Approach for Evaluation and Prioritization of a Technological Idea Portfolio Supporting the Management of an R&D Lab of Multinational Corporation in the Brazilian Consumer Electronics' Industry

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Abstract--**The paper aims to propose an approach for evaluating and prioritizing a technological idea portfolio, supporting a R&D Lab to select the ideas that can produce better outputs in innovation technology projects in partnership with Universities. Research methodology is based on analysis of the literature about Project and Technology Portfolio Management, the criteria for measuring innovation (Oslo Manual), and the collaboration between research institutions. As a result it was proposed 5 multi criteria drivers, with different weights, in order to strategically evaluate and prioritize ideas: Strategic Contribution (40%), which has evaluated the adherence of the ideas to the strategic areas of the R&D Lab; Technological Contribution (20%), which has assessed the contribution of an idea to the state of the art in that research area; Institutional Relationship (20%), which has verified the elements needed for establishing a partnership with Universities and intellectual property clauses; Technology Transfer (10%) which has evaluated the potential for creating and improving internal competencies, and Social Impact which is related to the contribution to local social development. This approach also can support others R&D Labs who needs to evaluate ideas based on strategic drivers that goes besides of the innovation funnel for products.**

I. INTRODUCTION

The R&D Lab was founded back in 2011. It is tied to the Brazilian subsidiary of a Multinational Corporation (MNC) active in the industry of consumer electronics. Through this paper the term R&D Lab will be utilized to refer to the organization subject of this study.

The R&D Lab was constituted not only for the traditional role of supporting local production, but also with the intent of creating interfaces with specialized competences and innovation opportunities at a global level in a increasingly competitive context. Its mission is to build local technological competence and self-identity in the context of the MNC R&D Centers worldwide, therefore becoming a reference in key-technologies to the Global Headquarter Research and Development (R&D HQ). The R&D Lab simultaneously proposes innovative projects as competes for global projects within the R&D Centers network, on other hand it must also cooperate with those same R&D centers in global projects where complementary competences are necessary and profitable.

Within this context one of the first concrete actions in innovation management was to map local technology competences in the areas of Computer Science (CS) and Electrical-Electronic Engineering (EE) in the domain of the main Brazilian universities. This mapping resulted in workshops with researchers of recognized competence in their research fields which are connected to areas of interest of R&D Lab and MNC.

After workshops, brainstorming sessions where held gathering together internal experts, afterwards creating a database of over two hundred ideas to guide basic and applied research with potential to become innovative technology projects – technology push, in the first place, but also considering the market pull [5] and therefore contribute to the construction of local knowledge.

From the demand to evaluate and strategically select ideas with the highest potential to become basic research with the probability to be utilized in the consumer electronics industry, it spawn off the opportunity to propose the approach presented and discussed in this paper.

The start point was the search for existing strategical innovation management processes and tools, that could fit this specific demand, including stage-gate, innovation funnel, portfolio project management, technology portfolio management, TRIZ, among others [51, 52, 41, 24, 26, 46, 12-15, 49, 9].

It was verified that those existing approaches are oriented to companies and projects, as showed in the conceptual section (section 2) and under the assumption that the R&D activity is executed within a given specific department integrated with the other organizational functions, with the objective of developing new products, what fits in logic of stage-gate and innovation funnel – the first option considered to respond to the addressed problem – of portfolio project management as proposed by Cooper, Edgett and Kleinschmidt [12-15] and even with the technology portfolio proposed by Jolly [26]. It was also verified that the tools and processes to support the ideation phase, for instance TRIZ, did not address the problem of strategic selection of ideas [46].

However, in the context of competition and collaboration with the R&D centers network of the R&D HQ, summed up with the co-related activities tied with the Brazilian subsidiary, the ideation stage for future projects in basic and applied research ended up drawing attention in the scope of the R&D Lab activities. One of the main functions of its organizational process, towards basic and applied research, is the identification and acquisition of knowledge in key technologies through the establishment of partnership with universities and hiring specialists, what must result in relevant contribution to the state-of-the-art and the generation of new patents (new concepts). This function in the basic and applied research area of the R&D Lab is considered concluded when a materialized prototype demonstrating the possible applications of the key-technologies to corporation services and product lines is made. Therefore, the prototype will follow to development areas and/or other organization departments concerned with the other production process phases [53, 40].

