

THE NEED FOR NEW PARADIGMS FOR INDICATORS OF INNOVATION IN COMPANIES

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Abstract. *This paper will cover the main concepts of innovation, their evolution and importance to economical development, and their measurement by an indicator of innovation in a group of companies, being a new metrical model suggested. The innovation theory will be the basis for the description of technological innovation as a changing process of the socio-cultural paradigm, associated with the transformation of the capitalistic accumulation process, together with its evolution and the importance of the pertinent concepts to the measurement of innovation processes. The objective is to demonstrate the need for new performance indicators to the innovation measurement in companies, based on a field survey of 34 significant companies in the national and international markets. The inappropriateness of the traditional indicators was verified as the results of the field survey and its theoretical analysis. As a conclusion, it is proposed a new methodology for the measurement of innovation, based on new systemic performance indicators (ISDI) which are based on the systemic analysis and on the processes involved in it.*

Keywords: *Innovation; Technological Innovation; Indicators of Innovation; Technological Development.*

1. Introduction

The great number of innovations throughout the world in the last decade is held responsible for great changes in the dynamics of development, being the adoption of new Technologies its most explicit manifestation.

The rapid technological advances and the application of knowledge to the solution of problems, turn productive processes more and more complex in a self-feeding dynamics in which technological changes resulting from innovations in products and processes, bring out necessities, which, in turn, feed other solutions, products and processes, in a continuous and interactive manner (Rocha and Ferreira, 2001).

The ability to innovate rapidly is a vital component of competitiveness in companies and the main reason for their social and economic well-being; although, according to Arundel et al. (1998), citing the point of view of managers, economists and politicians, it is a costly and risky process.

The technological innovation process is, in itself, the change of the socio-cultural paradigm associated with the change of the capitalist accumulation standards, one of the facets of a much broader and more profound phenomenon experienced by contemporary societies (Rocha and Ferreira, 2001).

In Brazil too, the idea that innovation is a fundamental element for economic growth and that industries are the privileged environment for its materialization, is being consolidated; thus being the universities' main role, that of developing people qualified for the generation of knowledge necessary to innovation (Cruz, 2003).

The most fundamental aspects related to the change of paradigm result from that phenomenon and generate a new scenario – the Information Society, in which information and innovation earn renewed distinction and constitute the object of privileged studies in areas such as Science (Rocha and Ferreira, 2001).

With the rise of the Information Society, the new economic models need to incorporate knowledge as a factor essential to the process of production and generation of wealth and not just another factor inherent to production; for knowledge has become economy's essential resource. Therefore, the decisive production factor is no longer capital, nor

work, but knowledge (Drucker, 1994). That does not, however, mean that classic production factors have disappeared, they have only become secondary.

In the present work, we firstly analyze the Theory of Innovation, highlighting the role of innovation, and later carry out the analysis of the process of measurement of innovation in companies. Secondly, we describe the methodology used in the field survey for data collection, and later the result analysis. And finally, in the third stage, we offer a new model for the measurement of innovation in companies, taking into consideration the new paradigms.

2. The theory of innovation

As soon as in the eighteenth century, Adam Smith indicated the relation between capital accumulation and manufacturing technology, studying concepts regarding technological changes, job division, production growth, and competition (Freeman and Soete, 1997). In the nineteenth century, List pioneered the introduction of the intangible investment concept, stating that “the state of a country results from the accumulation of all discoveries, inventions, improvements, perfection and efforts by the generations that lived before us: that constitutes the intellectual capital of the human race.”

Such studies did not, however, intend to understand the dynamics of technological change. It was only after Marx, in the second half of the nineteenth century, and Schumpeter, in the first half of last century, that technology started being analyzed more deeply.

According to Schumpeter (1988): “It is necessary that we develop means to integrate ‘materials’ and knowledge in order to reach economic development, and thus, the discontinued introduction of new combinations of the above mentioned elements is the innovation process itself.

