ISSN 2286-4822
www.euacademic.org

EUROPEAN ACADEMIC RESEARCH
Vol. IX, Issue 10/ January 2022

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

A multidimensional evaluation framework for the regional benefits of publicly supported R&D projects

LETÍCIA ANDRADE DE OLIVEIRA BRILHANTE
Department of Production and Systems Engineering
School of Engineering | University of Minho
Campus de Azurém, P 4804-533 Guimarães, Portugal

Abstract

Public policies that aim to establish an R&D ecosystem need to contextualize it in a flexible system of network cooperation constituted by the various actors involved in the context such as: industries, government, institutes, universities, partners and other public or private components. To determine its efficiency it is essential to know the degree of cohesion and synergy of its agents, which directly imply the strengthening of competitiveness, products and services, as well as the support and infrastructure of the network as a whole. Establishing measurement criteria and indicators represents a complex task, since R&D activities linked to public support or funding aim at tangible and intangible results, as they also contemplate a social bias established by positive socio-economic externalities. This article is based on empirical studies and from a set ofex-ante R&D assessments, uses a case study of 08 companies in the Manaus Industrial Pole to diagnose possible results (financial and non-financial) and effects about the regional benefits of R&D projects.

Keywords: Research and Development; Project Evaluation; Regional Policy.

1. INTRODUCTION

The complexity and dynamics of R&D activities constitute a challenge for the elaboration of a structure that can measure the performance of the projects. Despite the extensive literature and the approaches used, each method brings its specificities and demands data that will not always be available. Large-scale government-funded projects, in which a large volume of resources and various stakeholders are involved, must be examined from multiple perspectives and the characteristics of the public sector must be considered in addition to the isolated analysis of the results, as it is necessary to take into account the establishment of an entire ecosystem that incorporates comprehensive points of view covering technological and economic perspectives, as well as dynamic and social expectations. A systematic assessment of the various effects of public support for R&D policies can decisively support decision-making and public policy guidelines. The objective of this work is to outline a framework for multi-dimensional evaluation of the regional benefits of R&D projects of 08 companies in the Industrial Pole of Manaus, starting from the concepts of ex-ante evaluations taken in a case study.

FINANCIAL AND NON-FINANCIAL R&D INDICATORS

The identification of all factors associated with R&D projects requires acomprehensive understanding and knowledge of technological aspects, organizational strategies, market conditions and regulations. Long-term investments are characteristics of complex systems that require simultaneous analysis of subsystems, implying optimal portfolio selections. As a result, organizations need to select projects that contribute to long-term competitiveness. Thus, the process of screening and prospecting for R&D projects encompasses the organization's strategies, the perspectives of the interested parties and the qualitative aspect of the benefits and risks of the projects. This process also considers financial aspects, objectives and uncertainties that make up a general panel and end up guiding guidelines for decision making. Some evaluation methods for R&D investment decisions are complex and present a reasonable degree of difficulty, as they use mathematical models that cannot be applied to concrete cases in the daily lives of companies. In addition, it is necessary to consider that not all information will always be available in the initial phases of the projects due to their gradual and medium to long term nature. Commonly, financial data such as expenditures and investments are reported preliminarily, but qualitative results can be consistently assessed when projects reach a more advanced degree of maturity. The criteria are reflected in the variables: technical, organizational, market, economic, environmental / regulation. The first two variables relate to internal conditions of organizations and the sub-criteria are divided into required skills, availability of resources, readiness and risk of technology, replicability, availability of qualified personnel, knowledge, skills, experiences and R&D strategies. The last three variables are external and their sub-criteria refer to the potential size and market risk, time to market, project costs and risks, return on investment tools such as Net Present Value (NPV), value added to products and the in the case of the last variable, economic, environmental and market regulation policies list the sub-detailing of levels of a hierarchical model structure (Garces et al., 2021).

The selection of R&D projects is considered a complex problem not only because of the risks and uncertainties, but also because it involves quantitative and qualitative issues that often conflict. Therefore, there is a need to balance important factors and assess the interdependence between them. Criteria such as potential to generate innovation, technological maturity, operational alignment with objectives and strategies, availability of resources (financial, intellectual capital, infrastructure), risk management and stakeholder satisfaction are factors that can provide parameters in the analysis of portfolios (Silva et al., 2010).

