Industrial Research Achievements-Lebanon
إنجازات البحوث الصناعية – لبنان

KONRAD ADENAUER STIFTUNG

ACADEMIA GENERATED INDUSTRIAL INNOVATION IN LEBANON

REPORT . Dec. 2022

GAP ANALYSIS AND PRELIMINARY RECOMMENDATIONS

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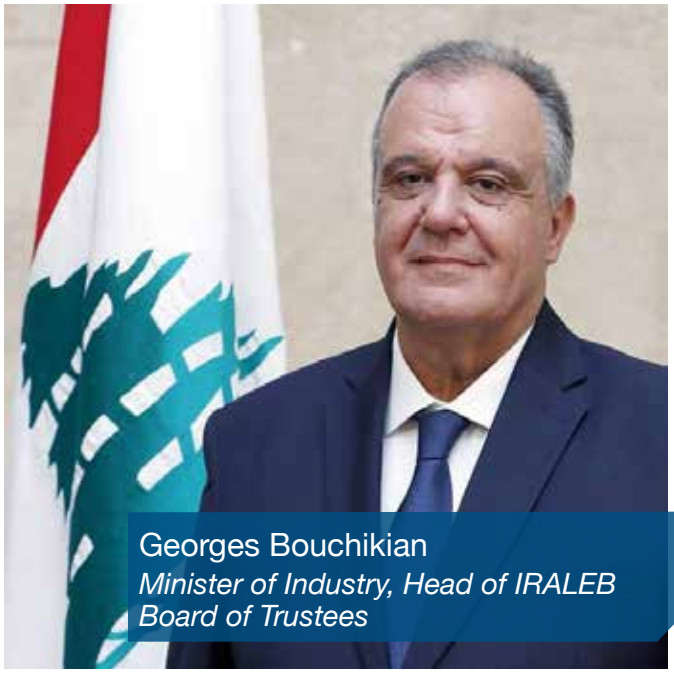

Georges Bouchikian
Minister of Industry, Head of IRALEB Board of Trustees

REPUBLIC OF LEBANON
MINISTRY OF INDUSTRY

since 1997 IRA
Industrial Research Achievements-Lebanon
إنجـازات البحـوث الصنـاعية – لبنـان

Supporting the MSME ecosystem was always important in the advancement of nations. This is more critical in Lebanon, due to the unfortunate economic headwinds that are facing the country.

In this research, Iraleb has covered in details the strengths and weaknesses of the entrepreneurial activities within the main universities and industries in Lebanon. It has suggested lot of thorough recommendations that need to be materialized on the ground, in order to make the entrepreneurial ecosystem thrive.

IRALEB, a main part of this entrepreneurial ecosystem, has demonstrated to be a resilient entity that survived for 25 years the highs and lows in the country. Meanwhile, it has acquired lot of experience and expanded over time its network to support the Youth and millennials in their new endeavors. Iraleb is an essential pillar in building the ground for a healthy entrepreneurial ecosystem in a country that has lot of unutilized potential.

The Ministry of Industry will always try hard with Iraleb, this successful and promising institution, along with the founding partners ALI and CNRS, to make its ambitions a reality.

We wish Iraleb further successes and we support any fundraising's activity aiming at supporting this NGO to give a better future for the new generation of this country that we all love.

Eng. Ziad Shammas,
Head of IRALEB Executive Board

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www.iraleb.org

There is no doubt that developing the innovation ecosystem is a crucial prerequisite to regain an acceptable economic stability in Lebanon. This has been a common conclusion in many studies. Without pretending to bring a solution to such a complex process, IRALEB has conducted a thorough study to draw the contours of the Lebanese innovation ecosystem by mapping innovation related stakeholders and processes. Significant efforts have been spent to conduct surveys and meetings, analyse the outcomes, and to define the mapping. After thorough analysis, a set of sounding and innovative recommendations both structural, regulatory, and operational are proposed. We believe that the present study paves the road towards a clear policy and engages in developing the Lebanese innovation ecosystem.
Careful attention should be given while reading the study as it contains important details.
My thanks go to all who supported and participated in this huge effort.
Finally, I must say that in times of deep crisis dialogue, openness, and cooperation become existential.

As a hub, IRALEB has this at its core values. But dialogue and cooperation is also an economic pillar.
Wasn't this a message in Moore's article in 1996:
"The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems".

ABOUT IRALEB

IRALEB (formerly known as LIRA program) is a Private Non-Governmental Organization registered in June 2021 at the Ministry of Interior and Municipalities. It has been founded by the Ministry of Industry, Association of Lebanese Industrialists, National Council for Scientific Research who agreed that the institutionalization of LIRA became evident after a culmination of 25 years of hard work and success in building effective cooperation between Industrial and academic sectors in Lebanon.

LIRA program aims, since its inception in 1997, at providing university researchers with career opportunities that match their potential, in order to reduce the brain-drain and support advancements in the Lebanese industrial sector leading to the promotion of competitiveness and productivity.

LIRA has officially partnered to date with 13 most well-known Lebanese universities and several leading local industries.

Michael Bauer,
KAS Resident Representative to Lebanon

KONRAD ADENAUER STIFTUNG

www.kas.de/libanon

Economic growth, job creation, social prosperity and international competitiveness depend to a large extent on a country's ability to generate innovations. Academic institutions and the private sector, especially the industry, play key roles in this regard: by providing a research infrastructure, incubating researchers and investing in R&D, they create the conditions for creativity and ingenuity to yield fruitful results. Hence, a close cooperation and interlinking of industry and academia is needed in order to ensure that existing potentials are fully utilized. This study provides an overview of the Lebanese innovation ecosystem, its shortcomings and potentials, and analyses in particular the interface between academia and industry. With this, we want to contribute to putting the discussion about the Lebanese innovation ecosystem on a valid empirical basis and thus identify concrete options for action for academic institutions and the industry themselves as well as for political decision-makers in Lebanon and internationally.

Together with its partners, Konrad-Adenauer-Foundation Lebanon will continue its efforts to support the Lebanese innovators and Lebanon's innovations ecosystem.

ABOUT KAS

Konrad Adenauer-Stiftung (KAS) is a political foundation, closely associated with the Christian Democratic Union of Germany (CDU). Freedom, justice and solidarity are the basic principles underlying the work of the KAS. It encourages people to lend a hand in shaping the future along these lines, with more than 100 offices abroad and projects in over 120 countries, KAS makes a unique contribution to the promotion of democracy, dialogue, conflict prevention, civil society and social market economy.

To foster peace and freedom KAS encourages a continuous dialog at the national and international levels as well as the exchange between cultures and religions.

I. EXECUTIVE SUMMARY

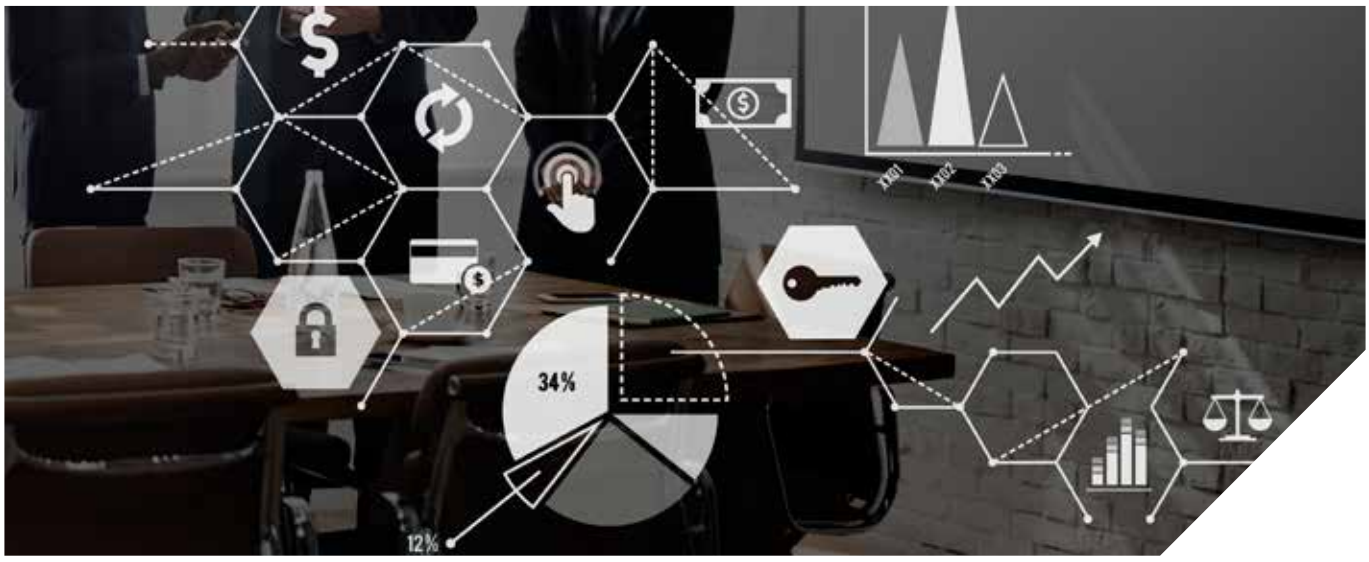
I. EXECUTIVE SUMMARY

Technology and innovation are among the primary engines of a nation's growth and economic development. The private sector must expand its investments in research and development (R&D) to boost its production.

The development of innovation, also known as the "knowledge economy," should be considered to transform the Lebanese economy into a more productive model. Studying the Lebanese innovation ecosystem forms a basis to draw a policy plan. In the present document, a study of the innovation ecosystem is reported yielding a set of recommendations.

The study is based on a survey conducted with the two major innovation stakeholders: the industrialists and the universities. Interviewing executives and decision-makers complemented the survey and permitted to deepen the understanding of several elements. For each stakeholder two questionnaires were defined. The questionnaire is formed of two parts, one descriptive and the other qualitative. The methodology is detailed in the document.

The analysis of the outcomes of the survey permitted to draw a mapping of innovation related stakeholders and processes in academia and industrial sector.



The descriptive part of the survey for the universities showed the alarming number of students that cannot be absorbed when graduated by the current industry. This confirms the urgent need for developing the innovation ecosystem and for a better alignment of the university programmes with the market needs.

The descriptive survey also showed many laboratories with a general tendency among universities to have them accessible to the industry. In parallel the survey of the industrialists showed an important interest of using some of those laboratories. The qualitative part of the survey has revealed many elements of interest.

The existing research activities seem to be significantly important to be used as a solid pillar to develop the innovation ecosystem. Many students' clubs and associations promote innovation and entrepreneurship.

While the final year projects are mandatory and an important share of them is dedicated to applied research, the respondents judged the maturity level of the prototypes developed to be at early or very early stage.

Moreover, there is no or few incentives to encourage faculty members to engage in applied research projects. Technology transfer offices are not established and developed in all universities.

The access to incubators and accelerators is limited. Very few IP rights protection models exist. This provides a set of elements to be improved to serve the development of the Lebanese innovation ecosystem. The descriptive survey of the industrialists showed that most industrialists are small enterprises with few medium enterprises. Small enterprises have more interest generally in short-term R&D and have limited resources to invest in.

Therefore, we suggest assigning the long-term R&D to sectoral industrial associations.

The interest of the industrialists in R&D is clear and they are willing to invest into it. This is a strong element to build upon.

Moreover, the industrialists are keen to outsource part of their R&D to academia and showed interest in using some universities' laboratories.

However, the limited financial resources prove the need for external support to develop the innovation ecosystem. It is also clear that the industrialists need to accelerate the digital transformation to progress towards the fourth industrial era. They also need to adhere to the Sustainable Development Goals (SDGs). It is worth noting that the survey has also revealed the priority industrial sectors (food and beverage, packaging, chemicals, …).

Food and beverage industry, chemical industry and machinery industry are the most interested in cooperation with academia and in investing in start-ups. The main domains of interest for the industrialists to sponsor research projects are: mechanical, agri-food, packaging, and electrical and electronical.

Once the mapping drawn, an assessment of the potential, challenges and needs of the academia-generated industrial innovation is conducted. Many potentials exist at the academic level including the facilities and infrastructures, active research activities, number of students enrolled in programmes, participation to competitions, number of applied research projects etc. Some universities have gone far in establishing incubators and accelerators.

Many potentials exist at the industrial level where many industrialists are active in conducting R&D both internally and through outsourcing.

Industrialists also finance, in the limit of the available resources, applied research projects. They are also keen to strengthening collaboration with universities at many levels.

The potential of IRALEB-LIRA as a hub connecting industry and academia has also been shown. During the past decades,, LIRA, now an IRALEB program, has beenstrengthening dialogue and connections between the two major actors of the innovation ecosystem and has an important expertise in reinforcing the cooperation.

Multiple challenges and needs have been revealed. Obviously, resources are lacking to develop the innovation ecosystem. But other needs exist.

The evaluation of the value-chain in priority industrial sectors is a major need.

Raising awareness in both academia and industry about the need and potentials of innovation is also required. The universities are invited to establish technology transfer offices and to define policies to incentivise the stakeholders to engage in innovation applied research project and to bring their ideas to the marketplace. Needs also exist to accelerate the digital transformation and to engage in achieving the SDGs.

It is also crucial to have a common understanding and to set the texts and procedures for IP rights protection and enforcement.

As for the challenges they have been described for students, academia and industry depending on their nature:

I. Political, II. Economic, III. Financial, IV. Education, human capital and training, V. Social, VI. Technological, VII. Legal and regulatory framework, VIII. Infrastructure, IX. Environmental.

For some of the challenges we can but call for solutions. Typically, at the political and economic levels, we call the decision-makers to assure stability and the rule of law and to do whatever is possible to offer minimum basic services so as Lebanon regain its attractiveness. We also call to facilitate the access to international markets.

For some other challenges recommendations for action to be taken by the stakeholders are taken. This is the case for the education, human capital and training, financial, or legal and regulatory framework. A third set of challenges opened the door to reinforce innovation and collaboration even if not covered by the survey and its analysis. Technological, infrastructure and environmental challenges call for the acceleration

of digital transformation and for the respect of SDGs. These challenges are opportunities for collaboration and point out domains for development.

The mapping being drawn, and the potentials, needs, and challenges being identified, the document proceeds in defining an academia-generated industrial innovation framework to which are connected the previous outcomes.

A series of recommendations are then formulated to serve the development of the framework.

Two alternative frameworks are defined, and three commercialisation types are identified. The commercialisation types are: licensing, intrapreneurship and entrepreneurship. Licensing being the smallest in scope and potential of growth. It consists in selling an innovative idea or product to an industry through a licensing procedure. Intrapreneurship consists in inviting the innovator to integrate the industrial enterprise and develop its innovative idea(s) within. Finally, the entrepreneurship consists in transforming the innovation into a start-ups that offer its services or products to the industry.

Finally, a set of recommendations are suggested building upon the elements of strength identified. They form an attempt to bring a response to the needs and challenges. The need for policies and organisational processes at both academia and industry, the need for external support, and the need for active regulations and governmental support are at the core of the recommendations.

With the present crisis external support is essential and efforts need to be spent in order to obtain such support. Since the resources are limited and the constraints are high for small and medium enterprises, it is recommended to assign the long-term R&D and the value-chain analysis to sectoral associations part of the Association of Lebanese Industrialists. Currently, industrial R&D are mainly limited to product and product line development and need to extend beyond. We expect that a value chain analysis per sector would identify opportunities that will instigate innovation processes leading to new start-ups or intrapreneurship.

Industrialists need to sponsor university innovative projects and to assist in for better alignment of academic programmes and market needs.

The universities need to revisit their programmes to reinforce the entrepreneurship skills. It is also crucial to adjust the academic programmes to better align with the market needs. Incentives must be offered to researchers and students to develop innovative applied research.

Ways need to be found to improve the maturity level of developed prototypes in applied research projects. The access to laboratories for industrialists needs to be facilitated and organised.

The transfer of technology to the marketplace is essential in an innovative ecosystem and dedicated technology transfer offices and policies need to be set. The relations with incubators and accelerators are to be strengthened. The students' clubs promoting innovation need to be supported. From the regulator side, incentives and tax reduction measures need to be taken.

Policies should be defined to facilitate the access to the international markets.

Stability, rule of law and basic services are necessary for Lebanon to regain attractiveness for investors and multinational enterprises.

Intellectual property rights protection and enforcement are required for the benefit of all parties. Networking with international partners is crucial.

As a final recommendation we are calling for fostering inclusiveness, climate of trust and mutual understanding through dialogue and transparency. IRALEB can play a determinant role in this direction.

II-INTRO DUCTION

II. INTRODUCTION

The political, economic, financial, infrastructural and technological challenges Lebanon is currently facing push the decision makers as well as the main actors to accelerate the development of the country's innovation system as a solution to overcome the present constrained situation. The McKinsey report entitled "Lebanon Economic Vision" and approved in October 2017 by the decree 13669/2017 issued by the Council of Ministers, identifies several aspirations among which one is dedicated to the "knowledge Economy" and is formulated as: "To become [by 2025] a knowledge-driven digital nation, at the forefront of innovation, acting as a talent hub for technology, outsourcing, creative industries and education". During the past decades the "Lebanese Industrial Research Achievements Program" (LIRA) has been intensively working in bridging University and Industry to foster cooperation and to help in transferring applied research to become useful in the socio-economic development. This program is now part of the IRALEB NGO that has a broader goal to play a significant role in the development of a national innovative ecosystem.
We believe that Lebanon has young creative human potential and promising active industrial sectors that can glow if supported by adequate resources and policies enforcing the development of innovative applied research projects to turn them into industrial and productive needs.

The industrial sector is strongly influenced by innovation. The Organisation for Economic Co-operation and Development (OECD) provides the following definition for innovation[1]: "Innovation is the implementation of a new or significantly improved product (good or services), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations".
The ability to develop new production lines and novel products is considered essential to the industrial sector survival and growth. Effective innovation is a prerequisite for long-term and sustainable economic growth and competitiveness. During times of economic crisis, innovation is considered one of the possible ways of minimizing the negative impact of the crisis.

The New Growth Theory by Romer[2] defends that, unlike land and capital, knowledge is not subject to diminishing returns, and thereby, sets the basis for the development of the Knowledge-based Economy that is a major aspiration in "Lebanon Economic Vision". There are many definitions of the knowledge-based economy. Powell and Snellman[3] provides the following definition: "the knowledge economy [is defined] as production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence." The theoretical knowledge is seen central and fuel further innovation. Thus, expenditure on research, development, and innovation creates the basis for economic growth.

The innovation process, being long and costly, relies heavily on complex inter-organizational relations and the interaction between different types of actors (industries, universities, R&D centers, support organizations, government) that can boost technology transfer and innovation.

[1] OECD, 2005, "The measurement of scientific and technological activities: Guidelines for collecting and interpreting innovation data: Oslo manual, Third Edition", Paris.
[2] P.M. Romer, "Increasing returns and long-run growth," Journal of Political Economy, 94(5): 1002-1037, 1986.
[3] W. W. Powell and K. Sellman, "The Knowledge Economy," Annual Review of Sociology, 30(1): 199-220, 2004.

The Lebanese innovation system has become central to the economic sustainability and development. This system must be assessed and measured to help decision-makers steering it. OECD has conducted several projects aiming at defining tools and indicators for better understanding national innovation systems.
In a first attempt, the assessment focused on four types of knowledge or information flows[4]:

I. Joint industry activities
III. Public/private interactions,
III. Technology diffusion
IV. Mobility of personnel.

Three approaches were suggested to perform the analysis:

I. Surveys to identify the sources of knowledge for the enterprises and the corresponding linkages
II. Cluster analysis focusing on the interactions between types of firms
III. Internal knowledge flows within innovation clusters.

The Lebanese innovation network is challenged by the lack of funding for applied research, lack of Intellectual Property (IP) policies and support as well as weak links between academic research and industrial needs, and lack of cooperation between the different key actors.
The Lebanese economy suffered during last years from severe external and violent shocks that curbed growth and accelerated the rate of young talent leaving the country what we call brain drain.

This report aims at performing a first measurement of the Lebanese innovation system. It focuses on two classes of actors:

I. The value creation support actors mainly the universities
II. The direct value creation actors mainly the industrialists.

The first objective is to analyze the characteristics and dynamics of innovation within the Lebanese academic institutions and industries who are the major key players involved in academic generated industrial projects. It maps factors that are driving innovation in both entities, and how the scientific and research scenery is being reconfigured by convergence, interdisciplinarity of innovation hot spots. Human capital is the basic input of innovation, and a series of indicators and factors points how education systems are contributing to the knowledge and research bases.
Further data and graphics examine how industries transform skills and knowledge by spending on R&D and shed light on the different roles of public and private investment in fostering innovation.

The second objective is to assess the potentials, challenges and needs of key stakeholders.

The third objective is to provide a framework to analyze the innovation system and the interactions inter-actors within the Lebanese industry to elaborate a list of recommendations for a better incorporation and development of Academia-generated industrial innovation.

Our analysis is based on a combination of the research on the innovation drivers in industry and academia.

[4] OECD, "National Innovation Systems." 1997. http://www.oecd.org/science/inno/2101733.pdf

III-METHODOLOGY

III. METHODOLOGY

The report focuses on the innovation economy of the Lebanese industrial sector. It looks from the lens of IRALEB how to identify, map, assess and diagnose the challenges, needs and potentials of both industrialists and academic institutions.

This report encompasses a holistic assessment of the current situation of academia industrial innovations in Lebanon and the strategy that should be enforced.

To achieve the objectives a process has been defined. In Lebanon, data is often lacking while it is important in order to achieve the objectives 1 and 2, i.e., the analysis of the characteristics and dynamics of innovation within the two major groups of stakeholders as well as the assessment of their potentials, challenges and needs.
For this purpose, a survey on the structure of innovation has been defined and it is formed of two parts: a descriptive part and a qualitative part.
The surveys in their both parts were conducted online for the two types of stakeholders: universities and industrialists.
The academic survey included the 13 universities members of IRALEB, and links were distributed by email to all these universities.

To achieve the third objective and to complete the landscape drawn by the survey, a series of interviews were conducted with executives and decision makers.
The outcomes of these interviews have permitted to finalise the assessments and recommendations for a better incorporation and development of Academia-generated industrial innovation.

By combining the findings of the quantitative survey and the qualitative interviews findings, the report aims to highlight the gaps and strengths of the academia industrial innovations ecosystem.
The study also aims to guide vested stakeholders to make more informed decisions in their investments, programs, projects, and policies.

Therefore, innovation experts, industrialists, academics, and subject matter experts were consulted to draft a framework for the development of innovation into the industrial sector.
This framework will be further discussed between relevant stakeholders.

SURVEY ON THE STRUCTURE OF INNOVATION WITHIN ACADEMIC INSTITUTIONS

The first part is descriptive helping to identify, at the level of the university, the innovation infrastructure, the existence of any entrepreneurial activity or technology transfer mechanism (in particular protecting valuable intellectual property, royalties sharing and commercializing knowledge), the existence of research centres and incubators, innovation clubs, research offices or research management units, research funding sources (internal and external), partnerships and collaboration in addition to supervisors and researchers' capacity.

The second part of the survey is qualitative focusing on researchers' challenges, incentives to enhance applied research in critical sectors, planned programs or diplomas at the faculty level to be aligned with industrial needs.

SURVEY ON THE STRUCTURE OF INDUSTRIAL INNOVATION

Conducting a survey near industrialists was crucial to identify industrial R&D needs.
The questionnaire collects information and data on the industrial enterprises to evaluate their performance in R&D for the year 2019 and their willingness to "sponsor a university project", "develop a product or production line" or "invest in a new product development".

The questionnaire contains identification information regarding the sector and activity in addition if the surveyed establishment "has carried out any R&D activity during the last two years" and if it "has an R&D unit with personnel involved in planning and management of scientific and technical aspects of research projects".
Industrialists have been contacted individually and some surveys were completed over the phone by executive assistants calling the industrialists and filling in their answers.

The collected information was published on the website and made available to the university partners of IRALEB. Findings are compiled and published in the report (by activity sector, size, and regional distribution) and interesting trends are also analysed leading the way to more technically oriented studies.

Ten highly qualified researchers from the Ministry of Industry (MOI) with long experience in surveying industrial establishments participated in both surveys along with data entry personnel. Data cleaning, revising duplicates, coding, data compilation and table generation were also conducted by a professional team from MOI supported by IRALEB management team. Desk auditors monitored the field work to meet the requirements of editing and control. Prior to the start of the survey on R&D, a workshop was done with all investigators to train them on the survey details as well as the particularities of the R&D data to be collected.

SURVEYS ON THE PERFORMANCE OF INDUSTRIAL ESTABLISHMENTS REGSITERED AT THE MOI

Several data collection methods were applied, especially those related to the mapping of the industrial capacity. The production of an efficient mapping report required the update of the Ministry of Industry (MOI) industrial database, allowing a comprehensive understanding of the various obstacles and difficulties facing the manufacturing activities including an update of the database of industrial R&D. In addition to this database being a key resource for the study, the industrial survey was helpful in providing sustainable information on industrial establishments and their performance. The collected data during the last two years was automated, computerised and reviewed for 1409 questionnaires pertaining to year 2018 and 1438 questionnaires for year 2019. In addition to the data entry, data cleaning and data compilation were performed and the output of the two surveys was integrated into the mapping report allowing a matching between them.
The figures on production, wages, and expenses were collected in Lebanese pound for years 2018 and 2019 and converted on the basis of 1,515 LBP per one USD, as the actual exchange rate at that time. To avoid the fluctuation of the exchange rate price of parallel market (black market), and due to the continuous lockdowns during 2020, expenditure figures on R&D were also collected for year 2019. As for calculating the industrial production and value added, scientific statistical methods were used to consolidate the data of input, output and Value Added, as published in the industrial survey for 2007 (as per UNIDO experts' recommendations).

INTERVIEWS AND ROUNDTABLES

Several methods were undertaken complementary to the surveys to help analyse the gap between the academic researchers and industrialists:

- Interviews and individual discussions
- One-on-one phoning or meetings,
- Structured online interviews,
- Focus group discussion (via zoom and in-person)
- Consultation meetings with Public Officials and renowned Lebanese businessmen.

The gaps were developed according to the following determinants: Gaps pertaining to Institutions and supporting tools, human capital, research, education, and culture, infrastructure, networks, financing gaps and legislation.

Universities and industrialists' representatives in IRALEB board were then requested to provide their input on the collected data and analysis based on their experience in the Lebanese technology transfer ecosystem, as well as evaluate the relevance and impact of the proposed recommendations. The feedback from the participants of the roundtables was collected and content of the report was adjusted accordingly.

IRALEB innovation ecosystem examined in this report is considered as university-based entrepreneurial ecosystem. It only targets industry-oriented research developed by university students and faculty members. Some community members considered critical for innovation might not be mentioned if they are not in direct correlation with local universities or industries.

PANEL DISCUSSION ON ACADEMIA GENERATED INDUSTRIAL INNOVATIONS

A panel discussion tackling the facts and challenges of joint industrial-Academic innovation held on 27th of July 2022 at Hilton Beirut Habtoor was jointly organized by IRALEB and KAS in order to present the findings of the mapping report on "Academia Generated Industrial Innovation".
A large number of members of the Lebanese parliament, industrialists, Deans, university representatives, media, academic professors and students attended the event.
During the ceremony, the facts and findings of the study on "Academia Generated Industrial Innovation" were presented followed by a panel discussion on the ecosystem profile and the findings of the mapping report as well as the recommendations and the challenges preventing the development of industrial research.
Academics and Industrialists participating to the ceremony intervened to evaluate the relevance of the assessment and recommendations.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LIRA FUND AWARD CEREMONY 2022
"Academia Generated Industrial Innovation"
Panel discussion


Mr. Daniel Abboud


IRA
IRA

IV. MAPPING OF INNOVATION RELATED STAKEHOLDERS AND PROCESSES IN ACADEMIA AND INDUSTRIAL SECTOR

A. THE STRUCTURE OF INNOVATION WITHIN ACADEMIC INSTITUTIONS

This section breakdowns the state of innovation within the academic institution as well as students. It tracks the process of innovation, ownerships, development mechanisms, management of research, incubation, and release.

I. ADMINISTRATION AND HUMAN RESOURCES

A. INTERNAL STRUCTURE FOR INNOVATION SUPPORT

Sixteen respondents from thirteen universities participated to the descriptive part and eighteen respondents (faculties) participated in the qualitative part of the survey. The difference is due to the fact that USJ and UOB has filled the descriptive survey on behalf of their two faculties member of IRALEB: Faculty of Engineering and Faculty of Sciences.
The 13 universities partners of IRALEB are:

- Lebanese University (UL)
- American University of Beirut (AUB)
- Lebanese American University (LAU)
- Saint Joseph University (USJ)
- Beirut Arab University (BAU)
- Holy Spirit University at Kaslik (USEK)
- Notre Dame University – Louaize (NDU)
- University of Balamand (UOB)
- Islamic University of Lebanon (IUL)
- Lebanese International University/BIU (LIU)
- Rafik Hariri University (RHU)
- American University of Science and Technology (AUST)
- CNAM ISAE Liban (CNAM)

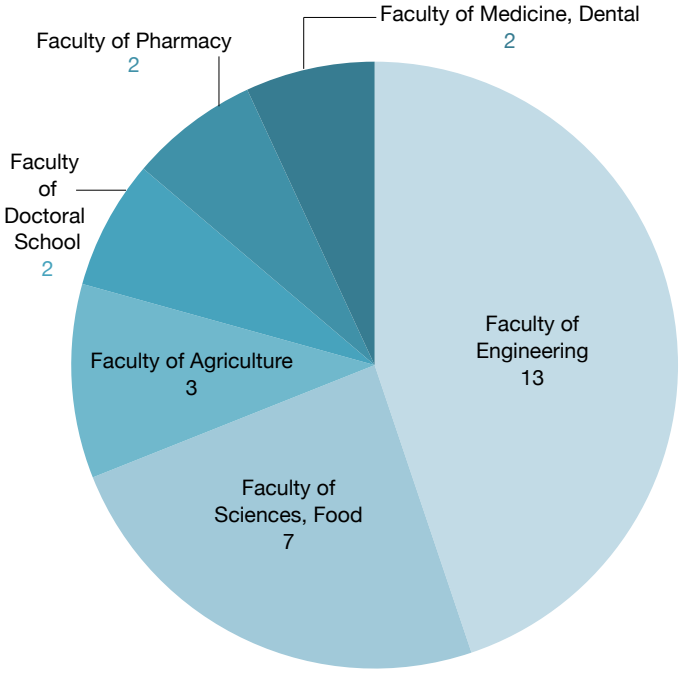
The Descriptive and Qualitative surveys were sent to all IRALEB members. The complete lists of respondents are provided in Appendix A.

FACULTIES

Descriptive Survey

In total thirteen faculties of engineering, seven faculties of sciences, three faculties of agriculture, one institute of technology, two doctoral schools and few other faculties and schools have been indicated as currently working or potentially might collaborate with IRALEB on innovative industrial projects. These faculties were not all included in our survey. Only partners filled the descriptive and qualitative questionnaires.
42% of the participants in the Descriptive survey are from the Faculties of Engineering. 21% are from the Faculties of Sciences and 9% from the Faculties of Agriculture. The remaining 30% are from other faculties also working on implementing innovative projects. IRALEB has partnered till now with 18 faculties from these universities and is targeting to expand its cooperation to cover the remaining ones to reach around 30 faculties involved in creating innovative industrial projects indicated below. The main faculties to be integrated are the Faculties of medicine, pharmacy and additional doctoral schools.

Figure 1. *The main faculties working on industrial innovative applied projects are distributed as follows:*



Name of the University (Academic Institution)	Faculties working with IRALEB (or might work) to create innovative industrial projects
American University of Beirut (AUB)	Faculty of Engineering & Architecture Faculty of Agriculture & Food Sciences (might join Iraleb)
American University of Science and Technology (AUST)	Faculty of Engineering
Beirut Arab University (BAU)	Faculty of Engineering
Holy Spirit University of Kaslik (USEK)	Faculty of Engineering Faculty of Sciences (might join) Faculty of Doctoral School (might join)
ISAE CNAM Liban (CNAM)	Faculty of Engineering
Islamic University of Lebanon (IUL)	Faculty of Engineering
Lebanese American University (LAU)	Faculty of Engineering Faculty of Arts and Sciences (might join)
Lebanese International University/BIU (LIU)	Faculty of Engineering
Lebanese University (UL)	Faculty of Doctoral School Faculty of Sciences Faculty of Engineering Faculty of Agriculture
Notre Dame University (NDU)	Faculty of Engineering Faculty of Sciences Faculty of Nursing and Health Sciences (might join)
Rafik Hariri University (RHU)	Faculty of Engineering
Saint Joseph University (USJ)	Faculty of Engineering Faculty of Sciences Faculty of Agriculture (might join) Faculty of Pharmacy (might join) Faculty of Medicine (might join) Faculty of Dental Medicine (might join)
University of Balamand (UOB)	Faculty of Engineering Faculty of Sciences Issam Fares Faculty of Technology (might join)

English and French are the languages of provisioning of the courses. USEK declared using Arabic in addition.

UNIVERSITIES SIZE: CAMPUSES AND SPECIALISATIONS

The tables below show the distribution of campuses and specializations among the different faculties working on innovative industrial projects and mentioned in the Descriptive survey.

Table 1. Campuses and specializations in the faculties of Engineering and Sciences.

	Faculty of Engineering			Faculty of Sciences		
	Number of Campuses	Campuses	Number of Specializations	Number of Campuses	Campuses	Number of Specializations
AUB	1	Beirut	20	1	Beirut	
AUST	3	Beirut	3			
BAU	4	Debeieh	9			
CNAM	1	Beirut	7			
IUL	1	Werdanyeh	4			
LAU	2	Beirut, Byblos	7 (undergraduate) 4 (graduate)	2	Beirut, Byblos	20 (undergraduate) 7 (graduate)
LIU	8	Beirut	7			
NDU	3	Zouk Mosbeh	3	3	Zouk Mosbeh	12
RHU						
UL	3	Tripoli, Roumieh, Beirut	15	5	Hadath	9
UOB	2	El Kourah, Souk el Ghareb		3	El Kourah, Beirut, Souk el Ghareb	
USEK	2	Kaslik	9	2	Kaslik	25
USJ		Mar Roukoz	4	4	Mar Roukoz	4

Table 2. Campuses and specializations in the faculties of Agriculture and Pharmacy.

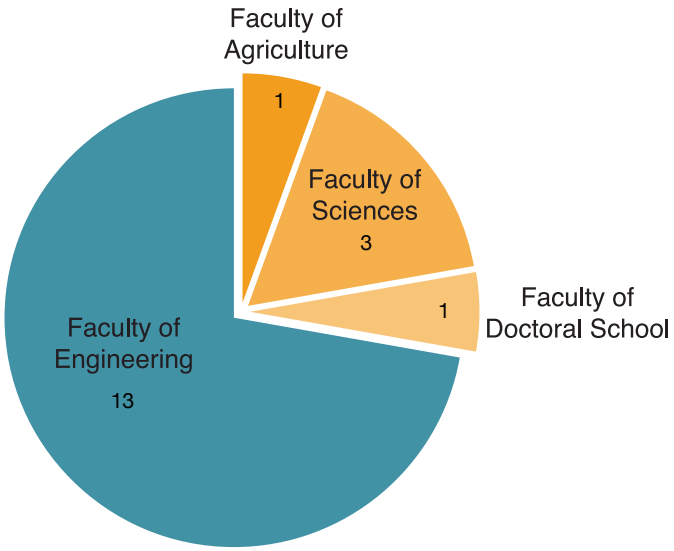
	Faculty of Agriculture			Faculty of Pharmacy		
	Number of Campuses	Campuses	Number of Specializations	Number of Campuses	Campuses	Number of Specializations
UL	1	Dekwaneh	8			
USEK	2	Kaslik				
USJ	1	Mar Roukoz	2	1	Beirut	3

SURVEYED FACULTIES

Qualitative Survey

In total thirteen faculties of engineering, three faculties of sciences, and one doctoral school - members of IRALEB- have been indicated as working on innovative industrial projects and are considered in this survey.

Figure 2. *Distribution of the 18 faculties working on innovative industrial projects considered in this survey*



Most of the respondents stated that their respective faculties offer multidisciplinary programmes citing:

- Automation
- Biomedical engineering
- Biotechnology
- Chemical engineering
- Computer and communication engineering
- Control systems
- Engineering management
- Environmental, energy and sustainability
- Food engineering
- Mechatronics engineering
- Microbiology
- Robotics

Only CNAM and LIU stated that they are not offering multidisciplinary programmes.

B. HUMAN RESOURCES

STUDENTS AND FACULTY MEMBERS

Table 3. Number of students and faculty members in the faculties of engineering for academic year 2021- 2022.

	Number of undergraduate students	Number of master students	Number of PhD students	Total students	Number of faculty members
AUB	2051	323	68	2442	100
AUST	400	150	0	550	45
BAU	1515	39	0	1554	47
CNAM	1716	0	0	1716	180
IUL	800	100	0	900	15
LAU	1301	46	0	1347	91
LIU	7039	1481	27	8547	179
NDU	913	18	0	931	77
RHU	500	10	0	510	21
UL	2425	150	0	2575	382
UOB	657	132	4	793	54
USEK	823	39	0	862	70
USJ	1500	90	61	1651	40
Total	21640	2578	160	24378	1301

Table 4. Number of students and faculty members in the faculties of sciences for academic year 2021/2022.

	Number of undergraduate students	Number of master students	Number of PhD students	Total students	Number of faculty members
AUB					
AUST					
BAU					
CNAM					
IUL					
LAU	2683	309	0	2992	354
LIU					
NDU	603	29	0	632	98
RHU					
UL	18400	741	220	19361	980
UOB	956	60	0	1016	29
USEK	1155	412	55	1567	264
USJ	385	246	60	631	30
Total	24182	1797	335	26314	1755

Table 5. Number of students and faculty members in the faculties of agriculture for academic year 2021/2022.

	Number of undergraduate students	Number of master students	Number of PhD students	Total students	Number of faculty members
UL	200	180	20	400	11
USJ	59	25	0	84	7
Total	259	205	20	484	18

Table 6. Number of students and faculty members in the faculties of pharmacy for academic year 2021/2022.

