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TECHNOLOGICAL MONITORING RADAR: A WEAK SIGNALS INTERPRETATION TOOL FOR THE IDENTIFICATION OF STRATEGIC SURPRISES

Adalton Ozaki
Doctoral student in the Post-graduate Program in Administration
Faculdade de Economia, Administração e Contabilidade, USP, Brazil
prof.adalton@gmail.com

Alexandre Del Rey
Masters student in the Post-graduate Program in Administration
Faculdade de Economia, Administração e Contabilidade, USP, Brazil
alexandre.delrey@ig.com.br

Fernando Carvalho de Almeida
Doctorate Professor
Faculdade de Economia, Administração e Contabilidade, USP, Brazil
fcalmeida@usp.br

ABSTRACT

In the current competitive scenario, marked by rapid and constant changes, it is vital that companies actively monitor the business environment, in search of signs which might anticipate changes. This study poses to propose and discuss a tool called Technological Monitoring Radar, which endeavours to address the following query: "How can a company systematically monitor the environment and capture signs that anticipate opportunities and threats concerning a particular technology?". The literature review covers Competitive Intelligence, Technological Intelligence, Environmental Analysis and Anticipative Monitoring. Based on the critical analysis of the literature, a tool called Technological Monitoring Radar is proposed comprising five environments to be monitored (political, economical, technological, social and competition) each of which with key topics for analysis. To exemplify the use of the tool, it is applied to the smartphone segment in an exclusively reflexive manner, and without the participation of a specific company. One of the suggestions for future research is precisely the application of the proposed methodology in an actual company. Despite the limitation of this being a theoretical study, the example demonstrated the tool´s applicability. The radar prove to be very useful for a company that needs to monitor the environment in search of signs of change. This study´s

main contribution is to relate different fields of study (technological intelligence, environmental analysis and anticipative monitoring) and different approaches to provide a practical tool that allows a manager to identify and better visualize opportunities and threats, thus avoiding strategic surprises in the technological arena.

Key-words: Technological monitoring. Technological intelligence. Competitive intelligence. Weak signals.

RADAR DE MONITORAMENTO TECNOLÓGICO: UMA FERRAMENTA DE INTERPRETAÇÃO DE SINAIS FRACOS PARA IDENTIFICAÇÃO DE SURPRESAS ESTRATÉGICAS

RESUMO

No atual cenário competitivo, marcado por mudanças constantes e rápidas, é fundamental que as empresas monitorem ativamente o ambiente de negócios, em busca de sinais que antecipem as mudanças. Este estudo tem como objetivo propor e discutir uma ferramenta denominada Radar de Monitoramento Tecnológico, que procura resolver o seguinte problema: "como uma empresa pode sistematicamente monitorar o ambiente e captar indícios que antecipem oportunidades e ameaças para uma determinada tecnologia?". A revisão bibliográfica abrange os temas Inteligência Competitiva, Inteligência Tecnológica, Análise Ambiental e Monitoramento Antecipativo. Com base na análise crítica da literatura, é proposta uma ferramenta denominada Radar de Monitoramento Tecnológico que compreende cinco ambientes a serem monitorados – político, econômico, tecnológico, social e concorrencial – cada qual com tópicos chave a serem analisados. Para exemplificar o uso da ferramenta, é realizada sua aplicação para o segmento de telefones inteligentes (*smartphones*), de forma apenas reflexiva e sem participação de uma empresa específica. Uma das sugestões de pesquisas futuras é justamente a aplicação da metodologia proposta em uma empresa real. Mesmo com a limitação de ser um estudo teórico, o exemplo permitiu verificar a aplicabilidade da ferramenta. O radar mostrou-se bastante útil para uma empresa que precise monitorar o ambiente em busca de sinais

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de mudança. A principal contribuição deste estudo é relacionar diferentes correntes de estudo (inteligência tecnológica, análise ambiental e monitoramento antecipativo) e diferentes abordagens para apresentar uma ferramenta de caráter prático que permita a um gestor a identificação e uma melhor visualização das oportunidades e ameaças, evitando assim as surpresas estratégicas no campo tecnológico.

Palavras-Chave: Monitoramento tecnológico. Inteligência tecnológica. Inteligência competitiva. Sinais fracos.

1 INTRODUCTION

Several academic articles set the framework for discussion stating that the world is experiencing major transformations and that companies face scenarios of great change. However, there is no novelty in this fact. Approximately 40 years ago, Bright (1970) already claimed that companies endured environments of increasing change and turbulence and he was one of the first to discuss the importance of monitoring the environment and anticipating technological changes that might give rise to opportunities and threats.

Although change has, for years, been present in the field of management, one of the characteristics which may be observed nowadays is the increase in the pace with which technological innovations are launched, attain widespread adoption scales and are eventually forgotten by consumers. For instance, one might mention Palm, recently acquired by HP. Palm, whose products were considered synonymous of handheld computers, was not able to keep up with technological evolution. They watched their market erode because of the so called digital convergence given that people started to use their mobile phones to execute the same functions (Mahlmeister, 2010).