Although widely used by the private sector, the Balance Score Card approach can be efficiently applied in the evaluation of financial and non-financial indicators of R&D efficiency in the public sector. The BSC brings the customer-focused perspective to the latter with emphasis on stakeholder satisfaction, people development, learning and growth, and community relations, which includes cooperation with research institutes and universities. On the one hand, it evaluates individual company results such as the rate of commercialization of products and services, sales, patents and the generation of jobs and income. On the other hand, it analyses structural results such as the level, openness and equality of technological cooperation, as well as the level, openness and equality of transactions between the companies that make up the ecosystem, measuring the density of the network (E. Kim et al., 2017).

The selection criteria for R&D projects should incorporate not only the technological potential of new products, services and processes, but also the value perceived by the customer regarding this new technology or innovation. That is, what utilities these solutions will bring to users and how much they will be willing to pay for them. In terms of the market, this is considered a foundation within the context based on competitive advantage. Recently with the growth of technology complexity, strategic management must consider a wide number of factors such as: technological paradigms, socio-economic pressures for change, management of diverse knowledge bases, global standards and intellectual property. The customer may perceive value in monetary and non-monetary terms. The former are related to costs such as price, availability, research time and operating costs. The latter include competence, market positioning (for this factor the novelty index is relevant), social recognition. Recent studies try to measure the value perceived by the customer with a multidimensional construct considering the functional, economic, emotional and social concept. Others consider the ecological, economic, social and sustainable contexts (Lee et al, 2017).

Assessing the complexities inherent in R&D projects requires tools to support decision making that include the non-financial nature such as strategy, flexibility, quality and social returns. Traditional financial methods based on flows, Net Present Value (NPV), and Internal Rate of Return (IRR) do not always provide meaningful insight into the strategic agenda. In the case of R&D projects, different studies question the need to incorporate social criteria in scientific research and in the engineering field in order to establish a balance between profitability and social responsibility (Fernández et al., 2015).

For Shen et al. (2020) investment in R&D presents substantial positive externalities. The literature suggests that technological progress arising from R&D activities have a positive impact on growth and productivity in a country's economy (Chen et al., 2021; Becker, 2015; Leung, 2020; Buyse et al., 2020; Crespi et al., 2020). Counterfactual analysis shows that the global subsidy is more effective than the proportional subsidy in increasing expected firm value and the probability of innovation. R&D continuators respond more actively than initiators to the R&D subsidy (Chen et al, 2021).

Public policies are considered within three categories: R&D tax credits and direct subsidies support from the university research system and formation of highly qualified human capital, and support from formal R&D cooperation in a variety of institutions. One of the indicators of R&D output is based on the measure of highly qualified intellectual capital that includes the number of scientists and engineers in a company, the share or the total number of workers with tertiary or higher education and years of formal education (Becker, 2015).

The management literature widely documents that innovation is a major driver of companies' competitive advantage and generates more growth opportunities for companies in the future. A company's investment policy in R&D can address threats from product markets, as high-risk companies that invest more in R&D have higher sales growth in the future compared to similar high-risk companies that invest less in R&D (Le et al., 2021).

For Becker (2015), a question is how to measure and compare R&D between companies, industries and countries. There are alternatives such as R&D input, expenditure or intensity measures, and production measures such as patents or innovation counts. An advantage of input measures would be that their economic (monetary) value can be considered homogeneous, while the economic value of output measures such as patent counts are heterogeneous, however, the propensity to patent varies considerably across industries and countries, and even a high patent count does not necessarily imply a high level of innovation, as some patents may never be implemented.

In a study on the evolution of productivity, Chen et. Al (2021), using a sample of Chinese high-tech manufacturing firms, found that 47.8% to 67% of the benefits of investing in R&D come from unpatented R&D activities; that on average, an invention patent (a utility model) causes an increase of about 0.76 (0.66) percent in the company's value. However, only indicators of research productivity, such as the number of articles or citations, are insufficient to fully describe the benefits that research brings, and it is also necessary to measure what counts in terms of significant social changes (Pinho & da Rosa, 2017).