	Number of undergraduate students	Number of master students	Number of PhD students	Total students	Number of faculty members
USJ	392	34	14	426	40
Total	392	34	14	426	40

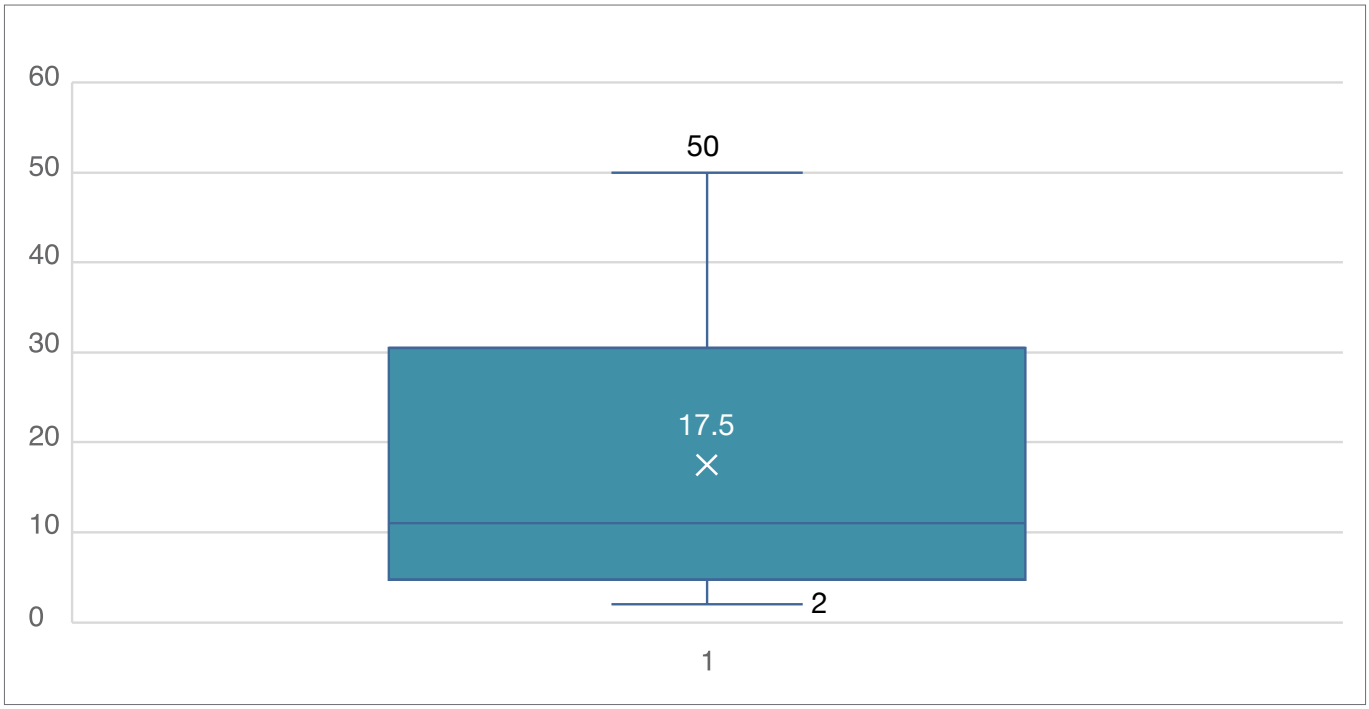
The total number of declared students that potentially could work on innovative projects exceeds fifty one thousand about half (48%) of them are in engineering faculties. The sum[5] of the faculty members declared is 3114, forty two percent of them being in engineering schools and faculties. The student to faculty member ratio is 16.5 in average. This average is 18.7 in the engineering schools and the standard deviation is 17.2. These approximative number show the high potential in developing a culture of innovation. They are also alarming regarding the number of highly qualified graduates arriving to a limited labour market, which proves the urgent need to develop the innovation ecosystem. Unfortunately, no details are collected regarding the details of specialisation in order to compare with the market needs.

[5] We have no details about the share of full time and part time faculty members, nor about faculty members working in different faculties or universities. The notion of Full-Time Equivalent (FTE) is not commonly used in Lebanon.

BRAIN DRAIN

The number of students who travelled to pursue their studies abroad vary from a university to another from few percent to fifty percent of the students. The average (median) of students' brain drain, as declared by 10 respondents is around 18% as shown in the graphic below. The current crisis has led to a drastic rise in youth emigration recording an increase in student's migration between 2020 and 2022 and expecting the number to double along with the worsening of living conditions. Investing in research may contribute to reduce the brain drain since it opens opportunities for fresh graduates to work in R&D. This requires extending support to these Youth and working on channeling their success to create job opportunities.

Figure 3. Number of students who travelled last year to pursue education abroad (in %)



C. INFRASTRUCTURE AND FACILITIES

INNOVATION LABORATORIES

12% of the declared laboratories are in the field of Information Technology and Electronics followed by Mechanical, artificial intelligence and Civil.
Petrochemical, multipurpose labs and materials' labs have the lowest rates 6 and 7%. It is common to have less laboratories that require high investments. This trend is expected to amplify soon because of the present crisis.

There is no distinction provided, or possibly requested, between teaching laboratories and research and development laboratories. From the laboratories' names provided one may guess that the majority are general purpose laboratories used for both teaching and research.

Many respondents indicated that the laboratories are accessible from outside the university, either in an open or controlled mode. This element may be used to reinforce connection with the industry.

Further investigations are needed to identify how the accessible laboratories can be used to develop the innovation ecosystem.

Figure 4. *Types of research facilities/ innovation labs owned by the universities*

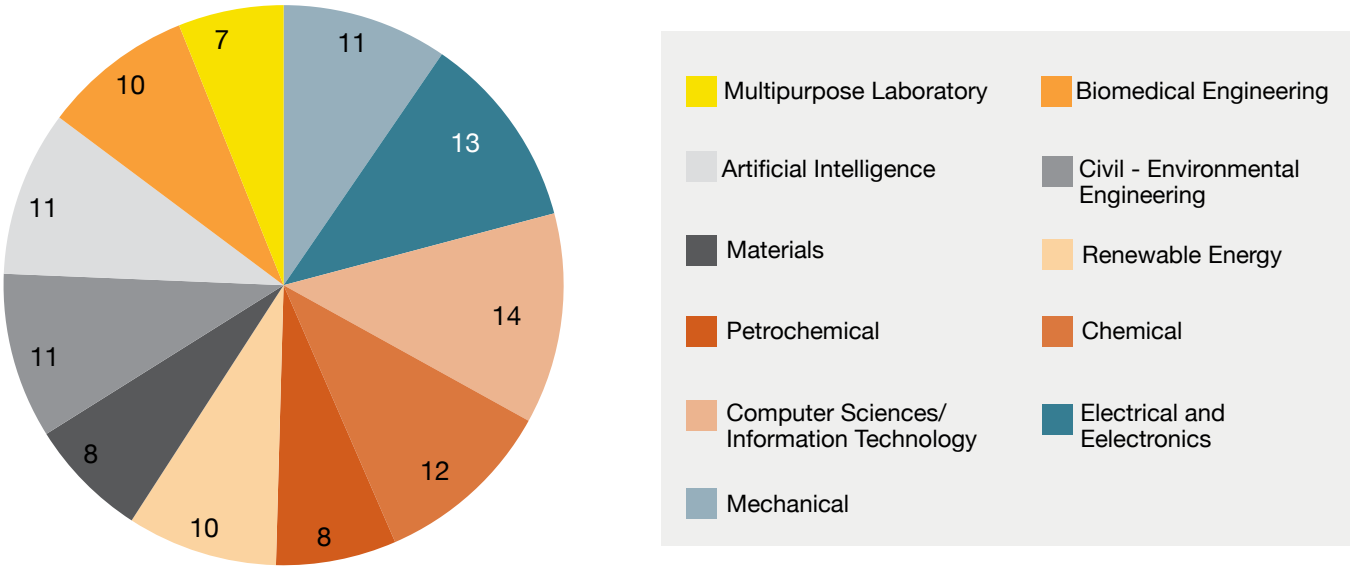


Table 7. **Laboratories, operational status, and access to outsiders.**

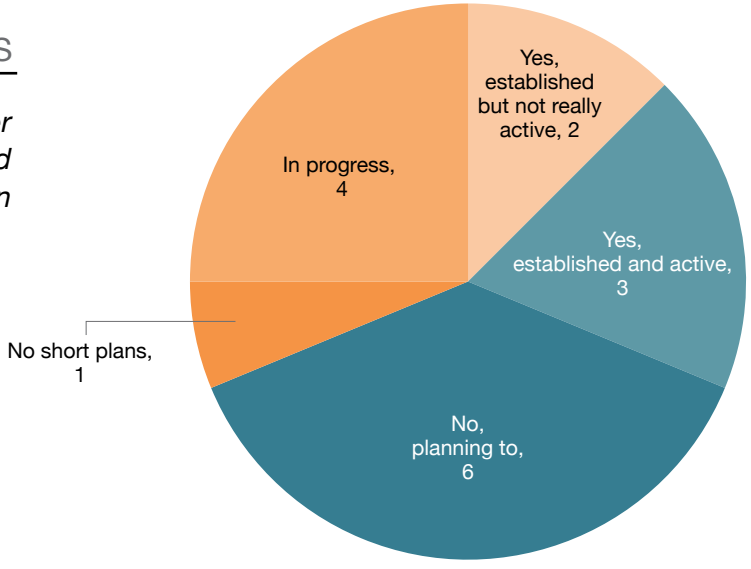
	Types of Research/innovation labs	Operational	Access to outsiders	Contact
AUB	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Materials Civil - Environmental Engineering Multipurpose laboratory Artificial intelligence Biomedical Engineering	YES		
AUST	Mechanical Electrical and electronics Computer Sciences/Information Technology multipurpose laboratory Artificial intelligence Biomedical Engineering	YES	YES	Contact University
BAU	Mechanical Electrical and electronics Computer Sciences/Information Technology Petrochemical Renewable Energy Materials Civil - Environmental Engineering Artificial intelligence Biomedical Engineering	YES	YES	Contact University: *bau@bau.edu.lb*

	Types of Research/innovation labs	Operational	Access to outsiders	Contact
CNAM	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Civil - Environmental Engineering	YES	YES	
IUL	Electrical and electronics Computer Sciences/Information Technology Civil - Environmental Engineering Artificial intelligence Biomedical Engineering	YES	YES	
LAU	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Materials Civil - Environmental Engineering Artificial intelligence	YES	YES	Dean's Office LAU Innovate LAU Industrial Hub"
LIU	In the process of construction	-	-	Dean's Office
NDU	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Materials Civil - Environmental Engineering Multipurpose laboratory Biomedical Engineering Science Laboratories, Medical Technology Laboratories	YES	YES	
RHU		NO	-	
UL	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Materials Civil - Environmental Engineering Artificial intelligence Biomedical Engineering	YES	YES	Contact the International Affair Office

	Types of Research/innovation labs	Operational	Access to outsiders	Contact
UOB	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Materials Civil - Environmental Engineering multipurpose laboratory Artificial intelligence Biomedical Engineering	YES	YES	Dean's Office
USEK	Mechanical Electrical and electronics Computer Sciences/Information Technology Chemical Petrochemical Renewable Energy Materials Civil - Environmental Engineering multipurpose laboratory Artificial intelligence Biomedical Engineering Doctoral College Higher Center for Research	YES	YES	Dr. Samar Azzi
USJ	Mechanical laboratory Electrical and electronics labs Information Technology Chemical Lab Petrochemical Civil-Environmental Engineering lab	YES	YES	

TECHNOLOGY TRANSFER OFFICES

Figure 5. *Number of Technology Transfer Offices TTO that offer services and information for funding research in universities by status.*



Three respondents declared that their corresponding universities have a well-established operational technology transfer office (TTO). These universities are AUB, USJ and USEK. USJ has an established experience in this field especially with the creation of Berytech in 2002. USEK has recently established its TTO. Four universities are currently implementing a TTO and six are planning to do that in the short term. The information about TTOs has been obtained after several round of discussions. This showed the need for raising awareness about technology transfer and its importance in supporting the applied research activities, in reinforcing the innovation ecosystem, and in diversifying the source of funding for the institutions. This is becoming crucial since many surveyed faculties reported difficulties related to the worsening conditions of financial and infrastructure services. Donors, business incubators and NGOs are solicited to assist to provide basic necessities and infrastructures along with an increased attention to youth development and upskilling.

Table 8 The status of TTOs in member universities is as follows:

Name of the University (Academic Institution)	Does your university have any Technology Transfer Office TTO that offers services and information for funding research?
Lebanese University (UL Doctoral School)	Yes, established but not really active
Islamic University of Lebanon (IUL)	Yes, established but not really active
American University of Beirut (AUB)	Yes, established and active
Saint Joseph University (USJ)	Yes, established and active
Lebanese University (UL FOA)	No, planning to
Rafik Hariri University (RHU)	No, planning to
Lebanese International University/BIU (LIU)	No, planning to
Lebanese University (UL FOE)	No, planning to
Lebanese University (UL FS)	No, planning to
Holy Spirit University of Kaslik (USEK)	Yes, established and active*(recently established)
Notre Dame University (NDU)	No, planning to
University of Balamand (UOB)	No short plans
Beirut Arab University (BAU)	In progress
American University of Science and Technology (AUST)	In progress
Lebanese American University (LAU)	In progress
ISAE CNAM Liban (CNAM)	In progress

ENTREPRENEURSHIP CENTERS

Nine respondents stated that their universities have an entrepreneurship research centre while seven stated they do not have.

Figure 6. *Existence of Entrepreneurship research center(s) in universities*

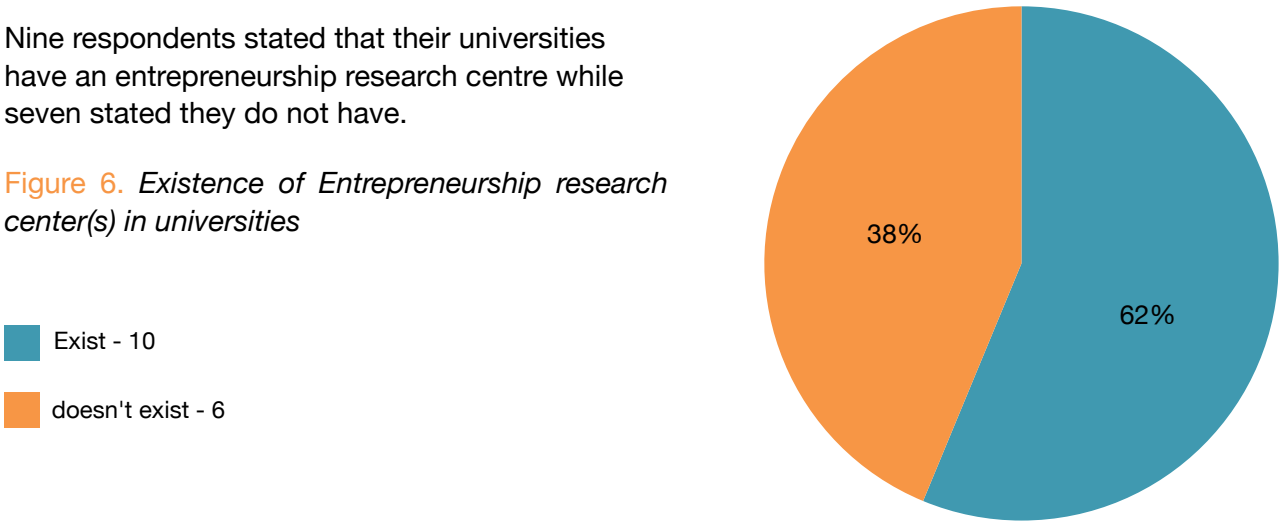


Table 9 The table below shows their distribution among the universities:

Name of the University (Academic Institution)	Existence of Entrepreneurship research center(s)
American University of Science and Technology (AUST)	Yes
University of Balamand (UOB)	Yes
American University of Beirut (AUB)	Yes
Lebanese American University (LAU)	Yes
Lebanese International University/BIU (LIU)	Yes
Saint Joseph University (USJ)	Yes
Beirut Arab University (BAU)	Yes
Lebanese University (UL)	Yes
Holy Spirit University of Kaslik (USEK)	Yes
Rafik Hariri University (RHU)	No
ISAE CNAM Liban (CNAM)	No
Lebanese University (UL) Doctoral School	No
Lebanese University (UL) FS*	Yes
Islamic University of Lebanon (IUL)	No
Lebanese University (UL) FOA	No
Notre Dame University (NDU)	No

**LU have centre mine for all the faculties centralized in the Rectorate.*

The kind of services offered by the Entrepreneurship center are listed as follows:

- Research projects with community engagement and solving real-world problems.
- Publications of research results in peer reviewed journals and international conferences.
- Organizing competitions for the students and providing startups with support.
- Consultancy, Service Level Agreements, Incubation & Acceleration,
- Develops methods and tools for founders, which are conveyed to the start-ups by the start-up consultancy, promotes entrepreneurship spirit within the students by hosting webinars in the domain and posts job offers and prepared for job interviews.

The main activities mentioned of the centre for entrepreneurship at the research level are:

1. Develop policies and procedures governing research and evaluates systems and structures for the effective interaction between faculty, graduate schools, Research Training Committee, relevant academic committees, and associated administrative supporting.
2. Oversee research and ensures that information about funding opportunities and regulatory matters are broadly communicated across university.
3. Maintain an overview of research professional development programmes within the schools and seeks funds accordingly.
4. Identifies research/funding opportunities and fosters research ethics, integrity, safety, and compliance.
5. Ensure effective infrastructure for the support of research and development and the dissemination of research results.
6. Establish cooperation and ratifies Memoranda of Understandings with international research centers/ organizations to secure financial support and research topics.
7. Promote a culture of sharing knowledge and of networking across the University.

Comparing the mentioned activities to common ones[6] proves that awareness raising is also needed at this level.

[6] "Reflecting on the role of universities in entrepreneurship education" G. Maas, P. Jones, University Industry Innovation Network
"A guiding framework for entrepreneurial universities" OECD, 2012, EC-OECD entrepreneurial Universities Framework.pdf
About the center for entrepreneurship, Hochschule Reutlingen, https://center-for-entrepreneurship.reutlingen-university.de/about-us/?lang=en

INNOVATION UNIVERSITY CLUBS

Seven universities nurture students' clubs related to entrepreneurship and technology transfer. The number of those clubs vary between 1 and 20.
The table shows that ten faculties from nine universities nurture student organizations or clubs that promote entrepreneurship or technology transfer. The five other faculties do not.

Table 10 *Existence of Innovation Scientific Clubs*

Name of the University (Academic Institution)	Clubs that promote entrepreneurship or technology transfer	Number of active innovation clubs
Beirut Arab University (BAU)	No	-
ISAE CNAM Liban (CNAM)	No	-
Lebanese International University/BIU (LIU)	No	-
Lebanese University (UL) FS / Doctorat	No	-
Rafik Hariri University (RHU)	No	-
American University of Beirut (AUB)	Yes	-
American University of Science and Technology (AUST)	Yes	2
Holy Spirit University of Kaslik (USEK)	Yes	8
Islamic University of Lebanon (IUL)	Yes	2
Lebanese American University (LAU)	Yes	9
Lebanese University (UL) FOA	Yes	1
Lebanese University (UL) FOE	Yes	20
Notre Dame University (NDU)	Yes	7
Saint Joseph University (USJ)	Yes	-
University of Balamand (UOB)	Yes	-

Table 11 *The main innovation clubs that promote entrepreneurship or technology transfer and that are active in the universities are listed below with a description of their main activities.*

Name of the University (Academic Institution)	Clubs promote entrepreneurship or technology transfer	Innovation Clubs	Main activities
American University of Science and Technology (AUST)	Club 1	IEEE SB	Organize events related to engineering and technology
	Club 2	Innovation and Entrepreneurship Club	Organize competitions and help with startups
Holy Spirit University of Kaslik (USEK)	Club 1	IEEE-EMBS	Engineering in Medicine and Biology Webinars Conferences Rally Papers Organization
	Club 2	IEEE-PES	Power Engineering Systems Webinars Conferences Rally Papers Organization
	Club 3	IEEE	Institute of Electrical and Electronics Engineers Webinars Conferences Rally Papers Organization

Holy Spirit University of Kaslik (USEK)	Club 4	AICHE	Chemical Engineering Webinars Conferences Rally Papers Organization
	Club 5	ASME	Webinars Conferences Rally Papers Organization
	Club 6	ASCE	Webinars Conferences Rally Papers Organization
Islamic University of Lebanon (IUL)	Club 1	IEEE Student Chapter	
	Club 2	ACI Student Chapter	
Lebanese American University (LAU)	Club 1	Bioinformatics Club	
	Club 2	Biotechnology Club	
	Club 3	Computer Science Club	
	Club 4	Data Analytics Club	
	Club 5	Entrepreneurship Club	
	Club 6	Logistics Automation	
	Club 7	Artificial Intelligence	
	Club 8	Developer student	
	Club 9	Robotics	
Lebanese University (UL) FOA	Club 1	ULFa Alumni	participate in several agricultural and environmental activities
Lebanese University (UL) FOE	Club 1	IEEE	
	Club 2	ASHRAE	
	Club 3	ASME	
	Club 4	ASCE	
Notre Dame University (NDU)	Club 1	Consulting Club	Promote innovation and consulting-related activities
	Club 2	ASME Student Section	Activities related to mechanical engineering
	Club 3	ASHRAE Student Branch	Activities related to air-conditioning/refrigeration and related fields.
	Club 4	IEEE Student Section	Activities related to electrical/ computer engineering
	Club 5	ASCE Student Section	Activities related to civil engineering
Saint Joseph University (USJ)	Club 1	IEEE	
	Club 2	Consulting Club	
	Club 3	ASCE	
University of Balamand (UOB)	Club 1	IEEE	Trainings, Workshops, Webinars
	Club 2	Balamand Entrepreneurs Club	Trainings, Workshops, Competitions
	Club 3	LeWAP student chapter	Trainings, Workshops, Webinars
	Club 4	ASME	Trainings, Workshops, Webinars
	Club 5	Robotics	Trainings & Competitions

It is relevant to note that LIRA program has signed agreements with the universities to launch LIRA clubs within every faculty member of IRALEB. The Clubs are not yet operational at this stage.

About eighty percent of the respondents believe that a LIRA club would be beneficial. Two major suggestions for the activities of the LIRA clubs are made: organizing workshops, competitions for best applied industrial projects, internal forum/ exhibition and, promoting innovation through raising awareness. Some suggested that IRALEB has a role in promoting entrepreneurship and start-ups, and in the initiation to IP policies and innovation.

All the respondents confirmed that it would be very useful connecting top researchers with International Industrial partners/researchers to exchange knowledge and expertise in the purpose of launching viable start-ups or technology transfer. This confirms the conclusion previously reached regarding the need for awareness raising and development of TTO and entrepreneurship.

B. INTER-INSTITUTION COORDINATION SCHEMES

INTERNAL COLLABORATION WITH FACULTY OF BUSINESS

The collaboration with faculties of business to add commercialization features and business planning seems to be average as per the responses reported in the Figure 7. One respondent mentioned an existing course on economy for engineers and a planned master program in management in engineering. Another respondent stated that students are advised to seek the support of a centre for innovation and entrepreneurship in ideation, validation, business planning and financial projections of their projects.

One respondent informed that students are often encouraged to enroll in the MBA program. In one case, students from engineering or sciences faculties collaborate in their projects with students from the business major.

It is to be noted that more than half of the respondents did not provide details about the collaboration with their respective faculties of business.

Eighty percent of the respondents (thirteen) confirmed offering entrepreneurship elective courses to their students.

In summary, the collaboration within the higher education institutions and with faculty of business is not at the desired level and needs to be fostered.

Only 5 respondents from the faculties of engineering approved that they collaborate frequently with their institution faculty of business. The remaining 74% from the faculties of Sciences and Engineering said that such collaboration is very rare and almost non-existent.

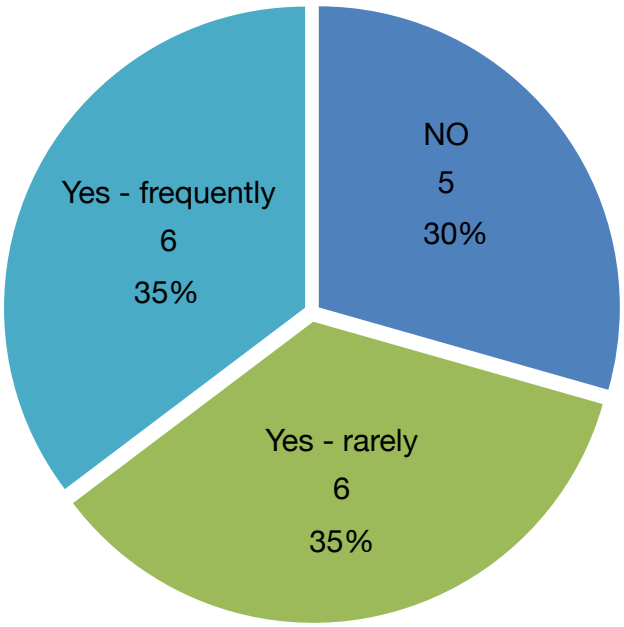


Figure 7. *Collaboration with Faculties of Business*

ALIGNMENT OF THE EDUCATIONAL OFFER WITH THE MARKET'S NEEDS

The survey inquired about the creation during the past five years of new degrees driven by the market needs. Eight respondents did not answer and four denied the creation of such degrees (more than sixty percent). The seven positive answers mentioned several degrees as: Management in Engineering, Petroleum Engineering, Renewable Energy, Food Chemistry, Biomedical engineering, Biomarketing, Physics of sensors, Actuarial Sciences, Medical Devices Design, Artificial Intelligence and Data Science.

Similarly, regarding the plans to launch new diplomas to fit industrial needs, three surveyed persons did not respond, three responded negatively, two answered positively without details and, two answered strictly about training.

The remaining answers enumerate several degrees to be offered including: Artificial Intelligence, Health, Recycling, Cybersecurity, Embedded systems, BIM for smart engineering, Smart Cities and Smart Grids and others.
Most of the faculties participating in the survey consider that there is a misalignment between offered qualifications and needs of the industrial sector for more technical, technological, and vocational graduates.
Six of the respondents admitted the existence of a gap between the offered degrees and the market needs. They enumerated existing and possible solutions.
Some of those are:

- Regular review of courses
- Exit and employer surveys
- Advisory boards
- Increase the number of seminars and workshops with industrialists
- New master programs
- Double degrees
- More involvement of industrialists in the delivery of courses and programs

Few initiatives have been launched lately in the benefit of driving youth graduates to fit in more labour markets.

One of the attempts was launching of new innovative diploma/masters by faculties in Lebanese universities helping in introducing their students to the professions needed in labour market.

Lately a new master has been implemented by the FS USJ in partnership with the Lebanese NCSR[7] , as the referent in Lebanon of the International Atomic Energy Agency (IAEA), to graduate professionals specialized in medical radio physics to cover the shortage of specialists in the medical and industrial sector. While the participants are aware of the misalignment with the market needs, it is not clear if structural procedures have been established to overcome this issue. This is an additional issue to be further investigated in the future.

> Alarming number of students compared to the present size of the labour market - The need to develop the innovation ecosystem is urgent
> Existing laboratories and infrastructure that seem to be used for both teaching and research with readiness to open to industry
> Many clubs exist to promote entrepreneurship and technology transfer. However, training and connections are needed. LIRA clubs can respond to part of this.
> Need to further investigate to reinforce the link with industry
> Need to raise awareness about technology transfer and entrepreneurship
> Need for structural reform for a better understanding and consideration of market needs to align the educational offer
> Need to reinforce cooperation within the university and across universities locally and internationally

[7]NCSR: National Council for Scientific Research

II. RESEARCH MANAGEMENT AND INNOVATION

A. PROCESS OF INNOVATION

(HOW THE INNOVATIVE IDEAS ARE TREATED, HOW CAN A STUDENT OR GROUP OF STUDENTS DEVELOP INNOVATIVE IDEAS)

PUBLISHED RESEARCH

Table 12 The table below summarizes the distribution of Published Researches for the last five years (articles, conferences papers, reviews, books,...) & FYP, master and doctorate projects (Fundamental & applied) for the Faculties of Engineering member of IRALEB. These data provided does not consider precise criteria about the type and relevance of the publications. It indicates a fair level of publications. It also shows the large number of final year undergraduate and master projects.

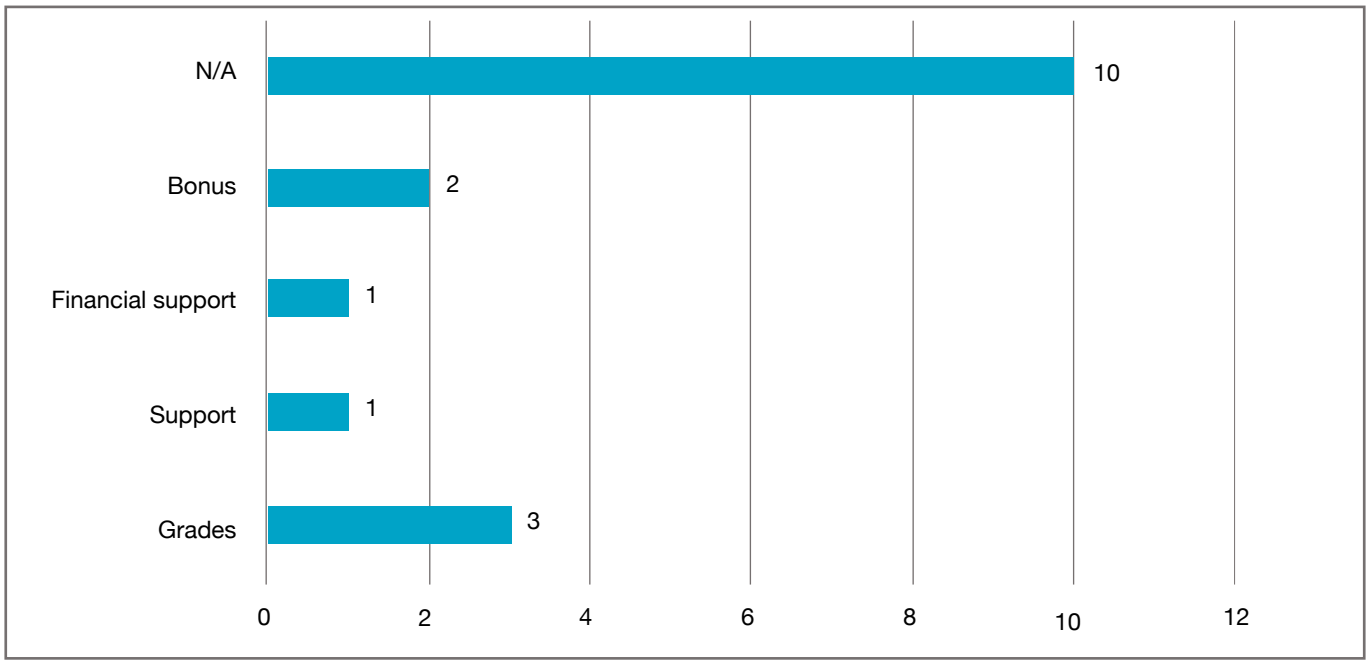
	Faculty of Engineering			
Name of the University (Academic Institution)	**Published Researches by Faculty members**	**FYP Students projects (Undergraduate)**	**Student projects (Master)**	**Student projects (PHD)**
American University of Science and Technology (AUST)	50	70	10	-
University of Balamand (UOB)	55	50	10	-
American University of Beirut (AUB)	-	-	-	-
Rafik Hariri University (RHU)	112	125	50	-
Lebanese American University (LAU)	295	105	40	-
ISAE CNAM Liban (CNAM)	35	685	-	-
Lebanese International University/BIU (LIU)	685	2117	1277	-
Saint Joseph University (USJ)	421	35	71	45
Beirut Arab University (BAU)	201	558	112	29
Lebanese University (UL)	441	2500	834	30
Islamic University of Lebanon (IUL)	60	100	30	-
Holy Spirit University of Kaslik (USEK)	74	87	8	5
Notre Dame University (NDU)	296	373	16	-
Lebanese University (UL) Doctoral School	100	5	5	60
TOTAL	**2825**	**6810**	**2463**	**140**

Lebanese University (UL) Faculty of Science: 530 publications
LIU publications from 2017 till 2021
USEK publications: (from 2018 - Early 2022)

IMPEDIMENTS AND INCENTIVES FOR RESEARCHES

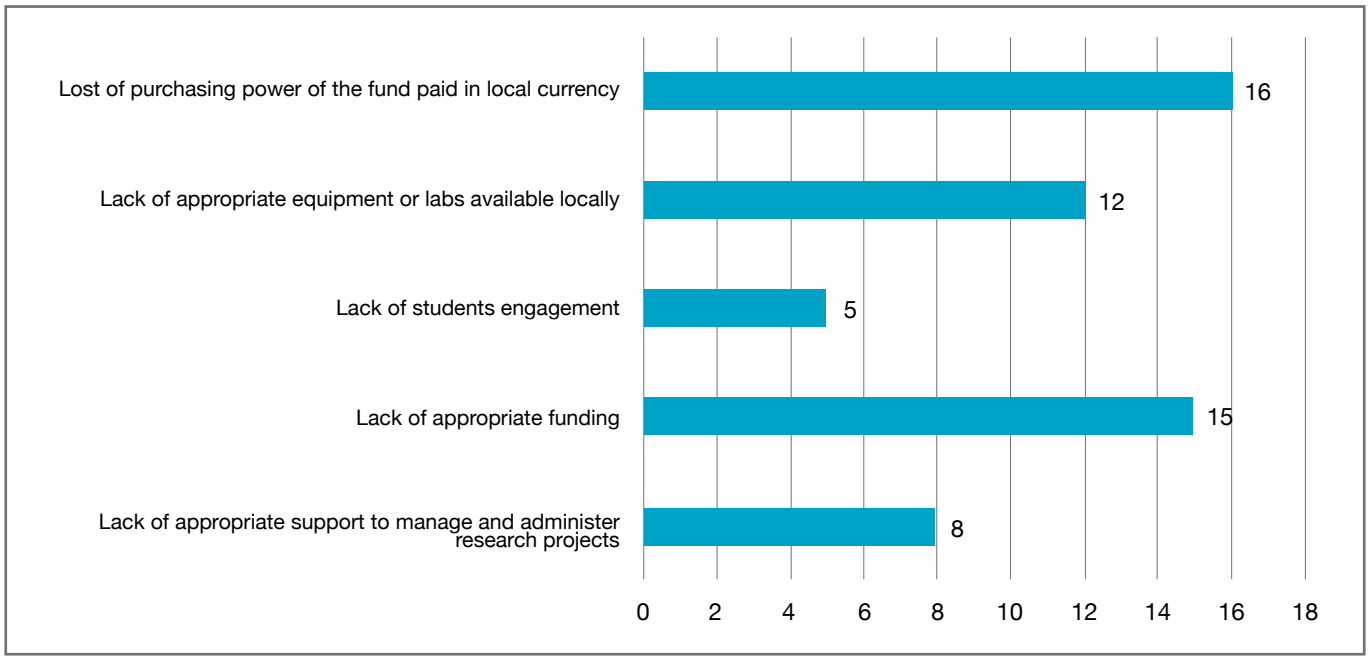
Only 44% of the respondents state that their universities provide incentives to professors to supervise industrial applied projects. The types of incentives are provided in Figure 8.

Figure 8. *Types of incentives provided to the supervisors of industrial applied projects.*



The main impediments facing researchers in Lebanon are shown in Figure 9. The answers on how the innovative ideas are encouraged show clearly that a system to promote innovation is lacking.

Figure 9. *The impediments researchers are facing in Lebanon*



AWARDS FOR DISTINCTION IN RESEARCH

Seven respondents replied positively and eight denied the granting of any award by the university.

Table 13 shows the distribution of universities that offer awards for distinction in research to Masters/PhD students, professors, and senior undergraduates.

Awards for distinction in research to Masters/PhD students, professors, and senior undergraduates	Offers awards	
Name of the University	No	Yes
American University of Beirut (AUB)	-	1
Notre Dame University (NDU)	1	-
Rafik Hariri University (RHU)	-	1
Saint Joseph University (USJ)	2	-
University of Balamand (UOB)	1	-
American University of Science and Technology (AUST)	1	-
Beirut Arab University (BAU)	1	-
Holy Spirit University of Kaslik (USEK)	-	1
ISAE CNAM Liban (CNAM)	1	-
Islamic University of Lebanon (IUL)	1	-
Lebanese American University (LAU)	-	1
Lebanese International University/BIU (LIU)	1	-
Lebanese University (UL)	-	3
Grand Total	**8**	**7**

Only 50% of the respondents confirm their universities offer awards for distinction in research. The current allocated rewards offered in universities are mostly related to faculty promotion and grades. It is critical that universities adopt an effective rewards system for researchers to incentivize them to generate quality research projects and to promote the commercialization of their findings and generated technologies.

Additional incentives should be allocated to encourage all kind of collaboration with industries. Such incentives might be financial, such as prizes or non-monetary, such as honorary awards and recognition.

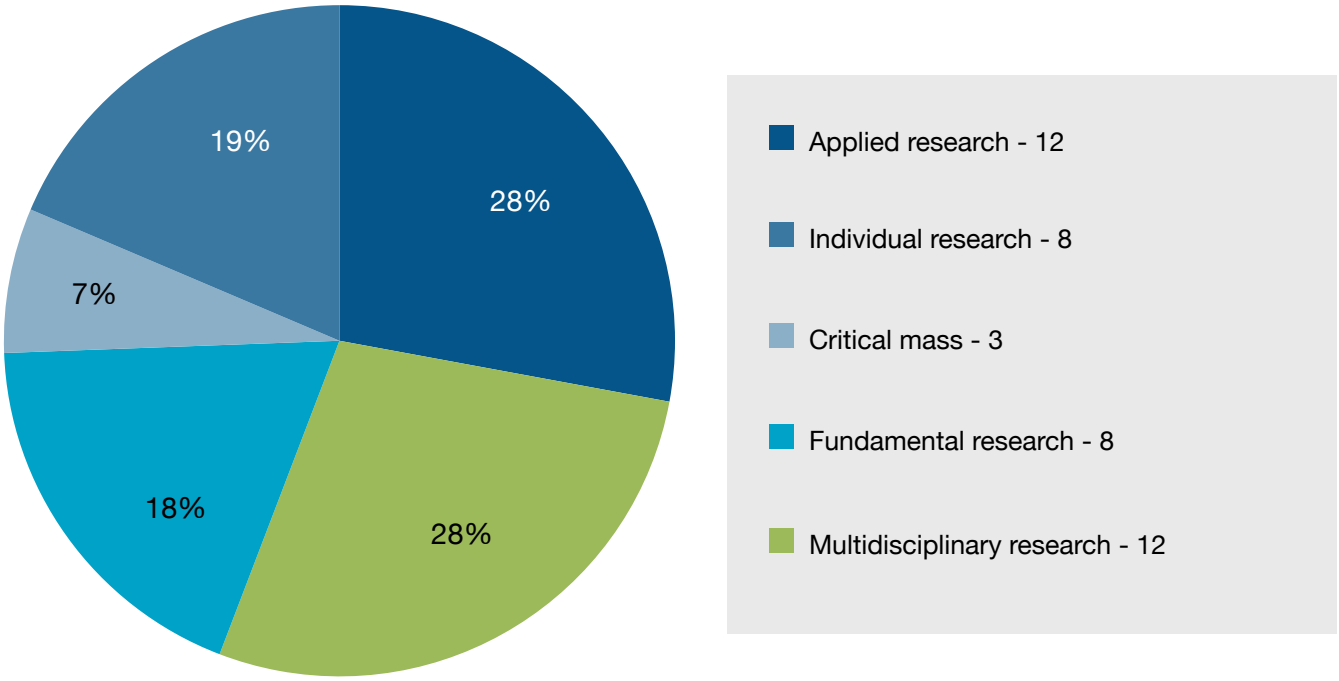
BREAKDOWN BY TYPE OF R&D (BASIC RESEARCH, APPLIED RESEARCH, etc.) TOPICS COVERED BY RESEARCH OFFICES

The typical projects that receive funding are in the field of Software, Communication, Robotics, Mechanical and Civil engineering, Biomedical and CCE, patient Counseling and Education, Public Health Awareness, Drug Utilization Review, Renewable Energy and Energy Management, Mechanical Engineering, science and technology. Most of them are funded from industrial collaborations and/or European funds.

As shown in the graphics below, the funding granted by the universities covers applied and multi-disciplinary projects. These two types of research are mentioned 12 times compared to individual and fundamental research that are mentioned 8 times only.