From this particular context emerged the need to adapt existing approaches and propose steering multi-criteria to evaluate ideas in a phase where they are just a promise of possible projects (before the phases of feasibility studies both financial and technical) with the potential to create relevant innovation. Thus, this paper aims to discuss the proposition of an approach to evaluate and prioritize, strategically, a portfolio of ideas to support the needs identified by R&D Lab. Such approach made it possible to select those ideas with the highest potential to become basic and applied research projects in partnership with local universities, enabling the R&D Lab to differentiate itself within the R&D HQ network.

Beyond introduction and final considerations, in order to achieve the proposed objective, this article was organized in four sections. The section two presents a critical review of existing literature utilized in the making of the proposition of approach multi-criteria to evaluate ideas portfolio. The emphasis is in discussing the contribution of Cooper, Edgett and Kleinschmidt [12-15], main references. The third section presents the methodological procedures, based on research-action [50, 6]. Section four describes some of the R&D Lab processes to support basic research and its context, justifying the need for the proposed tool. Finally, the fifth section explains the construction of the steering multi-criteria, weights and scores utilized to evaluate and prioritize the ideas. This section was built based on both the central theory and also measurement criteria of innovation as proposed in the Oslo Manual [33] and the reference theory about the inter-relationship universities and corporations [36, 37, 27]. The outcomes of the strategic evaluation of the ideas portfolio were already converted into basic research projects together with the main Brazilian universities.

The main concepts of portfolio project management still have not reached scale in companies. Despite of its academic development, the techniques of portfolio project management are relatively new to organizations, particularly in Brazil, where this subject is emerging [8], increasing the relevance for the discussion proposed by this paper.

II. THEORETICAL FRAMEWORK: A VISIT TO THE CLASSIC CONCEPTS AND BASEMENT OF PORTFOLIO MANAGEMENT.

The portfolio management has its roots in the investments portfolio inspired by the article “Portfolio Selection” from Harry Markowitz in 1952 [43]. Since this event, many authors have studied and proposed project portfolio management, the most recognized ones being Cooper, Kleinschmidt and Edgett [14, 15], Archer and Ghasemzadeh [2], Rabechini, Maximiano and Martins [42] and PMI [38]. Since the decades of 1980 and 1990, it was established the bases of Project Portfolio Management [20, 18]. The portfolio management is a very important activity which belongs to the process of strategic innovation management [52, 41].

It is possible to see significant progress in the last years coming from works addressing the processes of new product development and new technologies from the perspective of innovation [47, 4]. The framework covering the processes of product development is consolidated in approaches as stage-gate [11] and innovation funnel [9] where the volume of ideas to shape new products is usually higher than the amount or available resources. Thus, the innovation teams, through the execution of evaluations and phases, seek to optimize the volume of ideas and prioritize effort on the ones with higher probability of success in the market.

The innovation funnel was considered the most obvious option to evaluate the portfolio of ideas as starting point, however it was found to be insufficient itself for the problem and the R&D Lab specific context, therefore the reference concept of portfolio management, given its own characteristics, demonstrated to be more affordable, making it possible the approach proposed by this paper.

According to Cooper, Edgett and Kleinschmidt [14, 15], the project portfolio management evaluates the effectiveness of the projects from a given company, it means that it verifies if the existing projects are the ones that will lead the organization way towards its business purposes. The projects portfolio management is a tool to allocate and prioritize resources in projects that implements the innovation strategy established by the organization. It is the portfolio management that allows the organization to have a clear vision and visualize the connections between innovation projects and business purposes, the projects priorities in line with their strategic relevance or potential to generate value. For Cooper, Edgett and Kleinschmidt [12, 13], it is necessary to integrate harmonically the gates decisions and portfolio decisions in order to minimize conflicts between gates decisions and portfolio reviews.

Three aspects are the basis of projects portfolio management, according to Cooper, Edgett and Kleinschmidt [11-13]: i) strategy: once it is necessary to draw a set of projects that will implement the innovation strategy consistently synchronized with the business objectives; ii) resource allocation: in order to decide how to distribute the organization resources to the many strategic projects; and iii) project selection: with the intent of choosing and prioritizing the projects or actions that will ensure the execution of the innovation strategy chosen by the organization.

It must be highlighted that this tool offers subsidies to balance the project risks and benefits in a sense that it is possible to minimize the technological risk for companies [14, 15, 2, 42].