The interest in the spatial distribution of the benefits of public investment in R&D is not restricted to regional development agencies, but also to national and supranational organizations as an alternative to neutralize the center-peripheral disparities. Empirical and theoretical models suggest that even if technological spillovers are spatially concentrated, they may still be less than ideal for locating R&D activities in backward or less favored regions. This under-investment will be greater where expenditures are rationed and R&D projects compete with other priorities and expenditures with less uncertain results (Roper et. Al, 2004).

A role assigned to regional R&D policy is to facilitate and support the formation of regional clusters of university and private R&D activities, in order to explore economic clusters. The prediction is that university research will increase opportunities for the development of regional technology and R&D productivity in the private sector. This association can be effected through cooperation agreements (Becker, 2015).

Indeed, public investment in R&D in terms of economic growth depends on governments creating a global infrastructure boost, not only correcting market failures, but prospecting new niches and stimulating them. The hypothesis is that such investments have a greater multiplier effect as they involve several sectors of the economy. The overflows resulting from such investments are, by definition, greater due to their intersectoral character (Deleidi&Mazzucato, 2021).

In fact, in a microeconomic analysis, public investment in R&D brings about a reduction in costs in innovation and the related positive repercussions increase the productivity and the average cash flow of the companies. However, investments may not benefit all companies equally, as they are positively related to each company's absorption capacities and R&D intensity (Chen et al., 2020).

Obviously, the size and intensity of investment in R&D is limited for each company and country. To improve R&D results, a country must seek international R&D collaborations. One solution is attributed to the flexible formal and semi-formal networks of innovators that facilitated access to various sources of knowledge outside the company, including other companies, research institutes and universities. In this situation, R&D performance at the country level benefits from the structure of the collaboration network internationally. Through these networks, scientists and inventors collaborate and exchange knowledge to seek innovations and scientific knowledge. Innovation stems from the recombination of existing ideas and knowledge (Guan et al., 2016).

METHODOLOGY

A systematic literature review was carried out in order to understand the main variables and techniques inherent to quantitative, qualitative and quanti-qualitative methods within public policy strategies linked to R&D. This approach was used as a background to the description and development of the case study, based on ex-ante evaluation data collected from research with companies from the Manaus Industrial Pole to outline an ex-post evaluation framework of the benefits of the proposed R&D projects for the 2021-2023 trienniums.

THE CASE STUDY

The institution of the Manaus Free Trade Zone (ZFM), through Decree-Law No. 288, of February 28, 1967, is considered one of the most relevant economic landmarks in the region. The ZFM's main objective is to economically develop the Western Amazon region as well as the social condition of its inhabitants, respecting the natural ecosystem in which they operate. Among the legal instruments of Brazilian public S&T policies, Law No. 8,387 / 1991, known as the Information Technology Law in the ZFM determines that computer goods (BI) manufacturing companies invest five percent of their gross sales, discounted taxes and incentive acquisitions, in R&D activities to be carried out in the Western Amazon, in order to receive the expected benefits in law.

In this way, it is expected that the tax benefits granted to industries installed in the Manaus Industrial Pole (PIM) will stimulate not only the generation of jobs and income, but also that the scientific and technological development of this region will strengthen it through activities of R&D. Therefore, the law seeks to develop innovation, new technologies and the training of human resources involved.

Thus, a survey was conducted with 08 companies benefiting from the computer law in order to previously analyze the values and projects in the period 2021-2023 in order to assess what would be the data and indicators relevant to the construction of an ex post model of effective evaluation.

For a brief characterization of the profile of the companies, it should be noted that: company A is a South Korean transnational manufacturer of smartphones, smart TVs, smartwatches, tablets and notebooks. Companies B and D are US multinationals that manufacture products and solutions for banking automation. Company C is a North American multinational producer of lithium-ion batteries. Company E is a Brazilian company that produces cards, components, smartphones and notebooks. Company F is a South Korean manufacturer of batteries for smartphones and notebooks, in addition to LED lighting. Company G is a South Korean manufacturer of electronic boards and components acting as a contract manufacturer. Company H is a French manufacturer of set up boxes and modems.

In total, 60 projects were presented totaling USD 43,418,145. The number of projects was divided among the companies as shown in the table below. Company A presented 13 projects, followed by 6, 1, 13, 10, 1, 14 and 2 projects by companies B, C, D, E, F, G and H, respectively.