The yearly amount spent on R&D by the University varies a lot between one university and another. Replies of respondents were around 1 million 800 USD (2 universities), 400,000 USD, 200,000 USD, 2 billion LBP and 4 billion LBP. To this amount is to be added national, regional and international funding.

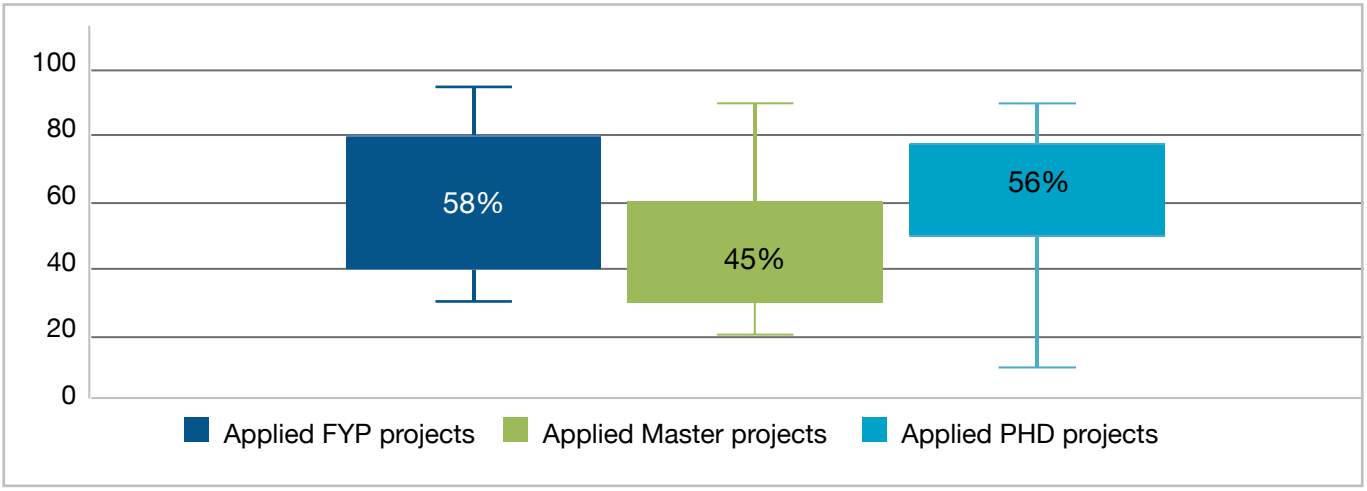
Figure 10. *Topics covered by Research Offices*



APPLIED RESEARCH

According to the answers more than half of the projects developed for FYP are applied. Only 45% of these projects are applied in case of Master projects. The range for doctorate projects varies from 50% to reach a maximum of 75% a little bit lower than FYP. Figure 11 provides the ranges of percentages of applied projects per level as in the received answers.

Figure 11. *Share of applied projects in FYP, Master and PHD*



The development of an applied project is required for many universities like AUB, USEK and LIU before graduation. The percentage of applied research projects developed by the students in % of total projects developed for FYP, Master and PHD projects varies greatly within the partner universities.

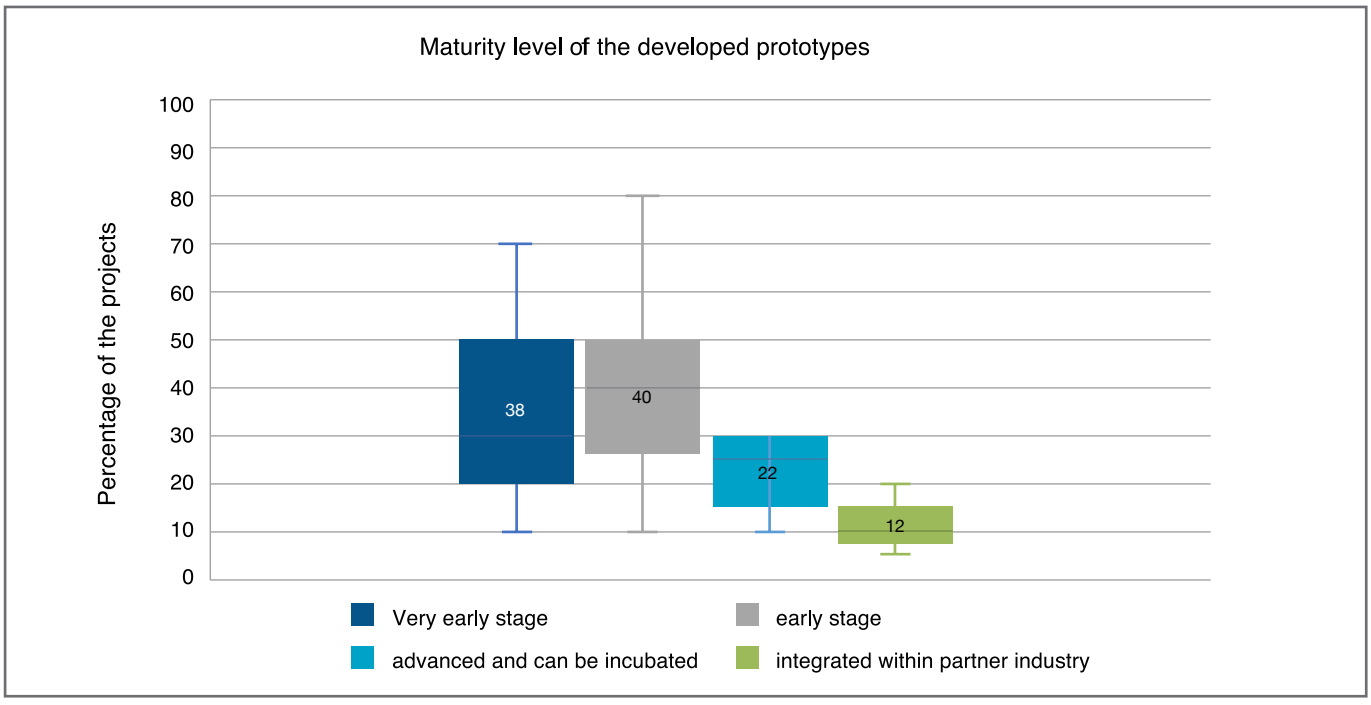
Table 14 Distribution of Applied Research Projects by university and educational status

Name of the University	in % of total researches		
	Applied FYP projects	Applied Master projects	Applied PHD projects
American University of Beirut (AUB)	95	90	90
Notre Dame University (NDU)	40	60	
Rafik Hariri University (RHU)	60	30	
Saint Joseph University (USJ)	50	50	30-80
University of Balamand (UOB)	50-70	50	50
American University of Science and Technology (AUST)	70	30	
Beirut Arab University (BAU)	50	50	50
Holy Spirit University of Kaslik (USEK)	90	60	80
ISAE CNAM Liban (CNAM)	30	30	
Islamic University of Lebanon (IUL)	30	20	50
Lebanese American University (LAU)	40	25	
Lebanese International University/BIU (LIU)	95	78	68-70
Lebanese University (UL)	50	20-50	10

MATURITY LEVEL OF PROTOTYPES

According to the answers most of the prototypes developed in the projects are at either very early stage or early stage. A small percentage of the prototypes are advanced or integrated with partner industry. Figure 12 provides the ranges of percentages of projects per level as in the received answers.
It is not clear why the high majority of the developed prototypes are at early or very early stages. Further investigations are needed in this direction.

Figure 12. *Maturity level of the developed prototypes*



CONFERENCES AND NETWORKING (PROMOTION OF ENTREPRENEURSHIP/ COMMUNICATION)

According to the responses received ten universities hold conferences on research, science and technology at a rate varying from one or two times per year to eight times per year depending on the university.

These conferences cover a broad range of topics in engineering and technology. They are opened to academics, industrialists, funding agencies, service providers, incubators, and accelerators.

Among the listed topics of the conferences we have: Engineering, Innovation and Entrepreneurship, Communication skills, Healthcare innovations and technology, Design Thinking, Sustainability, Emotional Intelligence, Agricultural sciences, environmental Sciences-food technology- animal and plant production-Veterinary Sciences, Material science, Electrical Engineering, ICT, Biomedical Engineering, Biology, immunology, dentistry, maths, material science, physics, medicine...

APPLIED RESEARCH AWARDS FOR EXCELLENCE/ MERIT BASED AWARDS (COMPETITIONS AND BOOT CAMPS)

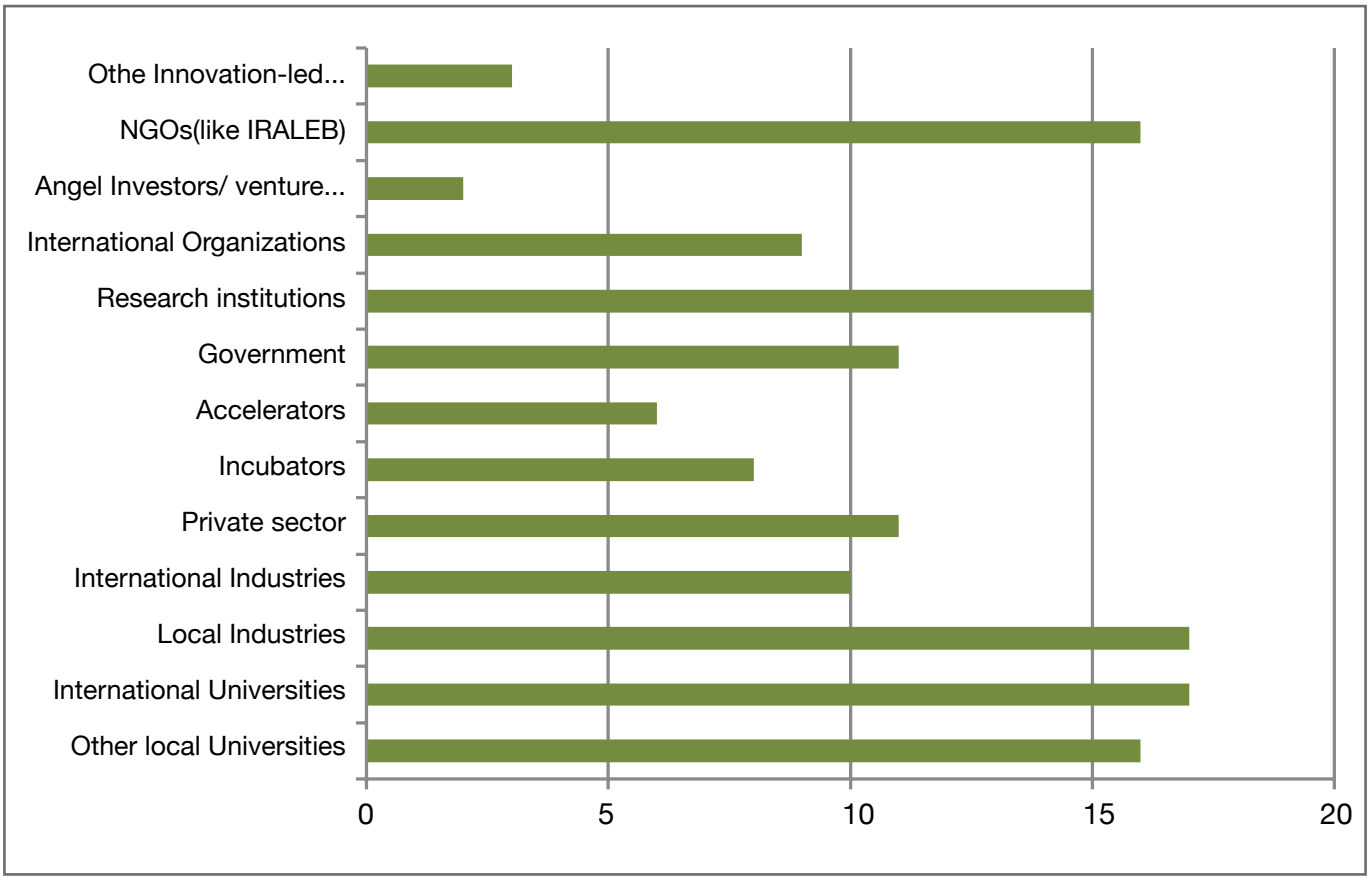
Most respondents confirm that their students participate to competitions. The number of competitions vary from one or two and might reach 15 competitions per year. More than half of respondents participate between 3 and 10 competitions per year. Two respondents use to participate in around 15 competitions and more.
For the boot camps the answers differ since only about half of the respondents confirm organizing them from two or three per year to more than five. Five faculties stated that they don't participate in boot camps. The competitions and boot camps are organized by: AUF, Berytech, CEDRE, CERN, Erasmus+, IEEE, IRI, LIRA, NCSR, UNICEF and USAID. The competitions levels are both for early and advanced stage of research development.

50% of participating faculties exhibit both kind of projects: early and advanced stage. One third has early research projects and one third exhibit projects has an advanced stage of research development.

A. STAKEHOLDERS' COLLABORATION AND PARTNERSHIPS

The figure below shows that all respondents have partnerships mainly with Local universities and industries, international universities, research institutions and IRALEB. We note here that this partnership is limited to a small number of local and international industries. The collaboration with angel investors, accelerators and other innovation led institutions is still very weak and is limited to 2 or 6 faculties only. This reveals a limited interest in the entrepreneurship side of the projects developed by academia and reconfirm the conclusion previously reached.

Figure 13. *Kind of partnerships or collaborations for educational/research/funding*



Some Venture Capitals (VCs) contribute to the Lebanese ecosystem in monetary investments. Somehow, to accelerate the product development, they should provide start-ups with stronger support like seed capital, mentors, access to fully outfitted laboratories and technical expertise.

The current ecosystem lacks experienced VCs not constrained with limited amounts of funding who are ready to take high risks.

The collaboration between universities and industries had made big improvements before the last crisis expanding its focus on human resources, recruitments, and internship.

The mission of the Lebanese universities is currently moving beyond employment and well preparing young people for the job market to empower students effectively, pushing them towards productive careers.

The new university graduates are mostly high skilled, multilingual, and cost-competitive which would increase the performance of the industry.

This is mainly due to the country's advanced educational system.

Today, Lebanon ranks 19th worldwide for the quality of its higher educational system, while it occupies the 6th place for math and sciences education.

The World Economic Forum's "Global Information Technology Report" ranked Lebanon 14th out of 144 countries for its quality of education and fourth in mathematics and science.

Somehow, this collaboration remains weak.

B. COORDINATION MECHANISM AND SCHEMES

COLLABORATION WITH LOCAL UNIVERSITIES

Only one example of joint degree with international universities is provided. However, most respondents (fourteen) confirm the existence of exchange programs with international universities allowing mobility of students.

With the exception of CNAM and LIU, respondents from the other institutions declared having collaborations with local universities. Each university indicated the fields of collaboration and the partner institutions.

The matrix is shown in Figure 14 where the rows represent the institutions of the respondents and the columns the partners' institutions.

A shaded row indicates that the respondent did not precise a specific partner. This mapping shows an existing collaboration between the different universities. The lack of details does not allow to construct a precise map on the collaboration partners and fields.

Figure 14. *Mapping of collaborations with local universities.*

	AUB	AUST	BAU	CNAM	IUL	LAU	LIU	NDU	RHU	UL	UOB	USEK	USJ
AUB													
AUST													
BAU	◆◆◆◆					◆◆◆◆	◆	◆◆◆◆		◆◆◆◆	◆◆◆◆		
CNAM													
IUL										◆			
LAU													
LIU													
NDU													
RHU			◆										
UL	◆		◆										
UOB													
USEK	◆					◆							
USJ													

◆ Artificial intelligence
◆ Biomedical
◆ Civil
◆ Electrical
◆ Mechanical
◆ Chemical
◆ Telecom
◆ Nutrition

UL has collaboration with usek , AUB, UOB, USJ LAU, NDU, RHU (with official agreements in SC. and Technology.

We note here that efforts are being made to foster collaboration between universities.
Therefore, Memorandum of Understanding (MoU) have been signed in June 2022 between the prominent universities affiliated with the Universities Association of Lebanon (UAOLB) with the aim of promoting and facilitating inter-university research cooperation.
Among the member universities, we list USJ, UL, IUL, AUB, LAU, UOB, Antonine university, USEK, NDU and BAU.

EXCHANGE PROGRAMS WITH INTERNATIONAL UNIVERSITIES

All respondents stated that their respective institutions have active collaborations with international universities. Here also the answers are not precise enough to draw a clear map of the collaborations' partners and fields. Figure 15 provides the map of collaborations with international universities.

Figure 15. *Mapping of collaborations with international universities.*

University	Fields	Partners
AUB		
AUST		
BAU	◆◆◆◆◆◆	Partners in Italy, France, Romania and USA
CNAM		
IUL	◆◆	Partners in France
LAU		
LIU		Partners in France, Italy and Russia
NDU		
RHU	◆	Partners in France
UL		Partners in Fr, UK, Canada, Europe, USA, china, Iran, Iraq, Jordan
UOB		
USEK		Partners in France, Canada and Turkey
USJ		Partners in France, Belgium, Canada, Italy, Tunisia, and others

◆	Artificial intelligence
◆	Biomedical
◆	Civil
◆	Electrical
◆	Mechanical
◆	Chemical
◆	Telecom
◆	Nutrition

**UL FOA: CIHEAM – Montpellier*

OTHER EXTERNAL COLLABORATION (INDUSTRIES, INCUBATORS, PUBLIC ENTITIES, ….)

Except for respondent from IUL, all respondents declare having collaboration with local industries.
The fields of collaboration cover: biomedical, mechatronics, microbiology, mechanical engineering, chemical engineering, and others.
Few industrialists are named.
The forms of collaboration are projects, internships and/or training. Many less respondents indicated having collaborations with international industries and very few of them (BAU and RHU) provided the fields of cooperation and the names of the partners.
For the collaboration with the private sector also very few evidence is provided in the responses.
Efforts must be spent to improve and better organize the collaboration between the universities and both local and international industries.
Regarding incubators, even fewer collaborations are cited. Some future projects are mentioned. Berytech and the Centre for Innovation and Entrepreneurship (ACIE) at USEK are nearly the unique concrete two examples provided as incubators and accelerators.
Collaborations with governmental institutions are more mentioned. Respondents declare several collaborations with different ministries and public companies like Middle East Airlines (MEA), "Electricité du Liban" (EDL), National Council for Scientific Research (NCSR), Lebanese Army, LIBNOR, and municipalities.
Collaborations also exist for financing research and development activities with national and international agencies. Here also, many respondents did not declare having active collaborations.
The following agencies are mentioned:

- National Council for Scientific Research (NCSR)
- LU-Azm, LU-NRC
- French Lebanese Program CEDRE
- Fulbright
- SAFAR
- Erasmus+
- DAAD
- AUF
- UNIDO
- USAID
- FAO

As for cooperation with venture capitalists, only USEK mentioned a cooperation with Mr. Carlos Ghosn. For collaboration with NGOs, LIRA, IRALEB, JOUZOUR LOUBNAN, Moawad Foundation, Adyar, and Youth for Peace were mentioned.
Other collaborations were cited like with Polytechnic University of Hong Kong, GiZ, and Swiss Embassy Hult Prize.

C. ROLE OF INDUSTRIALISTS STAKEHOLDERS

ROLE OF INDUSTRIALISTS AND ALUMNI

Around eighty percent of the respondents asserted that industrialists are invited to deliver lectures on entrepreneurship and to share their experiences with the students. The details provided classify this cooperation into two categories:

- industrialists participating in courses on project management, entrepreneurship, accounting, ethics, and corporate law and,
- industrialists participating in technical courses such as: biomedical equipment, telemedicine, food chemistry, industrial technology, sensors, biomarketing, …

Figure 16. *What industrialists offer in the collaboration.*

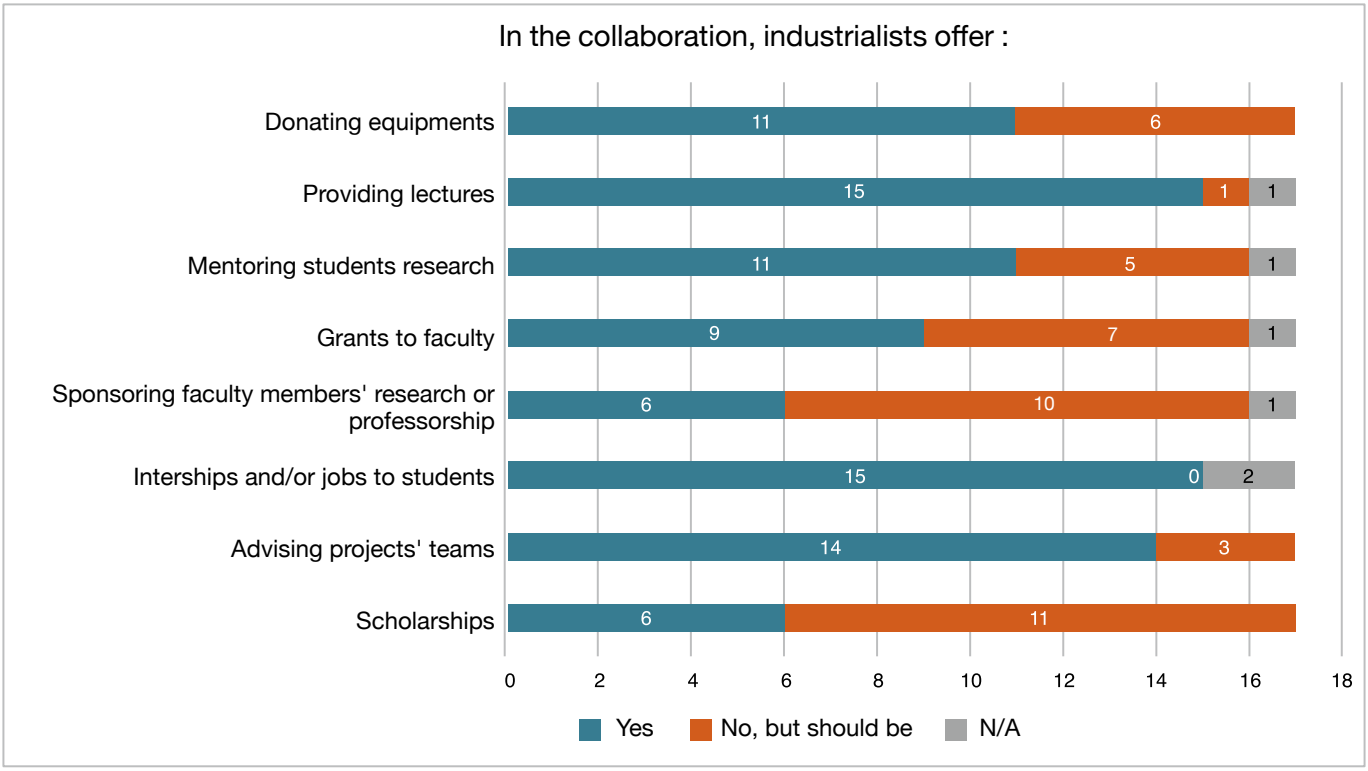


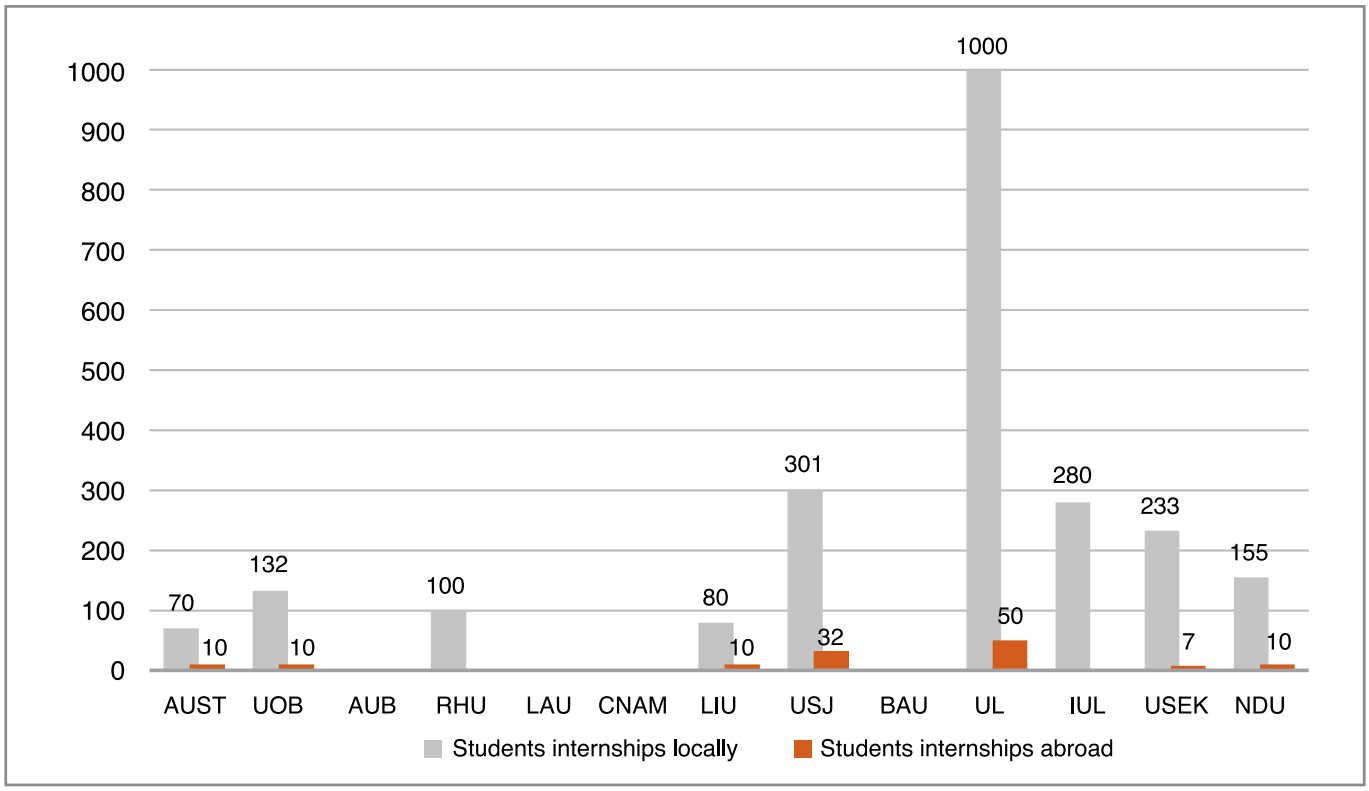
Figure 16 summarizes the answers regarding what the industrialists offer in the collaboration with the universities of the respondents. The offers mainly cover lecturing, advising, and internships and/or jobs. In significant number of cases industrialists offer equipments. Scholarships, financing research and grants seem to be less frequent.

Alumni are mainly considered as facilitators to finding internships and job offers. They also participate in orientation and providing seminars. Some respondents called for strengthening the role of the alumni and diaspora.
Several suggestions are made on how to strengthen cooperation with external stakeholders. These include co-construct courses and co-training the students, trust academia members, developing common projects, initiate research plans, implement technology transfer offices in the universities, develop an online platform to share information about projects and interests, provide financial support.

INTERNSHIPS

All respondents indicated that their universities promote students industrial or research-based internships. While not all respondents provided the needed internships in engineering yearly, the provided numbers show a need for 2463 local and 153 international internships per year. In order to encourage the students to perform the internships those are often made mandatory. In most of the cases the students are requested to find their internships by themselves with no or limited support.

Figure 17. *Students Internships by Faculty/ university*



Undergraduate programs require a minimum of 1 to 2 credits of internship within the student's curriculum. Internships are mandatory and are integrated within the student's study plan starting 2nd or 3rd year of undergraduate studies.

Table 15 Local and abroad students' internships by university

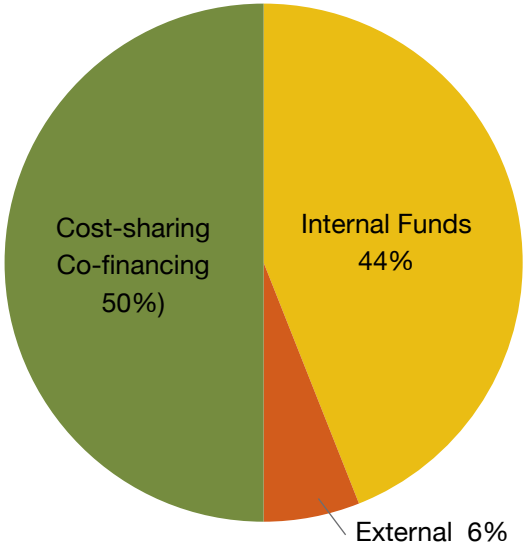
Name of the University (Faculty of Engineering)	Students' internships locally	Students' internships abroad
American University of Science and Technology (AUST)	70	10
University of Balamand (UOB)	132	10
American University of Beirut (AUB)		
Rafik Hariri University (RHU)	100	
Lebanese American University (LAU)		
ISAE CNAM Liban (CNAM)		
Lebanese International University/BIU (LIU)	80	10
Saint Joseph University (USJ)	301	32
Beirut Arab University (BAU)		
Lebanese University (UL)	1000	50
Islamic University of Lebanon (IUL)	280	
Holy Spirit University of Kaslik (USEK)	233	7
Notre Dame University (NDU)	155	10
Total Internships	**2351**	**129**

D. RESEARCH FUNDING OPPORTUNITIES

FINANCING RESEARCH PROJECTS

Only a small percentage of the projects are financed by external sources as shown in sources of R&D funding. 44% of the financing comes from university internal sources and the other half is co-financed. The external funds, when existing, come mainly from local and European sources (Figure 18).

Figure 18. *How university research projects are funded.*

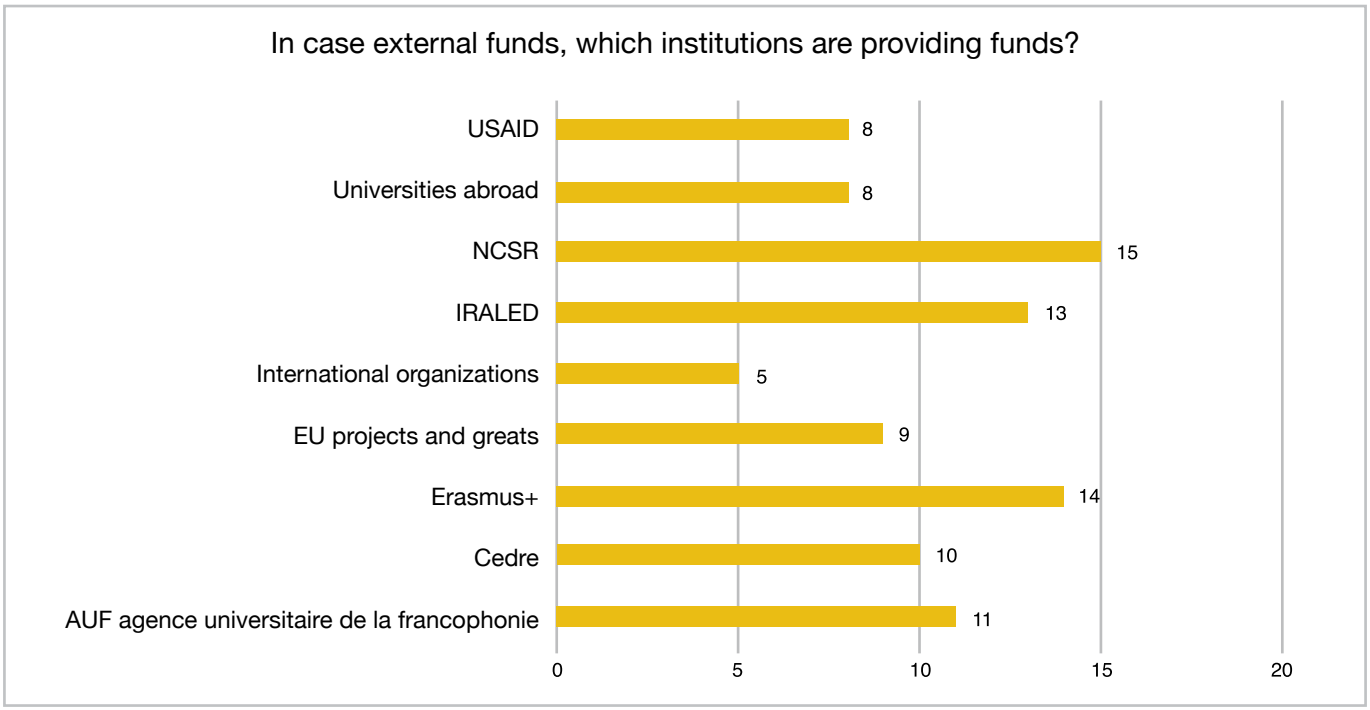


Initiatives have been launched recently by some universities to enhance the cooperation between academia and industries. We mention here the Institute at AUB that is offering R&D and professional services to local and regional industries in order to help them innovate and improve their performance, by collaborating with faculty members of the Faculty of Engineering. Through this initiative, AUB professors have been leading projects with Lebanese industries to address the challenges identified by those industries. High financial rewards are allocated to the staff to compensate such efforts.

SOURCES OF R&D FUNDING

For the projects that are co-financed, the university share goes from 20 up to 90% for some respondents.

Figure 19. *Financing organizations.*

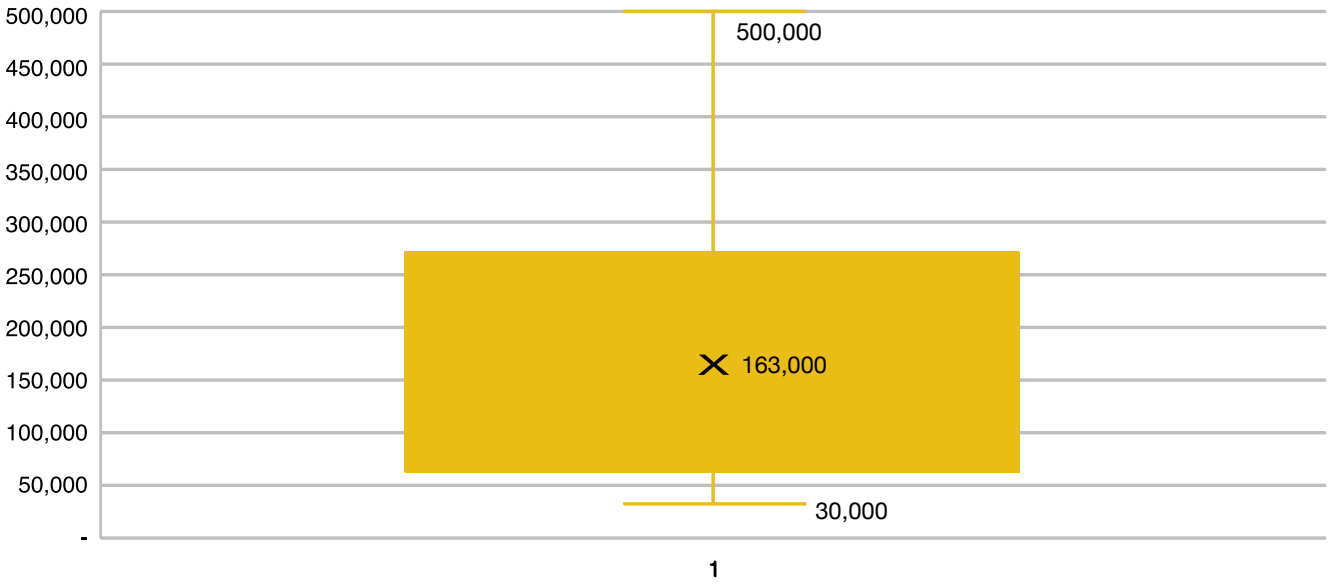


The above figure shows that 11 respondents answered that AUF is contributing to the research projects funding, CNRS was mentioned 15 times and IRALEB 13 times in addition to ERASMUS 14 and Cedre 10 times.

PROTOTYPING BUDGET

The estimated yearly required budget for students and supervisors to implement operational prototypes exceed 1.300.000 USD with an average of around 163.000 $ for respondents. The answers vary between a minimum of 30.000 $ and a maximum of 500.000$ according to the university. Lebanese university budget required is surely the highest of these figures reaching 500.000 $ with an average of 2.000$ per prototype. The Universities that answered this question are: AUST, LAU, UL foe, BAU, USJ, USEK, BAU.

Figure 20. *Estimated yearly required budget to implement operational prototypes ($)*



> While final year projects are mandatory and most of them are considered applied research, it is alarming to have most of the prototypes developed at very early or early stages
> - It is important to further investigate the reasons behind

> There is no or limited incentives to engage in applied research projects
> - Such mechanisms need to be developed

> Most of the funds for the applied research projects are internal. This is of risk in the present crisis period.
> - Connecting with industrialists and supporting programmes is to be fostered.

> There is a need to further develop the conferences, workshops and seminars for creating/ developing scientific community and reinforcing the climate of trust

> International mobility is to be further developed and organised

III. UNIVERSITY BASED OR AFFILIATED INNOVATION LED INCUBATORS/ACCELERATORS

A. ROLE OF UNIVERSITY OWNED INCUBATORS FOR PROMISING TECHNOLOGIES/INNOVATIONS

Only Four respondents declare that their universities do have incubators/accelerators offering mainly consultancy services, capacity building and networking. The universities are AUB, LAU, USEK and USJ.

Figure 21. *Innovation led incubators affiliated to the university*

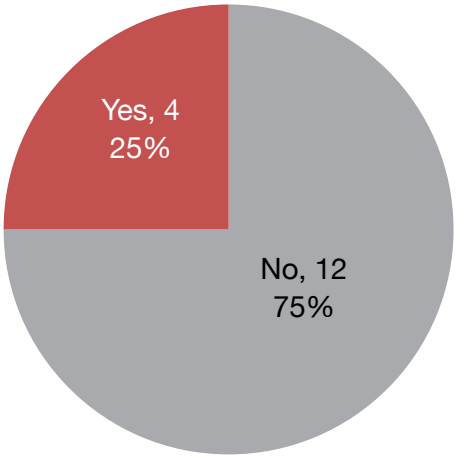


Table 16 The table below highlights the existence of incubators led by the universities.

Name of the University (Academic Institution)	Existence of an Incubator	Incubator name
Lebanese American University (LAU)	YES	**LAU SPARK** hosted at LAU Fouad Makhzoumi https://lau-fmic.com/
American University of Beirut (AUB)	YES	**IPARK:** Talal and Madiha Zein AUB Innovation park-Innovation park, https://sites.aub.edu.lb/ipark/ **CRINN:** Center for Research and innovation https://www.aub.edu.lb/ogc/Pages/crinn.aspx
Holy Spirit University of Kaslik (USEK)	YES	**ACIE:** ASHER Center for innovation and Entrepreneurship https://acie-usek.org/
Saint Joseph University (USJ)	YES	**BERYTECH** https://berytech.org/
American University of Science and Technology (AUST)	NO	
Beirut Arab University (BAU)	NO	
ISAE CNAM Liban (CNAM)	NO	
Islamic University of Lebanon (IUL)	NO	
Lebanese International University/BIU (LIU)	NO	
Lebanese University (UL - FOA)	NO	
Lebanese University (UL - FOE)	NO	
Lebanese University (UL - FS)	NO	
Lebanese University (UL Doctoral School)	NO	
Notre Dame University (NDU)	NO	
Rafik Hariri University (RHU)	NO	
University of Balamand (UOB)	NO	

AUB owns two incubators IPARK and CRINN to support the development of innovative ideas into profitable and scalable start-ups.

