthermore, Plehn-Dujowich (2006) finds that on average, smaller companies obtain three times more patent citations per dollar as larger firms. Thus innovation activities in smaller enterprises seem to be much more efficient than in large enterprises.

Aghion et al. (2007) report that, in industrialized countries, SMEs undertake greater efforts to improve products and processes than large enterprises. In turn, innovation requires to overcome internal and external barriers which seem to be easier in companies with less employees.

1.2 Barriers to Innovation

Barriers to innovation for SMEs have been widely studied in the literature. SMEs can foster an environment encouraging innovation, technological progress and entrepreneurship if they perceive how to overcome the barriers to innovation. Enterprise's strategies and government policies supporting innovation activities can contribute to the economic development and competitiveness of companies improving the country's economy in the international comparison (MADRID-GUIJARRO; GARCIA; VAN AUKEN, 2009).

Barriers to innovation can be subdivided into external and internal ones (PIATIER, 1984). External barriers are constraints imposed by the external environment while internal barriers are classified in financial and human resources barriers. Due to their limited resources SMEs usually face more problems for innovation than larger companies.

SMEs main difficulties to conduct R&D and implementation of innovation strategies are related to financial constraints (e.g. costs), to the human resources and external environment difficulties given by bureaucratic overhead in e.g. government policies, taxing and regulations (BALDWIN; LIN, 2002; COBBENHAGEN, 2000; MOHEN; ROLLER, 2005).

Teece (1996) emphasized that a better understanding of the barriers of innovation especially with respect to SMEs may help to overcome these obstacles and contribute to the improvement of the economy of the country. The current paradigm asserts that the more the company embraces innovation the more obstacles it has to face (GALIA; LEGROS, 2004). The main barriers to innovation can be classified into three major categories: **financial, human resources and external** barriers.

1.2.1 Financial Resources

Financial resources are the most frequently mentioned barriers to innovation in the literature and one the most important resources to stimulate innovation activities in SMEs (JENSEN; MECKLING, 1976; PIATER, 1984; SHARMA, 2007).

Innovation activities often involve large potential risk for their successful implementation. Limited financial resources are a major obstacle for SMEs to perform innovation activities because a single wrong decision can jeopardize the company's existence (HADJIMANOLIS, 1999). Souitaris (2001) perceived that the most innovative companies often are managed by directors who are more favorable to accept economic risks.

The high uncertainty and the resulting difficulties to get a loan have become a hard constraint for financing R&D in SMEs (BERGEMANN; HEGE, 2005; GIUDICI; PALEARI, 2000; MADRID-GUIRRARO; GARCIA; AUKEN, 2009). These difficulties result from commercial bank's perception related to risk evaluation.

1.2.2 Human Resources

The successful implementation of innovation activities requires the full commitment of all employees, from the management down to the ordinary workers (ACEMOGLU; PISHKE, 1999). Several studies on innovation have shown that resistance to change by the employees is often due to insufficient communication in the company and a lack of commitment of the top management to support employees with further training (ZWICK, 2002).

McAdam et al. (2004) found that resistance to changes especially affect small and medium companies, where the management style strongly depends on the manager-owner relationship and a lack in the ability to communicate sufficiently with the employees (MOSEY; CLARE; WOODCOCK, 2002). In turn managers of SMEs are often not enough qualified to deploy innovation strategies in their companies and communicate them to their employees correctly (FREEL, 2000).

This lack of communication often leads to friction in the company's organization structure and hinders the successful implementation of innovation activities (BALDWIN; LIN, 2002). The successful implementation of innovation strategies can hardly be achieved with unmotivated and unskilled personnel (GALIA; LEGROS, 2004).

1.2.3 External Environment

External environment barriers are obstacles to innovation that lie outside of the company's control, such as governmental policies, complicated tax administration rules or economic uncertainty. The managers have to be aware of these factors to deal with the challenges emerging in an increasing competitive and turbulent market to ensure their businesses' success (FREEMAN; SOETE, 1997; FRISHAMMAR; HORTE, 2005).

One of the most important external environment barriers to innovation in SMEs are regulations and bureaucracy in public aids (GALIA; LEGROS, 2004; PIATIER, 1984). A better understanding of the environmental factors may help companies as well as government policy makers to reduce bureaucratic obstacles and provide a better environment to boost innovation activities among SMEs (GALIA; LEGROS, 2004).

2. Research Methods

The method applied in this study is a descriptive type, according to the typology suggested by Gil (2010). The main objective of this part is to find and characterize the major features and phenomenon in the dataset or to establish relationships between variables.