We can see that Schumpeter approached innovation as the introduction of new products that transform the competitive environment: [...] *in the capitalist world, it is not competition that counts, but the competition of the new item, the new technology, the new source of supply, the new type of organization [...] competition for a decisive cost or a quality advantage that does not reduce the profit margins and the productivity of companies* (Schumpeter, 1988).

Within that rough approximation with innovation, Schumpeter suggested three basic stages for the innovation process:

1. **Invention**, as the result of a process of discovery, of new technical principles, potentially open to the commercial exploration, but not necessarily undertaken;
2. **Innovation**, as the process of development of an invention in a commercial manner;
3. **Diffusion**, as the expansion of an innovation, new products and processes in the market.

Innovation is, therefore, limited to the marketing of a new product or the implementation of a new manufacturing process.

Schumpeter’s definition of innovation opens up two main routs to innovation:

- The implementation of equipment in a new process which is bought from another company or the sales of a new product obtained from another company. For such kind of innovation there is no need for intellectual incentive or creative effort; and
- The marketing of new products or implementation of new processes it has developed.

Schumpeter’s Theory of Economic Development distinguishes five types of innovation activities involved in the innovation process (Schumpeter, 1988):

1. **The introduction of a new product or the qualitative change in an existing product;**
2. **A new process** of innovation in the industry (not necessarily involving new knowledge);
3. **The search for a new, untapped market space**, one in which a specific industry has not penetrated, regardless of its prior existence;
4. **The development of new provision sources** for raw-materials or other contributions, regardless of the fact that such source existed previously or not;
5. **An organizational change.**

The forms of change remain as ‘the fundamental impulse that perpetuates and maintains the capital system in motion’ (Schumpeter, 1988), despite the author having considered three factors that later reduced the development rate, since the end of the nineteenth century:

1. The entrepreneurship, as a means of competitive behavior that searches for new combinations of elements generating innovation;
2. The human factor as a component of economic activity and consequently of innovation;
3. The long-term view that individuals should incorporate.

Schumpeter’s critics consider such concept of innovation too broad, once it is related to technical, marketing and organizational aspects (Arundel et al., 1998).

Innovation, according to Schumpeter (1988), refers to radical innovations, that is, those that produce great economic or marketing impact, leaving the innovations of incremental nature and technical improvement to a second plan.

2.1. Theories on innovation definitions

The innovation process should be viewed in a systemic manner like a cycle (Lacerda, 2001), and thus can be defined as: “The productive use of knowledge as manifested in the prosperous development and in the introduction of new products, processes and/or services”.

Innovation is not limited to the product; a company may be highly innovative without selling a product which is technologically superior to its competitors’, for anything may be innovated: from the manufacturing process to the marketing and management relation (Ferraz, 2002).

To Tushman and Nadler (1986), innovation is the creation of some product, service, or process that is new to the business unit. The authors distinguish two types of innovation:

- (1) product innovation, when there is change in the product an organization manufactures or in the service it offers;
- (2) process innovation, which is the change in the way a product is made or a service is provided.

Definitions having been presented, we take as the basis of the present study the Schumpeterian definition, described earlier, in which innovation is the discontinued introduction of new combinations of “materials” and knowledge in society, which will lead to economic growth.

3. Innovation process measurement

A measurement is a process of counting or comparing in which we aim to compare attributes in terms of shared characteristics, which requires, *a priori*, similarities between attributes so that comparisons may be established in a quantitative manner.

According to Hronec (1994), the measurements developed must be used to continuously improve processes in order to innovate them.

“There is no consensus (in literature) on which variables should be included to explain the innovative effort, on the nature of the interrelation among the variables, nor on the most adequate empirical measurement,” according to Matesco *apud* Andreassi (1999).

As innovation is a novelty and the creation of something qualitatively new, there is the problem of measuring and comparison, once it is not only the extension of technical attributes or a combination of pre-existing characteristics. “It is difficult, if not impossible, to evaluate attributes by means of measures and techniques and, therefore, the degree of innovation of a product (Smith, 1998).