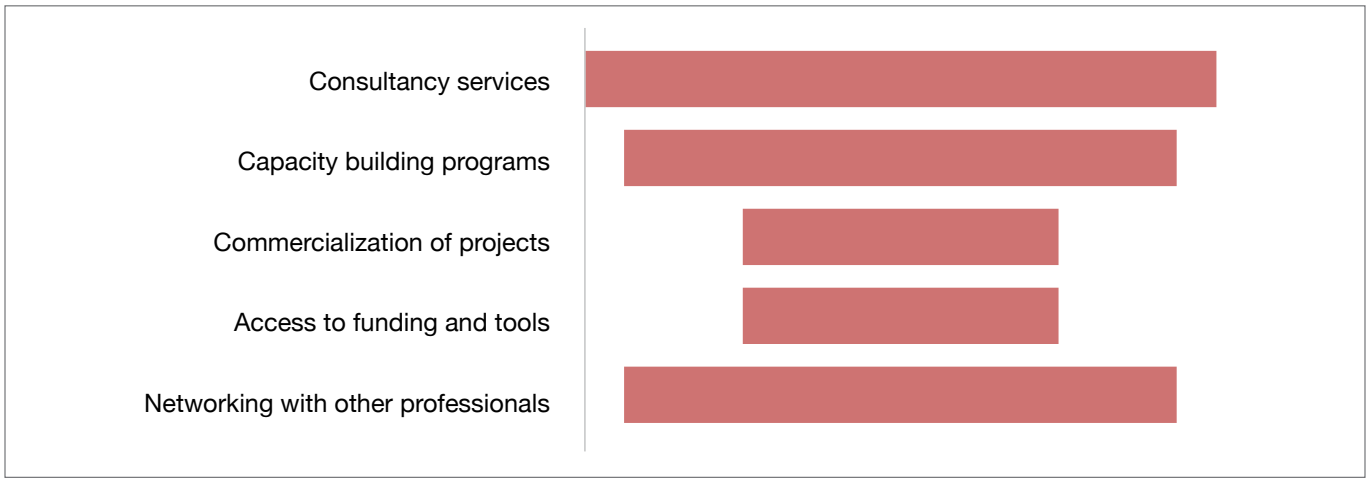
USEK has an incubator called ASHER Center for innovation and Entrepreneurship (ACIE) that is part of the Babson Collaborative, (which is Regional host for the Hult Prize Beirut Summit Cleveland State University: Joint symposium and competition organization AUF). LAU SPARK is hosted at LAU Fouad Makhzoumi. Berytech is the well known incubator launched by USJ and has now expanded its collaboration with many universities to foster incubation and acceleration.

It is considered as the hub for promising and innovative entrepreneurial students and faculty members. Berytech provides a dynamic ecosystem for the creation and development of Lebanese startups. It expanded its offices initially located at ESIB to cover also the area of Mathaf and Beirut Digital District.

B. SCOPE AND PROGRAMMES

AUB, LAU, USEK and USJ Universities are working on spreading and promoting the entrepreneurship spirit in their region by fostering fully functional university-based entrepreneurial ecosystems.

Figure 22. *kind of services the university based incubator offer*



Incubator and Business development centre offer the right and adapted environment for the creation and development of innovative start-ups. They support entrepreneurs, through incubation, business support, hosting in high -tech infrastructure, mentoring, networking, funding, trainings, innovation management, access to international markets, adapted programs and competitions.
Berytech provides business development, grants, access to markets and funding opportunities in order to enable to entrepreneurs to sustain themselves, grow regionally and internationally. Capacity building workshops and trainings that will include technical assistance, field visits, group workshops, one-on-one business clinics, and support in investment readiness are offered. Start-ups benefit from customized coaching and mentoring sessions; free incubation with an array of services, seed money support to develop prototypes, and connections with investors.

C. TECHNOLOGY TRANSFER OFFICES: MAIN FUNCTIONS

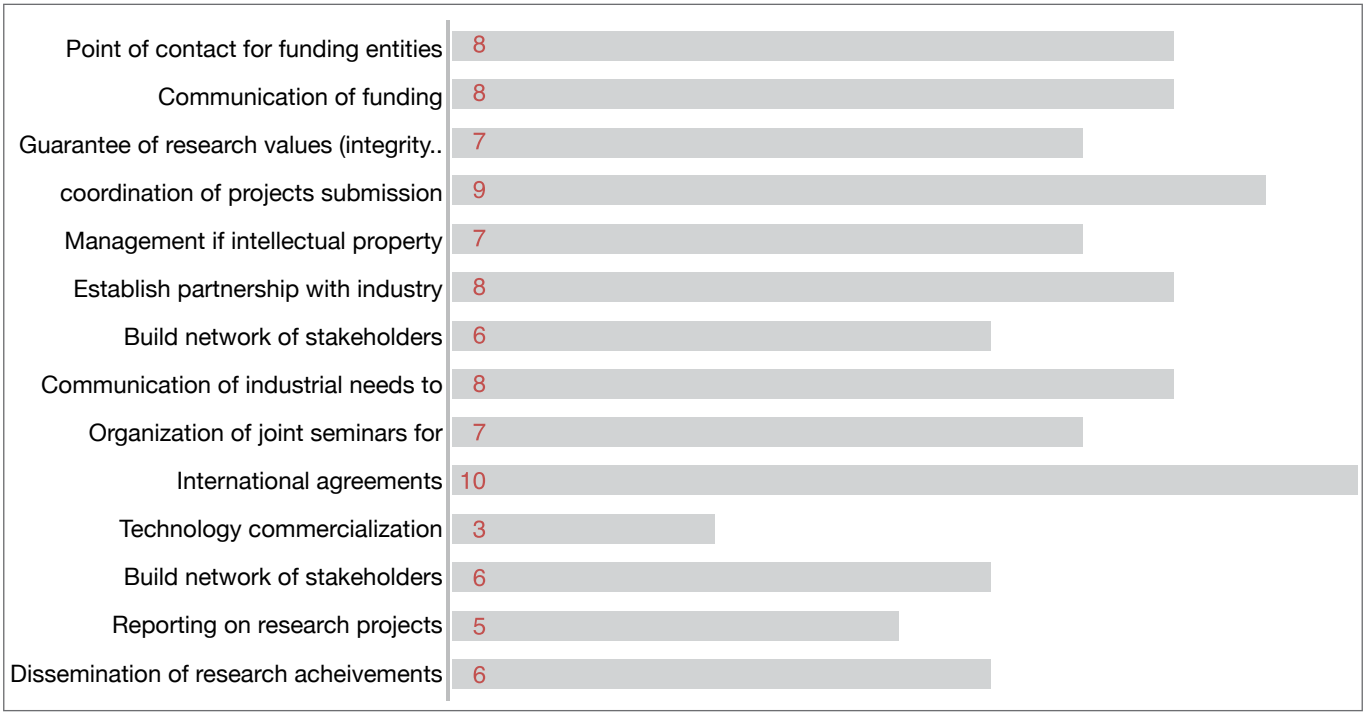


Figure 23. *Main functions of the TTO office*

For all of respondents, the TTO is considered as a point of contact for funding entities, Communication of funding, Guarantee of research values (integrity, ethics,..), Coordination of projects submission / applications, Negotiation of contracts and agreements, Management of Intellectual property rights & policy, Communication of industrial needs to academia.

> Berytech is a fully functioning incubator. Besides, only very few other are under development - Planification is needed regarding the incubation development, access and opportunities

> Raising awareness and training are needed for the establishment and/or development of technology transfer offices and procedures

IV. INTELLECTUAL PROPERTY OF THE INNOVATION

A. EXISTING FORMS OF INNOVATION OWNERSHIP

Most of the universities member of IRALEB have contracts that make them the owner of the results of research and development conducted by their faculty members. AUB is a rare example of a university encouraging its faculty members to engage in start-ups facilitating the ownership issue. It is commonly adopted that the outcomes of final-year projects are the property of the university. However, this is not enforced in practice.

In average, the innovation ownership is maintained ambiguous. It is of importance to determine an innovation ownership model(s) and to make it (them) public and explicitly known for all actors in the innovation process. Transparency favours the climate of trust needed for innovation and development.

B. IP FACTORS

On the number of patents produced in the past five years, the answers varied from none to more than twenty. This number reaches 15,17 and 20 patents for two faculty of sciences and doctoral school. About the motivation of researchers to commercialize the outcomes of their research activities, several suggestions are formulated. Mainly, it is suggested to providing them with a significant share of the commercial rights. As for the IP rights there is no clear process or procedures declared in the answers. Regarding the number of research turned into start-up during the last five years, the answers varied between none, 1, 2, 3, 4 and 20%. The reasons for that are provided in Figure 24.

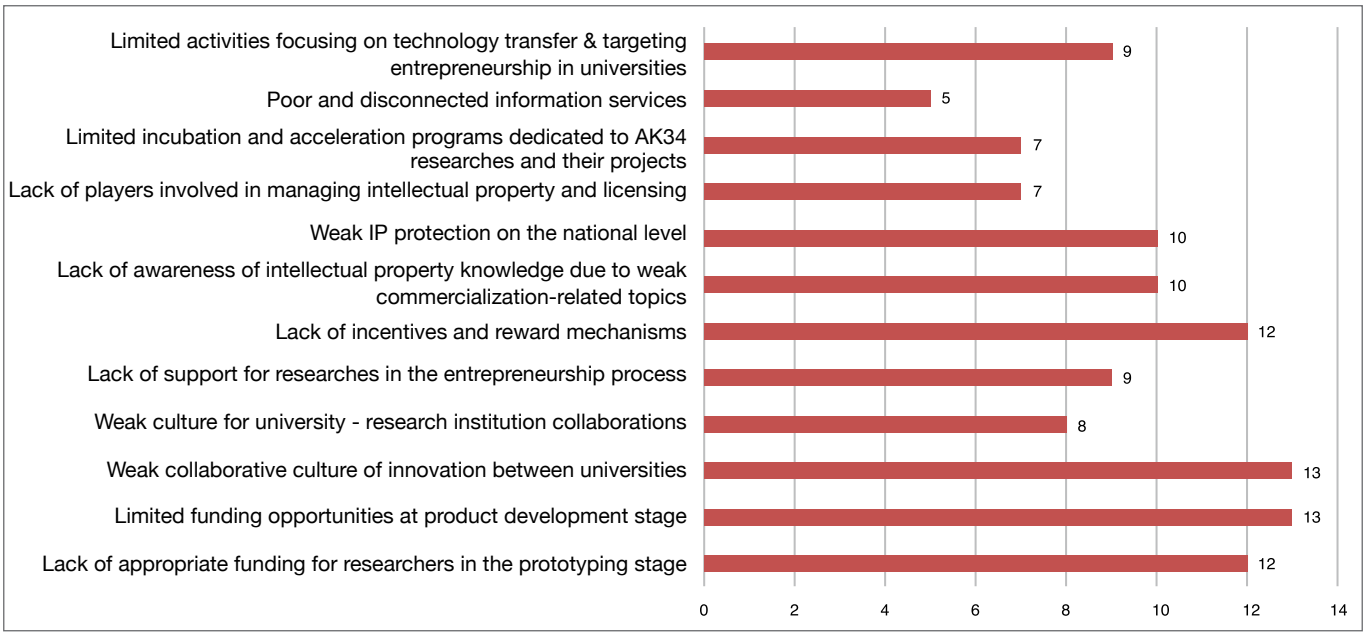


Figure 24. *Reasons for weak and limited IP and technology transfer process in the university*

Some suggestions to motivate researchers and faculty members to commercialize their research are listed as follows: i/ Faculty members involved in these projects are either compensated or they are encouraged to be part of the start-ups, ii/ Publish of IP policy, iii/ promotion will be granted on a case by case basis, iv/ they get percentage of the incentives or may totally own the product, v/ participating in different national and international competitions and exhibitions , vi/ by funding the process of commercialization, vii/ all incentives are granted on a case by case basis, viii/ the percentage share of the researcher should be as high as 70%, ix/ through incentives and revenues from the project.

Four respondents indicated that they do have an IP policy established. It aims at the protection of all IP categories.

It is worth to note that Lebanon ranking in Intellectual Property protection is very low 120/137 according to the WEF Global Competitiveness Report 2018. Developing policy-driven activities on the university level should involve the establishment of strong IP policies along with stable and connected technology transfer processes. The role of the government in this context is to provide an adequate legal framework and a conducive business environment in addition to the basic physical infrastructure like the internet, communications, and electricity.

C. EXISTING LEGAL MODELS

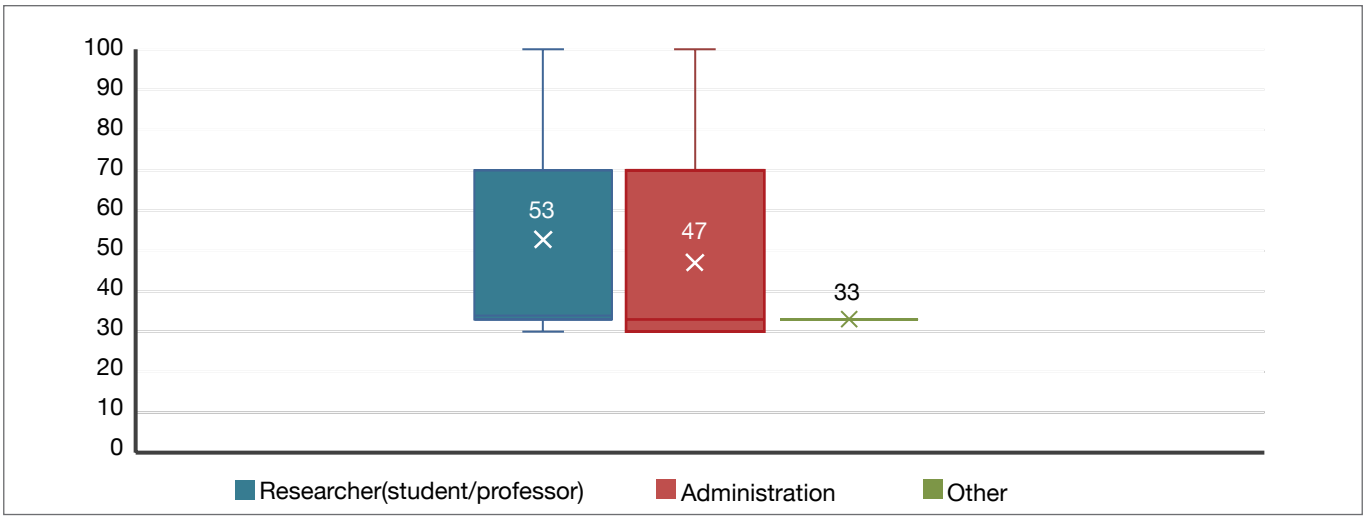


Figure 25. *Policy of ownership sharing in IP (%)*

Only 8 faculties answered to this question revealing the adoption of different IP policies among universities. Most of them adopt the following policy: share of one third (33%) for students and faculty members, one third for the administration and the rest for the industrialist or investor. The last share is fixed to 33% for all the respondents. For some respondents the IP royalties is fixed case by case. If it is on a case-by-case basis, some replies describe the factors that affect the determination of the intellectual property: Originality of the idea, owner of the project, lab equipment needs, funders,….

The different components covered by the IP policy are: Protection of all IP categories, IP ownership and rights of Use, Royalty Distribution, Governance of IP Policy and Role of TTO (Technology Transfer Office), Patents, Copyrights, Trademarks, and Trade Secrets. All outputs of creative endeavour in any field at the Institution for which legal rights may be obtained or enforced pursuant to the law. IP may include: a) literary works, including publications in respect of Research results, and associated materials, including drafts, data sets and laboratory notebooks; b) teaching and learning materials; c) other original literary, dramatic, musical or artistic works, sound recordings, films, broadcasts, and typographical arrangements, multimedia works, photographs, drawings, and other works created with the aid of Institution resources or facilities; d) databases, tables or compilations, computer software, preparatory design material for a computer program, firmware, courseware, and related material; e) patentable and non-patentable technical information ; f) designs including layout designs (topographies) of integrated circuits; g) plant varieties and related information; h) trade secrets; i) know-how, information and data associated with the above; and j) any other Institution-commissioned works not included above.

D. PATENTS MANAGEMENT PROCESS (STEPS FOR IP PROTECTION)

Six respondents declared that they have an IP policy, five others stated that it is in progress and the remaining don't have any policy yet. In more than 60% of the cases, patent submission is done by the lead supervisor, rarely by the TTO or lead student. Most of these IPs are registered locally. For most of them, the IP policy is shared with enrolled students online and published on the webpage of the university.

Table 17 The table below shows the existence of a settled IP policy and submission responsible within the partner universities.

Name of the University (Academic Institution)	Existence of Settled IP Policy?	Responsible for the process of patent submission in the institution
American University of Science and Technology (AUST)	In process	Lead supervisor
Lebanese International University /BIU (LIU)	In process	other
Lebanese University (UL Doctoral School)	In process	Lead supervisor
Holy Spirit University of Kaslik (USEK)	Yes	-
Notre Dame University (NDU)	In process	Lead student Lead supervisor
Rafik Hariri University (RHU)	No	-
ISAE CNAM Liban (CNAM)	No	-
Beirut Arab University (BAU)	No	Lead supervisor
Lebanese University (UL - FOE)	No	Lead supervisor
Islamic University of Lebanon (IUL)	No	Lead supervisor
University of Balamand (UOB)	Yes	Lead supervisor
American University of Beirut (AUB)	Yes	TTO
Lebanese American University (LAU)	Yes	TTO Lead student Lead supervisor
Saint Joseph University (USJ)	Yes	-
Lebanese University (UL - FS)	Yes	Lead supervisor
Lebanese University (UL - FOA)	Yes	Lead supervisor

> Very few IP models exist. This does not encourage the engagement in innovative projects and harms the climate of trust
> - It is of high importance to adopt a clear, transparent and fair model for IP rights

> In the time of crisis, encouraging the researchers to engage in innovation, consultancies, and start-ups limits the pressure and is beneficial to all parties

V. INNOVATION LED INSTITUTIONS

ROLE OF INNOVATION-LED INSTITUTIONS

ROLE/PROFILE OF INNOVATION-LED INSTITUTIONS

Regarding the role of innovation-led institutions in supporting students and academic activities, the answers were divided between:

- Connecting the students to entrepreneurs and labor market
- Technology transfer
- Building a culture of innovation
- Organizing accelerators
- Supporting financially the projects

SCOPE AND PROGRAMS

As per the activities of an innovation-led institutions the answers are reported in Figure 26=. As for the possible roles of the innovation mentors, angel investors and trainers, they are reported as to be:

- Offering funds/awards and consultancy
- Sharing expertise
- Promoting innovation culture and intellectual property
- Funding and mentoring start-ups
- Organizing workshops and seminars

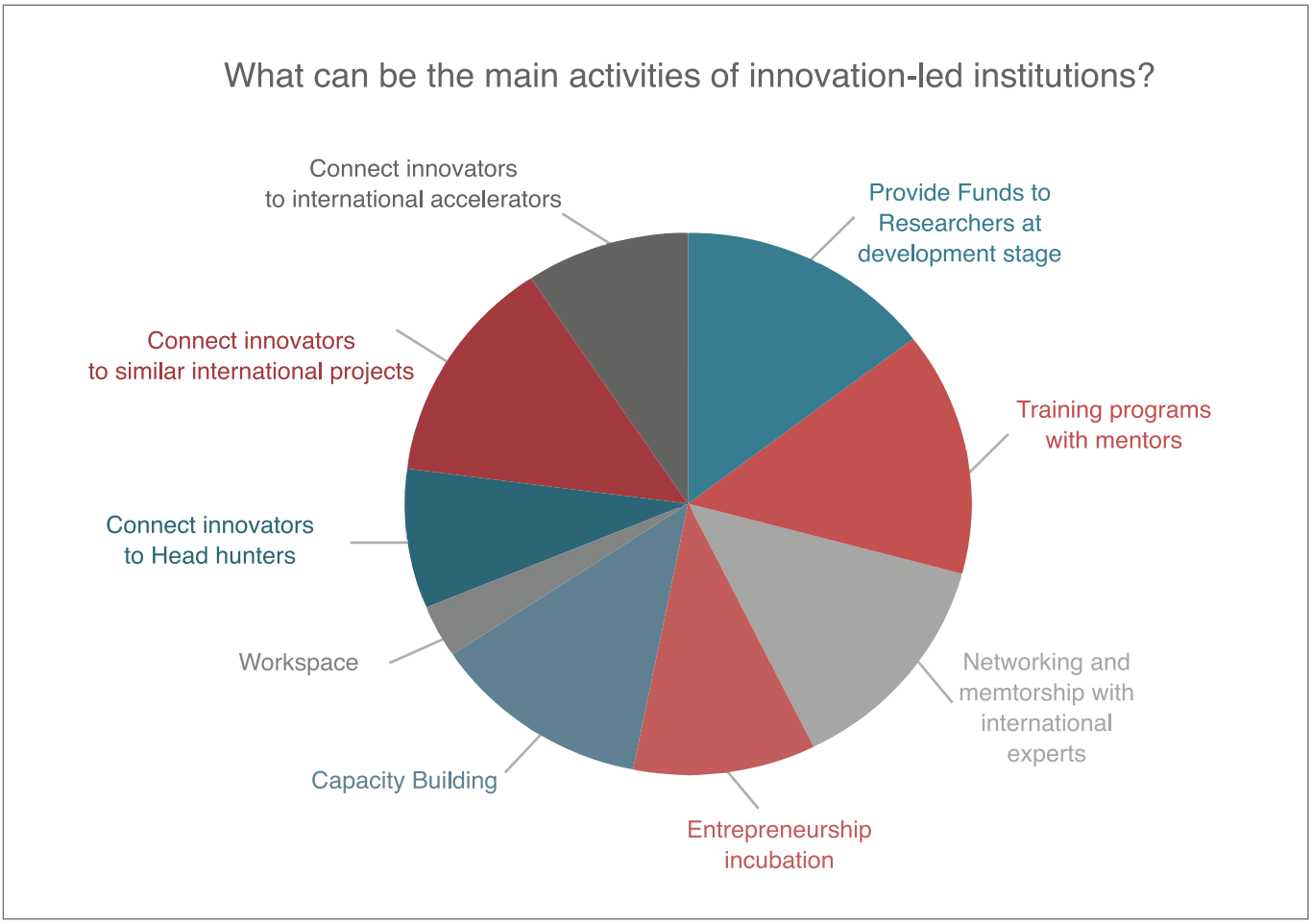


Figure 26. *The most mentionend activities of an innovation-led institution.*

Table 18 The table below list the organization collaborating with the Lebanese universities to foster innovation and link it to the industrial market:

Name of the University (Academic Institution)	Does the university own an incubator/ accelerator?	Do you cooperate with an innovation Led institution that support students in developing innovation and link it to the industrial market?	collaboration with innovation led institution (Incubators, accelerators): name of organizations
American University of Beirut (AUB)	Yes	Yes	
Lebanese American University (LAU)	Yes	Yes	Nucleus Ventures
Holy Spirit University of Kaslik (USEK)	Yes	Yes	
Saint Joseph University (USJ)	Yes		
American University of Science and Technology (AUST)	No	Yes	Berytech, IAAF, USAID
Lebanese Universit (UL Doctoral School)	No	Yes	
Beirut Arab University (BAU)	No	Yes	
Lebanese University (UL - FOE)	No	Yes	Berytech
Lebanese University (UL - FOA)	No	Yes	Berytech
Lebanese University (UL - FS)	No	Yes	Berytech
Rafik Hariri University (RHU)	No	No	
ISAE CNAM Liban (CNAM)	No	No	
Lebanese International University /BIU (LIU)	No	No	
Islamic University of Lebanon (IUL)	No	No	
University of Balamand (UOB)	No		
Notre Dame University (NDU)	No		

Only 6 faculties that do not own an incubator declared that they have collaboration with an innovation Led institution (Incubators, accelerators) that support students in developing innovation and link it to the industrial market. It is shown in the table above. The remaining respondents don't have an incubator and do not cooperate with an outside innovation led institution.

The main innovation led institution mentioned is Berytech. Students and Entrepreneurs have access to a Fabrication Lab (Fab Lab) managed by Berytech, an incubator and accelerator in Beirut. The Fab Lab, an open-access digital fabrication lab enables to create, prototype, and turn concepts into reality. The Fab Lab tools include 3D Printers, Laser Cutters, Vinyl Cutters, CNC Routers, Electronics Workbench, ….

> Access to incubation and acceleration is limited
  - There is a need to investigate the reasons behind the limited interest in incubation/ acceleration
> It is important to raise awareness about the need for incubation and acceleration in order to develop the innovation ecosystem highly needed to cope with the present crisis

B. THE STRUCTURE OF INDUSTRIAL INNOVATION

I. THE CATEGORIZATION OF INDUSTRIALISTS

A. SCALE OF LEBANESE INDUSTRIES

Over the two last years, Lebanon classified as a middle-income country with a small-sized economy, suffered a major economic depression, the most severe crisis episodes globally since the mid-19th century' (World Bank Data, 2021). The country's Gross Domestic Product has dropped by over 60% in 3 years from 55 billion USD in 2018 to an estimated US$21.8 billion in 2021, while real GDP per capita fell by 37.1% (Source: World Bank Data, 2021). The crisis in Lebanon has been exacerbated by a service-oriented economy, political struggles, and a deep enrooted corruption. Additional factors occurring lately aggravated the crisis. Besides Covid-19 and the 2020 Beirut port blast, the war in Ukraine is expected to negatively impact the country, importing around 90% of its wheat from Ukraine and Russia, while 85% of its food consumption is imported. As a consequence, the poverty rate rose up to 82% (UN-ESCWA, 2021), primarily impacting young people, with a high number of graduates leaving the country for a job abroad or to study.

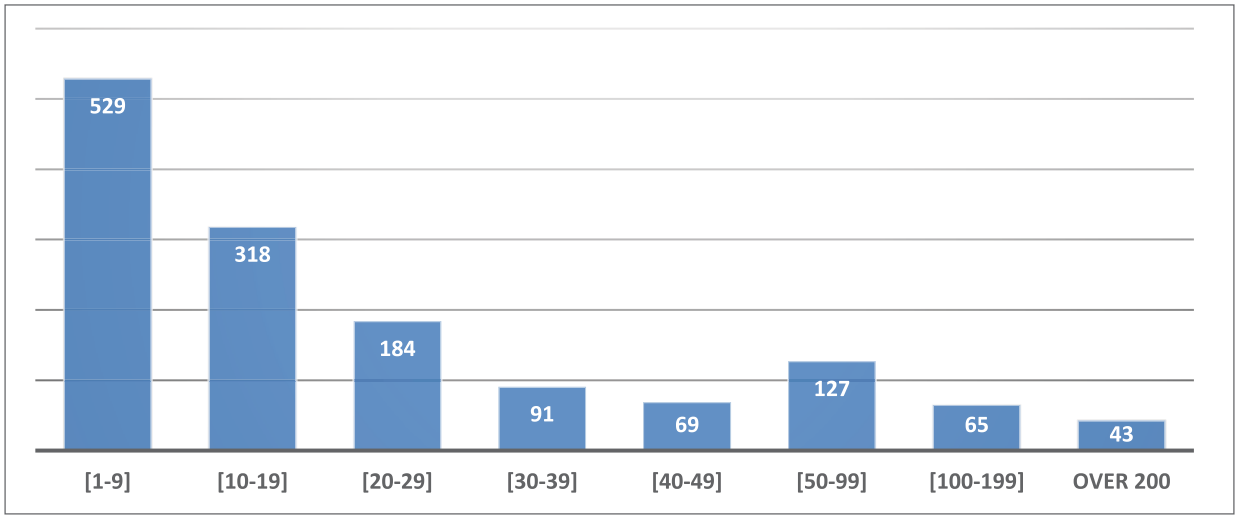
This unprecedented crisis has pushed Lebanon to become today the worse country in several financial rankings and outlooks done by international risk assessment organizations with sometimes no future perspectives. In many international reports, this has been largely attributed to corruption, political struggle, and an economy highly dependent on services.

The industrial sector, even contributing to only 6.86% of the GDP, is crucial for the expansion of the Lebanese economy. This sector has been a stabilizing factor during the current economic crisis through its contribution to the national GDP but also to the transfer of hard currency through the export of industrial products. The sector already employs a large portion of the population and there is currently a growing need for employment and to substitute imports with local production.

In the framework of its efforts to improve its policies for the Lebanese industrial sector, the Ministry of Industry (MoI) launched sustainable surveys and reports on the performance of the establishments registered at MOI working on the renewal of their industrial certificates. The output of the latest surveys collecting figures for years 2018 and 2019 revealed the below information.

The industrial sector is not very diversified. Over 86% of the industrial establishments belong to 11 major industrial sectors: i/ Food products and beverages, ii/ Non-metallic mineral products, iii/ Fabricated metal products, iv/ Electrical machinery, v/ Chemicals, vi/ Furniture, vii/ Paper products, viii/ Rubber and plastic products, ix/ Printed matter and recorded media, x/clothes and xi/ Machinery and equipment. These sectors generate 97% of total value added, employ 95% of total industrial workforce and spend 97% on industrial investments (MOI survey figures for 2018 & 2019).

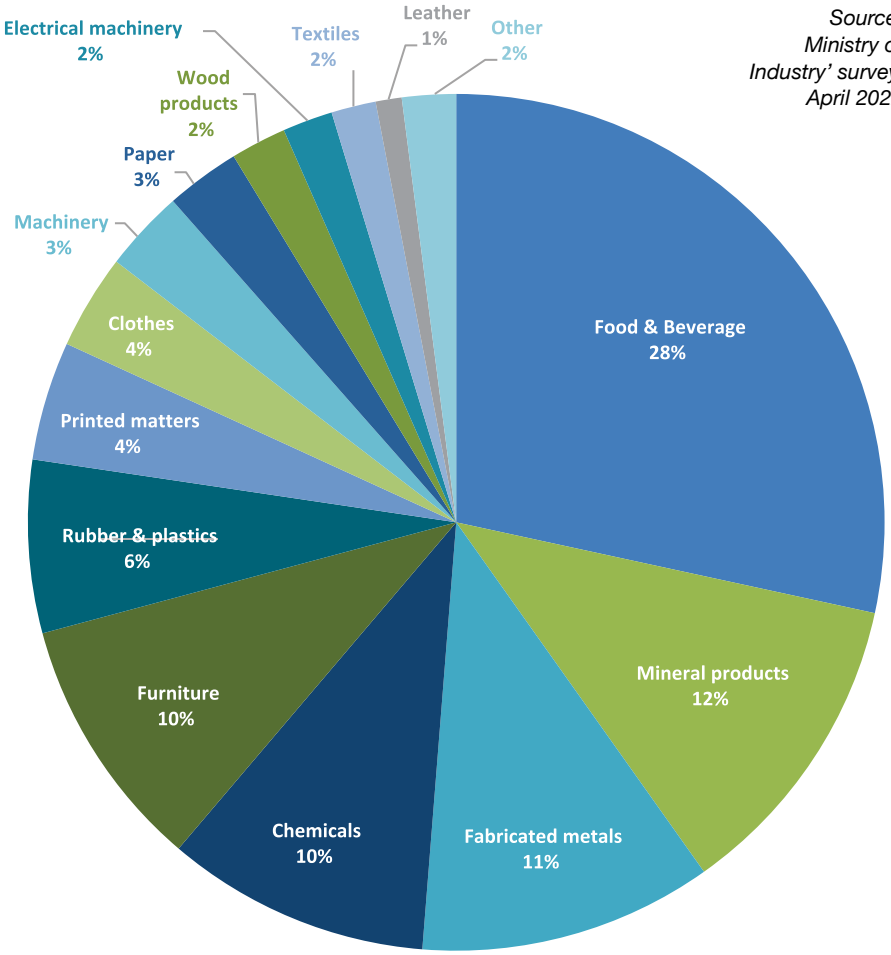
Figure 27. *Distribution of industries by workforce size*



Source: Ministry of Industry, April 2022

According to the Ministry of Industry figures, 34% of the industries surveyed hire between 11 to 34 employees and those hiring above 100 employees represent only 7% of the total. The profile of the industries in Lebanon is characterised by small and medium enterprises (SMEs). The ecosystem lacks large industries which could have better driven the development of an innovation ecosystem. SMEs have limited resources and can afford only limited investment in R&D. In addition, the Lebanese market is small and competitive. This reduces further the opportunities that SMEs can use to invest in innovation.

35% of total workforce is employed by the Food and beverage sector whose share is 28% of total industries. The workforce share drops to 9% for chemicals, mineral products and fabricated metals each.



Source: Ministry of Industry' survey, April 2022

Figure 28. *Industrial establishments by sector*

B. TYPE OF INDUSTRIES

The food and beverage industry is the largest contributor to the industrial output of the factories, with 38% of total output, followed by the industry of fabricated metal products with 11%, then chemical products (10%) and Mineral products (9%).

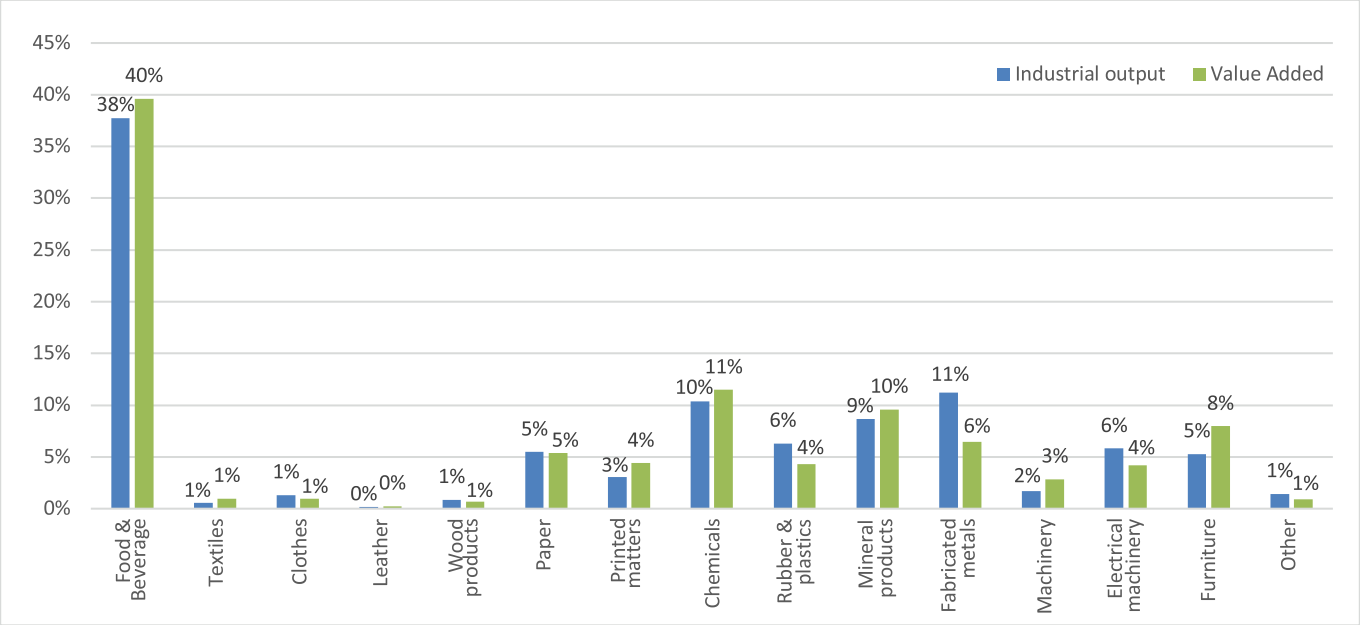
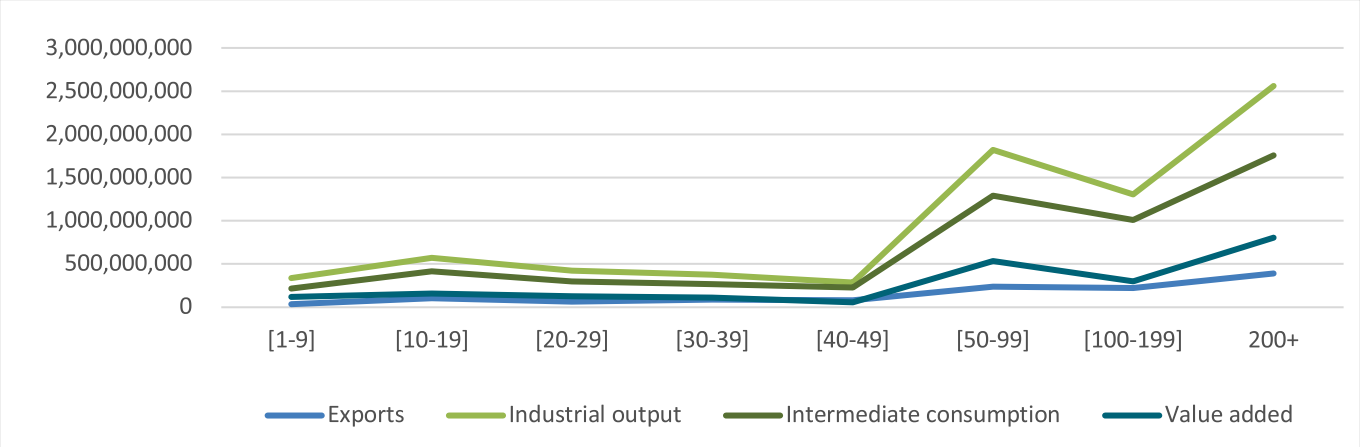


Figure 29. *Output and value added by economic activity (in %)*

C. SIZE OF BUSINESS

The value of industrial exports rises exponentially with the size of the enterprise in terms of the number of workers showing a close relationship between industrial exports and value added. The graph below shows the change in the value added and industrial exports according to the size of the factories in terms of the number of workers.

Figure 30. *Industrial exports, Output, Input and Value added by Industry size (in USD)*



Source: Ministry of Industry, April 2022

The value of industrial exports reaches its highest levels for food and beverages that hires 37% of the workforce followed by non-metallic minerals. The bigger the industry is, the higher is the value of exports and value added.

> Most industrialists in Lebanon can be considered small with few relatively medium enterprises
> - The absence of big enterprises constrains and reduces the resources and opportunities to develop an innovation ecosystem

> No significant high technological subsectors identified. Food and beverage industry is about forty percent of the industrial sector
> - This limits further the need for advanced Research and Development

> The previous elements explain the weakness observed in the links between the industry and academia
> - Novel solutions are to be found in order to foster this cooperation

II. THE STRUCTURES OF R&D IN DIFFERENT INDUSTRIES

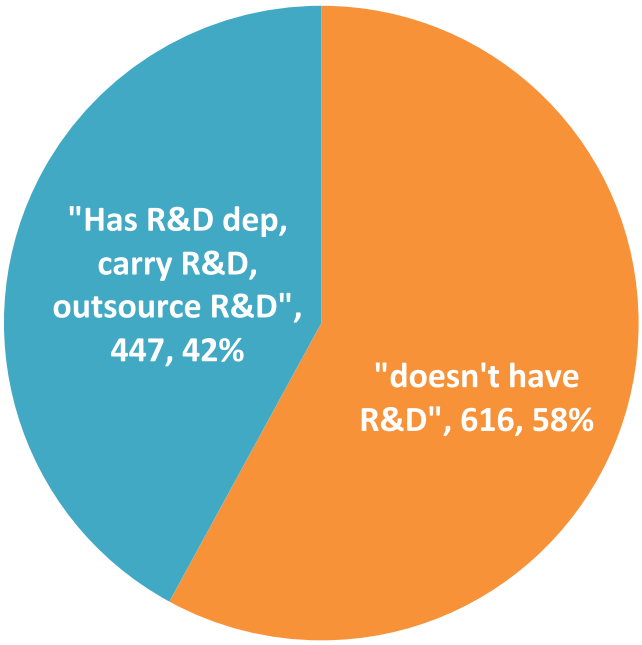
A. OPERATIONAL RESEARCH AND DEVELOPMENT DEPARTMENTS IN INDUSTRIES

Because of the predominance of the industrial sector in R&D, the industrial R&D expenditure data are closely watched as an indicator for the development of innovation at the enterprise.