There is plenty of evidence as to the speed with which the internet was adopted by the population, reaching the milestone of 50 million users in less than five years, whilst other technologies took much longer. Only to exemplify how the speed of adoption of new technologies has evolved, Facebook, a personal relationship site, took only 2 years to reach this milestone and a game known as Farm Ville, developed by the company Zynga and played within the very same Facebook, took 4 months to tag on this same number of users (MacMillan et. al., 2009).

This scenario becomes even more important for companies, primarily those of technological base, to monitor the environment in search of signs of change. Several companies have sought to develop "technological intelligence" so as to be ahead of such changes, detecting opportunities and threats in the technological field (Lichtenthaler, 2003; Schuh and Grawatsch, 2004; Vasconcellos and Diniz, 2000; Souza, Silva and Damázio, 2008). However,

detecting these changes is not enough. One must detect them at their early stages before they surprise the organization and, based on this identification adjust and mobilize the company for action (Ansoff, 1975; Gilad, 1998).

Despite the fact that there are numerous studies concerning technological intelligence, environmental analysis and anticipated monitoring themes, a gap between these fields of research was identified. This article seeks to integrate the concepts of these different approaches with views to presenting the technological monitoring radar as a tool that poses to address the following query: "how can a company systematically monitor the environment and capture indications that anticipate opportunities and threats for a given technology?".

Hence this article was structured as follows: revision of literature, approaching competitive intelligence (CI), technological intelligence (TI) and anticipative monitoring; methodology, whereby the philosophical essay approach utilized in this article is discussed; proposition of the technological monitoring radar tool, whereby the tool is presented and also an example that was prepared to test its applicability, and, finally, the concluding thoughts.

2 BIBLIOGRAPHICAL REVIEW

2.1 COMPETITIVE INTELLIGENCE

In Tyson´s definition (2002), CI "is the systematic process that transforms parts and pieces of random data into strategic knowledge". Thus, systematic environmental analysis and the identification and interpretation of anticipative signs are activities which might be described as CI activities.

For Awazu (2004), CI activities may be classified into three types, namely: activities to aggregate information, to transfer these to the desired unit (company, time, product, etc.) and those to sensibilize interested parties. In this sense, activities to sensibilize stakeholders are strongly impacted by intelligence professionals' ability in correctly interpreting data, and in reducing uncertainty and risks, for decision making purposes. According to Awazu, this last stage is very important given it integrates the thoughts of people, generating a new cycle of intelligence.

If one considers the classic intelligence cycle defined by Miller and revisited by McGonagle (2007), a five stage sequence arises, namely: planning and direction, whereby what one wants to investigate is established; collection activity, when relevant information is identified and obtained; analysis per say, whereupon amongst others, obtained data is interpreted; the information dissemination for decision making stage, and finally, learning and feedback.

Rodrigues et. al. (2006) conducted a quantitative research comprising 55 large Brazilian companies and concluded that the CI activity in Brazil is still in its initial development stages. Although CI presents a major contribution potential for innovation, the study indicates that this field, at the researched companies, is not focused on scientific and technological information, capable of supporting the development of strategies and the identification of essential skills.

According to Souza, Silva and Damázio (2008), whilst CI relates mostly to the general aspects of the company such as markets and competitors, TI is primarily about monitoring opportunities and threats that impact technologies that are of the company´s interest.

2.2 TECNOLOGICAL INTELLIGENCE

According to Norling et al. (2000) TI is an important instrument that supports research and development (R&D) activities, which can be defined as "sensitive information concerning external scientific or technological developments that may impact the company´s competitive position".

Vasconcellos and Diniz (2000) define TI as being part of the CI system, comprising the "monitoring of technological trends which might come to be transformed into opportunities and/or threats to the company".

Lichtenthaler (2003) conducted a survey with 26 companies with views to investigating the evolution of the TI activity at companies. He found that some companies already presented, between 1960 and 1970, TI initiatives. In his study, three major TI generations were identified. The first generation was characterized by the lack of connection between corporate strategy and technological strategy, whereby the main objective was to conduct technological forecasts. In the second generation, a greater interconnection between R&D and

corporate management is to be found, but still without long term strategic guidance. The third generation occurs in a technological management context, a terminology that was made popular by Rousell et al. (1991). It is characterized by the integration of technological and R&D strategies with corporate or business unit strategies. The learning ability is strengthened by the decentralization of the technological planning process and by the allocation of resources. R&D activities are globally integrated and the international sites are perceived as technology learning and global market tools. Decentralization changes the dissemination mode. Upper management receives less information which is distributed in a broader manner within corporations.

Corroborating with the strategic vision of TI´s third generation, Lichtenthaler, Schuh and Grawatsch (2004) claim that TI should subsidize the company´s technological planning process, with views to detecting technological opportunities and threats. The result of this process might be an exploratory technological roadmap describing the development of a technology and its surroundings. As of this result, the company should analyse opportunities and threats to develop the specific technological roadmap.