Gil (2010) describes survey research as the direct questioning of individuals to obtain opinions of a certain type. The number of samples has to be large enough to draw statistical conclusions and has to be analyzed carefully to consider bias in questioning and answers. It is important to identify issues, the degree of importance and their interconnections among the population (GIL, 2010).

Following SEBRAE's definition, companies in the industrial sector are classified into small enterprises which have between 20-99 employees, medium enterprises with 100-499 employees and large enterprises with more than 499 employees (TABLE 1). In the service sector these definitions are less as shown in Table 1.

This survey targets companies with the following criteria:

a) small and medium enterprises;
b) companies from the following industrial sectors based on National Classification of Economic Activities (CNAE) (TABLE 2);
c) geographical distribution (TABLE 3);
d) the respondent is the entrepreneur or technical representative of the company (industrial director, project manager, manager/production engineer, or equivalent positions).

Table 1 – Classification of Company Size

Company Size	Number of Employees	
	Commerce and Services	Industry
Individual Micro Entrepreneur	≤ 2	≤ 2
Microenterprise	≤ 9	≤ 19
Small Enterprise	10 – 49	20 – 99
Medium Enterprise	50 – 99	100 – 499
Large Enterprise	> 99	> 499

Source: SEBRAE (2013).

The stratification of the dataset resulted in a total of 1,917 industrial manufacturers, which became the reference population for sample extraction. The sample companies have been chosen randomly being the simplest and most adequate method, because all elements of the survey have the same opportunity to be considered for the selection (BOLFARINE, 2005).

The sample is also proportional, because it is composed of small and medium manufactures companies, the 24 wards that make up the section processing industry (Section C) in CNAE 2.0 – Brazil, located in the four geographic meso-regions of Ceará (Fortaleza Metropolitan Region, Northwest , North and South).

Table 2 – Industrial Sectors in Ceará

MANUFACTURING
Food Manufacturing
Drink Manufacturing
Textile Manufacturing
Clothing and Accessories Confection
Leather Preparation and Manufacturing of Leather Artifacts, Travel Articles and Footwear

Manufacturing of Wood Products
Manufacturing of Cellulose, Paper and Paper Products
Manufacturing of Coke, Petroleum Derivatives and Biofuels
Manufacturing of Chemical Products
Manufacturing of Pharmo-Chemical and Pharmaceutical Products
Manufacturing of Rubber and Plastic Products
Metallurgy
Manufacturing of Metal Products, except Machinery and Equipment
Manufacturing of Computing, Electronic and Optical Products
Manufacturing of Machinery, Appliances and Electronic Materials
Manufacturing of Machinery and Equipment
Manufacturing of Automotive Vehicles, Tow Trucks and Trailers
Manufacturing of Other Transport Equipment, apart from Automotive Vehhicles
CONSTRUCTION
Building Construction
Infrastructure Works
Specialized Construction Sevices

Source: Based on Research Project Demand Quantitative SENAI (2012).

After the definition of the population, we calculated the sample with a margin of error of estimate of 5% and a level of reliability of 95% confidence interval. The result is a final sample of 315 small and medium manufacturers companies.

2.1 Data Collection and Survey Instrument

The analysis presented here is based on a dataset, which was collected by the National Industrial Apprenticeship Service of the Regional Department of Ceará - SENAI (one of its operations as science and technological institute) and kindly provided for this study.

The survey took place during the period of January 2013 to June 2013 and performed a structured questionnaire addressing factors that underlie the present study. Four different meso-regions in the state of Ceará have been chosen for the analysis. The regions are indicated as following in Table 3.

As this study involves the collection of data collected in a single moment, based on samples previously selected it can be considered cross-sectional (MALHOTRA, 2006). The survey conducted by SENAI was based on a structured questionnaire. Hill and Hill (2008) argue that this is the most widely used method for primary data collection, especially in large-scale which aims to raise people's opinions.

Table 3 – Geographical distribution of the sampling regions

METROPOLITAN MESO-REGION OF FORTALEZA	**NORTH MESO-REGION**
FORTALEZA MICRO-REGION	BAIXO CURU MICRO-REGION
Aquiraz	São Gonçalo do Amarante
Caucaia	**SOUTH MESO-REGION**
Eusébio	CARIRI MICRO-REGION
Fortaleza	Crato
Guaiuba	Juazeiro do Norte
Itaitinga	Barbalha
Maracanaú	**NORTHEAST MESO-REGION**
Maranguape	SOBRAL MICRO-REGION
Pacatuba	Sobral
PACAJUS MICRO-REGION	
Horizonte	
Pacajus	

Source: Based on Research Project Demand Quantitative SENAI (2012).

The questions have been outlined considering three situations: nominal scale which is a figurative labeling scheme in which numbers serve only as identification and classification of

objects, open questions, and Likert scale intervals, one of the most recommended in the literature.