Cooper [16] synthesize the main evaluation models of portfolio management, including: i) financial models addressing the maximization of portfolio value, for instance, Net Present Value (NPV), Economic Value Added (EVA); ii) strategic models that seek to verify the adherence between projects and organization strategy; iii) scoring that supports high management translating evaluations in points to therefore compare projects using a common baseline and; iv) balance models, that creates a whole picture by crossing over relevant variables that usually are inter-related to management decisions, for instance, focus on incremental or disruptive innovation versus project values, risk level versus expected benefits versus probability of success.

The definition of evaluation criteria directly depends on the segment where the organization is competing and its organizational structure [12, 39, 44, 34, 25, 23, 35, 55, 30]. A mistake in establishing the criteria can lead the organization to fail in achieve its strategic purposes [34]. Therefore, adequate criteria is necessary to allow a correct measure of the contribution of each project and the traceability of its expected benefits [38].

In order to have non-subjective decision making process, based purely in stakeholders personal experiences, it is recommended to use methods and tools to support structured and explicit rationing. However, the decision makers should be familiar with that chosen techniques, otherwise, they will not be properly used [2].

It is worth to mention the work of Jolly [26] starting from a list of 32 criteria available in the literature and prioritized by a group of multinational executives for technology projects, where sixteen are co-related to competitiveness and sixteen to attractivity. The most relevant criteria proposed by Jolly [26] concerning attractivity are: impact of technology on competitiveness, the market size opened by it, the range of applications opened by, the vis-à-vis performance gap of technology alternatives and competition. On other hand, the competition criteria considered to be more relevant are: the development of team competences, the distance between a technology and the organization core business, time to market considering competitors, financial capacity, applied research, and the market reaction to the proposed design [8].

According to Cooper, Edgett and Kleinschmidt [10] organizations that are efficient in project portfolio management displays: projects that are synchronized with business strategy, medium to high projects values, adherence with relevant management variables and pragmatism when confronted with the business reality. The key factor to success is the adoption of hybrid evaluation models and a process to formulate and manage the portfolio committed by high management.

The reference tools in this section are subject to adaptation, and eventually the cases will demand it for segment particularities, organization size and/or strategic scope, fact endorsed by its authors [14, 15], and verified that in many case studies utilizing this technique.

The intersection of those tools is the fact that there is a concern with the synchronization with the organization strategic direction. This was the vector for the adaptation proposed in this study to evaluate and select the most promising ideas of the R&D Lab portfolio, as described in the section 5.

III. METHODOLOGY

This section presents the methodology and procedures for the development of the study. The work is structured in three main steps: i) bibliographic content survey; ii) context observation and diagnosis, where the proposition of portfolio management approach was necessary; iii) development, proposition and application of a tool to evaluate ideas portfolio, as showed in Figure 1.

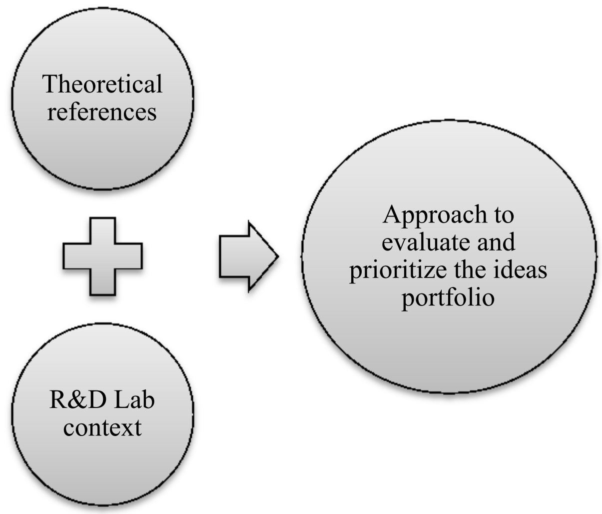


Fig. 1: Research Methodology

i) The bibliographic survey presents and discusses in a critical way the review of the existing literature which included different methods of portfolio management, from scientific publications and books addressing this phase of the innovation strategic management (section 2);
ii) The R&D Lab context observation and diagnosis, both locally and globally, helped and oriented the elaboration of weighted multi-criteria for the ideas evaluation. It is necessary to mention that the direct participation and engagement of the authors in the institutional context, at all phases of process and proposition of the approach here presented, contributed for better comprehension of the studied context (section 4);
iii) The proposition of steering and its multi-criteria for decision making was made possible by crossing-over the results obtained from the previous phases of the method. The objective was to define a tool aligned with R&D Lab strategy and context (section 5).