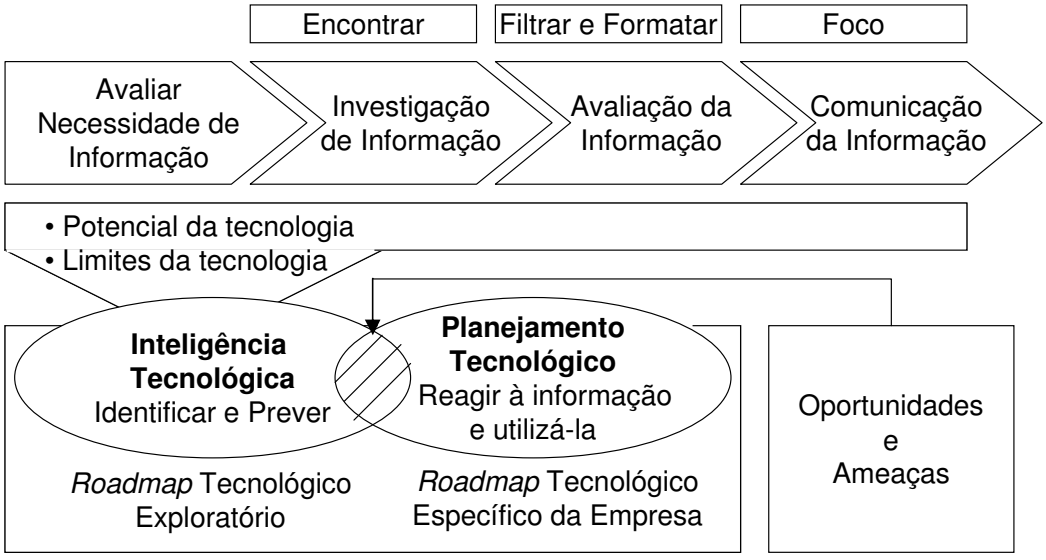

Figure 1: Technological intelligence according to Schuh and Grawatsch

Source: Adapted from (Schuh and Grawatsch, 2004).

Norling et al. (2000) discuss a structured four step process: planning and direction; information gathering; analysis; dissemination and use of information.

According to Vasconcellos and Diniz (2000) a TI system consists of two main components: continuous information collection and dissemination process and specific projects focused on top priority themes.

For the purpose of this study, it was defined that TI involves the planning, collection, analysis and dissemination of information relative to technologies of interest to the company. TI must be aligned with the corporate strategy and the company´s technological strategy, whilst the analysis process is instrumental to add value and make sense of the information collected. It must take into account not only current technologies and factors that impact the company in the short term, but must also concern future technologies and company´s long term, anticipating opportunities and threats.

Keeping this definition in mind, one must monitor in advance, as shall be discussed in the topic that follows.

2.3 ANTICIPATIVE MONITORING

Despite acknowledging the increased strategic importance of information and knowledge for corporate competitiveness, companies have not yet managed this resource adequately (Choo, 2001; Lesca and Almeida, 1994, Polizelli and Ozaki, 2008).

One of the intentions of environment analysis in CI resides in the identification and interpretation of weak signals. For Ansoff (1975), useful information to strategic planning must satisfy two conditions: being available early enough to allow for the preparation of plans and programs, and being sufficiently adequate to enable planners to estimate the impact that the possible forecasts might give rise to at the organization, identify specific replies and estimate the potential impact on profit that such replies might bring about. Thus, weak signals correspond to indications of threats or opportunities where information is vague and does not as yet present a clear breakdown, but which when amplified, meet the two above mentioned conditions.

In this sense, applied to TI, the main focus is in capturing information from the environment in search of signs of ruptures in the technological aspects of the business environment: some source of threat or opportunity.

For Ansoff (1975), one of the pioneers in the study of weak signals, the evolution of knowledge in relation to the identification of these signs occurs by means of the following stages: first one has a sense of threat/opportunity; then the identification of the source of threat/opportunity; subsequently the occurrence of the threat/opportunity; followed by the formalization of a reply to the threat/opportunity; and finally there is the stage when the result of the reply to the threat/opportunity is effective, and thus the cycle completes itself. Therefore the author defines the following strategies of generic replies: in relation to the external environment, develop an environmental awareness and alertness within the organization, ensure flexibility to adapt to external events and finally, the external action that seeks the opportunity or mitigates the threat.

From the internal configuration perspective, strategies include: the development of self-conscience and a permanent state of alert, structuring to ensure internal flexibility that provides rapid replies and the development of contingency plans for opportunities and threats that might arise.

For Gilad (2004) in his book *Strategic Early Warning*, the Cycle of Anticipated Strategic Alert is formed by three stages: anticipated identification, whereby the environment is scanned in search of weak signals; monitoring for verification, during which signs are interpreted and the search for new confirming events takes place; and the proactive management action where the company is mobilized to act in advance.