The survey was developed based on research consolidated government and business environment in Brazil, such as the Technological Innovation Survey (PINTEC), Demand Technological and Innovation Research of the Brazilian Association of the Electrical and Electronics Industry (ABINEE). The survey was carried out "*in loco*" through personal interviews with the entrepreneur or technical representative of the company (industrial director, project manager, manager / production engineer, or equivalent positions).

The sample consists of small and medium manufactures companies. Table 4 shows the percentage variation in relation to company size between the sample and the population, according to data in 2010 from "Sistema de Coleta e Gerenciamento" - SIGA (System of Management and Collection) made by National Confederation of Industry.

Table **4** – Variation between Sample and Population

SAMPLE COMPOSITION				
Company Size	**Population**	**%**	**Sample**	**%**
Small	1.600	83%	217	71%
Medium	317	17%	87	29%
Total	**1917**	**100%**	**304**	**100%**

Source: Own Elaboration.

The study information is based on a view as perceived by their owners/managers in a sample of 304 small and medium manufactures companies located in the five major industrial micro-regions in Ceará: Fortaleza, Pacajus, Sobral, Cariri and Baixo Curu. The information obtained through the survey has been properly stored in an electronic database, for further analysis. Table 5 shows the manufactures companies in the survey sample, classified by its geographic location and economic activity defined by National Classification of Economic Activities (CNAE) "Classificação Nacional de Atividade Econômica".

Table **5** – Sample Composition

Economic Activity	Geographical Region in Ceará				Total
	Metropolitan Meso-Region of Fortaleza	North Meso-Region	South Meso-Region	Northeast Meso-Region	
Food Manufacturing	39	1	2	3	45
Drink Manufacturing	3	0	0	0	3
Textile Manufacturing	8	0	0	0	8
Clothing and Accessories Confection	89	0	3	0	92
Leather Preparation and Manufacturing of Leather Artifacts, Travel Articles and Footwear	6	0	14	0	20
Manufacturing of Wood Products	2	0	1	0	3
Manufacturing of Cellulose, Paper and Paper Products	4	0	0	0	4
Manufacturing of Chemical Products	8	0	0	1	9
Manufacturing of Pharmo-Chemical and Pharmaceutical Products	1	0	0	0	1
Manufacturing of Rubber and Plastic Products	12	0	2	0	14
Metallurgy	2	0	1	0	3
Manufacturing of Metal Products, except Machinery and Equipment	13	0	3	0	16
Manufacturing of Computing, Electronic and Optical Products	2	0	0	0	2
Manufacturing of Machinery, Appliances and Electronic Materials	3	0	0	0	3
Manufacturing of Machinery and Equipment.	2	0	0	0	2
Manufacturing of Automotive Vehicles, Tow Trucks and Trailers	3	0	0	0	3
Maintenance, Repair and Installation of Machinery and Equipment	4	0	0	0	4
Building Construction	40	0	2	1	43
Infrastructure Works	9	0	1	0	10
Specialized Construction Sevices	18	0	0	1	19
Total	**268**	**1**	**29**	**6**	**304**

Source: Own Elaboration.

3. Results

The analysis of the survey data is based on descriptive statistics and confirmatory factorial analysis using the statistical software package SPSS (Statistical Package for Social Sciences) version 19 for Windows. For the descriptive statistical analysis we have chosen the arithmetic mean of the answers as a measure to describe the overall trend. Stevenson (1981) explains that the arithmetic mean is the simplest and the most commonly used to measure a central tendency in a dataset.

Table 6 summarizes the statistics of the analyzed barriers to innovation in SMEs in Ceará. For each of the 12 barriers to innovation the dataset contains punctuation from 1 (less significant) to 5 (crucial) - likert scale intervals - as perceived by owners/managers.

The descriptive analysis reveals that the most significant barriers to innovation, as perceived by owners/managers, are of internal origin. The main problems for SMEs lie in the lack of skilled personnel and the missing possibility of internally training the employees. The data demonstrates that especially small and medium manufacturing companies in Ceará have difficulties finding skilled labor in the region that fit their needs for their businesses. Furthermore, internal education and training are especially difficult in SMEs where the workers cannot be released for training or personnel certification.

Table 6 – Barriers to Innovation

Barriers to Innovation in SMEs	N	Mean
Lack of skilled personnel	304	3,91
Lack of internal employee training	304	3,58
Insufficient government support	297	3,42
Innovation costs are too high	301	3,42
Economic turbulence	299	3,36
Difficult access to sufficient financial resources	302	3,14
Resistance to change	302	3,13
Pay-off period of innovation too long	302	3,07
Excessive perceived economic risk	301	3,02
Lack of information on market opportunity	297	2,75
Lack of information on new technologies	297	2,72
Lack of opportunities for cooperation with other firms and technological institutions	291	2,60
Valid N (listwise)	285	

Source: Own Elaboration.