The data from primary sources were intentionally simplified to ensure confidentiality. The primary sources of this work were obtained through the privileged access to documents and information necessary to the understanding of the subject problem. The authors are formally employed by

R&D Lab. To facilitate understanding, it is necessary to define R&D Lab as the R&D center under the Brazilian subsidiary of a Multinational Corporation actively competing in the consumer electronics industry. R&D HQ is its global headquarter laboratory, R&D Centers network are other R&D laboratories around the world interconnected and reporting, as the R&D Lab itself, to the R&D HQ. And, Multinational Corporation (MNC) or simply Corporation, the headquarter with all its subsidiaries around the world.

The subject portfolio management is still emerging among Brazilian companies, so this study adopted the methodology approach of research-action, developed in the R&D Lab of the consumer electronics industry. The research-action is type of social research, based on empirical evidence, conceived and realized in close association with a given action, resolving a collective problem where researchers and participants, representatives or not of the situation of problem, are engaged in a cooperative and participative way [50].

According to Bryman [6], to execute a research-action, the researcher must engage directly with the subject organization under study, what differentiates from the method case study [17]. The objectives of the research-action are to obtain information that would be scarcely accessible through the use of other procedures, therefore increasing knowledge for specific situations and inferring generalizations.

IV. ABOUT THE R&D LAB

In the context of the last years firms have been facing growing challenges coming from fast technologic shifts, the multinational corporations have increased their efforts to integrate their subsidiaries into research, development and innovation activities. Those corporations have increased the decentralization of innovation activities in such a way each subsidiary contributes to generate knowledge and innovation for the benefit of the corporation [7, 19].

Therefore, multinational headquarters have been carefully analyzing the subsidiaries' capabilities in order to decide which one will receive more innovation responsibilities. At the same time, subsidiaries contribute to the process of decentralization of activities by seeking more complex responsibilities in order to assure their competitiveness and survival [21].

Following this trend, and despite all the controversies about geographic allocation and R&D organization [52], the R&D Lab was constituted not only to serve to the traditional role of supporting local production, but also with the purpose of create specialized interfaces and opportunities at global level. Its mission for next the years is aligned with the concept of reverse innovation of Govindarajan and Trimble [22]. For these authors, reverse innovation is a term referring to an innovation seen first in the developing world before spreading to the industrialized world.

The R&D Lab in Brazil is part of a global R&D HQ of a Multinational Corporation in the consumer electronic industry. The local laboratory is tasked to carry out applied research, creating innovative offers that can solidify the corporation position as a global leader. The R&D HQ has a strong presence research and generation of intellectual property. For instance, has being one of top producers of patents in the last decade.

The R&D HQ network interconnects over 20 R&D Centers around the world. The R&D HQ is located in the same MNC home country. The other R&D Centers are distributed in countries with recognized experience in technology research and development, in areas of MNC interest. This hierarchical structure is explained in the Figure 2.

It is necessary to highlight that some R&D Center are closer to activities in development and engineering, while others like the R&D Lab, also emphasizes basic and applied scientific research with the purpose of generating innovations to guarantee the better competitive position of new generations of MNC products and services.

The Brazilian R&D Lab had been formally founded in 2011, funded by the Informatics Law, initially delivering product development and customizations for mobile phones and printers divisions. Since 2012, it has expanded its responsibility to include basic and applied research in key technologies based on its internal core competences in the areas of Computer Science and Electronic Engineering and R&D HQ technology strategy.

In the last decades, the Brazilian Government launched many public policies with the intent of foster the innovation [31] aligned with the idea of technology push and market pull discussed in the classical article of Mowery and Rosenberg [32].