According to Gilad (2004: 5):

> "Surprises frequently are not that surprising. This might sound like a trivial statement but might not be so trivial. This means that those that are responsible for acting promptly, and not necessarily any other person, ignore the weak signals of an eminent "surprise". Failure resides in the lack of action and in the most surprising attacks, there was, in fact, someone who foresaw risks and set the alert, but usually these people were simply ignored or considered as prophets of the apocalypse".

Thus, one of the most important attributes of CI is in the capacity to mobilize people into action. However, one must ensure correct actions are taken and this is directly related to the scenario that is being identified and constructed. The incorrect interpretation of weak signals might lead to positioning mistakes. Gilad, in the same book alerts: "Obsolete internal convictions, blind spots, lead to adherence to incorrect strategies, ignoring

market evidence that they should be modified or substituted, and thus the sell out of companies, profitability or market share "surprisingly" crashdown" (Gilad, 2004: 6)

In Stephan Haeckel´s (2004) article, some new skills are recommended for one to become efficient in the reading and reply to weak signals. The first and most directly related to the core of this article skill is knowing in advance. As per the author, "if the environment of uncertainties makes it impossible to better foresee what will happen, organizations must invest in becoming better acquainted with the meaning of what is occurring at present" (Haeckel, 2004: 185).

Other skills that complement Haeckel´s recommendations are managing in a reflexive manner (*management by wire*), liberating capacity upon demand by means of flexible and re-combinable structures, and designing the business as a system oriented towards objectives.

The interpretation of weak signals is one of the most difficult activities of the CI process. Given its intrinsic nature, weak signals are of anticipatory, qualitative, ambiguous and fragmented type, obtained in various formats and from varied sources (Blanco & Lesca 1998, p. 3). Thus, the methods of interpretation and reduction of uncertainties for weak signals currently in use are primarily qualitative.

Therefore, to interpret and analyse weak signals in the environment, some techniques are utilized, amongst which the most relevant are: the scenarios technique (Schoemaker, 1995), collective creation of sense (Lesca, 1995) and discussion with specialists by means of the Deplhi methodology (Wright, 2000). Despite the fact that all of these techniques may be utilized in the analysis and interpretation of weak signals, current literature is short of techniques that focus on the technological environment itself.

Furthermore, several authors mention the limitations and setbacks that human cognition is subject to during decision making (Tversky & Kahneman, 1981; March, 1988; Bazermann, 1995; Thaler & Sunstein, 2008). Some of these most common setbacks - anchorage, pseudo-uncertainty and transactional utility - are discussed in detail in Del Rey & Zwicker´s (2010) research.

Thus, structured analysis methods tend to produce results that are superior to less structured approaches. Although the inference process is one that calls for the creation of alternatives and cause and effect relations, which in a certain manner defines it as a creative process (Clemen & Reilly, 2004), and the process of creating sense is inherently emergent, composed of an "insight" stage (Wallas apud Almeida et al, 2007) , the use of a structured methodology does not alter this condition, in fact, it complements it.

This article presents an analysis and weak signal interpretation tool for the technological environment, which enables a structured evaluation of threats and opportunities, in a company´s TI process.

2.4 ANTICIPATIVE MONITORING AND TI

Although Bright (1970) does not use the term technological intelligence, in his article he discusses anticipative monitoring of the environment for the identification of opportunities and threats. His proposal consists in monitoring four environments: political, economic, technological and social.

There are other studies that propose the utilization of Porter´s model of five competitive forces (Porter, 1980) as an analytical tool for the identification of technological opportunities and threats, analysing current competitors, clients, suppliers, new entrant threats and substitute product threats (Schuh and Grawatsch, 2004; Vasconcellos, Montessori and Bruno, 2007).

The environments to be monitored according to Bright (1970) remain incomplete for not covering competitors, new entrant threats, clients and suppliers. Porter´s substitute products threat is covered when analysing the technological environment, mentioned by Bright.

On the other hand, Porter´s (1980) five force model is also incomplete for not comprising political, economic and social aspects in a more ample sense.

Therefore, a technological monitoring tool should incorporate the four environments proposed by Bright (1970), plus four of the five Porter (1980) forces: clients, competitors, new entrant threats and suppliers.

In any event, the definition of environments is not sufficient for anticipative monitoring. Analysing literature in detail, both in Bright´s (1970) pioneer article as in that of other authors who studied environmental analysis at technology based companies (Mauad & Almeida, 2006), small technology based companies (Berte et al, 2007) and at technological incubators (Dutra et al, 2006), one can identify important monitoring items that are herein named key topics.

In the technological environment, Bright (1970) exemplifies some key technological efficiency and technological maturity topics and also some substitute technology indicators. In the economic environment, Bright (1970) also mentions some specific topics that were grouped by the authors into items linked to the supply and demand capacity. Some economic topics were also discussed in technological incubator studies (Dutra et al, 2006).