Table 1 – Distribution of the number of projects per company

A	B	C	D	E	F	G	H
13	6	1	13	10	1	14	2

Source: Elaborated by the author

Company A has forecast the application of the obligation ofUSD 22,037,287 which is equivalent to 50.76% of the total amount, followed by companies D with an estimated application of USD 10,476,761 equivalent to 24.13%, company E with expected application of USD 6,975,524 equivalent to 16.07%, company B with expected investment of USD 1,292,308 equivalent to 2.98%, company G with expected investment of USD 1,011,684 equivalent to 2.33%, company H with an expected investment of USD 860,529 equivalent to 1.98%, company F with an expected investment of USD 589.227 equivalent to 1.36% and company C with an expected investment of USD 174.825 equivalent to 0.40%. These values and percentages related to the total value are shown in the table below in more detail and correspond to the obligation of each company.

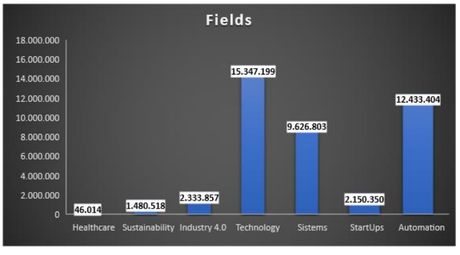
Table 2 - Amount of obligation/investment per company (U$ in million)

A	D	E	B	G	H	F	C
50,76%	24,13%	16,07%	2,98%	2,33%	1,98%	1,36%	0,40%
22.037.287	10.476.761	6.975.524	1.292.308	1.011.684	860.529	589.227	174.825

Source: Elaborated by the author

In general, the projects were presented outlined in the areas as follows:

Figure 1 - Values applied in thematic areas (U $)

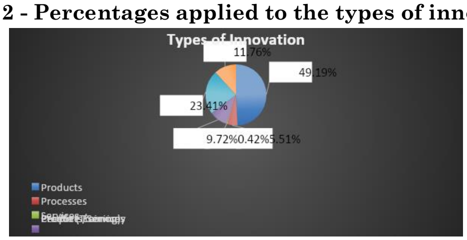


Source: Elaborated by the author

The division took place in the following fields and values: USD 15,347,199 in 5G technologies, disruptive, Soft Skills, Internet of Things, Artificial Intelligence, Games, Mobile Apps, Virtual Reality, Augmented Reality, Mixed Reality, Additive Technologies - 3D Printing, voice assistantBixby, Block chain, Data Science, Machine Learning, Data Mining, Consumer Robotics and Technologies for Autonomous Vehicles, USD 12,433,404 for automation projects, USD 9,626,803 for Information Systems projects, E-Commerce Service Platforms, Games, Bios Firmware and Operating System, USD 2,333,857 for Industry 4.0 projects, USD 2,150,350 for Start Up projects, USD 1,480,518 for Sustainability projects and USD 46,014 for healthcare projects.

Regarding the main objectives of the projects, 49.19% focused on improving or innovating products, 23.41% on training people, 11.76% on innovation focusing on the use of wearables in healthcare for the creative economy, 9 , 72% in product or service improvement or innovation, 5.51% in process improvement or innovation and 0.42% in service improvement or innovation, as can be seen in figure 2.

Figure 2 - Percentages applied to the types of innovation



Source: Elaborated by the author

In the table below, the distribution of outgoing additionalities is shown:

Table 3 - Companies x results

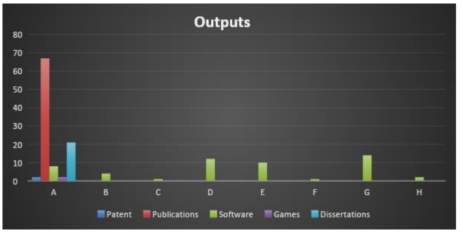
Company	Patent	Publications	Software	Games	Dissertations	Thesis
A	2	67	8	2	21	
B			4			
C			1			
D			12			
E			10			
F			1			
G			14			
H			2			
TOTAL	2	67	52	2	21	0

Source: Elaborated by the author

In terms of results, there are patents, publications, software, games and master's dissertations, broken down according to table 3. With the exception of company A, none of the others presented such diversification on the themes related to the projects.