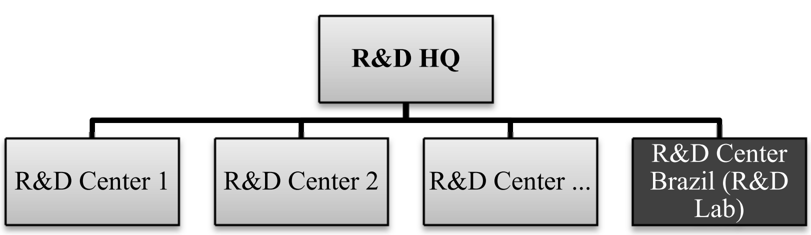


Fig. 2: R&D HQ hierarchical structure
Source: The authors, based on R&D Lab specific information

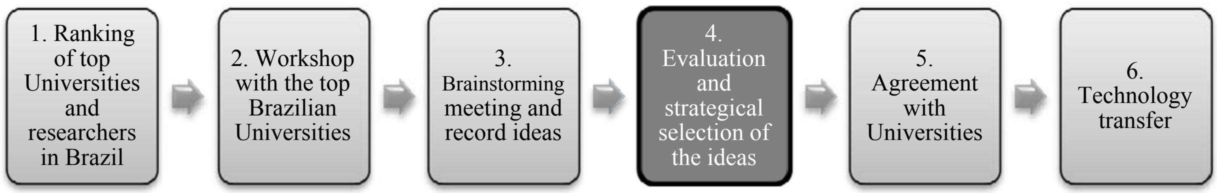


Fig. 3: R&D Lab startup processes
Source: The authors, based on R&D Lab specific information

The Law 8.248/1991, modified by Laws 10.176/2000 and 11.077/2004 is known as Informatics Law. This legal framework establishes tax benefits for Brazilian and multinational corporations equipped with manufacturing facilities in Brazil to produce some electronic goods, with the objective of expanding the technology capabilities, the local competition and the strengthening of R&D activity. Eligible companies that adhere to this Law must invest, annually, in local R&D activities in information technology, around 3% to 4% of gross revenues, deducted taxes. This law is valid until 2019.

The Brazilian Subsidiary of Multinational Corporation, connected with the R&D Lab subject of this study, has made option to use the incentives of Informatics Law since 2004, investing such incentives notably in activities of development. The effort and strategy on basic and applied research had it start back in 2011 coinciding with the foundation of the R&D Lab, however the hiring of highly qualified human resources and the effective start of its activities only took place in 2012. This initial process is summarized in Figure 3[1].

The ranking of universities and researchers (phase 1 of Fig.3) was based in an internal methodology developed by R&D Lab, following the guidelines of R&D HQ. Some criteria that contributed for this ranking were: the number of publications in indexed journals, number of patents, number of thesis and dissertations, background of collaboration of universities and researchers with corporations and research institutes, among others. This methodology is describes in detail in the article of Leite, Lenhari and Lizárraga [28], also presented in PICMET 2014.

Starting with phase 1, it was organized a series of workshops (phase 2), in partnership with 43 researchers from the seven best ranked universities of phase 1, in areas of Computer Science (CS) and Electronic Engineering (EE). The workshops of phase 2 plus the extensive data collection and analysis of documents in phase 1resulted in a knowledge of technologies with promising application in consumer electronics industry and in the R&D Lab research fields for the next years.

In phase 3, a series of brainstorming meetings were held after each workshop [24, 49] together with the R&D Lab internal experts team to collect and record ideas with potential to become innovative technology project proposals. Over two hundred ideas were submitted to. At this point it was identified the need to evaluate this ideas database (phase 4) in a robust and coherent way, considering the R&D Lab purposes and strategy, and not only select it based on non-subjective stakeholders perception. The section 5 will handle in details the elements behind the steering multi-criteria that were used to score the ideas database in the phase 4, object of this article.

After the strategic evaluation based on the steering multi-criteria proposed on phase 4, the best ranked ideas were discusses with its respective researchers and they were requested to prepare specific project proposals. Those proposals were analyzed and once it was resolved legal issues, both on technology and intellectual property [36], contracts were signed off formalizing the partnership with seven Brazilian universities (phase 5). Through the execution of all projects there are specific project control mechanisms for follow up and technical reviews, by internal researchers with expertise in the respective technology. As projects are progressing, future actions are planned like forthcoming workshops and even the employment of some of the external researches already engaged. Those actions part of phase 6 – technology transfer [29, 45, 1].