Bright (1970) lays forth an impressive list of key topics that can be grouped into populational, activity, social condition and value growth. Dutra et al (2006) also emphasize the need to follow up on social conditions.

Important political environment topics were extensively mentioned (Bright , 1970; Mauad & Almeida, 2006; Dutra et al, 2006; Berte et al, 2007). Aspects of the regulatory, public policies and corporate articulation level environments were mentioned to a greater or lesser extent in the above mentioned articles.

One of the contributions of the current article is that of grouping into pre-established categories the examples and key topics mentioned in the literature. These topics must be monitored in their respective environments, so as to facilitate the identification of relevant weak signals.

Ansoff (1975) in his weak signals monitoring study proposes to also identify the temporal issue (the timeframe within which the event shall impact the company). The temporal issue is important because upper management cannot be advised only when the problem (whether one of opportunity or threat) is eminent and demanding a short term reply, given that the time of reaction might be long for the company to prepare itself adequately and thus, make best use of the opportunity or defend itself from the threat. Much the same way, it

can not only be presented when one is absolutely certain since often the company must take on an active role to build its future, intervening on reality. Ansoff (1975) also explores the representation of the magnitude of estimated impact (in terms of increases in profitability or potential damage) and the levels of ignorance that a company might have concerning a given monitoring item. The problem concerning the techniques presented by Ansoff (1975) is the use of different graphs to represent each of these aspects. The visualization of these aspects in a single graph would facilitate management´s ranking and decision making.

Finally, Bright´s (1970) methodology consists in four stages: 1) seek signals in the four environments proposed by him which might be evidences of technological change; 2) identify the possible consequences; 3) choose the parameters to be observed and monitored; 4) present the data, in the adequate time and manner, for decision making.

This methodology seems to be very adequate, however, it is understood that upon defining parameters to be observed and monitored - which in principle might be complemented with anticipative monitoring – gains in both efficiency and focus arise. As far as the authors are concerned, previously established key topics for certain environments facilitates both the identification of technological change evidences and the identification of possible consequences.

3 METHODOLOGY

In this research, the method known as philosophical essay was employed. According to Martinich (2002) a philosophic essay is usually composed of five blocks.

In the first block there is a proposition that calls for demonstration. Thus, in this article, section 1 addresses the mentioned objective of presenting the overall topic of discussion, the theoretical grounding deemed necessary for discussion purposes, the thesis, the motivation for the essay and its targets.

Subsequently, the arguments in favour of the proposition are presented, which, in the case of this article, transformed itself into a set of concepts and

ideas introduced by other authors and original contributions. This was undertaken in section 2 of this article once themes concerning the management of information, CI and TI, weak signals and interpretation of such signals, was discussed.

The third block seeks to demonstrate that the discussion undertaken is valid. Here other authors are utilized who present aspects that are previously related to the theme and the deductive process to build and validate the argumentation. The block before last demonstrates that the assumptions are true. These aspects shall be discussed in section 4, in which the radar tool for technological monitoring is presented.

Finally, the last section of a philosophical essay discusses the conclusions of this study and the final recommendations.

With views to exemplifying the use of the radar, it was applied to the intelligent telephones technology. To this effect, the authors utilized primary and secondary sources of information, using as script the items of analysis of the proposed technological monitoring radar. As primary source, the authors interviewed a former manager of the regulatory area of a telecommunications company. As secondary source, the authors sought news and information related to smartphones as well as research using the Google Trends tool.

4 TECHNOLOGICAL MONITORING RADAR TOOL PROPOSITION

4.1 ENVIRONMENTS, KEY TOPICS AND MONITORING DIMENSIONS

The proposal presented in this article consists in a radar tool for the monitoring of TI, comprising 5 environments: political, economic, technological, social and competition. Each environment is composed of a set of key monitoring topics, which analysed might reveal opportunities and/or threats. These opportunities and/or threats must be analysed in three distinct dimensions: temporal, magnitude of impact and level of uncertainty.

To facilitate the monitoring of the respective environments, a list of key topics is suggested, based on the recommendations of Bright (1970) and authors who studied environmental analysis at technology based companies (Mauad &

Almeida, 2006), small technology based companies (Berte et al, 2007) and technological incubators (Dutra et al, 2006), and in the competitor analysis presented by Porter (1980). One comes to the following list of aspects to be analysed within in each environment:

- ✓ Technological Environment
  - Technological efficiency. Increased technological efficiency might be a result of cost reduction given scale increases, reduction of size, product improvement and technology progress rates.
  - Technological maturity. The product´s life cycle and the quantity of information produced by a given technology must be analysed.
  - Substitute technologies. This is merely the monitoring of emerging technologies that might converge and substitute the current technology and breakthrough technologies that make the current one obsolete.
  - New functionalities and uses. Calls for the analysis of technological convergence and the incorporation of new functionalities or new uses for the technology.
- ✓ Economic Environment
  - Production and Capacity. Aspects such as production costs, supply capacities, availability of resources and production increase rates must be analysed.
  - Demand. Analysis of current demand, refrained demand and increase in consumption rates.
- ✓ Social Environment
  - Population growth. Data analysis includes: population in absolute terms, population growth rates, birth rates and death rates.
  - Activity. Involves the analysis of the level of education, use of free time and occupational interests.
  - Social conditions. In this item, data concerning the rate of disease occurrence, criminality, poverty and pollution is analysed.