Likewise, Andreassi (1999) reinforces the lack of a consolidated methodology to measure innovation.

3.1. The current process of innovation measuring

One of our greatest challenges is to find out how we can measure the contribution of innovation in companies, once we must translate such contribution into competitive growth. We can only count on the methods we already use to measure innovation activities.

Many of the traditional indicators are based on data of public domain, which, being collected far from the place where the innovation process is taking place, avoids problems with industrial secrecy. Such traditional indicators include patent data, scientific journals, and the number of scientists and engineers employed by the company (Campanário, 2002).

3.2. Innovation indicators definition

The political and academic concerns were the driving force underlying efforts in the field of development of innovation indicators in the last decade.

Due to innovation’s central role, such impulses, combined, led institutions and their investigators to search for the development of better quantitative indicators with the aim of having a tool to aid not only the economy but also innovation policies to create social unity by means of economic development (Freeman and Soete, 1997).

3.3. Traditional innovation indicators

The traditional innovation indicators provide us with measures of organizations’ summarized innovation activities, but should also distinguish between innovation as “adoption” and innovation as “creative activity” (Arundel et al., 1998).

The following may be cited as examples of traditional indicators: patent data, scientific journals, and the labor force or number of employees working as scientists and engineers in research areas, that is, the cost with R&D (Research and Development).

Some indicators are presented with the intent of measuring the innovative effort, although there is no consolidation of a unique method of innovation measuring.

Based on studies carried out by Archirbugi (1988), Patel and Pavitt (1995) and Sbragia (1986), the innovation indicators most commonly used in economic studies have been classified in six categories: statistics of R&D, patents, macroeconomic indicators, direct monitoring of innovation, bibliometric indicators, and semi-quantitative techniques.

Such indicators, in the present study, are called innovation traditional indicators, once new studies for the definition of innovation indicators are yet to be carried out.

According to Batocchio and Yongquan (1996) there is the need for new performance measurement that better depicts the reality of a global class organization.

4. Methodology

A field survey was carried out in order for us to identify which methodologies and indicators are used by organizations to measure their innovation activities and if their needs are being met.

The universe of such survey encompasses private companies, and more specifically that of the present study, small, medium-sized, and big companies, in some way linked to UNICAMP, through a research project or an employee doing his/her post-graduate studies, for instance. The companies surveyed are mainly in the sectors of automotive and metallurgy. However, companies in the following sectors of the economy were also surveyed: paper and cellulose, food, aeronautics, automotive, electro-electronics, White line, energy, petrochemical, chemicals, plastics and fiber, and those service providers

The sampling technique utilized was the intentional non-probabilistic. The intentional samples, or sample by judgment, occur when the researcher, through good judgment and adequate strategy, chooses the cases he believes necessary for the samples to meet the demands of the research, usually, those defined as typical of the population (Selltiz et al., 1974).

The data was collected through a questionnaire consisting of 16 questions which was sent to the companies, filled out by a representative of managerial level, and returned to us.

In the present work, we present the results of seven of those questions, the first four of which are about the company (sector, work force, etc.) and the other three about the company's measurement of innovation activities. The remaining questions in the questionnaire are about issues which do not concern the present study and thus will be presented in a later study on a relevant theme.

Following the receipt of the questionnaires, the data was computed and the conclusions elaborated.

5. Results

The great majority of the companies, 97%, stated they created some type of innovation, which leads us to believe that innovation is of great importance to the majority of the companies surveyed.

The majority of the companies, 50%, create incremental innovations, of which, 24% are radical and only 24% of them adopt innovation from other companies (Fig. 1).