V. APPROACH PROPOSED FOR EVALUATION AND PRIORITIZATION OF A TECHNOLOGICAL IDEA PORTFOLIO

This section presents and describes the construction, application and some results of the approach multi-criteria proposed by the authors to evaluate a portfolio of ideas. The process of building the proposed approach demanded many meetings to define the steering multi-criteria that allowed the evaluation of over two hundred mapped ideas by R&D Lab internal experts, as stated in phase 4 of Figure 3, in section 4.

Considering the critical review of the existing literature (section 2), the R&D Lab context (section 4), the concepts, methodologies and R&D metrics as proposed by Oslo Manual [18], supported by the concepts of university/industry collaboration [36, 37, 27] and technology transfer [29, 45, 1], it was selected five steering strategic to evaluate ideas: i) contribution to strategy; ii) contribution to technology; iii) institutional inter-relationship; iv) technology transfer and v) social impact, for what specific evaluation and balance criteria was elaborated, in relation to its critical dimensions, as showed in Table 1.

[1] There are other strategic lines of action of the R&D Lab such as partnership with local research institutes and startups with expertise in key technologies selected in addition to the development skills that are not described because they are not the focus of this article.

TABLE 1: STEERINGS AND EVALUATION MULTI-CRITERIA

Steerings/Weight	Evaluation Criteria	Scoring
Contribution to Strategy 40%	**Strategic Areas Adherence (SAA)**	
	Highest adherence	13
	Fundamental concept that can be applied in strategic areas	8
	Low adherence	5
	Not adherence	3
	Strategic Areas Relevance (SAR)	
	Highest relevance for building knowledge	13
	Fundamental concept that can be applied in strategic areas	8
	Low adherence	5
	Not adherent	3
	Core Technologies Adherence (CTA)	
	Core technology 1	13
	Core technology 2	8
	Core technology 3	5
	Core technology 4	3
	Presence of Others R&D Centers (ORD)	
	There is no R&D Center working on this technology	13
	R&D Center working with the technology but the local R&D Lab has a differentiated proposal	8
	One or more R&D Center working on the same technology	5
	Information is not available	3
Contribution to Technology 20%	**Contribution for State of the Art (CSA)**	
	Improving state of the art worldwide	13
	New interpretation for state of the art (not necessarily better)	8
	Contribution for state of the art local	5
	No contribution for state of the art	3
	Technological Maturation (TM)	
	It is already implemented, but it is necessary to adapt it/buy it	13
	2 years	8
	5 years	5
	7 years	3
Institutional Relationship 20%	**Friendliness of Agreement Signature (FAS)**	
	Existence of previous agreement and absence of Intellectual Property (IP)	13
	Existence of previous agreement and need to acquire IP	8
	Absence of previous agreement and absence of previous IP	5
	Absence of previous agreement and need to acquire IP	3
	General Impression of Researchers (GIR)	
	Highly positive impact	13
	Moderately positive impact	8
	Neutral impact	5
	Negative impact	3
Technolog y Transfer 10%	**Technology Transfer from University (TTU)**	
	Core competence/ease of team to assimilate knowledge	13
	Need to train team to follow up the project	8
	Need to hire engineers to follow up the project	5
	Technology transfer will only happen through deliverables	3
Social Impact 10%	**Contribution for Social Development (CSD)**	
	Direct and immediate application in social projects	13
	Possible application in social projects	8
	Not direct application in social projects	5
	There is not application in social field	3

Source: The authors

The steering **contribution to strategy** is broken down into four sub criteria. The first two items observed the adherence and relevance of ideas to the four R&D Lab strategic areas. Those four areas were defined by R&D Lab high management and they are not explicit in this article in order to keep confidentiality. The relevance of specific ideas to construct knowledge and its application to strategic areas also considerate the existence (or not) of competitors with expressive market share in industry of consumer electronics.

The third criteria examined the adherence of ideas to the R&D Lab core technologies with the purpose of building local and differentiated knowledge. The selection of core technologies has happened through i) mapping technology competences from the main universities and researchers in the country both in CS and EE; ii) the technology expectations of R&D HQ for medium and long term. From the strategic perspective, another important criteria was the existence (or not) of similar basic research in other MNC R&D Centers network.

The criteria **contribution to technology** analyzed the ideas contribution for the research state of the art in Brazil and in the world and the possibility of applying the proposed technology in the consumer electronics chain, through its maturation time. The scoring logic took into consideration the maturation time for R&D Lab to incorporate the technology.