- Values. Analysis concerning consumer attitudes, preferences, interests and political opinions.

✓ Political Environment

- Regulatory environment. Involving governmental supporting or restricting actions towards a given technology, committee revisions and recommendations and debates concerning alternatives.
- Changes in public policies. Includes the analysis of changes in the command of important institutions (regulatory agencies, ministries, etc), elections or programs launched by the government.
- Level of corporate articulation. The formation of clusters, incubators or incentive centres must be analysed.

✓ Competitive Environment

- Internal rivalry. Aspects to analyse: expenditures incurred by competitors in research and development, presentation of new products and concepts and their declared strategies.
- New entrants. Includes analysis of companies that research the monitored technology or that operate in converging technologies.
- Supplier power. Seeks the analysis of the quantity of suppliers of the new technology´s raw materials and the existence of alternative inputs.

It is worth noting that this is not an exhaustive list and that for each environment there may still be other aspects to be monitored. However, the list presented, in addition to consolidating monitoring recommendations made by other authors, offers the company a starting point to begin its monitoring process.

Based on Ansoff (1975) the proposal is that the radar represent the following dimensions:

- Temporal: classified in long, mid or short term impact, represented in Figure 2´s radar by the three circles. The closer one is to the centre, the greater is the proximity with the potential threat or opportunity. The classification into long, mid or short term depends on the nature of each company´s activity. For instance, in a telecommunication

company that operates in Brazil, over 2 years is considered long term, given the dynamic nature of the segment.

- Impact magnitude: the magnitude of impact would be represented by the size of the circle in the radar and colour might indicate a classification of opportunity or threat. If it were an opportunity with profit increase potential, it could be represented in green, and if it were a threat with potential loss, it might be represented in red. In many situations the issue might be either an opportunity or a threat leading to a colourless representation.
- Level of uncertainty: might be classified into high, average or low and represented by the pattern of the colouring.

4.2 TECHNOLOGICAL MONITORING RADAR TOOL UTILIZATION METHOD

The utilization method of the tool "Technological Monitoring Radar" may be described by the stages below:

1. Definition of a technology to be analysed from an organization´s or entity´s point of view;

2. Based on this technology and organization, an anticipative monitoring is started in one of the five relevant environments: political, economical, technological, social and competition;

3. Weak signals are analysed (evidences) of threats and/or opportunities in this environment covering previously established key topics. Should no evidence be identified in a given topic, one moves on to the next. Once finalizing the last topic of that environment, it is still necessary to evaluate if there is any evidence relative to that environment that has not been covered by any previous topic.

4. For each weak signal observed, the three distinct dimensions are evaluated: temporal, impact magnitude and level of uncertainty.

5. This weak signal is plotted onto the respective environment, following the visual criteria established. Short term evidences remain closer to the centre of the radar and those of long term closer to the external circle.

Evidences of greater impact on profitability are proportionately greater to lower impact evidences, green being utilized for opportunities and red for threats with patterns representing the level of uncertainty as to the observed weak signal.

6. The plotted point is numbered and in a separate document, the meaning of the weak signal is detailed: if of short, mid or long term, opportunity or threat, the estimated impact in monetary units and the estimated probability of occurrence of the opportunity or threat, expressed in percentage. Furthermore, it is recommended that the item come along with the analysis of what was interpreted and why.

7. Once finalizing the plotting of all weak signals of a given environment, analysis returns to stage 3 to look upon a new environment.

8. At the end of the analysis of the 5 environments, one has the technological monitoring radar filled in and a detailed report with the identified opportunities and threats. Items closer to the centre are the most urgent and the largest with more intense patterns, are the most important.

The figure that follows presents an example for the use of the radar.