Until present, there is no data available on R&D expenditures by Lebanese industries. The current mapping, funded by Konrad, reveals figures for the first time on R&D indicators leading the way to more sectorial studies and adequate policies aiming to foster the industrial innovation ecosystem.

The survey on industries spending on R&D conducted by IRALEB team on February 2022 and funded by Konrad Adenauer Stiftung, based on the Ministry of Industry and the Association of Lebanese Industrialists databases, shows the following:
Around 42% (447 establishments) of all surveyed enterprises hiring above 20 employees reported that they had a unit or department dedicated to Research and Development (R&D) activities and/or declare their expenses under “R&D expenditures”.
The current study limited the scope of work to industrial establishments that have R&D department, develop research activities or spend on R&D. Statistics on Industries that are willing to cooperate with industries have also been drawn. We note here that the selection of industries even though was evenly distributed among sectors and mohafaza was limited to industries who were supposed to be hiring above 20 employees (as per our previous databases).
Adherence to the Association of Lebanese Industrialists (ALI) was used as a second criteria to choose the sample.
Despite all hindering difficulties, the industries participating in the survey covers all industrial sectors in various regions from different sizes with 1063 industries. A little interest was given to the furniture sector that doesn’t reply on innovation to expand.

Figure 31. *R&D status*



The graphics below shows the distribution of R&D status for surveyed industries according to the establishment size. According to the survey, out of 1063 establishments, 447 industries have R&D department, carries R&D, or outsource R&D.

Table 19 Distribution of R&D status for surveyed industries according to the establishment size

Workforce' class	Industries that does not carry R&D	Industries that Carry R&D	Total	Industries Carrying R&D (in %)
1—49	376	260	636	41%
50—99	98	93	191	49%
100—199	44	47	91	52%
over 200	18	47	65	72%
ND	80		80	0%
Grand Total	616	447	1063	42%

It is well know that R&D activities are very correlated to the size of the industry: 72% of industries hiring over 200 employees carries R&D followed by 52% for industries hiring between 100 and 199, 49% for those hiring between 50 to 99, and 41% for those hiring less than 50 employees.

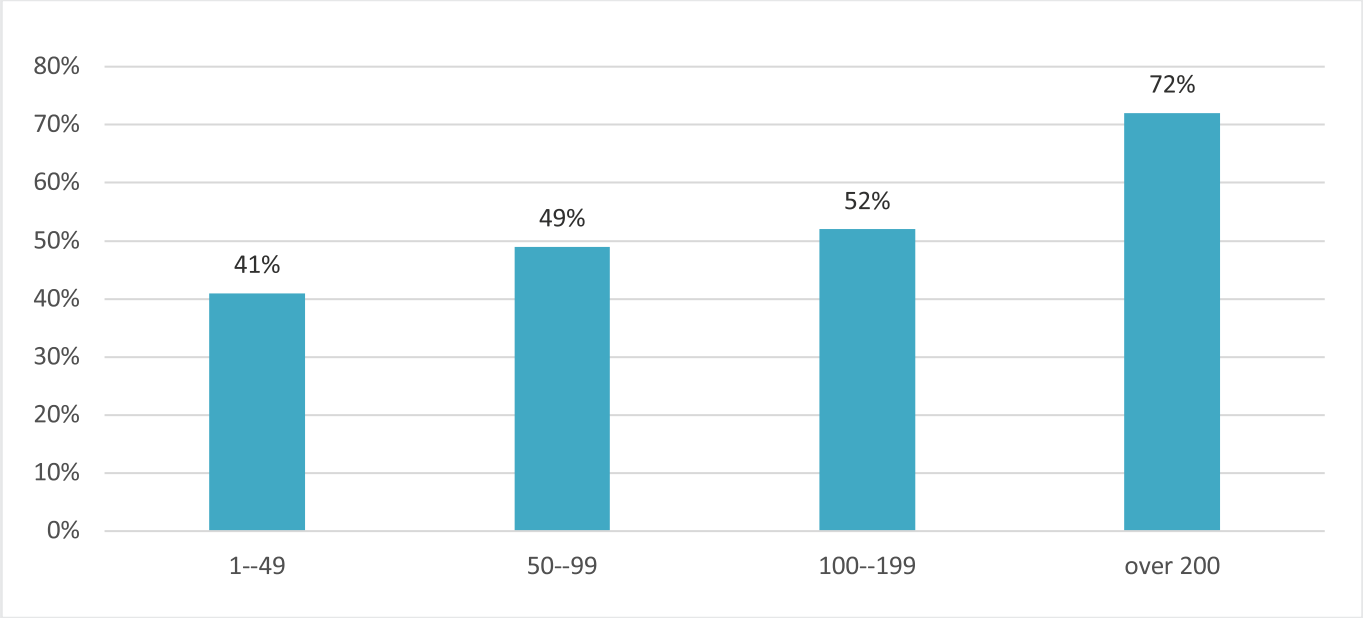


Figure 32. *Share of industries carrying R&D by size*

The distribution of R&D departments by classes reveals the existence of around 80 well operationnal R&D departments in industries hiring between 20-29 employees and 50 – 99 and 59 departments for classes between 30-39 employees.

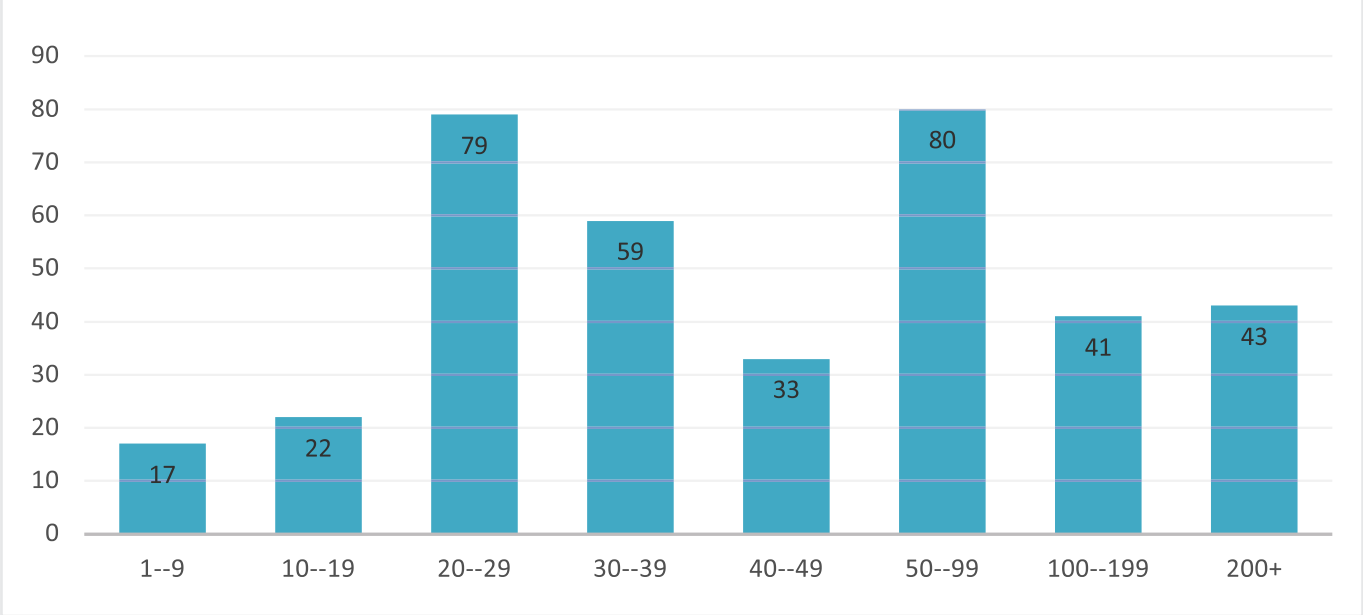
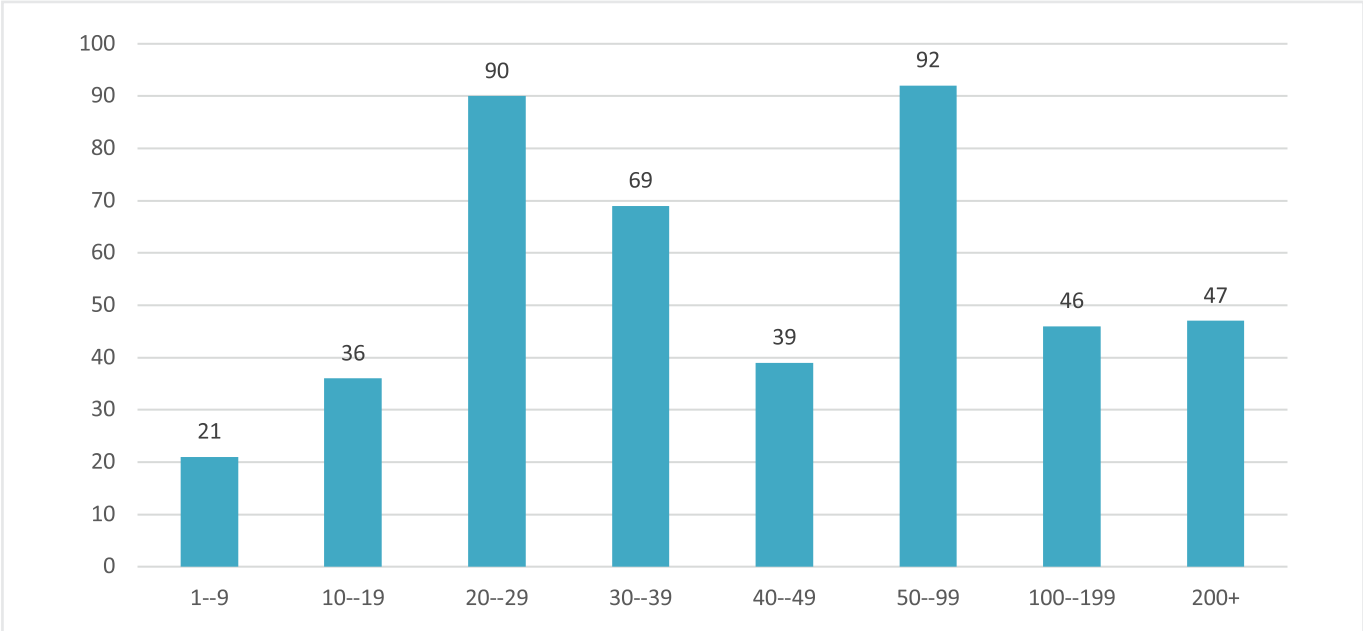


Figure 33. *Industries that have R&D department by size (374 ind.)*

Somehow, 32% of the enterprises surveyed who don't have a department dedicated to R&D activities works on improving the quality of their products and processes of production through outsourcing with outside experts or companies or by carrying R&D.

Some of the firms that do not have R&D departments work on enforcing innovation in the firm through dedicating a small number of employees to R&D activities.

Figure 34. *Distribution of Industries that have carried R&D for the last five years by size (424 ind.)*



Agri-food is at the forefront of establishments interested in R&D. 37% of the surveyed industries that declared they carry R&D activities are in this sector, 12 % are in the chemical sector, 6% in the mineral products and 10% in fabricated metals.

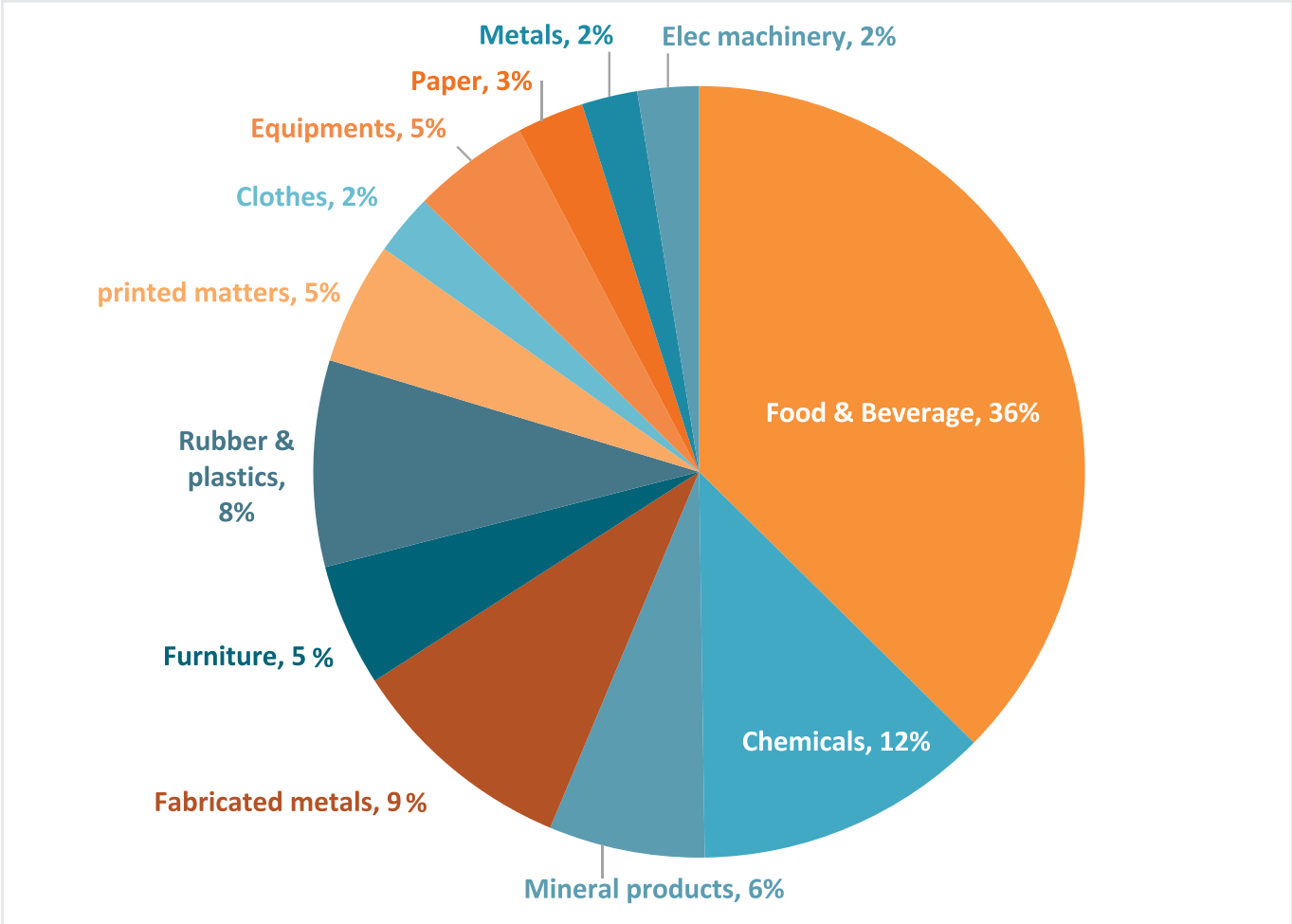
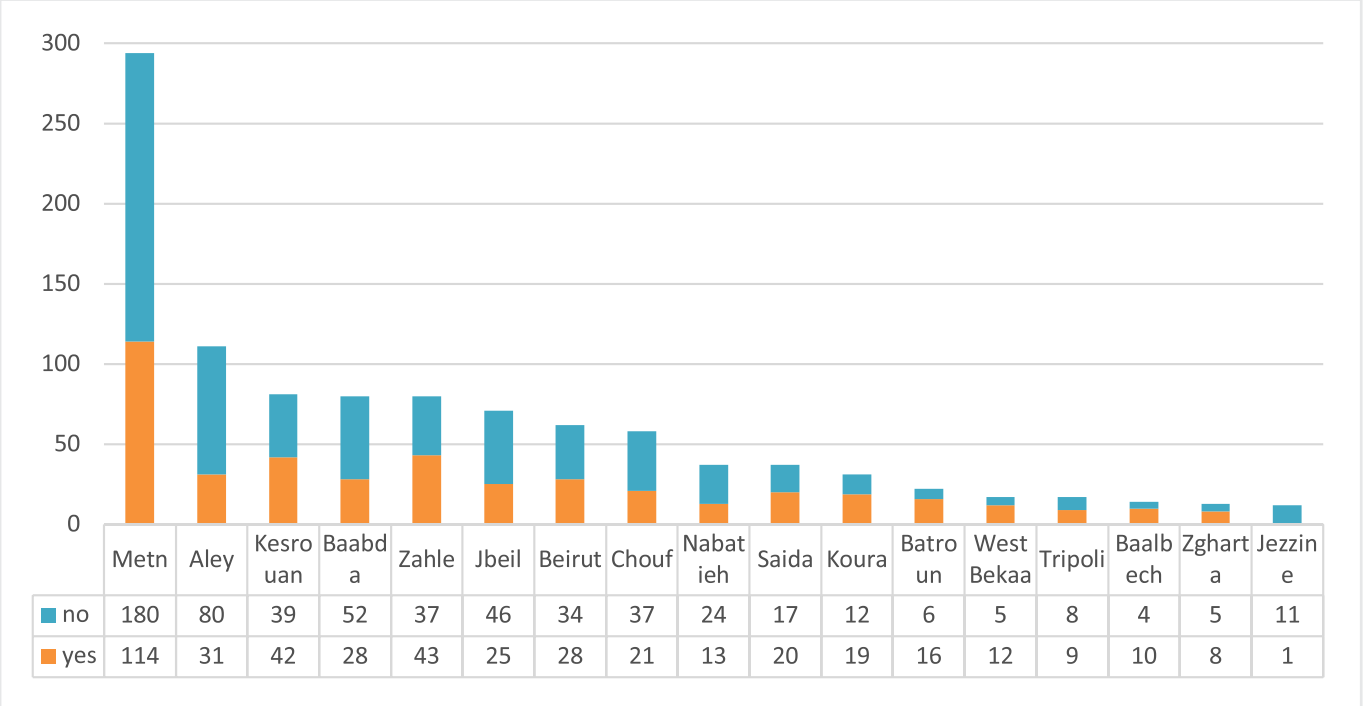


Figure 35. *Industries involved in R&d by Economic Activity (447 ind)*

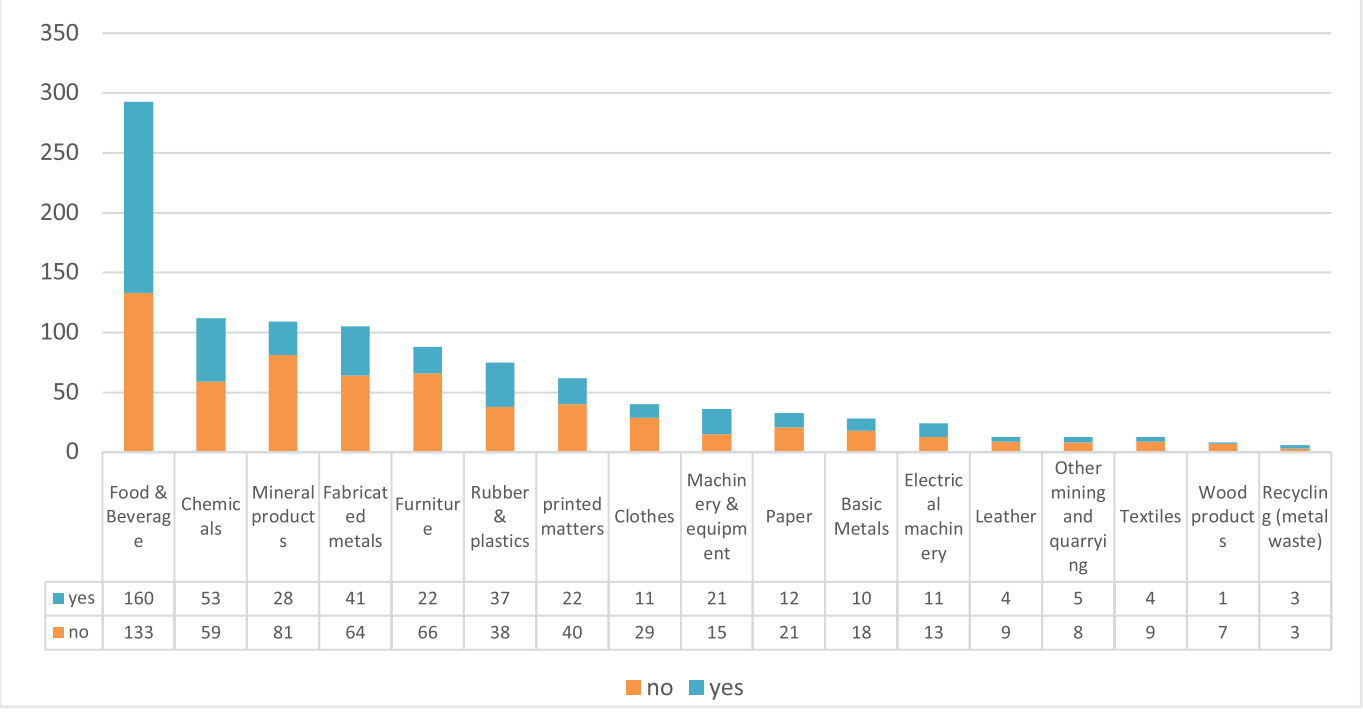
The distribution of surveyed industries by caza shows that the share of industries who has R&D departments or carry R&D is estimated at 39% in Metn. This share reaches its highest levels in Baalbeck and west Bekaa (71% each), Zgharta (62%), Koura (61%) and Batroun (73%) dropping to 28% in Aley, 35% in Jbeil and 52% in kesrouan and Saida.



	Metn	Aley	Kesrouan	Baabda	Zahle	Jbeil	Beirut	Chouf	Nabatieh	Saida	Koura	Batroun	West Bekaa	Tripoli	Baalbech	Zgharta	Jezzine
no	180	80	39	52	37	46	34	37	24	17	12	6	5	8	4	5	11
yes	114	31	42	28	43	25	28	21	13	20	19	16	12	9	10	8	1

Figure 36. *R&D Status for surveyed industries by caza*

The food and beverage, rubber and plastics, recycling and chemicals electric machinery are the most important sectors carrying R&D or having R&D departments with around 50% of total surveyed industries in every sector. Furniture, Leather, wood products and textiles are the sectors that carries the lowest R&D with less than 31% of the industries in the sector.



	Food & Beverage	Chemicals	Mineral products	Fabricated metals	Furniture	Rubber & plastics	printed matters	Clothes	Machinery & equipment	Paper	Basic Metals	Electrical machinery	Leather	Other mining and quarrying	Textiles	Wood products	Recycling (metal waste)
yes	160	53	28	41	22	37	22	11	21	12	10	11	4	5	4	1	3
no	133	59	81	64	66	38	40	29	15	21	18	13	9	8	9	7	3

Figure 37. *R&D Status by Economic Activity*

If we consider all the 1063 industries surveyed, the share of industries involved in R&D for each type of industry reach its highest levels in Machinery and equipments (58%), food and beverage (55%), recycling (50%), purification of water (50%), medical instruments (50%), rubber and plastics (50%),

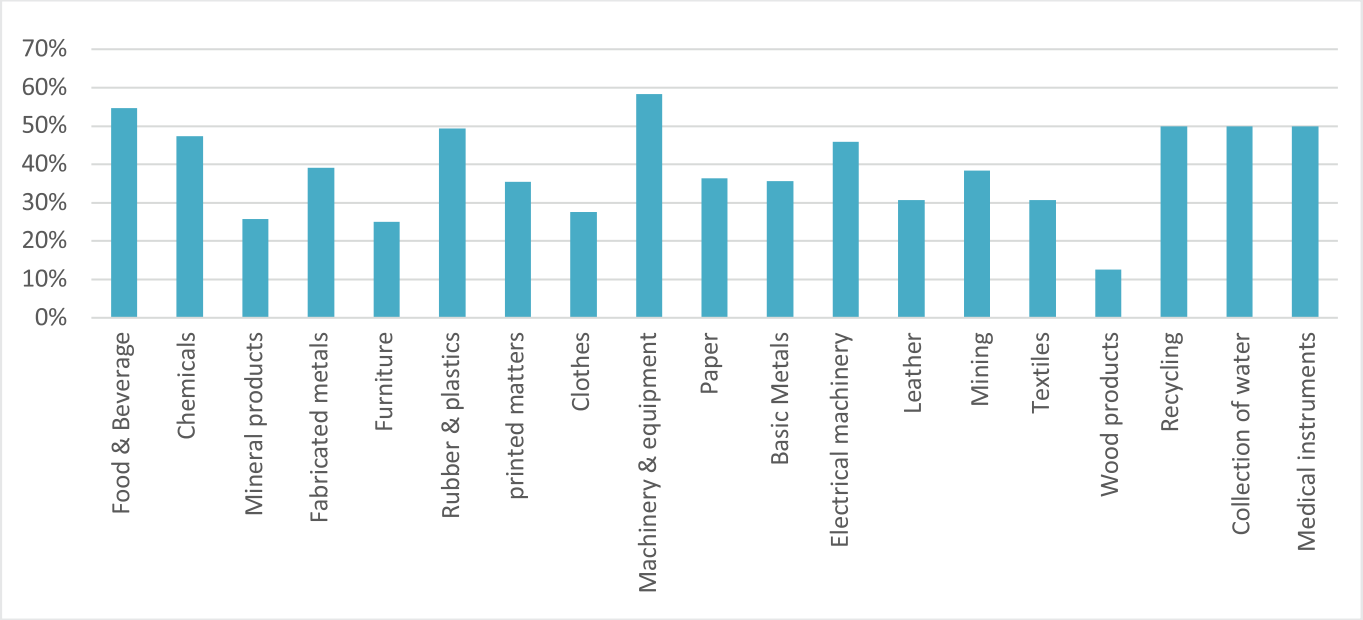


Figure 38. *Percentage of industries involved in R&D per type of industry*

B. OUTSOURCED RESEARCH AND DEVELOPMENT ACTIVITIES

221 industries stated that they are outsourcing R&D with 80 industries in the food and beverage sector with a share of 36% against only 26 industries in chemicals (12% of total) and 20 (9%) in fabricated metals. This share reaches its lowest levels for textiles, papers, wood, clothes and furniture (below 5%). This is due to the high number of surveyed industries in the food and beverage sectors involved in R&D.

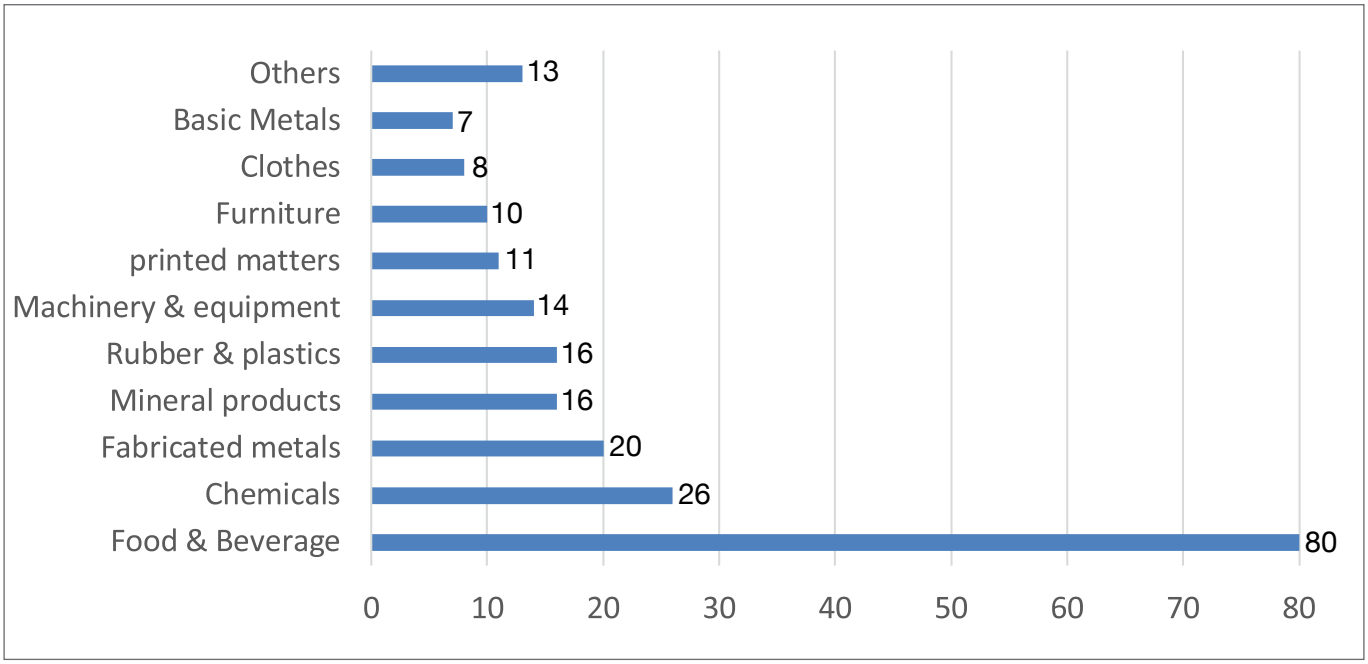


Figure 39. *Distribution of industries outsourcing R&D (221) by economic activity*

45 industries hiring from 50 to 99 employees declared outsourcing R&D activities with a share of 20% of total followed by industries employing 20 to 29 employees with a share of 16% and around 13% for those having between 100 and 199 employees and hiring above 200 employees.

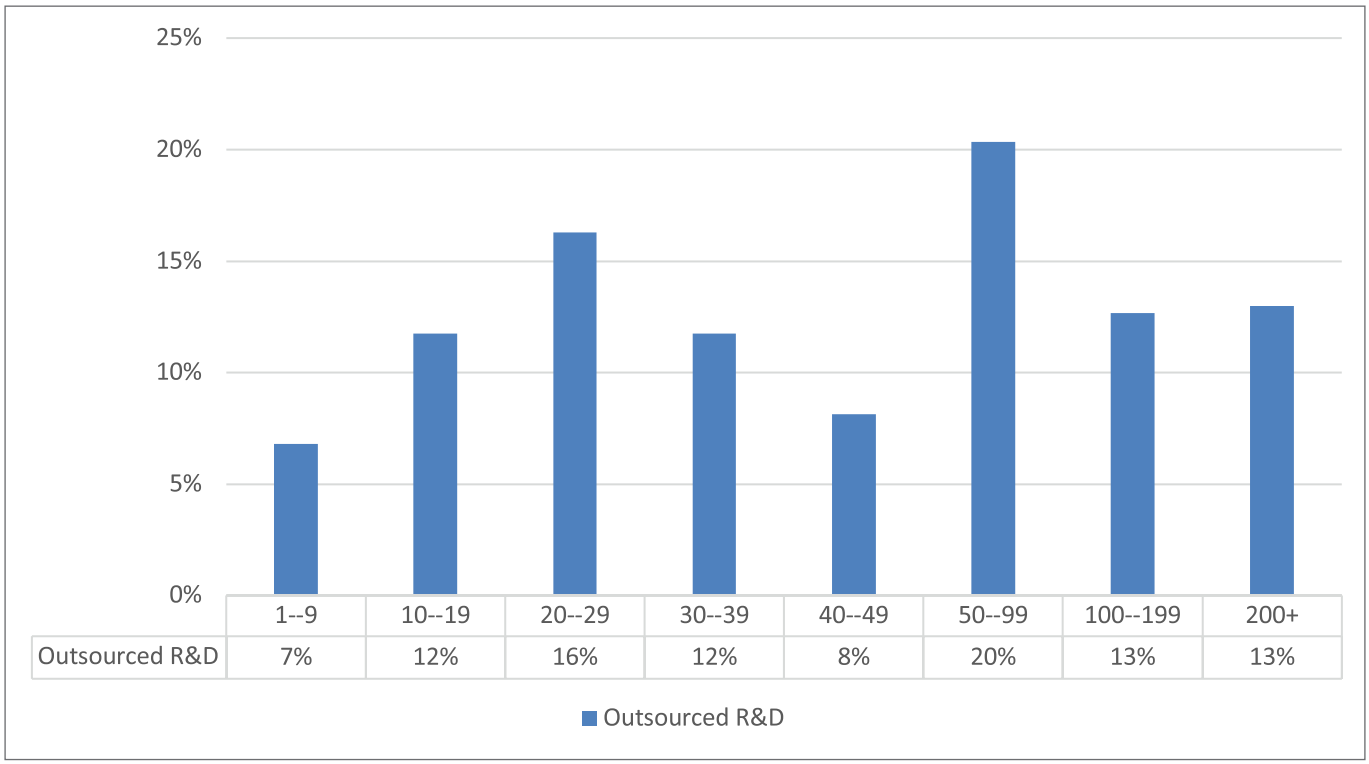


Figure 40. *Share of outsourced R&D by industry size*

C. RESEARCH AND DEVELOPMENT EXPENDITURES IN INDUSTRIES

- Spending on R&D carried out by Lebanese industries is still very low as compared to total expenditures: less than 1.1% of total expenditures on average for surveyed industries. This indicator is extremely low since the innovation capacity of the industries is contingent on their internal capacity to generate new ideas. The share of R&D is higher than 2% of total expenses for only 85 industries with an average of 3.9% reaching a maximum share of 24% for few industries.
- The average expenditures on R&D for surveyed industries are very low, estimated at 0.8% of industrial output.
- The amounts spent on R&D in Lebanon remains extremely low compared to other countries. R&D national expenses do not exceed 0.2% of GDP.

GEOGRAPHIC DISTRIBUTION OF R&D EXPENDITURES

Based on the survey, industries working in the same caza spend on average 4,700,000 $ on activities related to R&D distributed between 2,500,000 $ for in house R&D and 2,700,000 $ for outsourced R&D.

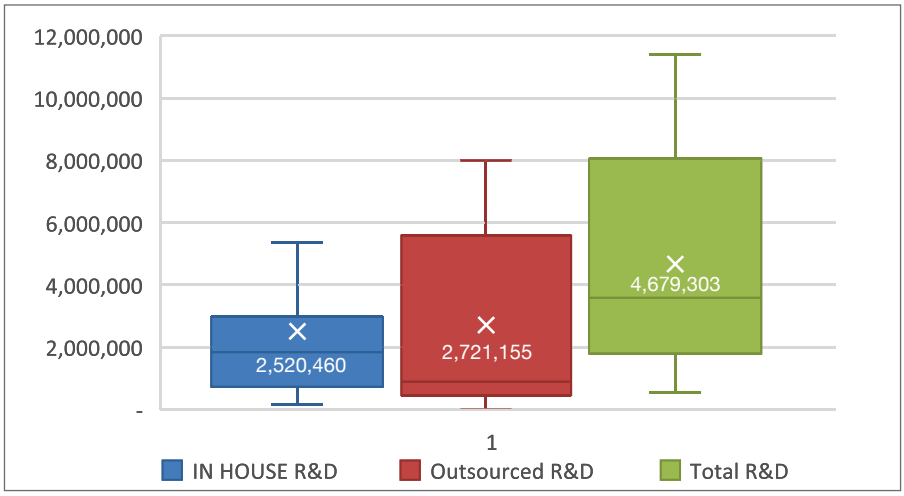


Figure 41. *Average R&D expenditures by area (in $)*

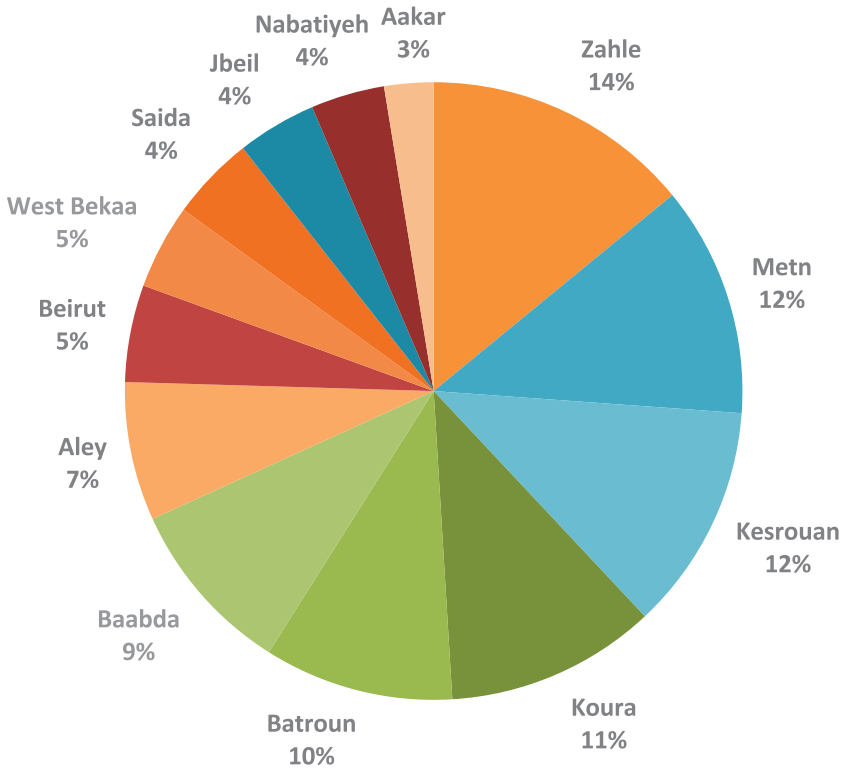
R&D expenditures by geographic areas shows that spending on R&D reaches its highest in Zahle, kesrouan and Metn (around 13%) where the highest number of industries are located, followed by Koura, Batroun and Baabda (24%).

Table 20 Distribution of R&D expenditure by Caza

Caza	Nb of Industries	IN HOUSE R&D ($)	Outsourced R&D ($)	Total R&D ($)	R&D by industry ($)
Rachaya	4	535,000	10,000	545,000	136,250
Jezzine	1		671,940	671,940	671,940
Baalbeck	10	705,777	432,500	1,138,277	113,828
Chouf	21	1,220,904	370,000	1,590,904	75,757
Tripoli	9	1,805,000		1,805,000	200,556
Zgharta	8	1,985,000		1,985,000	248,125
Aakar	3	2,090,000		2,090,000	696,667
Nabatiyeh	13	150,000	2,985,000	3,135,000	241,154
Jbeil	25	2,828,500	548,000	3,376,500	135,060
Saida	20	2,699,000	891,581	3,590,581	179,529
West Bekaa	12	425,013	3,170,834	3,595,848	299,654
Beirut	28	748,302	3,377,960	4,126,262	147,366
Aley	31	5,375,536	517,500	5,893,036	190,098
Baabda	28	7,502,432	3,000	7,505,432	268,051
Batroun	16	1,719,000	6,336,580	8,055,580	503,474
Koura	19	1,359,000	7,588,358	8,947,358	470,914
Kesrouan	42	1,888,370	7,746,000	9,634,370	229,390
Metn	114	8,903,473	903,201	9,806,675	86,023
Zahle	43	3,427,964	7,986,026	11,413,989	265,442
Total	447	45,368,273	43,538,480	88,906,753	198,897

The share of R&D expenditures in the caza of Zahle Metn, Kesrouan, Koura and Batroun exceeded 50% of total expenditures for the year 2019.