In a context that considered the knowledge construction and acquisition, primarily, through the university-industry collaboration, it was important to observe the friendliness (or not) to establish a productive **institutional relationship**. On one hand, this institutional relationship needed to consider the legal interface in the R&D Lab process of hiring a university, and the mutual interest and motivations, such intellectual property sharing, scientific publications, etc.

Within these steering criteria there was also need to consider qualitative/subjective score to represent the main impressions about the researcher appointed to lead the project, given that the implementation of an idea in a research project would rely on the good personal inter-relationship with technical teams and management teams. The score embedded in this criteria considered the presentation skills, the idea´s potential of application, the personal feedback and impressions of internal researchers, the background of relationship with private companies, and the background in dealing with intellectual property filling processes.

Following the same logic and context, it was proposed another steering criteria to cover aspects of **technology transfer** from the university to R&D Lab. The criteria for this steering were proposed in a way to consider the R&D Lab core competences and internal expertise to follow up, assimilate and appropriate the knowledge generate by the university, as the possibility to employ researchers who are engaged in the project. This last one is very important due to the fact that not all the selected Brazilian universities are geographically close to the R&D Lab, what would be a concern to hire the external experts.

At last, following MNC guidelines and R&D Lab strategy, there was the need to consider **social impact** that the idea would produce, as well the potential for application in social projects to contribute for the local development.

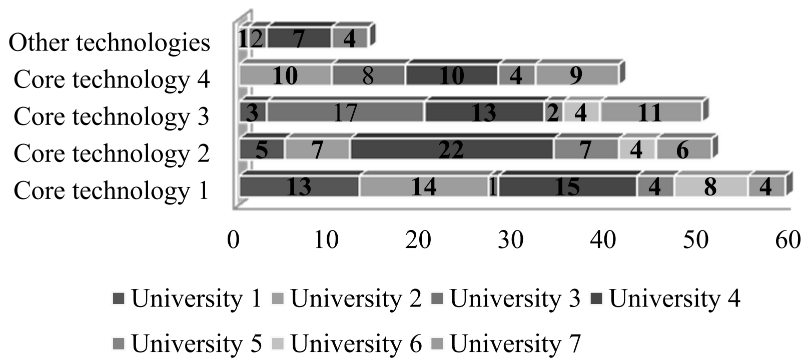
The multi-criteria model was used to score every idea from the database, attributing balanced points and weights according to the R&D Lab strategy. The weight was expressed in percentages and represented the relative relevance of each criteria, as noticed in Table 1 (the summation of weights is equal to 100%). The option to score how much the ideas would fit the criteria was Fibonacci numbers: 13 for high contribution, 8 for high-medium, 5 for medium, 3 for low contribution. For each criteria, the score was multiplied by its weight resulting a total. The sum up of totals determined the general score for each evaluated idea. This model was based on the logic proposed by PMI [38]. The Table 2 shows a sample of the ideas portfolio evaluated and some of their baskets. Some baskets and ideas that really have been selected are not listed in order to guarantee confidentiality.