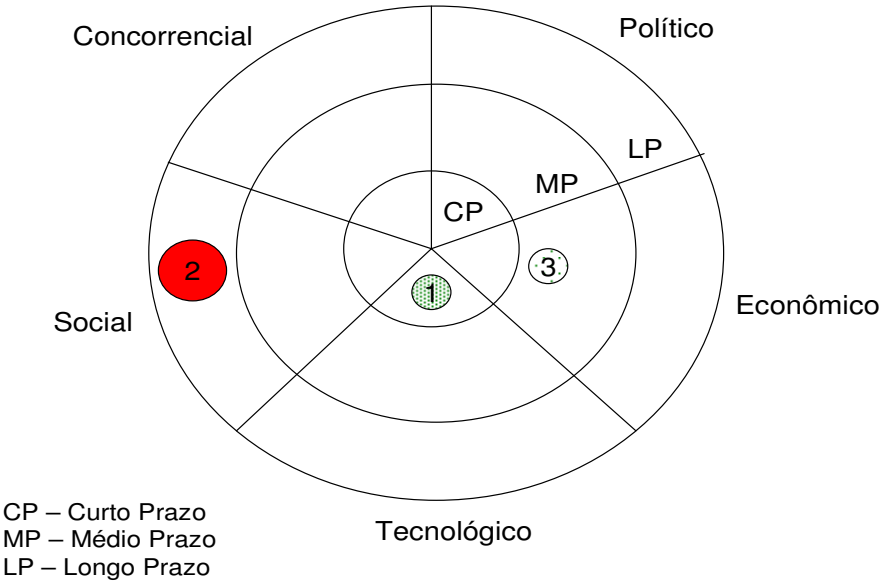

Figure 2: Technological Monitoring Radar

Source: Prepared by the authors

In the radar example represented by Figure 2, item 1 would be a short term technological opportunity (in green) with average uncertainty (average granulation pattern) . Item 2 would be a long term social threat (in red) with high certainty levels (solid colour). Item 3 would be a highly uncertain (scarce granulation) mid term economic opportunity (green). From the radar one would also notice that item 2 would be that of greatest impact given the size of the circle.

4.3 TECHNOLOGICAL MONITORING TOOL EXAMPLE OF USE

With views to testing the applicability of the Technological Monitoring Radar tool, an analysis was conducted of the case involving the smartphone technology, from a mobile telephony equipment manufacturing company´s perspective. To this effect, the authors interviewed a former manager of the regulatory area of a telecommunications company, utilizing the methodology proposed in item 4.2. For each environment and utilizing as reference the key topics, technological opportunities or threats for smartphones were sought, resulting in the list presented in hereinunder.

⇒ Technological:

Technological efficiency:

- Reduction of the size of the equipment.
- Emergence of *Iphone* 4 might drive the use of videocalls.
- Increase in the demand for data transmission band width generating problems for carriers.
- Major dispute between operational systems, without definition of the dominant standard: *iPhone* (Apple); *Android* (Google); Windows (Microsoft).

Technological maturity:

- Smartphone sales forecasts shall overcome sales of conventional phones as of the end of 2011 on the American market, as stated by Digital Home (Figure 3).
- Searches with the word "*smartphone*" are more frequent than with "*cell phone*" (mobile telephone) as of 2010, as researched by the authors in Google Trends.

Substitute Products:

- Tablet (handheld computer in the shape of a board) with expanded functions (e.g. tablet that incorporates the functions of a mobile phone).

Others:

- Videocalls as a feasible technological resource made available on new devices.
- Sale of applications and content (music, movies).

⇒ Political:

Regulatory:

- Need for certification and homologation from the regulatory agency.
- Data transmission in 3G is not currently regulated.

Public Policies:

- Grey market of smuggled products is tolerated despite the fact that there are technological blockage mechanisms for these devices.

⇒ Social:

Activities, occupational interests:

- Expanded use of smartphones in social networks and their applications (e.g. social games)

- Business applications (salesmen, water/light measuring services, security company audits)

Values:

- Smartphone devices represent status

Trend drivers

- Influence of Apple´s top executive, Steve Jobs, on the market. There are always major expectations as to launches he announces.

⇒ Economic:

Cost of production, availability of resources:

- Cost reduction given increase in scale

Demand:

- Rise of the level of income in countries undergoing development such as Brazil with high consumption standards, enabling more consumers to purchase smartphones.

⇒ Competitors:

Internal rivalry:

- Competitive environment with major players offering smartphones.
- Consolidation with the convergence of other segments (e.g. HP buying out Palm).
- OEM manufacturers (Original Equipment Manufacturer*)* launching their own equipment (e.g. HTC company).

New entrants:

- Possible entry of operational system manufacturers (Google and Microsoft).

Supplier power:

- Application market predominance by large suppliers of operational systems (e.g.: Google, Apple, Microsoft).
- Pulverization of content production reduces the bargaining power of content suppliers.

Given space limitations of this article, it would not be feasible to represent on the radar all the items identified. Since the objective of this analysis is to illustrate the tool, choice fell upon drawing on the radar 4 of the identified opportunities/threats, extracted from the list above and subsequently emphasized in bold text and presented in further detail.