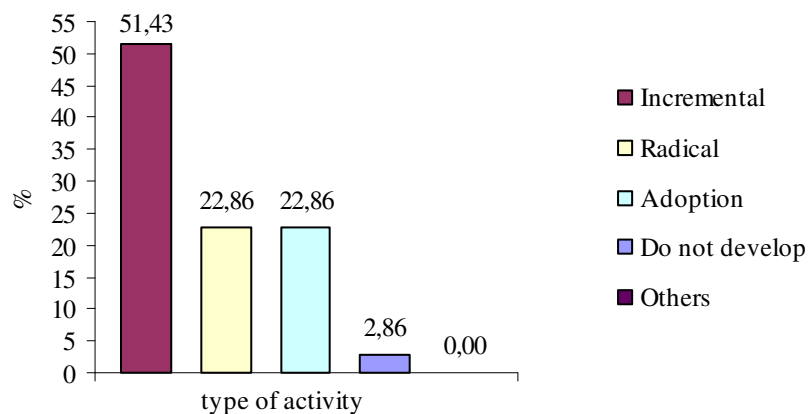


Figure 1. Types of innovation activities.

We can, therefore, conclude that the majority of the companies consider themselves beholders of know-how and of innovation activities, and that only the minority has not developed, or has just adopted innovation; thus, ruling out the common belief that Brazilian companies are 'buyers' of innovation and have no potential to develop and implement it on their own.

In the majority of the companies, 57.14%, (Fig. 2), innovation occurs in their products, that it, in the final good; 40% of the companies innovate in their processes, and only around 3% of them innovate in services.

The difference in investment between the types of innovation in products and processes is about 17%, which shows that in practice, these activities are financed by the companies themselves.

Once again, we can corroborate the thesis that companies innovate in order to guarantee their survival in a competitive environment, that is, investing in innovation in processes, products, and services, result in a real benefit to them and to the society, and not only in obtaining patents and royalties.

This is an aspect that seems to be very little explored in the literature and in the approaches currently explored by the world and organs of Finance and Incentive to Innovation in Brazil, and announced by UNICAMP, and other technical organs such as BNDES and FAPESP. Organs that foster, finance, and incentive innovation in Brazil value almost solely patents and royalties, and neglect incremental innovations and process innovation, which guarantee their competitiveness, according to the companies themselves.

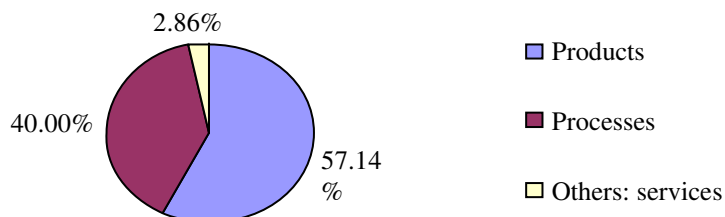


Figure 2. Distribution of companies' innovation activities.

In the services segment, as indicated in the results of the survey (Fig. 2), we found around 3% of innovation activities, evidence that it is still very little explored, and practically neglected by organs that foster, finance, and incentive innovation in Brazil.

As a conclusion, we believe that companies finance their own innovation activities, necessary to their survival, and, therefore, as an activity that guarantees their competitiveness, regardless of the generation of patents and royalties, and of external finance.

On where innovation activities occur, almost three quarters (73.5%) stated they are carried out in Brazil, and only 26.5% said they adopt innovations from other countries, being, in most of the cases, from countries where their headquarters are based.

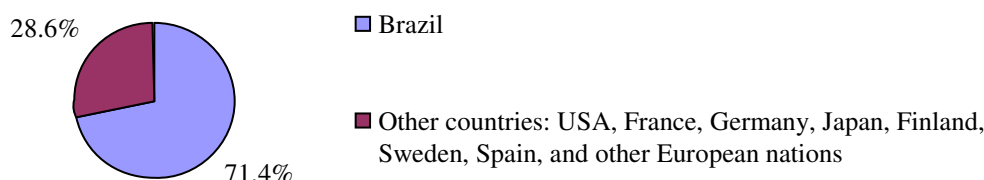


Figure 3. Concentration of innovation activities.