TABLE 2: SAMPLE OF THE IDEAS PORTFOLIO EVALUATED AND SOME OF THEIR BASKETS

				Criterias										
				Strategic Areas Adherence	Strategic Areas Relevance	Core Technology Adherence	Presence of otherd R&D Centers	Contribution for State of the Art	Technological Maturation	Friendliness of Agreement Signature	General Impression of Researchers	Technology Transfer from University	Contribution for Social Development	
Idea	Field	Possible Applications	University	SAA	SAR	CTA	ORD	CSA	TM	FAS	GIR	TTU	CSD	Total
Cataract Screening Tool	Signal Processing	Health and Welness Promotion	UFRGS	13	13	13	3	8	13	3	13	5	13	67,00
Smart Environments Architecture controlled by emotions through Brain-Computer Interface	Artificial Intelligence	Health and Welness Promotion	UNICAMP	13	13	13	3	8	8	5	13	8	13	65,00
Malicious/Non-Cooperative Behavior: Detection of Spammers and Content Polluters	Information Search & Retrieval	Social Networks Applications	USP	8	13	8	3	8	13	3	13	8	13	60,00
Integrating Smart Appliances with Digital TV	Artificial Intelligence	Digital Convergence	UNICAMP	8	8	13	3	5	13	5	13	8	13	57,00
Statistical modeling of education indicators: Impact of mother's educational level on newborn's risk	Artificial Intelligence	Statistical Modeling	UFRJ	8	8	13	3	5	13	5	13	8	8	54,00
Integrated Learning Environments for Automation Engineering	Human-Computer Interaction	Learning VR/AR Environment	USP	13	8	8	3	5	8	5	13	8	8	52,00
Visualization of Medical Data from Multiple Sources	Computer Graphics	Decision Support	UFRGS	13	13	13	3	5	8	5	8	5	8	51,00
Portatil Pupilometry for Sleep Detection	Signal Processing	Health and Welness Promotion	UFRJ	13	5	13	3	5	8	5	8	8	8	49,00
Learning Chain Recommendation	Artificial Intelligence	Topics Recommendation	USP	13	3	13	3	5	13	5	8	8	5	46,00
Intelligent Diagnosis Support of Tuberculosis	Artificial Intelligence	Decision Support	UFRJ	13	5	13	3	8	13	3	5	8	5	46,00
From Reading to Learning - Exploring active learning environments on tablets and mobiles	Machine Learning	Active Learning	USP	13	5	13	3	5	8	5	8	8	5	43,00
BCI based on Electrooculogram/Steady State Visual Evoked Potential (SSVEP)	Signal Processing	Brain Computer Interface (BCI)	UFRJ	13	3	13	3	5	8	3	8	5	8	42,00
Interaction Modeling: Structural Correlation Pattern Mining	Information Search & Retrieval	Pattern Mining	UFMG	8	8	8	3	5	8	5	8	8	8	41,00
Human-Robot Interface - Neurorehabilitation after CVI (cerebrovascular accident - AVC in Portuguese)	Human-Computer Interaction	Health and Welness Promotion	USP	13	3	8	3	5	5	5	8	5	8	36,00
Accessibility Evaluation of Android	Software Architectures	Accessibility	UNICAMP	13	5	3	3	3	8	5	8	8	8	34,00

Source: The authors, based on R&D Lab specific information

Graphic 1: Distribution of ideas by strategic areas
Source: The authors, based on R&D Lab specific information



Graphic 2: Distribution of ideas by core technologies
Source: The authors, based on R&D Lab specific information

Some results to support decision making are exemplified in Graphics 1 and 2. Graphics 1 and 2 also intentionally omitted the R&D Lab strategic areas and the numbers were simplified in order to guarantee confidentiality.

The proposed steerings, the evaluation criteria, its balance and the evaluation over two hundred ideas in the database were submitted and criticized by a team of experts both in business and technologies from the R&D Lab management team. Some ideas generated through this process were converted in fruitful projects with the universities as mentioned in section 5. Nevertheless all the ideas created, but not immediately consumed in projects, were stored, sorted and organized in a database, as part of the R&D Lab knowledge management process, available for future utilization in innovation opportunities.

VII. FINAL CONSIDERATIONS

This study presented the proposal made by authors to evaluate a portfolio of ideas in a R&D Lab, having the aim of demonstrate how it was made the construction of criteria to evaluate ideas, collaborating to make the decision process more transparent and efficient, once using explicit and structured criteria. It made the communication flow between stakeholders more efficient, once it was possible to have transparency for decisions and traceability for the expected benefits of each idea (promise.)

The approach proposed by this paper made it possible to verify that the ideas best scored were those that will support R&D Lab to achieve its strategic purposes. The tool allowed the implementation of the established innovation strategy and offered resources to balance risks and benefits in a way that minimized technologic risks, as praised by the main authors mentioned in section 2.

This study is considered relevant, since the subject R&D Lab evolved from an incipient stage to a formal stage in ideas portfolio management, in line with other tools for the remaining phases of a typical model of strategic management integrated with innovation as proposed by Tidd and Bessant [51], Quadros [41] and Tidd, Bessant and Pavitt [52].

This work brings additional thoughts to existing concepts, even though having limitations to its generalization due to the research-action [50, 6] handling a single R&D Lab in the context of consumer electronics industry in Brazil. It also fills the gap between technology and innovation management processes and tools that presents many consolidated options for the ideation stages and project management phases but poor support to strategically evaluate a portfolio of ideas. It can be useful, with proper adaptations, for other organizations and R&D Centers that would need a tool to select ideas with potential to become technology innovation projects endorsing the advance in the state-of-the-art.

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