Figure 42. *R&D expenditures by area 2019*



Source: IRALEB survey February 2022.
www.iraleb.org.lb

Jezzine, Aakkar, Batroun and Koura have the highest average expenditures by industry with over 500,000 $ followed by Zahle, Baabda and west Bekaa. The following figure provides a geographic distribution of R&D expenditures per industry.

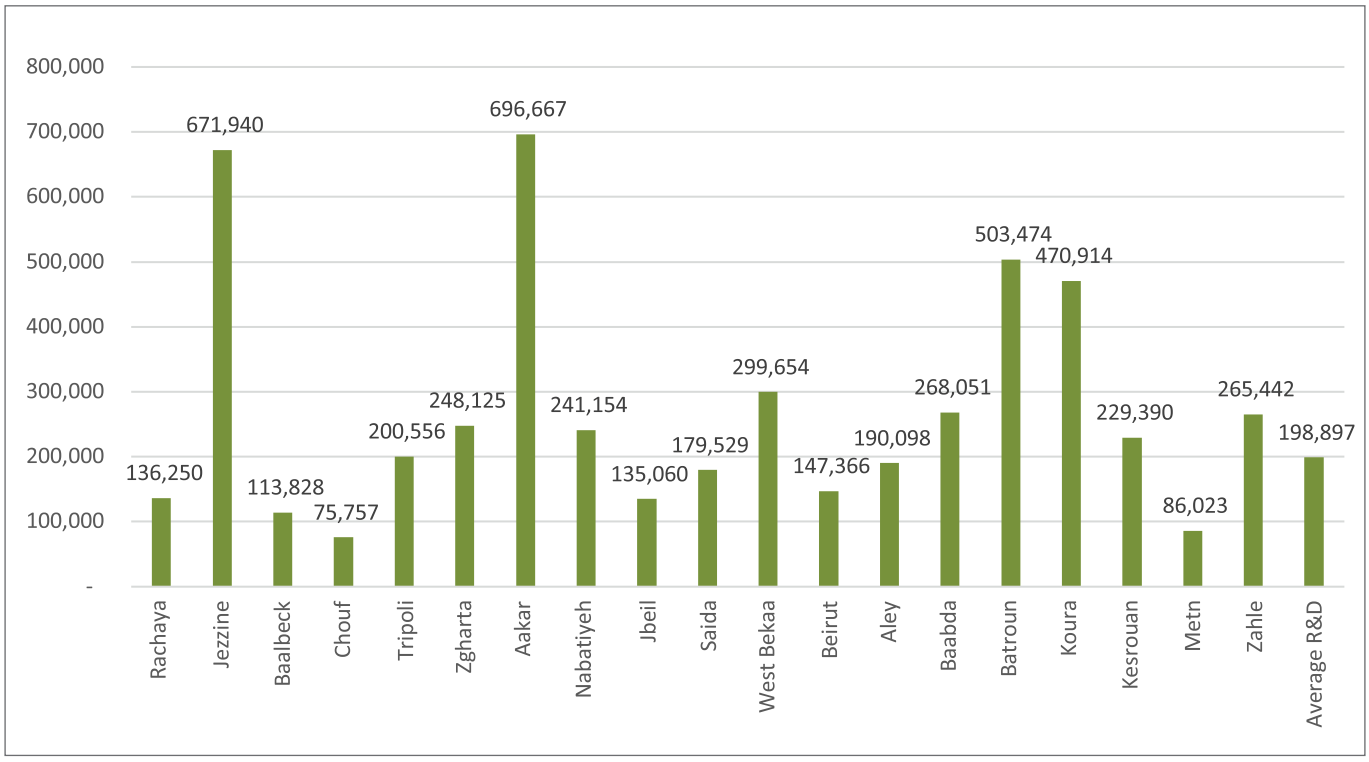


Figure 43. *Geographic distribution of average R&D expenditures per industry ($)*

The figure below shows the geographic distribution of industries and R&D expenses by type where Zahle, Metn, Kesrouan, Koura, Batroun, Baabda and Aley share around 65% of total number of industries and 70% of the total R&D expenditures.

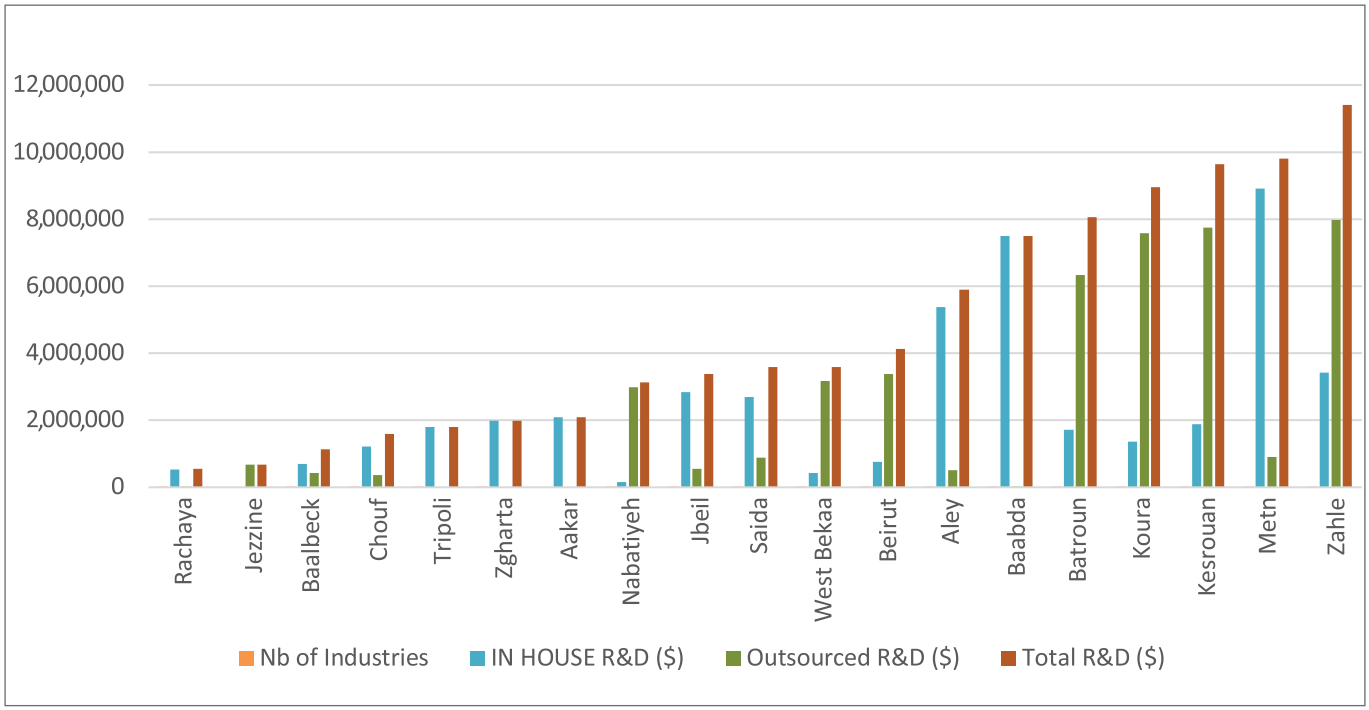


Figure 44. *Industries and R&D expenditures by Area and type (in $)*

SECTORIAL DISTRIBUTION OF R&D EXPENDITURES

Innovation processes differ greatly from a sector to another in terms of development, rate of technological change, and access to knowledge. Some sectors are characterized by rapid change and radical innovations, others by smaller, incremental changes. The chemical and mineral industrial sectors are strongly influenced by knowledge and innovation. Consequently, these industries require a high level of technological competence, in turn requiring ongoing innovation through continuous mobilization of human resources and R&D investments.

Innovation is not exclusive to manufacturing, ICT industries or those employing high number of scientists like the pharmaceutical industry. However, there are very significant differences in the rate of innovation across sectors, indicating some potential for both radical innovation and greater diffusion that increase productivity.

Somehow the share of these sectors in our survey doesn't exceed 6% of total industries that declared their expenditures. Food and beverage industry has the biggest share since the number of surveyed industries (160 industries) is very high as compared to other sectors.

Indeed, R&D expenditures broken down by industrial sectors shows that the sector of food and beverage products has the biggest share of expenses (39%) far beyond the chemical and mineral sector (6% each), followed by fabricated metals (14%). Even though companies investing in the "non-metallic mineral product" sector and "chemicals" invest the most in innovation research and products, innovation performance differs greatly from one sector to another.

Table 21 . Distribution of R&D expenditures by type and sector

ISIC	In House R&D ($)	Outsourced R&D ($)	Total R&D ($)	% of total
Basic Metals	953,500	290,000	1,243,500	1.4%
Chemicals	3,351,830	1,720,500	5,072,330	5.7%
Clothes	256,000	325,000	581,000	0.7%
Collection and distribution of water	200,000		200,000	0.2%
Electrical machinery	921,578	20,000	941,578	1.1%
Fabricated metals	2,828,554	9,183,960	12,012,515	13.5%
Food & Beverage	19,198,453	15,501,610	34,700,062	39.0%
Furniture	3,687,503	1,135,000	4,822,503	5.4%
Leather	54,901		54,901	0.1%
Machinery & equipment	1,308,000	738,581	2,046,581	2.3%
Medical instruments, watches	50,000		50,000	0.1%
Mineral products	1,923,001	4,034,274	5,957,275	6.7%
Other mining and quarrying	140,000	163,000	303,000	0.3%
Paper	1,132,950	800,000	1,932,950	2.2%
printed matters	1,942,802	3,811,955	5,754,757	6.5%
Recycling (metal waste)	59,901	228,600	288,501	0.3%
Rubber & plastics	7,159,300	5,586,000	12,745,300	14.3%
Textiles	200,000		200,000	0.2%
Wood products			-	0.0%
Grand Total	45,368,273	43,538,480	88,906,753	100%

R&D expenditure in the manufacturing sector is the highest for food and beverage, whose share moved up in 2019 to 40% with a total value of around 35,000,000$. The second share is for the fabricated metals and Rubber and plastics with 14% each.

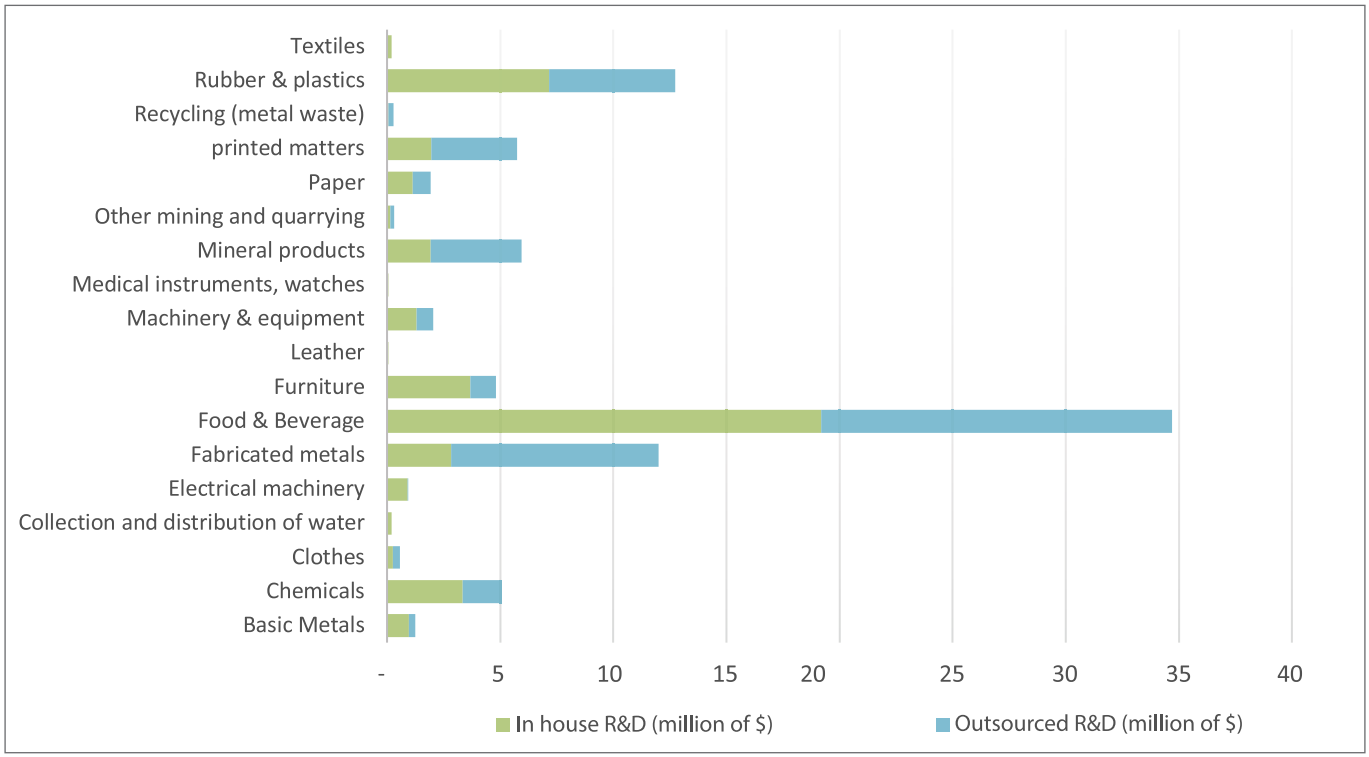


Figure 45. *R&D industrial expenditures by Sectors & Type*

Average R&D expenditures largely depends on the economic activity sector. R&D reaches its highest levels in Rubber and plastics (344,000 $) followed by fabricated metals (292,000$) and printed matters (261,000$). Details are provided in the graphic below.

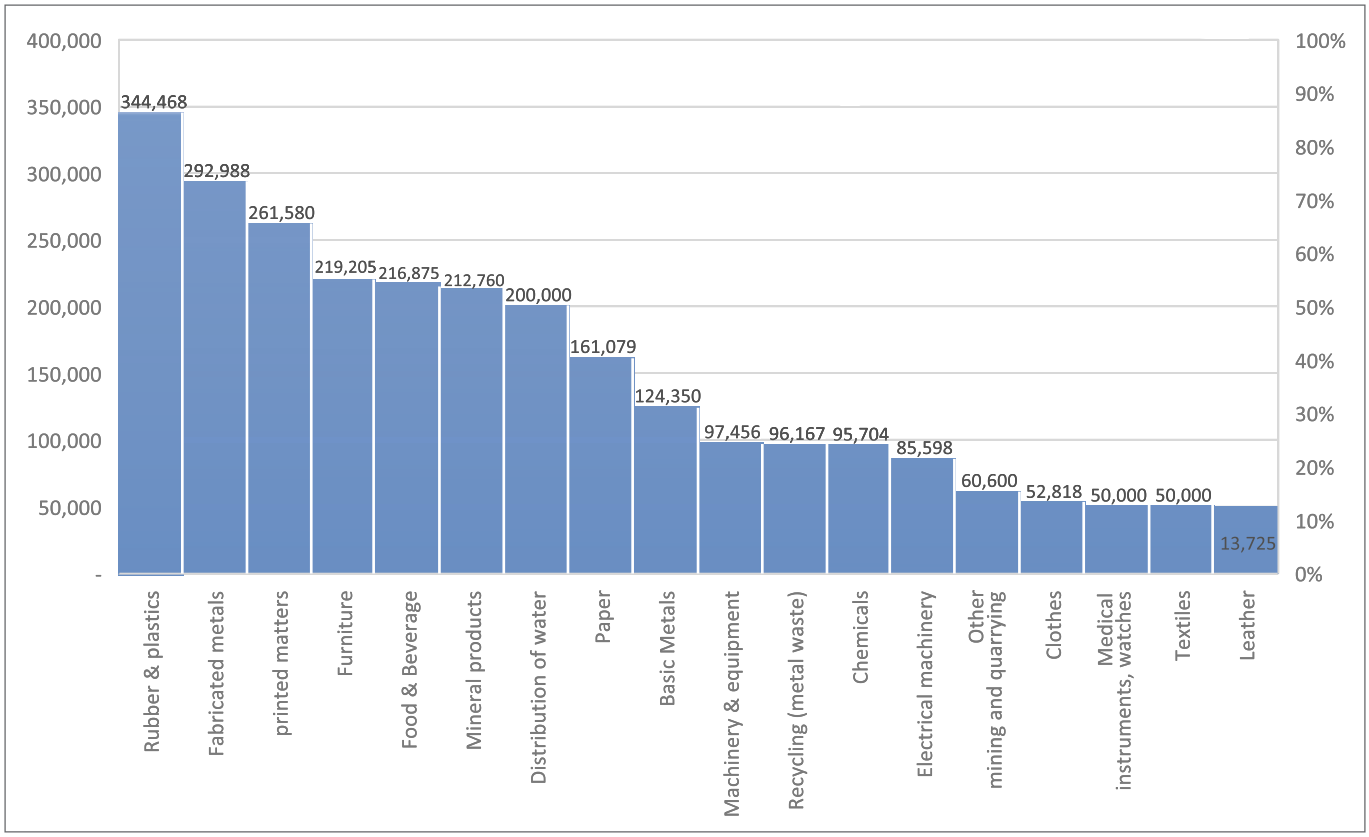


Figure 46. *Average R&D expenditures (in USD) by Economic Activity*

DISTRIBUTION OF R&D EXPENDITURES BY ESTABLISHMENT' SIZE

The graphics below reveals that industries hiring above 50 employees assume 57% of the R&D expenses. The share of small factories is very low since they don't have capacities to spend on research.

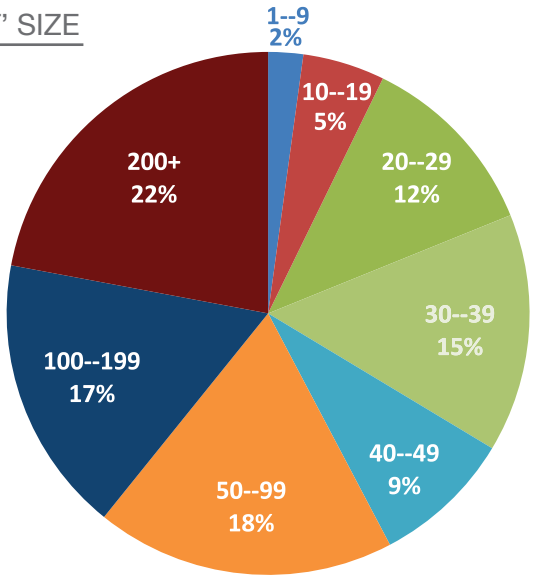


Figure 47. *R&D expenditures by Industry size*

Innovation is concentrated mainly in large companies, a pattern viewed for most of the surveyed industries. The percentage of smaller factories carrying out innovation is low.The average of research expenditure by industry increases with the size of establishment reaching 425,616$ for factories hiring over 200 employees followed by 331,000 $ for classes between 100 and 199 dropping to 180,000$ for factories having between 50 to 99 employees.

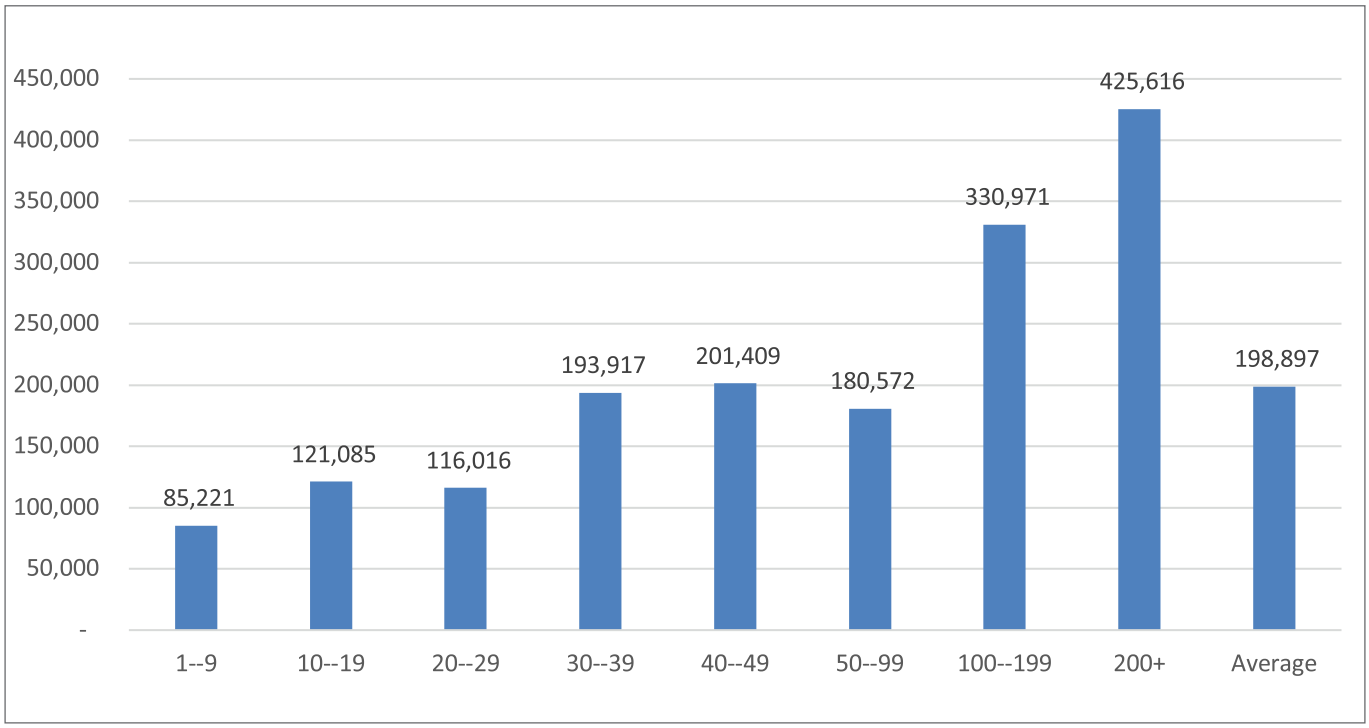


Figure 48. *R&D expenditures per Industry by size of establishment (in $)*

The below graphs shows that 22% of industries hire over 100 employees and assume (cover) more than 39% of R&D expenses. The share of industrial R&D for small enterprises is much higher than their expenditures in the field. It is well known that small industries don't have enough resources to carry R&D and they can hardly focus on their existing production cycle.

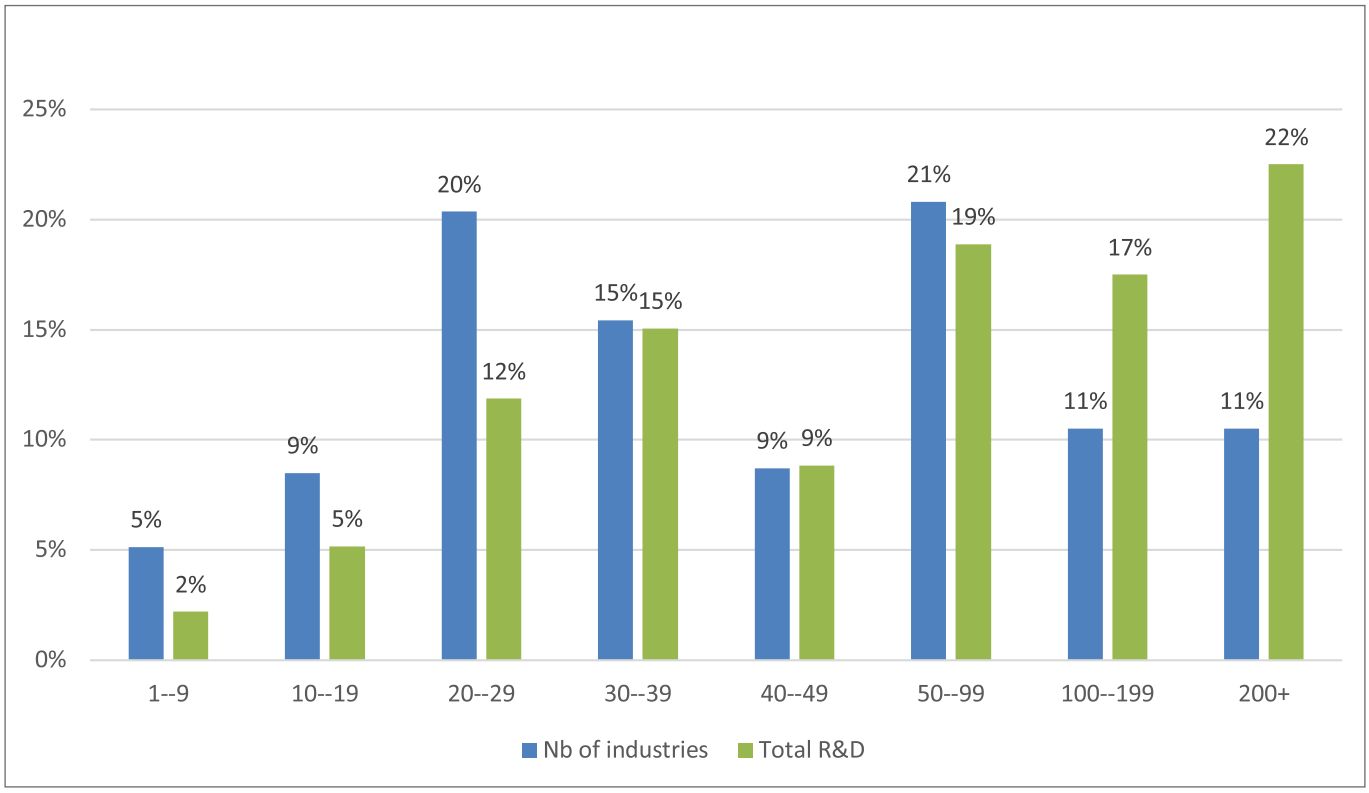


Figure 49. *Share of industrial r&d expenditures & industries by company size*

Innovation efforts and outputs exhibit a significant degree of concentration, as larger firms tend to be more innovative. 42% of industries hiring over 50 employees introduced a new product or business process in 2019. These innovative firms carried around 60% of total R&D expenditures.

Table 22 The Average R&D expenses per unit and establishment size can be summarized as follows:

Workforce	Nb of industries	IN House R&D ($)	Outsourced R&D ($)	Total R&D ($)	R&D by industry ($)
1—9	23	535,602	1,424,480	1,960,081	85,221
10—19	38	1,879,553	2,721,665	4,601,218	121,085
20—29	91	6,485,079	4,072,406	10,557,485	116,016
30—39	69	9,924,296	3,456,000	13,380,296	193,917
40—49	39	3,823,000	4,031,940	7,854,940	201,409
50—99	93	11,493,363	5,299,796	16,793,159	180,572
100—199	47	6,430,055	9,125,561	15,555,616	330,971
200+	47	6,597,325	13,406,633	20,003,958	425,616
Grand Total	447	45,368,273	43,538,480	88,906,753	198,897

The average of in-house R&D expenses are estimated around 5,800,000 $ by workforce class dropping a little bit to 5,400,000 $ for outsourced expenditures with an average of 11,000,000 $ for both type. According to the answers, a little bit higher than the half of the expenses on R&D are in-house developed. The other half are outsourced. The following figure provides the ranges of expenditures on R&D as per the received answers.

Figure 50. Level of research and development (r&d) expenditure: r&d driven innovation

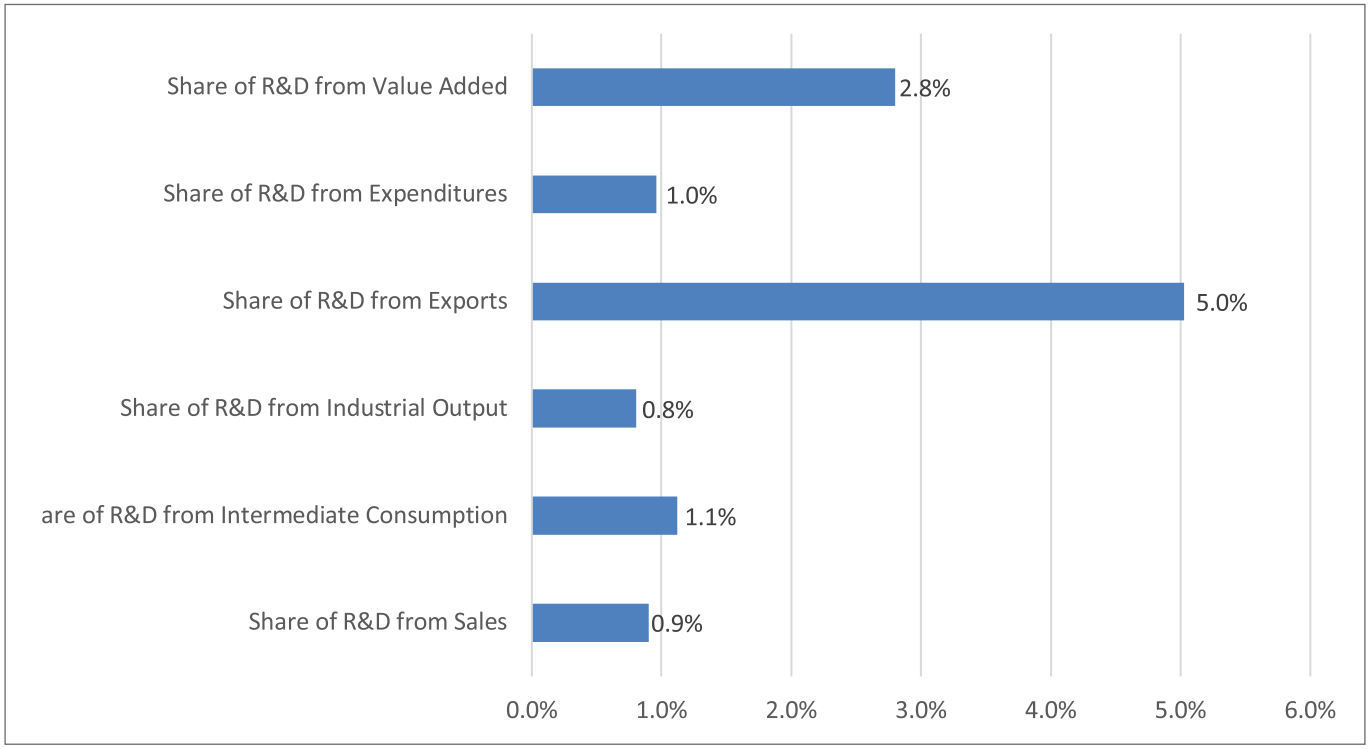


Table 23 The level of research and development (R&D) expenditure is calculated as the percentage of turnover within a factory that is spent on research.

Work force Class	Share of R&D in % of sales 2019	Share of R&D in % of exports	Share of R&D in % of sales	Share of R&D in % of Intermediate Consumption	Share of R&D in % of Expenditures including salaries	Share of R&D in % of Industrial Output	Share of R&D in % of Value Added
1--9	0.2%	1.4%	0.2%	0.2%	0.2%	0.2%	0.4%
10--19	0.3%	2.7%	0.5%	0.7%	0.6%	0.5%	1.8%
20--29	0.8%	11.2%	1.8%	2.6%	2.1%	1.8%	6.0%
30--39	2.2%	5.6%	1.3%	1.8%	1.6%	1.3%	4.4%
40--49	0.7%	5.5%	1.6%	2.0%	1.7%	1.6%	8.1%
50--99	1.1%	4.1%	0.6%	0.8%	0.7%	0.5%	1.9%
100--199	1.0%	5.9%	1.0%	1.3%	1.1%	1.0%	4.5%
Over 200	0.9%	4.6%	0.7%	1.0%	0.8%	0.7%	2.3%
Total	0.9%	5.0%	0.8%	1.1%	1.0%	0.8%	2.8%

The share of R&D in total sales is below 1% and reaches its maximum 2.2% for industries hiring between 30 and 39 employees where the highest number of surveyed industries are located.

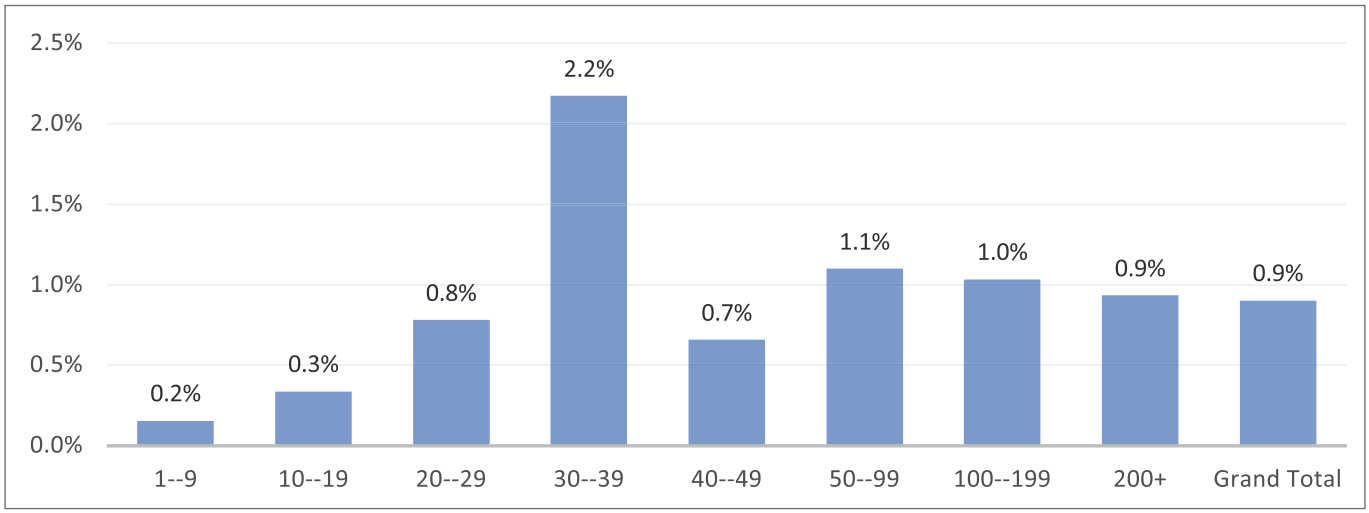


Figure 51. *Share of R&D in total Sales for 2019 by size of establishments (1426 industries)*

The average share of R&d in industrial output is around 0.8%. it reaches 1.8% in percentage of Value added going from 0.3% to a maximum of 4.2%.

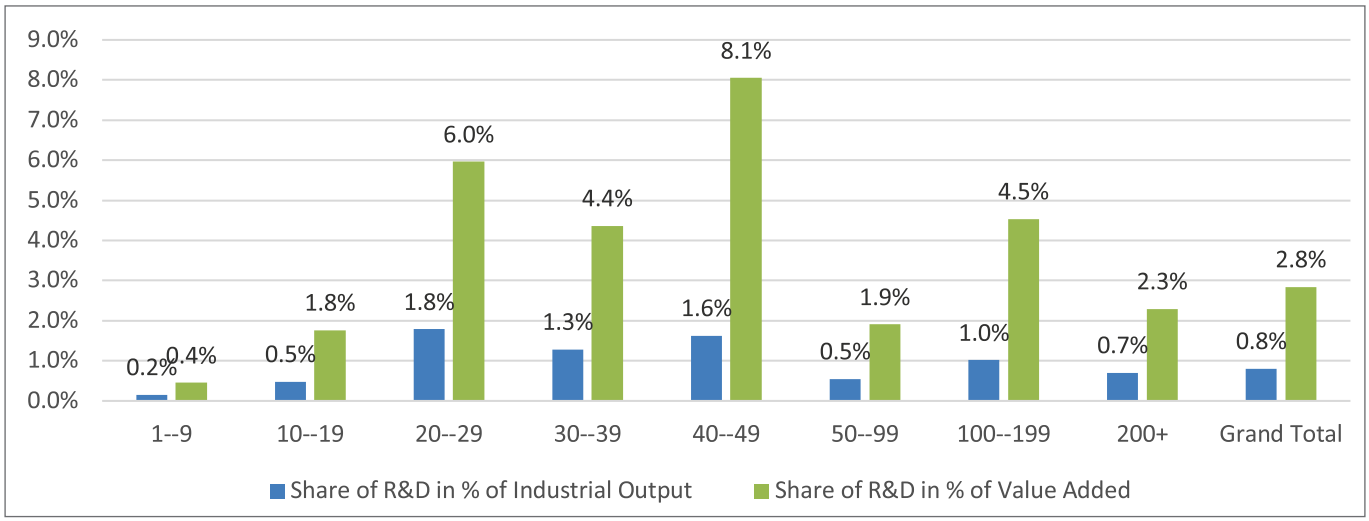


Figure 52. *Share of R&D in Industrial Output & Valued Added by establishment size*

According to the survey, the average share of R&D expenditures is very low and doesn't exceed 1% of total expenditures (including wages and salaries).

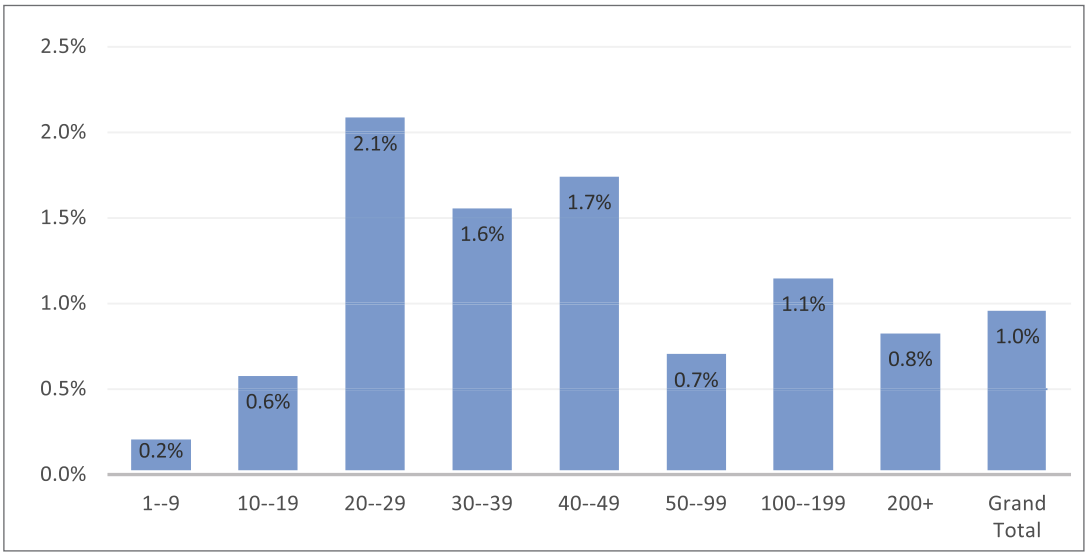


Figure 53. *Ratio of R&D over total Expenditures (incl. salaries) by establishment size*

A greater level of R&D expenditure is expected to generate greater rate of innovation resulting from the introduction of new products and services, and improved processes. However, various factors, such as the type of competitive environment in which the company operates and its ability to commercialize R&D outputs, can disrupt the relationship between R&D expense and innovation output ignoring sometimes process innovation, made by low-technology and mid-technology. Innovation usually makes a significant contribution to growth. Somehow, in Lebanon, R&D expenditures that are mainly in the form of current expenditures particularly wages and salaries are considered independent from economic growth.