We can conclude that innovation activities, in their majority, are concentrated in Brazil, corroborating the thesis that we are potential executors of innovation activities and not just importers of innovation. The majority of the companies, 55%, define themselves as executors of the innovation process, while the others (45%) develop such activities externally (Fig. 3).

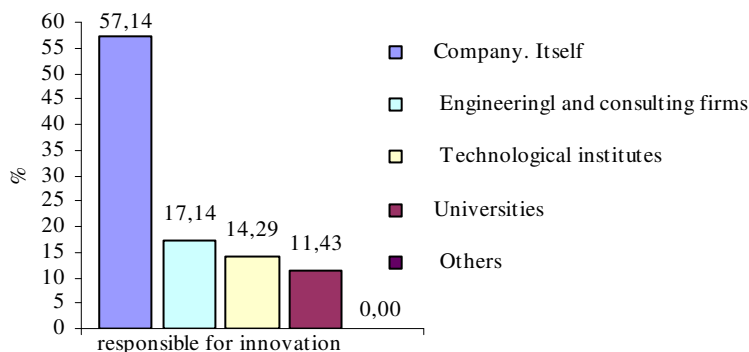


Figure 4. Responsible for the execution of the company's innovation activities.

In the case of external development of innovation activities, priority is given to engineering and consulting firms 17.6%, technological institutes, 14.7% and universities 11.7%, in that order (Fig. 4).

We can thus conclude that the companies consider themselves capable of executing innovation activities, supporting Cruz's (2003) statement: "the company is the place where innovation is materialized, necessitating support from other agents such as technological institutes and engineering and consulting firms, which corroborate the innovation process." However, the universities that make available the knowledge that subsidizes innovation end up having a minor participation in relation to the other agents', which is contrary to the common belief that universities are the companies' main partner for the development of innovation.

The majority of the companies surveyed, 62.9%, stated they possess some kind of methodology that aids them in the process of accountability or measurement of innovation in their organization.

We can conclude that, in their great majority, the companies feel the need for a methodology that aids them in the measurement of the innovation process, which, in turn, will aid in management's decision-making, generating competitive growth for the company, which is the an intrinsic objective of the innovation process. Further corroborating the objectives of the survey, the finance techniques that comprehend the analysis and the financial support of projects is the most commonly utilized methodology for innovation measurement (41.2%), as we can see in the graph that shows the answers obtained for the question on what type of methodology the company uses to measure its innovation process (Fig. 5).

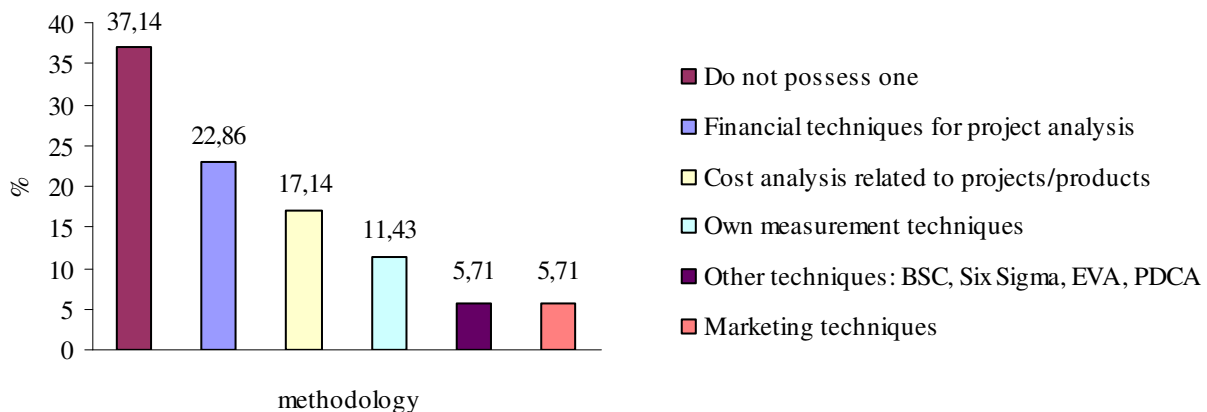


Figure 5. Type of methodology the company uses to measure its innovation process.