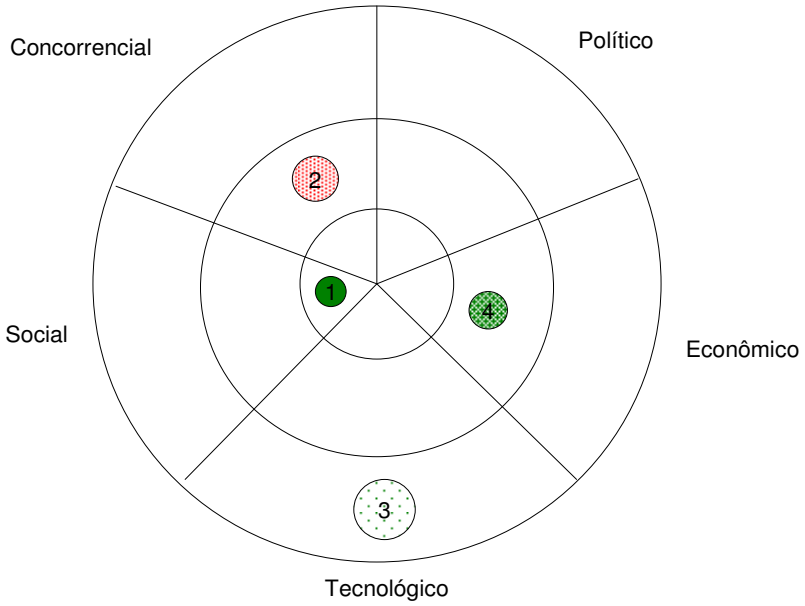

Figure 3: Radar Applied to the Smartphone segment

Source: Prepared by the authors

Each of the items indicated on the radar is explained in suit:

1) **Use of the device for social networks, short term, opportunity, $ 1x, 100%:** There is a growing number of people using the devices to navigate and update social networks. This is already taking place nowadays, with a relatively small opportunity impact given that it is difficult for the company to monetize this access. The manufacturer of the device basically shall benefit by positioning its products to meet this demand.

2) **Domain of the application market by large manufacturers of operational systems, mid-term, threat, $ 2,5x, 60%:** Companies such as Microsoft, Google and Apple not only have the device´s operational system but an entire ecosystem of partners and developers that produce applications for their systems. For manufacturers that do not have an operational system of their own this might mean a threat given that this technology may not only retain the consumer but also generate additional revenues in an applications market. There is still no clear definition as to whether there will be a dominant standard or if several systems shall coexist.

3) **Videocalls as a feasible technological resource, available on new devices, long term, opportunity, $ 3x, 20%:** Even with the new *Iphone* 4 incorporating two cameras on the device to this effect, there is still uncertainty concerning its large scale adoption. The magnitude of the impact may be high much the same way this was the case when cameras were incorporated into mobile phones. There is high uncertainty given factors such as: bandwidth (data traffic only already causes bandwidth issues to carriers), acceptance (many avoid speaking and prefer to send SMS messages through their phones) and agreements with carriers.

4) **Rise in the population´s income level, mid-term, opportunity, 2x, 75%:** The rise in the level of income of the population, primarily in countries undergoing development such as Brazil, generates new needs and allows consumers that previously would not have access to a smartphone, to be able to acquire one.

For the above example, the magnitude of impact was given in relation to a value X which was not estimated given the absence of more detailed information concerning the industry.

5 FINAL CONSIDERATIONS

In the current competitive market, marked by turbulence and rapid change, it is essential for companies that operate with high technology to perform environment monitoring so as to explore opportunities and take action against eventual threats (Bright, 1970; Vasconcellos, Montessori and Bruno,

2007; Norling, 2000). This monitoring can not only detect totally evident aspects but must capture evidence and the so called weak signals (Ansoff, 1970).

This article explored the issue concerning how a company can systematically monitor the environment and capture evidence that might anticipate opportunities and threats for a given technology.

One of the aspects emphasized by CI literature is the need to present information at the right time and in the most appropriate manner to enable decision making and action.

Based on the critical analysis of literature, a tool named "Technological Monitoring Radar" was proposed. It comprises the political, economic, technological, social and competitor dimensions analysed in previous studies (Bright,1970; Porter, 1980; Vasconcellos, Montessori and Bruno, 2007; Schuh and Grawatsch, 2004). The radar also involves the analysis of the temporal dimension, the estimated magnitude of impact and the level of perceived certainty (Ansoff, 1975).

Finally, the usefulness of applying a structured tool for the analysis of the technological environment was demonstrated, as of the preparation of a practical example where the evolution of technological aspects associated with smartphones was evaluated utilizing the "Radar".

In terms of this study´s main limitation, one might mention the fact that it is a philosophical essay (Martinich, 2002), with no empirical proof or application. This is also this paper´s major recommendation: that the proposed tool be utilized to solve real corporate problems. In terms of suggested future research, case studies utilizing the "Technological Monitoring Radar" are recommended as well as the improvement of the methodology, such as, for instance, better modes of calculating the future impact of threats and opportunities.

In any event, this article emphasizes the relevance of relating different fields of study (TI, environment analysis and anticipative monitoring) and different approaches to present a tool that enables a manager to identify and better visualize opportunities and threats, thus avoiding strategic surprises in the technological arena.

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