Table 24

Economic Activity	Share of R&D from Sales	Share of R&D from Intermediate Consumption	Share of R&D from Industrial Output	Share of R&D from Exports	Share of R&D from Expenditures	Share of R&D from Value Added
Purification of water	14.1%	1.6%	1.1%	33.1%	1.3%	3.8%
Rubber & plastics	3.4%	3.2%	2.6%	11.4%	2.9%	13.3%
Basic Metals	1.8%	3.9%	3.9%	3.9%	3.7%	1.3%
Recycling	1.5%	1.3%	0.9%	2.0%	1.1%	2.9%
Food & Beverage	1.2%	1.2%	0.9%	7.2%	1.1%	2.9%
printed matters	1.1%	2.8%	1.6%	5.0%	2.2%	4.0%
Clothes	0.9%	0.5%	0.4%	1.1%	0.4%	2.0%
Machinery & equipment	0.6%	2.5%	1.3%	4.6%	1.7%	2.6%
Electrical machinery	0.6%	0.3%	0.2%	1.1%	0.2%	1.0%
Fabricated metals	0.6%	0.9%	0.7%	6.2%	0.8%	4.6%
Mineral products	0.5%	0.5%	0.4%	36.5%	0.5%	1.3%
Furniture;	0.5%	0.7%	0.4%	2.0%	0.5%	0.9%
Leather	0.5%	0.6%	0.4%	1.3%	0.5%	1.1%
Chemicals	0.4%	0.8%	0.5%	3.2%	0.7%	1.5%
Paper	0.3%	0.4%	0.3%	1.9%	0.3%	1.0%
Textiles	0.2%	0.4%	0.2%	2.1%	0.3%	0.5%
Other sectors	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Grand Total	0.9%	1.1%	0.8%	5.0%	1.0%	2.8%

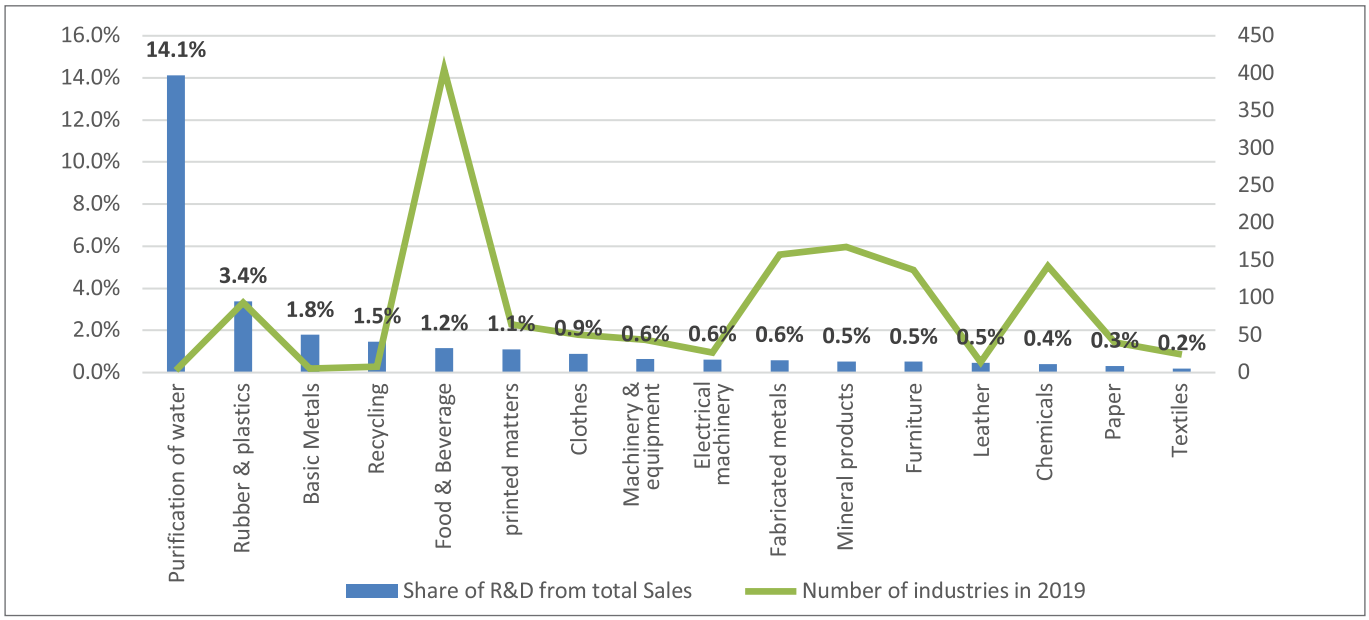


Figure 54. *Share of R&D from total Sales (1426 industries)*

D. STATUS OF INNOVATION

R&D COLLABORATION CHARACTERISTICS

Innovation can occur at different points of the value chain from initial conception, R&D, transfer to production and deployment to markets. It combines several modes in terms of products and processes and marketing.

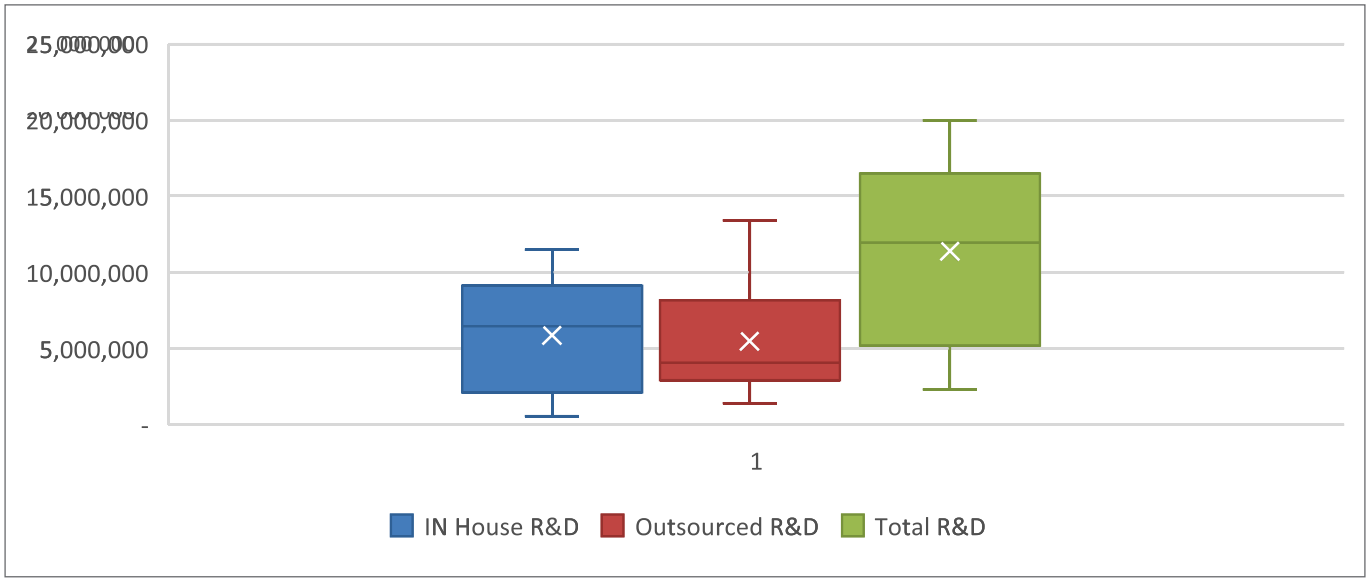


Figure 55. *Average R&D expenditures ($) by workforce class*

Total R&D activities performed are estimated around 11.400.000 USD per class of workers. In-house it reaches only 5,850.000 USD.

The industries perform 51% of their R&D in-house, while 49% is done in collaboration or is outsourced to third parties.
Firm size is an important determinant for how external R&D is organized.
Unlike European countries, the survey revealed that medium size companies in Lebanon (20 to 50 employees) make very little use of R&D outsourcing (9%) and prefer to have R&D in-house as a way of adopting new knowledge, likely due to less capacity to collaborate while for the other size subclasses, these proportions favor outsourcing rather than in-house (21% and 31% respectively for classes 100-249 and over 250 employees).
Looking more in detail at the R&D collaborations, we see that more than half of these collaborations are vertical in nature, performed with either suppliers or clients.

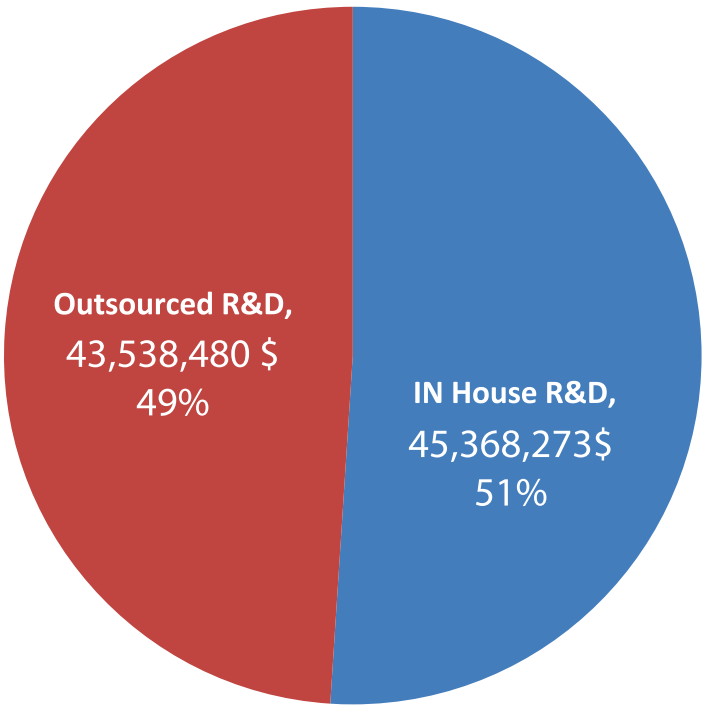
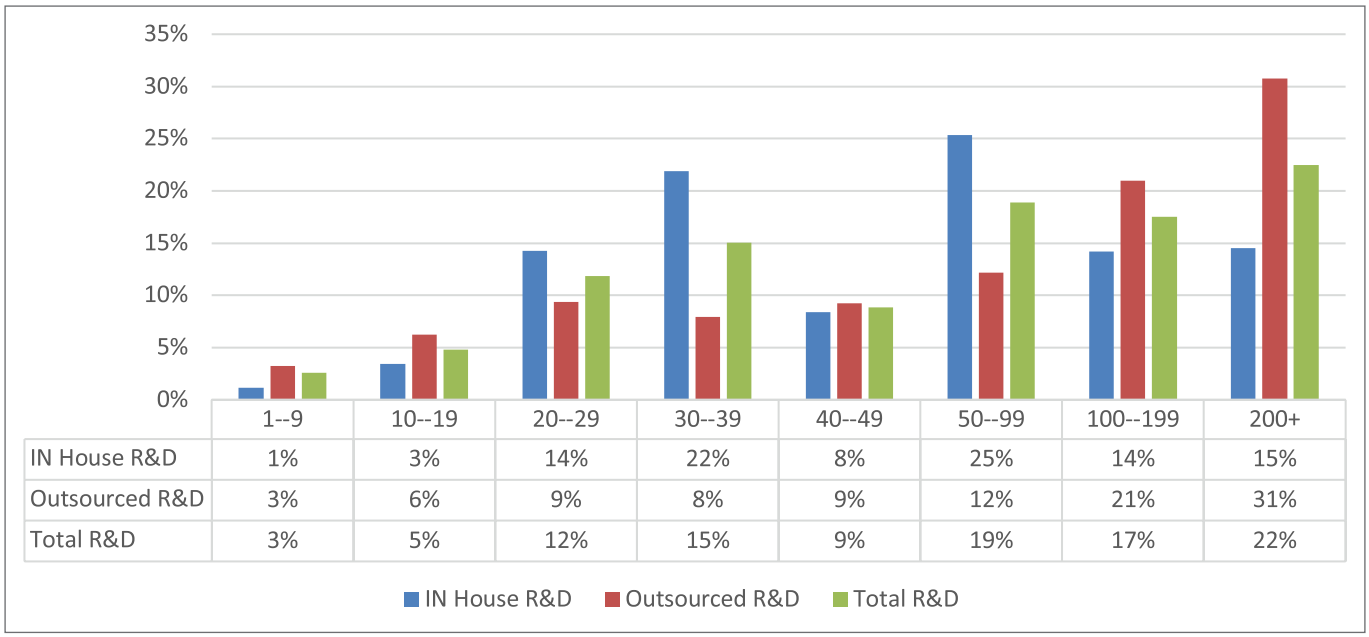


Figure 56. *R&D expenditures by type as declared by 380 industries*

The survey reveals that industries hiring between 100 and 199 and over 200 employees are more likely to outsource R&D activities since their share of outsourcing is between 21% and 31% against 14% and 15% for in-house research expenses.



	1--9	10--19	20--29	30--39	40--49	50--99	100--199	200+
IN House R&D	1%	3%	14%	22%	8%	25%	14%	15%
Outsourced R&D	3%	6%	9%	8%	9%	12%	21%	31%
Total R&D	3%	5%	12%	15%	9%	19%	17%	22%

Figure 57. *Share of R&D expenses by establishment size (In-house and outsourcing)*

R&D expenditures are broken down into two major accounting categories namely, current expenditure and capital expenditure: annual wages and salaries, non-capital purchases of materials, supplies and equipment to support R&D, including water, gas and electricity; books, journals, reference materials, subscriptions to libraries, land and buildings; instruments and equipment; and computer software.

Most of the Lebanese industries don't declare the value of their research expenditures in the balance sheet presented to the Ministry of Finance in a separate field dedicated to "R&D" since they don't have any incentive or tax exemptions provided by the Government. These expenses are mainly included in their current expenditures.

The survey revealed that industries that are active in the international markets are more likely to be innovative, and the one that sell only in the local market tend to be less innovative.

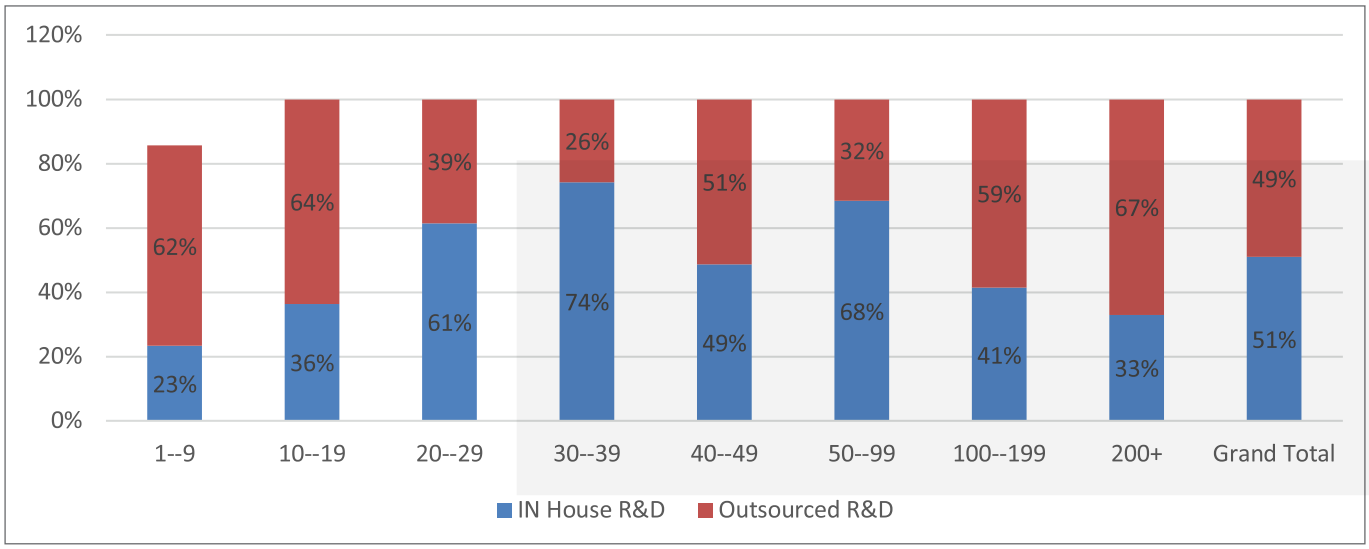


Figure 58. *Share of In-house vs Outsourced R&D for each class*

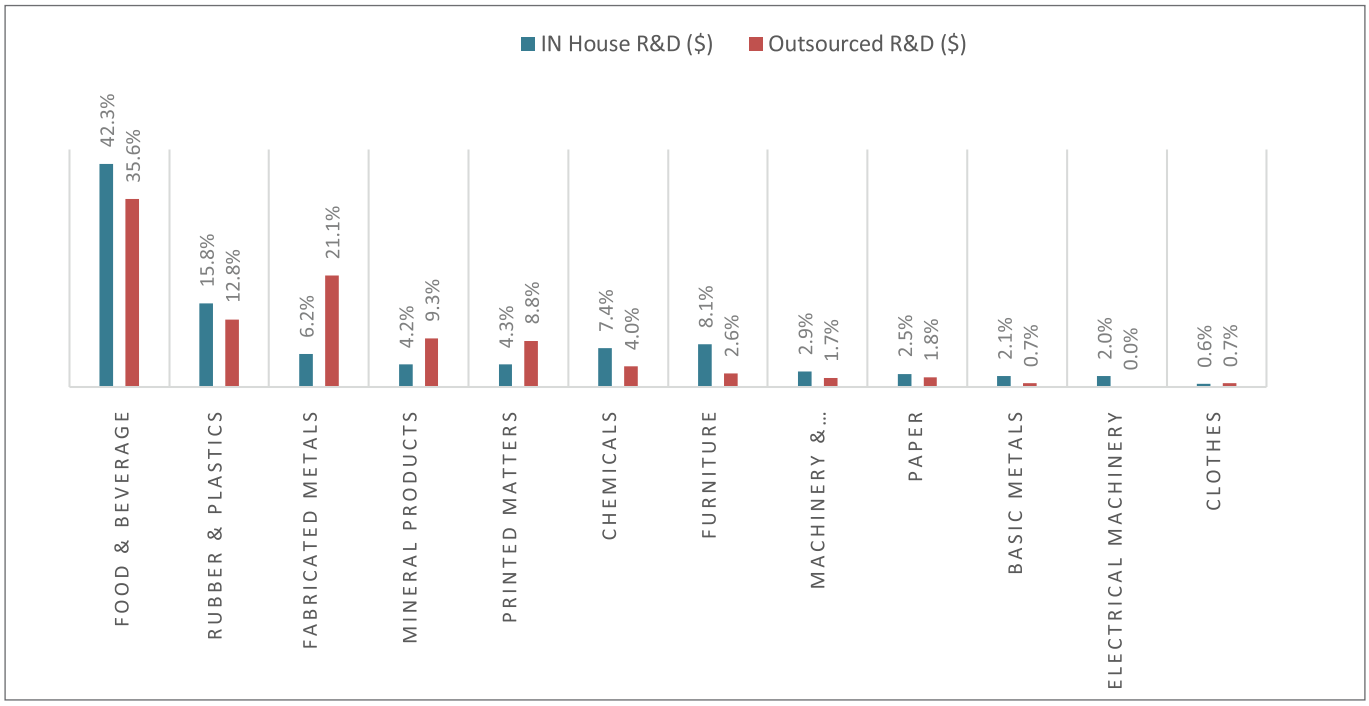


Figure 59. *Industrial R&D expenditures by type and sector (in % of total)*

Many factors hinder the performance of industries in R&D. Most of the surveyed industries reported a decline in their capacity to fund any research during the following years which is notably considered as hurdle to scaling.

The severity of the crisis was translated into funding difficulties correlated with a high increase in fuel cost and all operational expenses.

Indeed, depending on high priced private generators following the fuel and diesel shortages and reduced government-produced power has induced in higher costs negatively impacting their ability to expand.

The reluctance of these industries to increase their R&D expenditures in light of the absenteeism of the Government criticized for the lack of supporting any reform will negatively impact the innovation ecosystem.

In addition to the lack of access to investment and capital cited by the surveyed industrialists as the worse challenges to their business -even with the lower human resources cost- ; specialized tech skills exodus derived by the worsening of living conditions is also considered as a detrimental factor to the expansion of their industries.

The survey revealed that the small, medium and big factories were significantly affected: more than 65% of them consider decreasing during the following year R&D expenditures in their factories or are at best ascertain of their next step.

30% only of them will consider increasing their investment in research in the short run.

E. SOURCES FOR FINANCING R&D

Internal sources for financing R&D projects are used by most of surveyed industries.
Somehow, there is a wide selection of funding means used abroad:

- Internal resources
- Corporate bonds
- Bank lending
- Equity (including external Venture Capital)
- Own Venture Funds
- Tax Incentives

54% of surveyed industries have resort to internal resources to fund their R&D activities and 13% take a loan. 11% need both sources to finance any expansion in their production line or products.

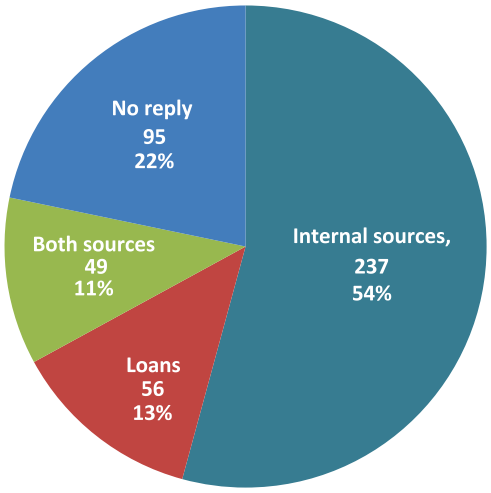
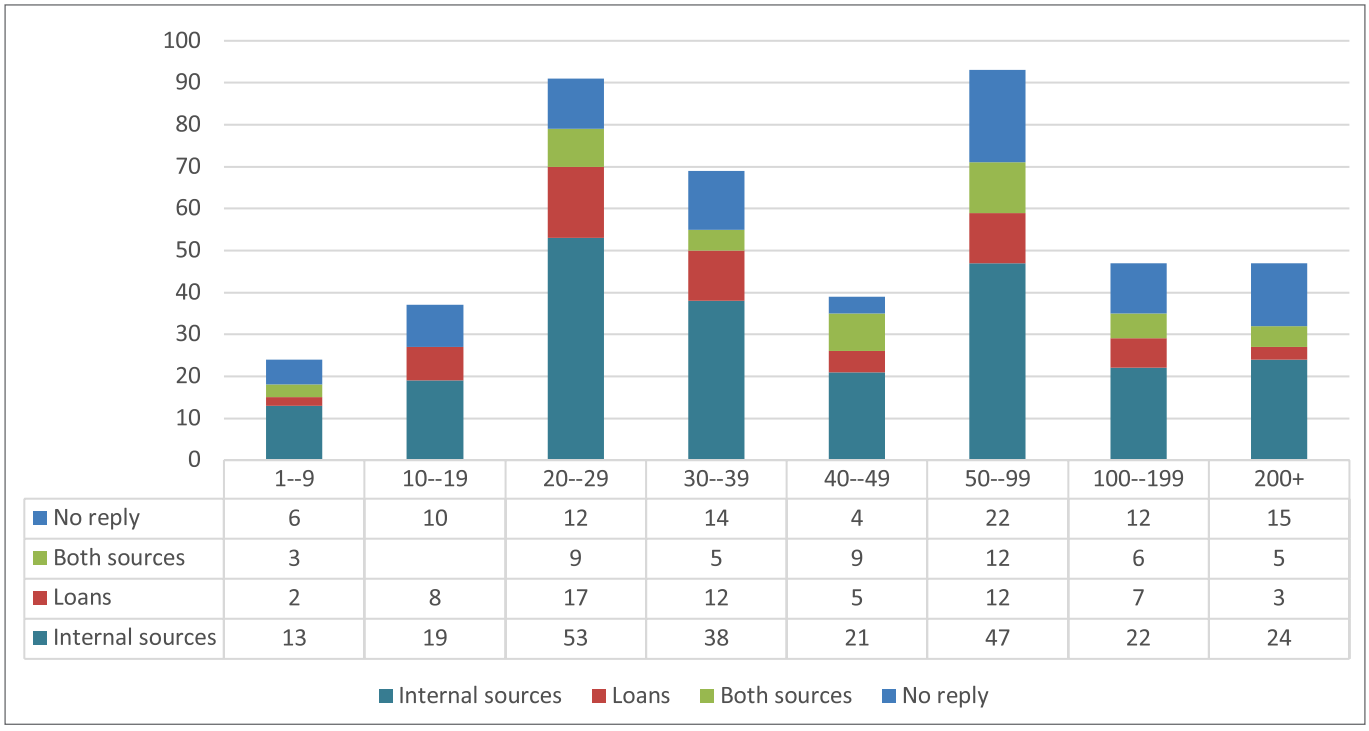


Figure 60. *R&D financing sources (447 industries)*



	1--9	10--19	20--29	30--39	40--49	50--99	100--199	200+
No reply	6	10	12	14	4	22	12	15
Both sources	3		9	5	9	12	6	5
Loans	2	8	17	12	5	12	7	3
Internal sources	13	19	53	38	21	47	22	24

Figure 61. *R&D sources by size of surveyed industries (447 ind)*

Tax incentives, internal sources and bank lending are the sources of funding that are most widely and commonly used and that have the widest interest from the industries operating abroad.

These instruments seem to be the default option for many companies. Somehow, the three sources of funding are not accessible by Lebanese industrialists due to the absence of:

- **Tax incentives:** the Law on exempting R&D expenditures from taxes is still not adopted and needs approval from the Parliament to be implemented.

- **Bank lending:** with the economic recession the country is facing, banks have freezed any lending to the companies.

The Government's failure to unify the exchange rate of the official rate, "sayrafa" and informal market has severely restricted bank's ability to lend money in foreign currency.

- **Liquidity for banks accounts:** industries cannot rely on company internal resources for innovation development due to the suspension of banks payments in fresh foreign currencies.

F. TYPE OF R&D UNDERTAKEN

There are different types of innovation for industries:

1. Product innovation related to a new or improved good that has been introduced on the market. it includes improvements to the quality, technical specifications, user friendliness or usability.
2. Business process innovation referring to a new or improved business process. This includes the various functions within a firm, such as the production of goods or services, distribution and logistics, marketing and sales, information and communication systems, and administration and management.

The majority of the R&D efforts is dedicated to development activities in the following types:

- Basic research
- Applied research/technology development
- Development for adapting products to local markets
- Development for market launch
- Development of software/data collection/ information system
- Acquisition of machinery, equipment, software & buildings

The innovation in the Lebanese context is more incremental than radical and rarely takes place in formal R&D laboratories.

Innovations are primarily driven by investments in new machinery and equipments to embody more advanced technologies.

Larger scale investments, even carried in a more formal setting by large industries, are not concerned with the generation of new knowledge.

The responses of the surveyed Industrialists revealed that they mostly invest in new machinery which got the highest share then in the production process itself or in product development as third choice. Salaries paid for the internal development team in addition to the external experts are also considered as an R&D investment.

Expansion of the company, packaging, training to the team and research studies were also mentioned. The graphics below shows the types of R&D mostly used by industrialists as mentioned in the survey:

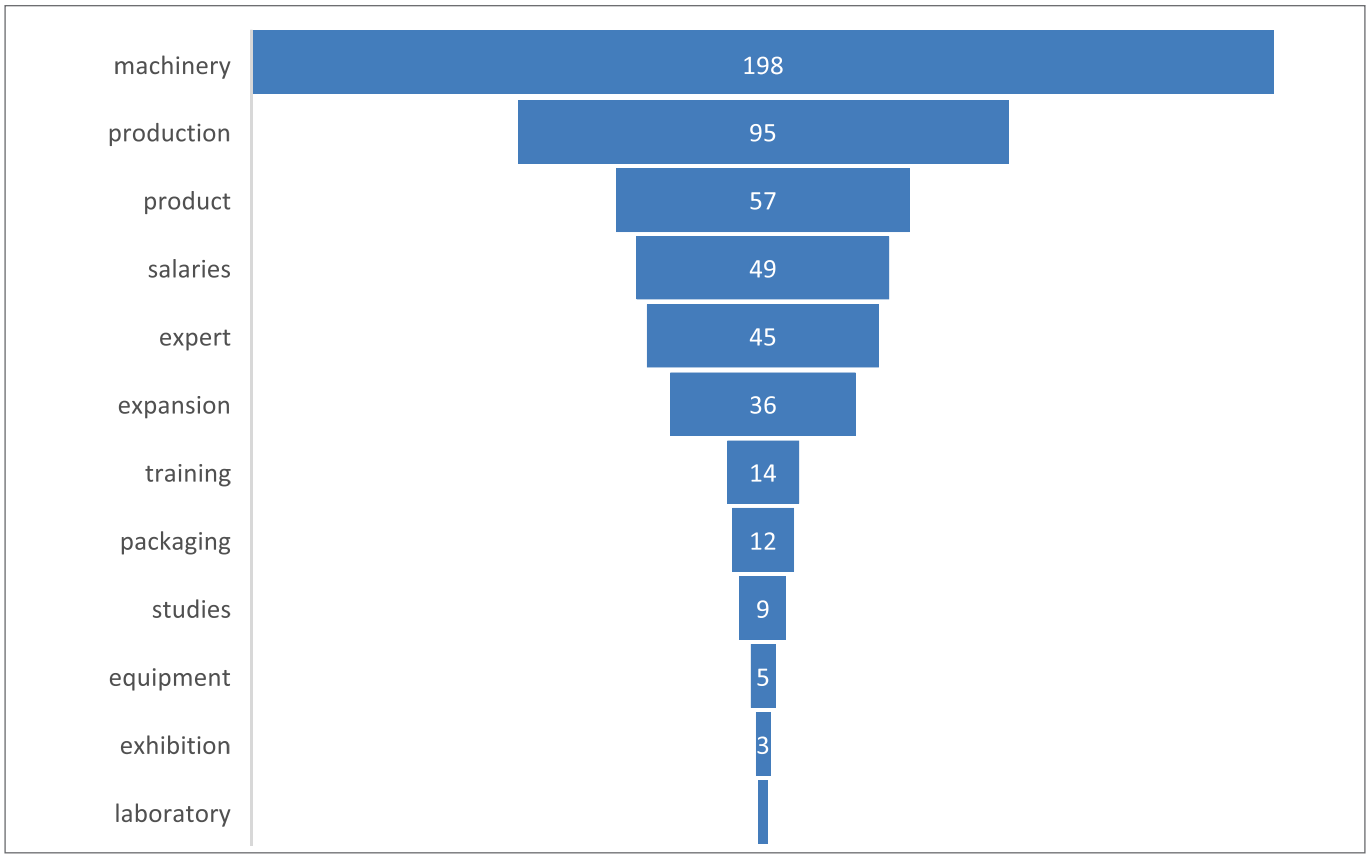


Figure 62. *Most R&D types used by industrialists*

G. MODELS FOR INTRAPRENEURSHIP: (HOW INDUSTRIALISTS RECEIVE INNOVATIVE STUDENTS AND INTEGRATE THE INNOVATION INTO THEIR INDUSTRIES)

Industry Intrapreneurship is still viewed in Lebanon as a western concept that does not apply to the Middle East. Whereas it has been an area of increased interest in the United States and in Europe in the last few decades, knowing that it will help revitalize and regenerate the manufacturing industry, in Lebanon, especially in the face of increased competition, Intrapreneurship is still a new and ambiguous concept with little understanding to its benefits.

Developing a model that will allow us to incorporate those factors that are critical to the intrapreneurial zone of an organization is at very nascent stages.

The industrialists often confuse the concept of "intrapreneurship" with hiring a graduate in their company. "intrapreneurship" means receiving innovative students and integrate their innovation into the industry. The student will then act like an entrepreneur within the industry and potentially brings a higher value added to its production process.

A high number of industrialists (253 from a total of 305) showed interest in applying intrapreneurship in their industries.

AVAILABLE COOPERATION BETWEEN ACADEMIA AND INDUSTRY

Only 16% of the surveyed industrialists (1063) stated that they have had a collaboration with universities. 36% never cooperated and 48% didn't answer. If we consider only the industries that carry R&D the share would be 36% in best case scenarios.

The distribution of these industries by sector revealed the following:

- 34% (highest share) work in the food and beverage,
- 15% are in chemicals and
- 9% are in fabricated metals and plastics.

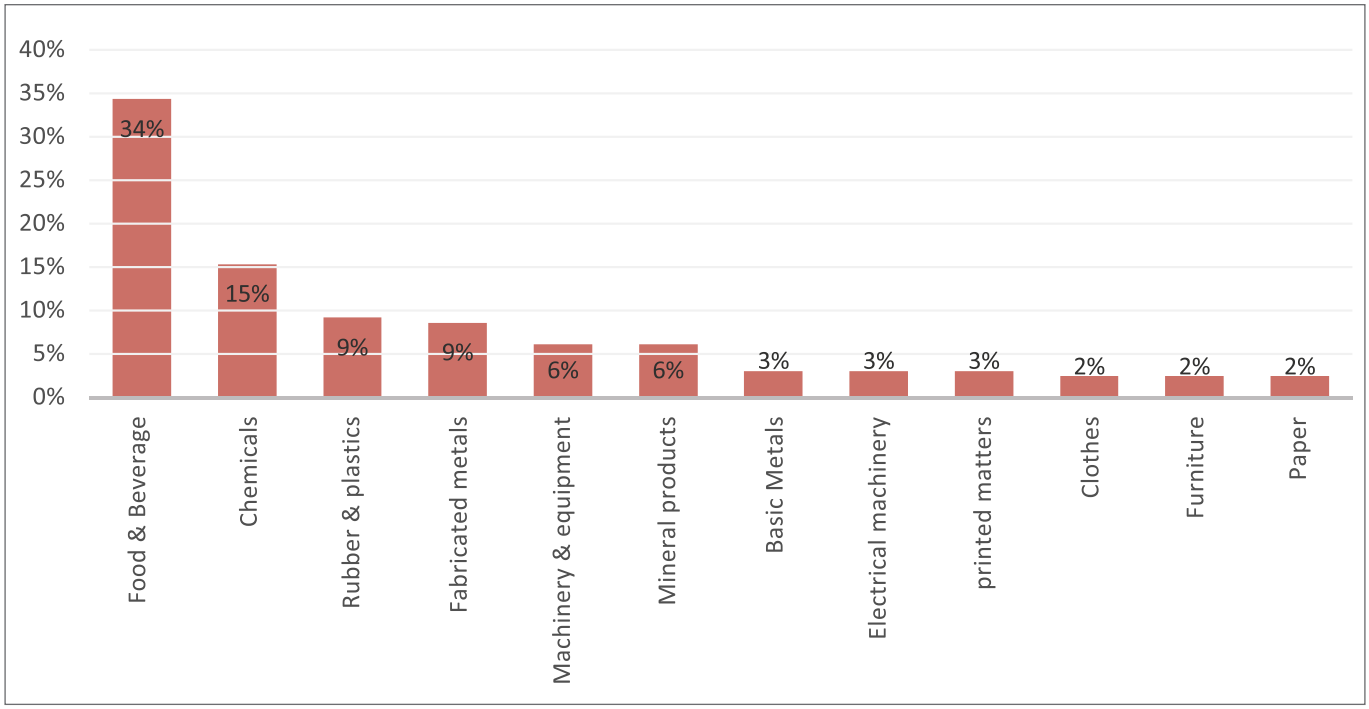


Figure 63. *Industries collaborating with Universities by economic sector*

Below is a chart of the most mentioned universities Industrialists use to collaborate with. According to the industrialists' responses, the highest share goes to the Lebanese University followed by the American University of Beirut, Saint Joseph University, Lebanese American University and USEK then University of Balamand, LIU and NDU.

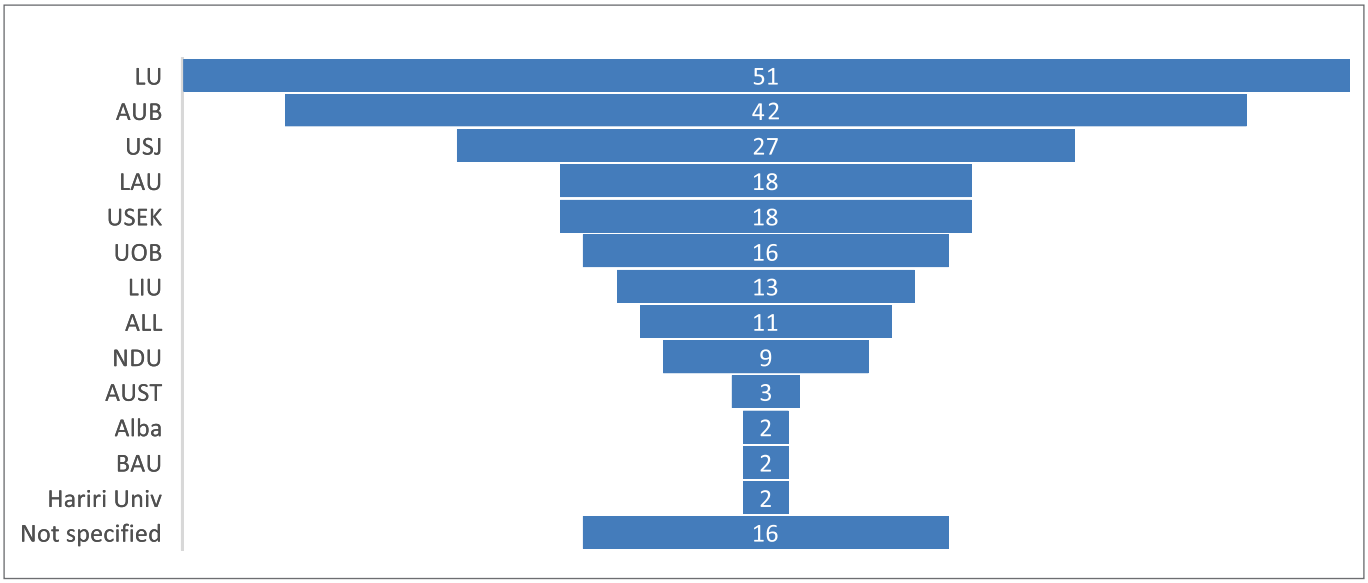


Figure 64. *The most mentionned universities for collaboration*

Around 45% of the industries that stated collaborating with academia hires 50 employees and above. The share of industries hiring less than 20 is very weak not exceeding 11%. 32% of these industries collaborating with academia hire between 20 and 40 employees as shown in the graphic below:

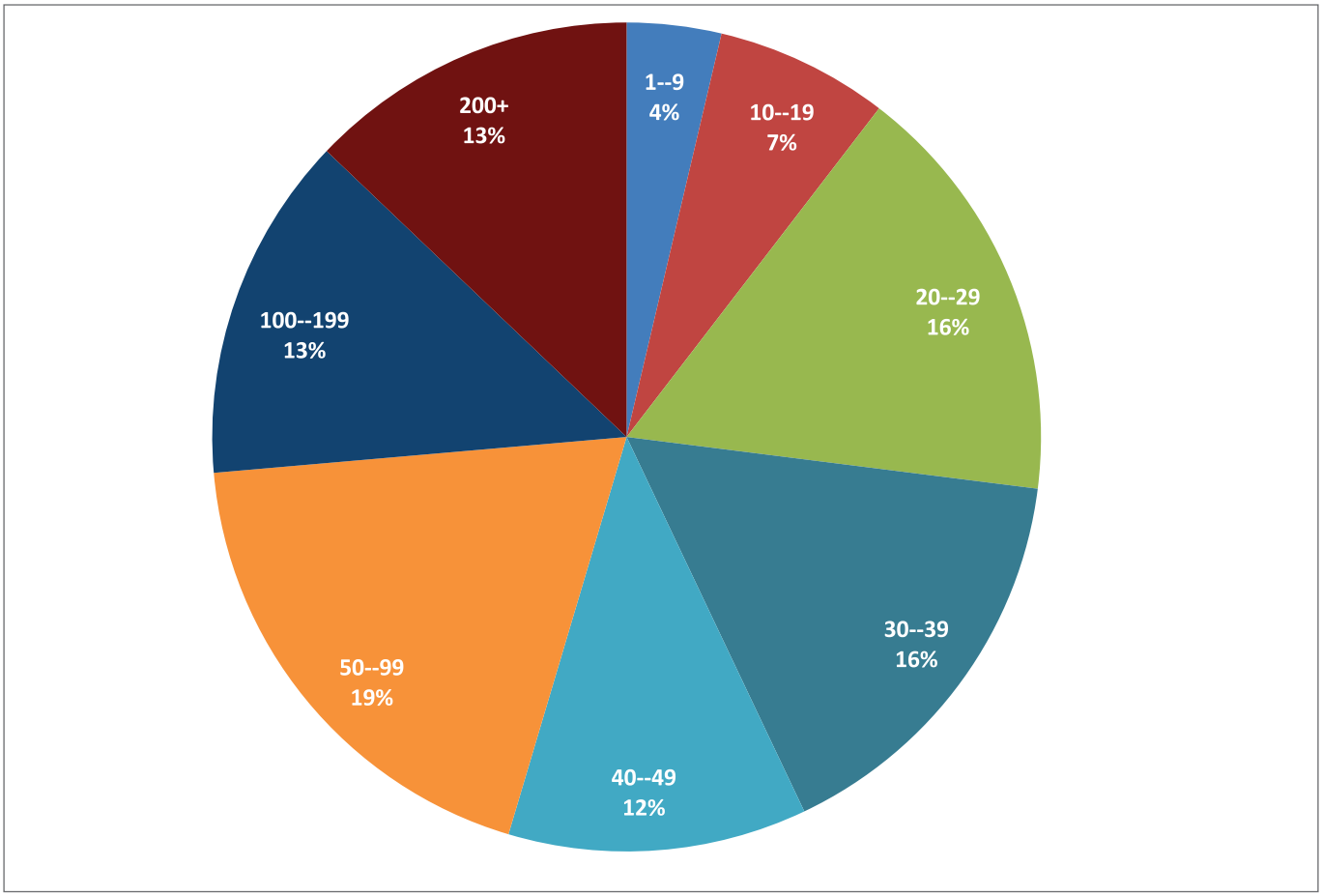


Figure 65. *R&D expenditures per Industry by size of establishment (in $)*

TYPE OF RESEARCH FACILITY REQUESTED BY THE INDUSTRIES

Industrialists expressed their interest in using Lebanese laboratories for their research. The kind of laboratories mentioned are reported in the below chart. A high number of respondents indicate an interest in chemical laboratories that are found in few universities.