Among all the companies surveyed, 12% present marketing or management techniques for innovation measurement; only 8.8% possess an own technique for the measurement of innovation processes.

We concluded that when it regards innovation the companies show predominant concern with financial issues. Nonetheless, the financial issue is just subsidy for the execution of innovation activities. Moreover, we concluded that companies use marketing and management indicators to measure innovation processes, whilst, they should actually only be regarded as support to such activities. Nevertheless, some companies stated they possess some kind of in-house methodology developed to measure innovation, but did not offer a description of such methodology.

Most of the companies, approximately 54%, said they adopt a specific indicator for innovation measurement, while the remaining part said they do not possess such specific indicators.

We identified inconsistency in these answers in relation to the previous question's (Fig.5) on what type of methodology the company uses to measure its innovation process, in which all companies stated they possessed some methodology.

We can finally conclude, regarding the surveyed companies, that:

1. The companies themselves develop their innovation processes, being the remaining organizations such as R&D institutes, Universities and Consulting firms in charge of support, exclusively.
2. The companies do not adopt specific methodology for innovation process measurement, whether they are radical or incremental.
3. The indicators used are not appropriate as they measure only activities that are means to or part of the business's innovation process and are limited to those generic and traditional indicators, such as financial, marketing, or manufacturing return to the company.
4. The indicators adopted are limited to measuring the management process of the companies' routine, neglecting that of the whole innovation process from the point of view of rupture or inflexibility regarding their routine.
5. The Brazilian economic development depends fundamentally on the resources allocated for innovation, many of which are available already, but must be used for efficiently and effectively.
6. The Brazilian economic development will only occur through innovation activities, which depend on a methodology for measuring the efficiency of the results of interrelations between the distinct agents involved, that is, between

different areas within the company and between the company and R&D Institutes, Universities and Consultancy firms.

7. The appropriate methodology for measuring the efficiency of the results of interrelations between the distinct agents involved has not yet been adopted by the companies.
8. There must be a more efficient policy for the incentive of innovation activities, which is validated by a qualitative measure and not just by the quantitative measure of efficiency of allocated resources.
9. Care must be taken when generalizing the results found in the present study, once, according to Roberts (1995), "there are big difficulties in making statistically significant generalizations when non-probabilistic samples regarding companies in different sectors of the economy are taken into consideration." We believe the study has presented contribution relevant to the understanding of innovation measurement in companies.

6. Proposal of an innovation process measuring model

Considering the conclusions of the present case-study, we propose new basis for a new methodology for innovation activities measuring, that is, new Systemic Indicators of Innovation Performance (*ISDI*), based on the systemic analysis of the processes involved.

We propose that:

1. The concept of innovation process measurement be based on the concept of investment for the growth of companies' competitiveness, where the factors being considered today constitute a mere means greater development.
2. The measuring of innovation activities, to ensure prosperous development, be based on the constant introduction of new products, processes and/or services, and not just on the resources allocated, as is done today.
3. The new performance indicators be the result of efficiency in the creation of value through the innovation network, taking into consideration the results of different processes, from market information to the development of the product and its adoption by the internal and external clients.
4. With this new metrics, we can grant the deserved credit to processes and people effectively involved in the creation of value, and not just for carrying out their tasks in due time, or with the allocated resources; and that way, be able to show the real benefits of the innovation process to the society through the different values created.
5. The creation of quantification measures of efficiency in the interfaces between processes that lead to innovation, and not only of the isolated processes.
6. The companies should adopt a methodology of innovation process measurement that incorporates a systemic analysis of all processes involved, which we call *ISDI* from the input to the output, thus generating an ample analysis of the all innovation processes.

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8. Responsibility notice

The three authors are the only responsible for the printed material included in this paper.