The most significant external environment barriers for the SMEs analyzed here are of financial origin like as insufficient government support and economic turbulence (TABLE 6). The major variable related to financial barriers in the SMEs are high innovation costs, whereas barriers related to excessive economic risks seem to be less significant. This stems from the fact innovation activities in Brazil are mainly of incremental character.

In Table 7 the statistics of the innovation activities performed by the 304 analyzed companies is presented. Here the most significant activities are those with the lowest mean because the punctuation in the original data ranges from 1 (corresponding to high importance/large investment) to 4 (low importance/small investment).

The major innovation investment for SMEs of this study was the purchase of machinery and equipment (TABLE 7). This is also characteristic for incremental innovation. In turn, innovative R&D activities have achieved the lowest level importance rating.

Table **7** – Innovation Activities

Innovation Activities (2010-2012)	N	Mean
Acquisition of machinery, equipment and other capital goods	300	2,28
Training	300	2,41
Market preparations for product innovations	300	2,50
Acquisition of other external knowledge	300	2,58
Other preparations for product and process innovations	295	2,60
Research and experimental development	300	2,61
Valid N (listwise)	295	

Source: Own Elaboration.

After the descriptive analysis, we run a factorial analysis to confirm the innovation barriers by type. Factor analysis is a multivariate technique of interdependence in which all variables are considered simultaneously, each related to the other in order to study the interrelations between them, seeking summarization of the variables (CORRAR et al., 2009). Here, the analysis was carried out in several steps. Firstly, correlation analysis was completed among the barriers to innovation variables to provide insight into relationships between the variables. It was selected the main barriers to innovation sorted in the literature and their correlation to apply the factors analysis. Then, the factor analysis was run to form groups of related variables among the 12 barriers to innovation variables (Table 8).

Correlation and factor analysis were carried out applying the recommended tests, such as, Kaiser-Meyer-Olkin (Measure of Sampling Adequacy – MSA) and Bartlett's test of sphericity. "Varimax rotation, a procedure through which each component is found to relate strongly with a small number of variables and weakly with the others" (MADRID-GUIJARRO et al., 2009, p. 472 - 474). This procedure was used to enhance the interpretability of the factors like as shown in Table 8.

Table 8. Barriers Factor Analysis

Variables	Component: Barriers to Innovation		
	Factor 1: Financial	Factor 2: External Environment	Factor 3: HR
Innovation costs are too high	,740	,160	,243
Difficult access to sufficient financial resources	,765	,307	,149
Excessive perceived economic risk	,782	,309	,170
Pay-off period of innovation too long	,814	,213	,192
Lack of skilled personnel	,275	,194	,815
Lack of internal employee training	,170	,194	,869
Resistance to change	,208	,446	,616
Economic turbulence	,428	,624	,230
Lack of information on market opportunity	,195	,865	,244
Lack of information on new technologies	,202	,843	,251
Lack of opportunities for cooperation with other firms and technological institutions	,366	,660	,140
Insufficient government support	,526	,529	,236

Source: Own Elaboration

The factorial analysis confirmed that all specific variables related each type of barriers present communalities. Hence, the four variables "innovations costs, access to financial resources, economic risk, and pay-off period of innovation" close in the barriers factor of financial risks. The three variables "skilled personnel, employee training, and resistance" formed the group of human resources barriers. Finally, the four variables "economic turbulence, market opportunity, new technologies, and government support" close in the factor external barriers.

Conclusion

We have shown in this study the major barriers to innovation which affect innovation activities of SMEs in Ceará. The barriers to innovation in SMEs are very expressive. The most significant barriers that hinder the development of innovation, as perceived by theirs owners/managers, are the high costs of innovation. Most companies hesitate of taking the economic risks to pursue innovation activities. Therefore innovation activities in Brazil are mainly of incremental character, which could be confirmed by the results of this analysis.

From the manager perspective the lack of skilled workers and employees was also a major issue for performing innovation project. Small and medium businesses do not have the resources to perform internal education project or put employee on leave for external education courses.

Aligned with Hadjimanolis (1999) assessment that “a better understanding of barriers to innovation can assist firms to foster development of an environment that supports innovation” the findings of this study may increase the comprehension of barriers to innovation in SMEs in Ceará. The outcomes can be used by governments to improve bureaucratic processes and by managers to encourage them to improve their pursuit to access to innovation support in the state of Ceará.

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