With respect to companies B and D presented in the table above, the number of new products was attributed to software development, since this was one of the fundamental stages of development of the projects. Below is a comparative graph of the respective table with the data distribution, in which it is possible to verify that only company A presents results with a wider range of coverage.

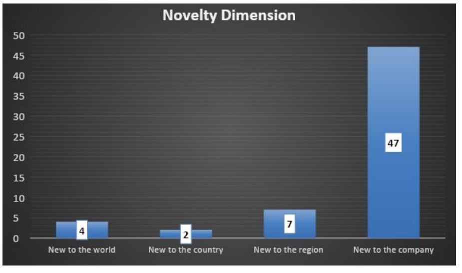
Figure 3 - Distribution of results between companies



Source: Elaborated by the author

Figure 4 shows the details of the dimensions of the innovations:

Figure 4 - Innovationdimension



Source: Elaborated by the author

Of the total projects reported by the companies, 47 would bring some innovation or improvement at the company level, 7 would have a scope for the region, 2 for the country and 4 would have a global reach.

Regarding the internal structures of human resources and technical staff of the companies, the data reported by the companies showed the number of professionals in full and / or partial dedication, allowing the stratification expressed by the number of doctors, masters, specialists and professionals of basic training as configuration in the table below.

Table 4 - HR table with full or partial dedication in the companies

Company	Doctors	Masters	Masters (Partial Time)	Experts	Experts (Partial Time)	Graduates (Partial Time)	Graduates (Partial Time)	MiddleLevel	MiddleLevel (Partial Time)
A	2	5	0	15	0	16	0	5	0
B	0	2	0	1	0	9	0	1	0
C	0	0	0	1	9	0	5	0	0
D	0	1	0	8	1	15	5	5	14
E	0	2	8	13	36	22	23	3	0
F	0	0	0	0	4	0	5	0	0
G	1	2	0	3	0	5	0	2	0
H	0	0	0	0	0	0	4	0	0
Total	3	12	8	41	50	67	42	16	14

Source: Elaborated by the author

With regard to the execution of projects, the partnership with research institutes and universities was designed, that is, with accredited institutions, and in other cases, internal execution was provided for exclusively by the beneficiaries. Only one case was presented envisaging execution only by the accredited institution / partner. These data are reproduced in the table below:

Table 5 - Number of projects by modality

Project Execution	No. of Projects
FullybyAccreditedInstitution	1
Partly by Accredited Institution and Beneficiary	40
TotallybyBeneficiaryCompany	19
Total	60

Source: Elaborated by the author

Within the presentation of companies' expenditures, in a general provision in the composition of the projects, the item of direct and indirect Human Resources (HR) stood out with the percentage of contribution related to the obligation of each company. It is observed that the average application in direct and indirect HR is 57.07%.

Table 6 - Projection of expenses with Direct and Indirect HR x Percentage due to obligation by company (US $ in millions)

A	**D**	**E**	**G**	**B**	**H**	**F**	**C**
45,16%	90,64%	69,36%	58,63%	65,78%	69,93%	19,99%	37,03%
9.952.427	9.496.200	4.838.287	757.689	665.446	601.735	117.803	64.741

Source: Elaborated by the author

Companies were asked about the position of the R&D area in the organization's hierarchy among the strategic (board of directors), tactical (management) or operational levels, the level of centralization of the activities and if the company carried out the planning in a structured way, in order to understand if there was a minimum of local structure for the development, follow up and management of activities through partial or integral execution in partnerships and agreements or by integral execution of the beneficiaries.

In 04 of the companies, the R&D area occupied the strategic position, in 03 of them the tactical position of middle management and in one of them, the operational level. As a result, 03 of the companies responded that they had R&D activities centralized in a single department, while 05 of them indicated that these occurred through multidisciplinary assignments to the R&D team. 07 of the companies reported that they had a structured planning of activities, while one of them replied that they carried out them in reaction to the company's strategic business plan, without a specific innovation methodology. Within this context, the answers to these questions are demonstrated by selecting the points highlighted in the table below:

Table 6 - Number of projects by modality

Company	R&D DEPARTMENT POSITION			R&D ACTIVITIES´ LEVEL		R&D ACTIVITIES´ PLANING		
	Strategic	Tactical	Operational	Centralized	Decentralized	Structured	Unstructured	Others
A	X			X		X		
B	X			X		X		
C		X			X	X		
D	X				X	X		
E	X				X			X
F			X		X	X		
G		X		X		X		
H		X			X	X		

Source: Elaborated by the author

DISCUSSION AND CONCLUSION

Due to the data presented in the study, in general, it was found that, in terms of economic indicators, investment in R&D by companies subject to the information technology law presents positive externalities (Chen et al., 2021; Becker, 2015; Leung, 2020; Buyse et al., 2020; Crespi et al., 2020) in aspects of productivity, since it was demonstrated that 49.19% of the projects would focus on product development or improvement, followed by 23.41% related to the qualification of human capital, 11.76% in innovation in the use of wearables in healthcare for the creative economy, 9.72% in improvement or innovation of products or services, 5.51% in process improvement or innovation and 0.42% in service improvement or innovation, all aspects inherent to competitiveness, profitability and permanence of companies in the industrial hub of Manaus that impact on the maintenance of jobs and development of socioeconomic indicators in the region (Becker, 2015).

However, it is important to note that development is centralized in the capital of Manaus, not meeting the expectations of the law to obtain the diffusion of technology and consequent improvements in growth and social welfare in other regions of the Western Amazon. It is noteworthy that the interest in the spatial distribution of the benefits of public investment in R&D

is seen as an alternative to neutralize the center-peripheral disparities (Roper et al., 2004).

Approaching indicators inherent to the effectiveness of public R&D policy within the context of S&T policy assessment such as: inputs, income, results and impacts, the investment projection of the companies described in table 2 was considered, totaling USD 43,418.145 as inputs. A prominent marker in this data is that companies are restricted to the application of the legal obligation in R&D (Guan et al., 2016).

There are alternatives such as expenses or R&D intensity, production measures, such as patents or innovation counts (Becker, 2015) and for the latter, the indexes in table 3 were considered with 144 scores being 2 patent expectations, 67 publications, 52 developments of software, 2 game developments and 21 master's dissertations.

In the above detailed stratification, only one of the companies expressed the diversification of items such as publications, patents, games and master's dissertations. The others designed the development of software or systems inherent to innovations or improvements in products and processes. It should be noted that even with the externalities and the positive repercussions related to the increase in productivity and the average cash flow of the companies, investments may not benefit all companies equally, as they are positively related to the absorption capacities and the R&D intensity of each company (Chen et al., 2020).

Cooperation agreements with universities and research institutes, although restricted to Manaus, were seen as a positive externality of the ecosystem, a fundamental role in facilitating and supporting the formation of regional clusters of university and private R&D activities (Becker, 2015) that would be carried out in 40 of the 60 planned projects. The projection of the average investment of 57.07% of direct and indirect HR project investments is also a positive reflection of these partnerships, which also translates into a socio-economic indicator in the generation of jobs and income.

According to the stratification of data related to the themes of the projects, highlighted in figure 1, it was noted that a wide range of technologies was approached, however still with low percentage representativeness of values of the sustainability and healthcare projects, which denotes that the R&D assessment is generally it focuses on technological objectives, leaving aside the crucial issue of socio-economic impacts and sustainability and environmental characteristics of policies (Lee et al, 2017).

The amplification of the areas of activity concerns the creation of new niches and represents a boost to global infrastructure, prospecting and stimulating new niches that have a multiplier effect in the sectors of the economy. That is why it is important to reinforce the intersectoral character of projects and businesses, stimulating chains of stimuli (Deleidi&Mazzucato, 2021).

In evaluating the quanti-qualitative results of the study, with regard to the achievement of results from the companies' R&D activities, different levels of aggregation were found, taken into account in the evaluation process. Among the spillover effects, assessed in the contexts of microeconomics, mesoeconomics and macroeconomics, associated with the impact of intervention policy at the local, regional and international level, the data shown in figure 4 indicate that 47 of the projects would bring some innovation or improvement at the level of company, 7 would have a scope for the region, 2 for the country and 4 would have a global reach, which suggests that companies need to intensify the development of solutions with international projection that provide exchange and exchange of knowledge or collaborative networks of greater amplitude (Guan et al., 2016).

Another indicator considered to be relevant among the R&D results concerns highly qualified intellectual capital including the number of scientists and engineers in a company, the share or the total number of workers with tertiary or tertiary education and years of formal education (Becker, 2015). Data related to this measure are shown in table 4, in which a total of 253 professionals were informed, 139 of whom were dedicated exclusively and 114 were part-time.

In the light of technical and organizational variables (Garces et al., 2021), it was observed that professionals with exclusive dedication were divided into: 03 doctors, 12 masters, 41 specialists, 67 with higher education and 16 with secondary education. The professionals with partial dedication were divided into: 08 masters, 50 specialists, 42 with higher education and 14 with secondary education. The numbers show that there are few doctors and masters composing the professional staff of the companies when taking into account the majority number of specialists and professionals with higher education, which may indicate that these hires are not priority or valued by the companies for structuring their area of expertise. R&D or that the expectation is that this expertise is complemented through partnerships with universities or research centers, which would increase the density of the network (E. Kim et al., 2017).

REFERENCES

1. Becker, B. (2015). Public R&D policies and private R&D investment: A survey of the empirical evidence. *Journal of economic surveys*, *29*(5), 917-942.
2. Buyse, T., Heylen, F., &Schoonackers, R. (2020). On the impact of public policies and wage formation on business investment in research and development. *Economic Modelling*, *88*, 188-199.

3. Crespi, G., Garone, L. F., Maffioli, A., & Stein, E. (2020). Public support to R&D, productivity, and spillover effects: Firm-level evidence from Chile. *World Development*, *130*, 104948.
4. Chen, S. S., Chen, Y. S., Liang, W. L., & Wang, Y. (2020). Public R&D spending and cross-sectional stock returns. *Research Policy*, *49*(1), 103887.
5. Chen, Z., Zhang, J., & Zi, Y. (2021). A cost-benefit analysis of R&D and patents: Firm-level evidence from China. *EuropeanEconomicReview*, *133*, 103633.
6. de Pinho, M. I. G., & da Rosa, M. J. M. P. (2017). Research Evaluation: the need to include processes and impact.
7. Deleidi, M., &Mazzucato, M. (2021). Directed innovation policies and the supermultiplier: An empirical assessment of mission-oriented policies in the US economy. *Research Policy*, *50*(2), 104151.
8. Garces, E., Daim, T. U., &Dabić, M. (2021). Evaluating R&D Projects in Regulated Utilities: The Case of Power Transmission Utilities. *IEEE Transactions on Engineering Management*.
9. Guan, J., Zuo, K., Chen, K., & Yam, R. C. (2016). Does country-level R&D efficiency benefit from the collaboration network structure?. *Research Policy*, *45*(4), 770-784.
10. Kim, E., Kim, S., & Kim, H. (2017). Development of an evaluation framework for publicly funded R&D projects: The case of Korea's Next Generation Network. Evaluation and program planning, 63, 18-28.
11. Le, D. V., Le, H. T. T., & Van Vo, L. (2021). The bright side of product market threats: The case of innovation. *International Review of Economics & Finance*, *71*, 161-176.
12. Lee, S., Cho, C., Choi, J., & Yoon, B. (2017). R&D project selection incorporating customer-perceived value and technology potential: The case of the automobile industry. *Sustainability*, *9*(10), 1918.
13. Leung, W. S., Evans, K. P., & Mazouz, K. (2020). The R&D anomaly: Risk or mispricing?. *Journal of Banking & Finance*, *115*, 105815.
14. Roper, S., Hewitt-Dundas, N., & Love, J. H. (2004). An ex ante evaluation framework for the regional benefits of publicly supported R&D projects. Research policy, 33(3), 487-509.
15. Silva, A. C., Belderrain, M. C. N., & Pantoja, F. C. M. (2010). Prioritization of R&D projects in the aerospace sector: AHP method with ratings. *Journal of Aerospace Technology and Management*, *2*(3), 339-348.
16. Silva, A. M., & Silva, M. R. (2016). Improving the design of innovation policies in follower countries. In *ISPIM Conference Proceedings* (p. 1). The International Society for Professional Innovation Management (ISPIM).