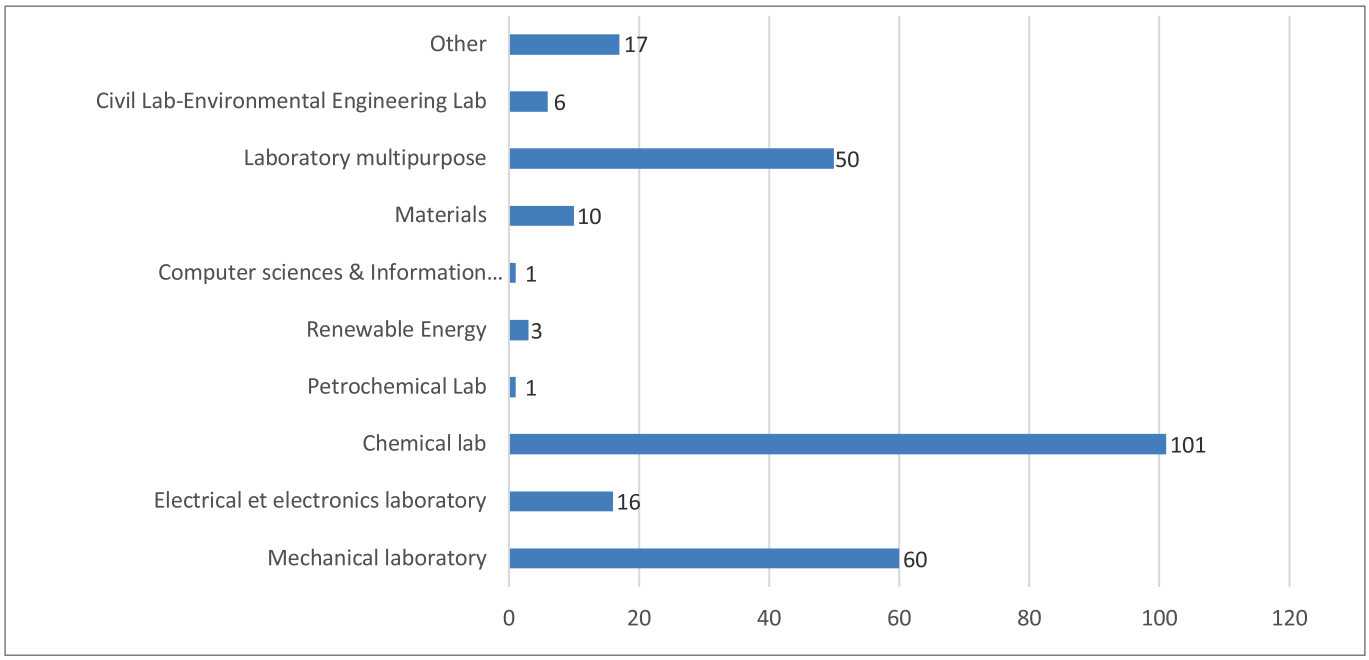


Figure 66. *The Lebanese Laboratories of interest for the industrialists*

H. ROLE OF THE ASSOCIATION OF LEBANESE INDUSTRIALISTS IN FOSTERING INNOVATION AND SUPPORTING INDUSTRIALISTS IN MAINTAINING, DEVELOPING AND SUSTAINING INNOVATION IN THE CORE OF THEIR BUSINESS.

The Lebanese industry has always been distinguished even though it has benefitted from intermittent and limited intervention and support from the public sector. Nowadays, the Lebanese industry is facing multiple challenges because of the inexistence of trade barriers, absence of protective measures, political and security upheaval, Lebanese pound devaluation to which we add COVID-19 pandemic, suspension of production and export due to the latest war between Russia and Ukraine, etc.. In this regard, ALI has an important role to play in influencing policies and decisions of the government officials and starves to create and maintain an environment which is favourable to industrial investment, job creation, growth and development.

ALI Board of Directors is playing a considerable role in supporting the Lebanese industries to overcome this crisis. Besides working on addressing basic issues starting with energy, financing, trade agreements, enhancing confidence with Lebanese consumer, industrial research; ALI as the main partner of IRALEB is actively supporting the funding of the Academia Industrial oriented projects.

In the present context, ALI has formed specialized committees to deal with industrialists' problems. A special committee was formed to prepare for the "industrialists of tomorrow" and another for "lobbying and advocacy". Specialized committees have also been established to address export gaps and open new markets, and to follow up on the industrial zones file.

ALI has also been active in leading and participating to projects aiming at developing and modernizing industrial sectors.

To increase the effectiveness of its intervention, the Association of Lebanese Industrialists should take an active role in dealing with international agreements, social protection policies, growth policies, as well as financial and monetary issues (Lebanese Industrial sector, Sectorial Study 2018-2021 and beyond, ALI).

I. IS THERE ANY OTHER ENTITY SUPPORTING INDUSTRIALIST DEVELOPING INNOVATION?

The industrialists interviewed confirmed that IRALEB (LIRA program previously) and Euro-Lebanese Center for Industrial Modernization (ELCIM), a programme within the Industrial Research Institution (IRI) are the two only local entities supporting industrialists to develop innovation. ELCIM have previously started a programme to liaise between academia and industry. The Euro-Lebanese Center for Industrial Modernization (ELCIM), which is co-funded by the European Union, and is part of the EU cofinanced Integrated SME Support Programme (ISSP), used to support Small and Medium Enterprises (SME) in Lebanon in their legislative, financial, and business development aspects.

Further, the financial crisis fostered the creation of private limited risk funds like Cedar Oxygen Fund, Cedrus investment Bank, LIBANK Lebanon Investment Vehicle and Trade Support Partners. These private Funds offers different forms of financing cooperation, such as direct partnerships between production institutions and banks/Funds, through equity investment, convertible loans, issuance common stocks on the financial market, or specific debt bond for a better market penetration.

Cedar Oxygen launched in late 2020 with the support of Banque du Liban for 175 million USD and in partnership with ALI, is offering various financing schemes and access for alternative capital from outside Lebanon for SMEs operating in the industrial sector, including equity and grant financing and loan guarantees.

Cedar Oxygen, who is soliciting the Lebanese diaspora, is allocating to industrialists trade finance credit facilities to purchase raw materials, conclude capital expenditure projects, finance renewable energy technologies, and improve their business efficiency. Oxygen is also providing financial support for industrial projects that foster the development of high-level product and manufacturing highlighting the technological and qualitative development that increases the competitiveness of the Lebanese industry. Somehow two years later, the initial ambitions are far from being fulfilled, both in terms of raising and deploying funds. Along with reluctance of investors to engage in the fund, the project encountered significant difficulties in deploying funds in its early stages, and despite many success stories raised in the media, only big companies exporting and having access to international banks benefited from this Fund with a small percentage of the total amount lend to the industrial sector. As for small companies who sell locally, they were considered having risky profiles unable to meet the eligibility requirements.

Despite attempts to engage the private sector more prominently in funding research and development, for instance through private-public partnerships, international initiatives led by donors remain the main sources of R&D financing in the country. Nowadays, Lebanon is highly reliant on international governments and donors support to survive.

An Additional support to innovation is provided by international organisations like USAID, UNIDO and European Union who launched lately several initiatives to support SMEs.

Among these initiatives, we mention the USAID assistance that has expanded following the latest crisis the supply of loans to micro, small and medium-sized enterprises that do not normally have access to commercial-based capital.
USAID supported eight key microfinance organizations in Lebanon by lending capital and providing technical management and planning support to technology companies and young entrepreneurs, to access reliable and competitive credit. The loans allow for the development of income-generating businesses and the enhancement of existing ones, thus increasing sales, job creation and economic growth. USAID's microfinance program disbursed grants, by end 2021, for more than 6,000 loans over three years across all regions of Lebanon.
Two additional EU interventions will start in fall 2022 to provide Technical Assistance Facility for the Lebanese Private Sector' projects aiming at promoting innovation as an engine of growth.

Through these programs, the European Union intends to stimulate a culture of collaboration around innovation in Lebanon, and this will be done through two parallel interventions:

(1) Provision of technical and financial incentives to SMEs and research providers to develop innovative market-oriented solutions that enhance companies' growth and expansion, locally and internationally;

(2) Stimulating the innovation ecosystem in Lebanon in a more systemic way.

For the first intervention, EU is pledging around 12 million Euros through the provision of small grants and customized technical assistance support to SMEs willing to use innovation to expand. For the second intervention, a grant of 3 million Euros is made available to build the knowledge and skills' capacity of the main stakeholders of the innovation ecosystem to support innovating activities, technology transfer, intellectual property protection, and commercialization of applied research.

- The industrialists recognise the importance of R&D and invest internal activities from their own resources
- The external resources to fund R&D are very limited
- The R&D activities are more important in larger industries
- The R&D activities mainly concern product line improvement and new product development - This is conformant with the short-term planning of small enterprises
- Food and beverage industry is one of the major sub-sectors with significant R&D
- Outsourcing R&D is also taking place mainly with partner universities
- Clear industrial interest in using the laboratories (in particular chemical labs)
- The role of ALI in developing and modernising industrial sectors is obvious
- European and USAID funds are provided to support the development of industrial activities and particularly to establish a needed innovation ecosystem

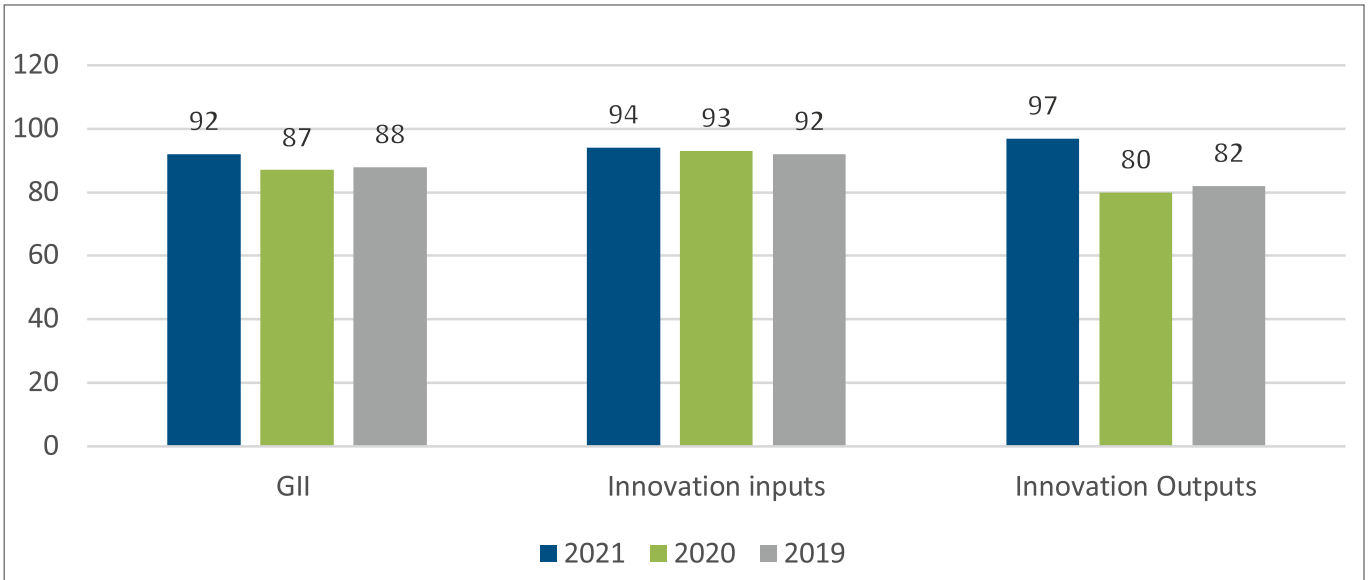
V- THE ASSESSMENT OF ACADEMIA-GENERATED INDUSTRIAL INNOVATION

A. THE POTENTIALS OF ACADEMIA-GENERATED INDUSTRIAL INNOVATION

I. TYPE AND VALUE OF INNOVATION (INTERNATIONAL MARKET COMPETITIVENESS / VALUE ADDED FOR LEBANESE INDUSTRIES…)

GII GLOBAL INNOVATION INDEX

Regarding Innovation, Lebanon ranks 92nd among the 132 economies featured in the Global Innovation Index 2021, and inside the GII its weakest point are "Business environment" (121rst), Intellectual property payment (108th), University-Industry R&D collaboration (66th), Knowledge-intensive employment(54th), furthermore Lebanon Global Entrepreneurship Index in 2019 was 66, ranking 6th among 14 MED countries, and 59th among the total 137 countries. In Lebanon there were around 54 Innovation Support Organizations (ISO) in 2018 (MIP report 2020), most of them – mostly NGOs and private organisations – don't have stable collaborations with regional and international networks.
The following graphics shows the rankings of Lebanon over the past three years, noting that data availability and changes to the GII model framework influence year-on-year comparisons of the GII rankings. The ranking of Lebanon in the GII 2021 is between 92 and 97.



Source: Global Innovation Index Database, Cornell, INSEAD, and WIPO, 2021

Figure 67. *GII ranking for Lebanon 2019-2021*

Lebanon performs better in innovation inputs than innovation outputs in 2021. Lebanon ranking is progressing slightly worse in the five input categories (institutions, human capital & research, infrastructure, market sophistication, and business sophistication) than the two output ones (knowledge & technology output and creative output).
This year Lebanon ranks 94th in innovation inputs, lower than both 2020 and 2019. As for innovation outputs, Lebanon ranks 97th. Lebanon produces less innovation outputs relative to its level of innovation investments.

Thus, Innovation linkages and public, private, and academic partnerships are essential to innovation. The GII team has been evaluating various data-based indicators to measure innovation linkages in an economy. Measuring innovation linkages adequately especially in Lebanon remains challenging:

- Global R&D companies, avg. 42 ranking
- QS university ranking, average score ranking 43
- University/industry research collaboration ranking 58

COUNTRY'S READINESS TO TRANSFORM INNOVATIONS INTO MARKEATABLE PRODUCTS

Although Lebanon ranked 92nd among the 132 world economies (GII 2021), it shows potential in innovation inputs thanks to the human capital, academic and research institutions, and a productive industrial sector. Lebanon has skilled talented & cost-competitive Workforce, firms with innovative products, internationally recognized certifications, and number of patents. However, it lacks the tools, mechanisms, financing, enabling environment and incentives to activate and commercialize innovations, hence depleting the overall innovation output.

To overcome Lebanese crisis, the country's need to transform innovations and technological findings emerging from universities into market-ready products and commercial ventures is becoming essential to drive the economy forward.

The industry's share of the national economy is estimated to 11.1% of GDP in 2018 and 10.8% in 2019, according to CAS. Industries have decreased their production in 2020 because of the continuous lockdowns but resumed their production in 2021. The last period of collapse showed the resilience of the Lebanese industry, with many companies remaining operational.
Indeed, industrial investments increased reflecting a determination to withstand the crisis as shown by the number of new licenses issued by the Ministry of Industry during the last three years. Following the deterioration of the exchange rate, the industry benefited from a dramatic improvement in demand first internally, because of the significant decline in imports and the growth of the "substitute" industry of foreign goods, and second externally due to improvement in competitiveness.

Thus, the industrial sector is recognized as one of the key driving-force for Lebanon's economy and is currently reducing the deficit of the balance of payment by transferring money in house from exports overcoming all the challenges. It is a fast-growing sector with an estimated market size of USD 615 million in December 2021 compared to 184 million USD of exports in January 2021. Furthermore, Lebanon is emerging as a leading manufacturer exporter for health equipment in the region. The share of medium and high-tech manufactured exports of total manufactured exports reached 21% in 2019 indicating promising technological capabilities in the sector. Consumer shifting from imported items to purchasing of local production is inducing in higher demand for local products.

During the last years, there has been a rapid and noticeable growth of some industrial sectors like agri-food, with internationally renowned products such as wine (and other alcoholic beverages), tahini, honey and others, and the chemical and pharmaceutical industries with high quality production. Other industries have partially declined like textile and furniture. Another trend, although more limited, is towards the utilization of advanced technology, nanotechnology, and robotics.
Some sectors like agro-food, healthcare, chemicals, Rubber and plastics, fabricated metals and ICT have shown a high potential for innovation opportunities, economic growth, and job creation.

1. Agrifood sector:

The agri-food sector is a major contributor to Lebanon's industrial sector growth and is expected to continue to play a major role in the economy. The challenges faced by the agrifood industry can be turned into opportunities if the country's imports will be replaced by local production allowing the increase in the purchases of raw material and boosting jobs. This sector is strategic to recover from the crisis while making better use of industrial production. The Food and beverage sector that has the highest share in infrastructure with 26% of total manufacturing industries, increased investments amounting to 120 million USD and highest R&D expenditures estimated at 35 million USD with a share of 39% of total. This sector proved to have high export potential to markets in Europe and other Arab countries, estimated at 974,207 USD million for 2021, almost half of which is from fruit and vegetable production (53%) and another 12% made by preparations of food products (source: Directorate of Higher Customs). Lebanese agri-food production is diversified with a wide range of traditional and innovative products being exported to regional and international markets. Despite all challenges, agri-food exports have been growing by 51.3% between 2018 and 2022, highlighting the sector's potential and resilience.

2. Pharmaceutical Industry:

Capitalizing on its competitive advantages, Lebanon's nascent pharmaceutical market is experiencing fast growth and becoming more competitive regionally and internationally. Opportunities are available in the manufacturing of Over-the Counter (OTC) medicine, generics and patented drugs under license of international companies. Lebanese pharmaceutical companies already started relocating branches and opening subsidiaries abroad. The health and pharmaceutical sectors include a strong cluster of pharmaceutical players, highly renowned medical schools, and research facilities. The market size of the pharmaceutical sector stood at USD USD 1.82 billion in 2018 and is expected to grow. Patented drugs account for around 50 % of the market, and over-the-counter (OTC) and generic drugs account for around 25 % each (IDAL). The sector includes 13 manufacturing industries. The biggest are Pharmaline, Benta Pharma M, Algorithm, Mediphar laboratories, Alpha Laboratories, MIDDLE EAST PHARMACEUTICAL & INDUSTRIAL CO, ARWAN PHARMACEUTICAL INDUSTRIES, LABORATOIRE VETERINAIRE LIBANAIS L.V.L, SERUM PRODUCTS.

Pharmaceutical Exports have been increasing in the last six years, reaching USD 53,000 million in 2019 compared to 30 million USD in 2012.

We note here that the share of pharmaceutical exports decreased to 31 million USD in 2022 following the restrictions set by the Government to forbid the exports of drugs that are subsidized by the Banque du Liban.

Lebanon already manufactures around 21% of total generics available in the market therefore there is an opportunity to increase this ratio especially after the Government declared its intention to amend existing regulations to allow pharmacists to offer generics brands of prescribed drugs to patients (IDAL).

3. Chemical Industry:

Lebanon's chemical sector has advanced and matured over the last years, positioning itself as a major player in the regional market. Several opportunities are available within this sector ready to be exploited in the high added-value chemical production that can serve niche global markets.

Production in the Chemical industry in Lebanon is mainly concentrated in phosphats, paints, varnishes, coating (30% of industries), cosmetics, perfumes, detergents and soaps and derivatives (32%), and pharmaceuticals (11 industries cited above). The Gross Value-Added of the chemical industry stood at USD 254 million in 2018 (ranking 2nd after food and beverage) and industrial output reaches USD 800 million.

Exports exceeded USD 343,200 million in 2021, accounting for 16% of total industrial exports.

This sector is expected to become more competitive witnessing increased investments since Lebanon signed its first offshore oil and gas exploration and production agreement in 2018 with drilling expected to start in the coming years. This might create new opportunities for the development of downstream industries including plastics, fertilizers, and other petrochemical products (IDAL).

The chemical sector can also benefit from increasing demand in the Arab countries for construction materials especially the paints and plastic industry.

4. ICT manufacturing digital sector:
The ICT sector encompasses ICT Services and Manufacturing, Hardware Retail, and Telecommunications. Around 550 companies are involved in ICT Services and Manufacturing, which represents the most productive component of the "knowledge economy". They are mostly small and medium-sized businesses (IDAL). Around 10,150 high-skilled individuals are employed in ICT Services & Manufacturing companies, the majority falling in the Software sub-sector. This sector has been striving mainly in software and digitization solutions regionally and is easily exportable due to its solid international reputation and global network. Given the skills and low cost advantages of employing the local workforce, there is an opportunity to position Lebanon as a hub for digital innovation activities. According to McKinsey and World Bank reports, the sector employs 4.5% of the workforce, but the estimate total workforce amounts to at least 5.8% of the active population, with a potential increase of persons hired, also absorbing the graduates from shrinking sectors. This makes it an asset for further development and job creating opportunities. This sector wasn't included in our survey since these companies do not register at the Ministry of Industry except for companies that assemble hardware. The ICT sector in Lebanon has demonstrated over the years a strong capacity for growth and a unique resilience in the face of economic uncertainties. Its export-oriented nature, low capital requirements, and robust regional and international demand make it an ideal sector for investment. A variety of opportunities exist across a broad spectrum of ICT activities:

a. Cloud Computing: Clouds offer an important opportunity for development. Opportunities exist at two levels: building or participating in building clouds, and cloud computing. Instability problems, deteriorated electrical services, and weak Internet connections reduce the attractivity of Lebanon for the installation of data centres. These prohibitive elements affect much less computation and services. Some engineering programmes have introduced cloud computing and big data courses and prepared skilled human resources to make a good usage of cloud resources, advise on building and using clouds, and/or develop programmes to process big data existing on clouds. Moreover, cloud computing can be also used to develop the Lebanese traditional industrial sector and transform it to enter in the 4th industrial era.
This can be done at many levels including: smart marketing, intelligent client services, product line automation, etc.

b. Artificial Intelligence: As for cloud computing, skilled engineers and data scientists have been prepared and are ready to participate in the development of artificial intelligence. Many start-ups exist today and are active in using artificial intelligence to solve problems in many sectors. This trend is expected to develop further in the coming years.

c. Robotic Process Automation: Automation and robotics is another field where skilled human resources exist. The use of modern technologies in this domain may help transforming many industries enhancing their efficiency and competitiveness. Start-ups can also offer their services in this domain regionally and/or globally.

d. FinTech/ EdTech/ HealthTech: HealthTech/ Medical technologies innovation has been identified lately, and specialized innovation program by top Universities supported by Banque du Liban funding has been taking place even during the crisis. E-health may also contribute to improving the healthcare system, allowing more citizens to receive appropriate services. Therefore, fostering advancements by leveraging on technology development and research & innovation projects in this area is crucial.

5. Rubber and plastics, Mineral products and fabricated metals are three remaining sectors with high R&D expenditures and high potential of expansion that might help the country overcome its crisis.
Connecting local research and innovations with those sectors through technology transfer, is a major driver of value creation and innovation for the country. The industrial mapping conducted shows a high interest of industrialists to foster intrapreneurship and their readiness to receive innovative students and integrate their innovations in their establishments. Therefore, it is essential to encourage the development of innovation that address market and develop technologies via licensing, selling and spinning-off into ventures.

INNOVATION DEVELOPMENT IN ITS NASCENT STAGES

Prior to the latest crisis, Lebanon has witnessed a rapid development in area of innovation and entrepreneurial ecosystem with a surge of companies due to the vitality of the private sector and the implication of the government. The support infrastructure for entrepreneurs has expanded with a system of incubators, financial support, Venture capital (VC)s, and a range of private sector and programs, and acceleration organizations: UK Lebanon Tech Hub, AltCity Bootcamp, Speed, Smart ESA etc.

Indeed, Lebanon's central bank—in an effort to foster the digital economy—initiated Circular 331 in 2013 to subsidize investments in start-ups in the knowledge economy. With the issuance of Banque du Liban circular 331, The entrepreneurship ecosystem experienced a significant boost of the start-up scene, with a rise of start-ups, accelerators, venture capital Funds, and ecosystem support programmes. The Circular issued in 2014 provide between 400 and 650 million USD in guarantees at 85% for banks and venture capital funds to support start-ups, particularly in the technological sector. The BDL circular and other sponsors such as World Bank-Kafalat and USAID have resulted in multiple VC and matching funds for Lebanese entrepreneurs. However, the local infrastructure (legal, internet, taxation, etc.) was not ready and did not incentivize a big number of entrepreneurs to start their companies in Lebanon. According to the Global Entrepreneurship Monitor, Lebanon's ecosystem includes a high number of early-stage entrepreneurial activity, reaching 15% of the working-age population due to country's liberal economic policies with high involvement of the private sector.

In addition to its efforts to foster the entrepreneurship ecosystem, Banque du Liban provided funds for academic industry-oriented projects for early-stage development through LIRA program.

Furthermore, Lebanese universities have launched several entrepreneurial and SME programs: AUB's Centre for Innovation Management and Entrepreneurship, the INSTITUTE@MSFEA, LAU's Institute of Family & Entrepreneurial Business (IFEB), USEK Asher center in partnership with Mr Carlos Ghosn.

Somehow, after a steady growth from 2013 following national initiatives encouraging investments in start-ups, this sector has been severely hit by the economic crisis. In 2020 Lebanon ranked 151 out of 190 countries in starting a business (World Bank, 2020). The banking system has stopped lending and funding the industrial sector, and many venture-capital funds, incubators, and accelerators have ceased their operations opening way for new private funds sponsored by diaspora and international banks. Therefore, relaunching and fostering an innovation industrial driven ecosystem becomes critical as a recovery path. Lebanon ecosystem requires more improvement, as the innovation ecosystem has not matured and is in the nascent stages of Innovation.

IMPACT OF THE COVID-19 PANDEMIC: TURNING CRISIS INTO SUCCESSFUL OPPORTUNITIES

The unprecedented global crisis that resulted from the outbreak of COVID-19 has propelled industries into reinvigorating innovation in order to mitigate the pandemic's adverse effects on them and restore and stimulate growth. While the crisis has catalysed areas, such as remote working, distance learning, e-commerce, and mobility solutions, it has naturally stimulated interest in innovative health-care products. Thus, despite the economic, financial and health crisis that hit the country since October 2019, investment opportunities have come to light and industries benefited from growing demand for various products and services needed to fight COVID-19.

While the pandemic adversely affected all sectors of the economy, its impact on innovative enterprises has been somehow less dramatic than its impact on more traditional businesses since innovators adjust faster and more efficiently to new circumstances. Regarding the health sector, the emergence of this pandemic has been a catalyst for growth for some industries largely depending on the sector they operate in.
High demand goods that were lately produced locally to fight Covid 19 fall under the following categories: Antiseptics, Disinfectants, Personal Protective Equipment, Medical Devices including medical gloves and surgical clothing and drapes, Manufactured Ventilator System. These products reached also foreign markets. Furthermore, one of the manufacturers started the production of the Russian Sputnik V vaccine in Lebanon by achieving the know-how transfer from Russia to the Lebanese manufacturer (Arwan). Many organisations funded by USAID (like The Lebanon Enterprise Development project, ….) were offering funds to these SMEs. Lebanon proved to be productive by translating investments made in innovation into high-quality outputs.

EMERGENCE OF NEW TECHNOLOGIES FOR FUTURE COMPETITIVENESS

The industrialists interviewed confirmed that Lebanon can be one of the thriving countries of digital innovation and identified different technologies as highly relevant to future competitiveness:

- Sustainable technologies
- Adaptation to industry 4.0
- Use of artificial intelligence
- Use of Big data
- Software investment
- Robot use
- ICT hardware & services investment
- Global organization of company's R&D processes

The ICT sector represented about 2% of the GDP in 2019 with more than 500 SMEs (IDAL report) and 4.9% of service exports in 2020 (World Bank). Compared to an average of 5 to 15% in the rest of the world, a potential to grow Lebanon's digital economy is real. Lebanon has been a key regional player in the digital industrial sector and ranks very high in good performance and participation in the network economy in terms of use of and investment in ICT. One of the reasons for such relatively high performance is the level of technology in Lebanon, including technologies developed internally as well as readiness for the adoption of technologies of the future, such as the Internet of Things (IoT). Although hardly hit by the current crisis, CCIs (computer and communication industry) still represents an opportunity for the country's future.
They encompass different economic sectors, including industry (jewellery, fashion, and furniture) and the knowledge economy (high skilled media and gaming industries), and they rely heavily on Intellectual Property and do not require initial high investments.

Thus, one of the promising sectors would be investing in information technology which may boost company's growth. An investment in new technology can reduce costs and improve profitability, inform of latest developments in information systems and communications technology (video and board games, Artificial Intelligence, Programming, computer simulation, machine learning, VR …,).
According to the Board of Directors of Association of Lebanese Industrialists; Industry 4.0 that refers to a new phase in the Industrial Revolution focusing heavily on interconnectivity, automation, machine learning, and real-time data can be a unique chance for Lebanon. Industry 4.0 follows the growing trend towards automation and data exchange in technology and processes within the manufacturing industry.
It includes:

- The internet of things (IoT)
- The industrial internet of things (IIoT)
- Cyber-physical systems (CPS)
- Smart manufacture
- Smart factories
- Cloud computing

Further, COVID-19 is accelerating the digitalization of Industries. The outbreak pandemic has pushed enterprises everywhere into an accelerated state of digitalization with enforced social distancing in place. Therefore, Lebanese Industry leaders should be looking for innovative ways to meet their sustainability goals like Digitalization. The industries must work nowadays on different achievements by adopting new technologies and automation and the workforce should have the necessary skills to follow. This is known as digital transformation. Moreover, the salaries of the skilled labour force are cost-competitive supporting the development of innovative and high-value industries. This digital revolution produces a new image of productive and industrial institutions characterized by smaller spaces since organizations tend to occupy limited spaces for operations with increased productivity rate. This is the case of large international corporations that shifted from large areas of operations towards small offices with hybrid and remote work. Digitalization induced in less mechanization with broader focus on high technologies performing several functions simultaneously and operated by few employees even though engaging highly skilled technicians.

INDUSTRIAL ESTABLISHMENTS NEEDS FROM SCIENTIFIC ACADEMIC APPLIED RESEARCH: RESULTS OF THE FIELD MAPPING FOR INDUSTRIES WILLING TO COOPERATE WITH UNIVERSITIES

IRALEB conducted lately a mapping on the research and development needs of industrialists to link with scientific research in universities with the aim of developing high value-added products or production lines in interested industrial establishments as well as creating new products that contribute to increasing the competitiveness of the Lebanese industry and securing job opportunities for youth and graduates.

Surveyed industrial decision-makers were asked to list the kind of partnership they would like to engage in with the university. The questionnaire identified industrial establishments that want to cooperate with universities to:
I. sponsor academic projects
II. co-invest in entrepreneurial spinoff companies
III. upgrade existing product or production line
IV. develop a new production line
V. develop a new product or vi/ foster Intrapreneurship.

As shown in the following figure, out of 305 respondents:
- 93 mention that they would like to sponsor academic projects, 11 might also be interested.
- 65 are willing to invest in entrepreneurial spinoff companies led by academia, 20 might also be interested.
- 250 would like to engage with academia to upgrade existing product or production line in their companies.
- 200 would like to engage with academia to develop a new production line.
- 225 would like to engage with academia to develop a new product.
- 253 want to foster Intrapreneurship:
  receive innovative students and integrate their innovation into their industry.

Same Industrialist can show interest in engaging in different kinds of collaboration with academia.

The below chart ranks the readiness of these industries to cooperate with academia at different levels:

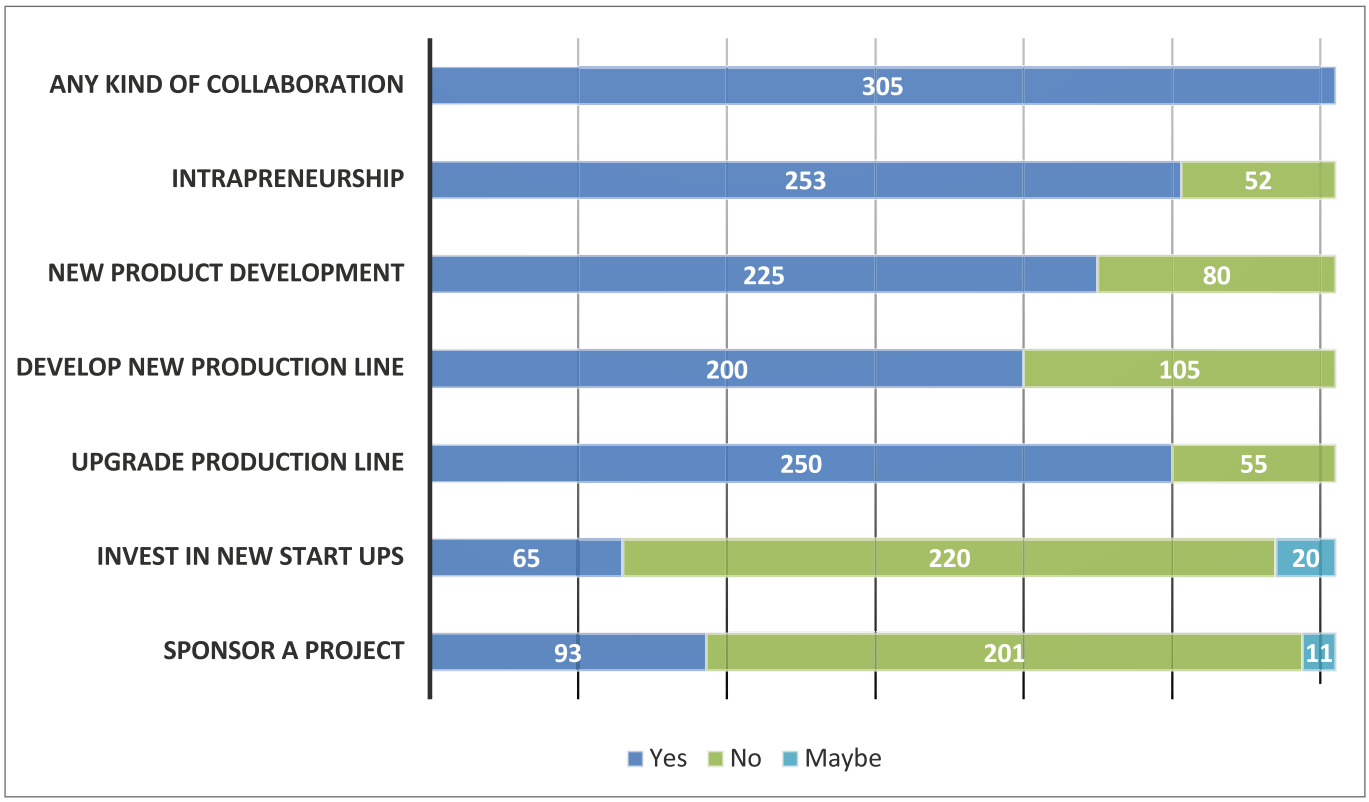


Figure 68. *Industrial Establishments needs from Scientific Academic Applied Research*

Even having limited interest in sponsoring academic project, many of the surveyed industrialists expressed their readiness to cooperate and engage with academia to upgrade existing product or production line in their companies or develop a new product in their factories. At first glance the survey shows a great readiness in cooperation. However, the low interest in investing in new start-ups and in sponsoring projects indicate that issues exist and are related to the profile of the industrial sector in Lebanon. SMEs are generally not keen to engage in long-term investment. They are favourable for short-term investments directly connected to their stream of activities.

21% of the industries hiring between 20 and 29 employees are willing to cooperate with academia where the biggest number of industries are located, followed by 19% of the industries hiring between 50-99.

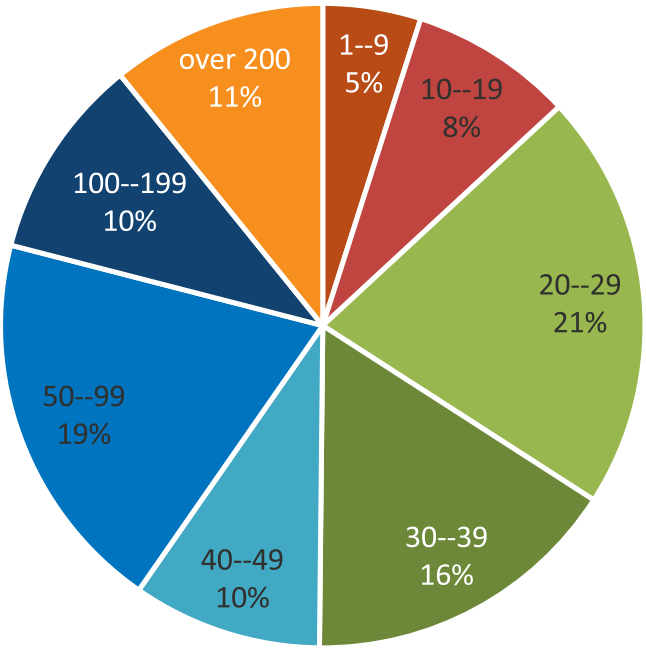


Figure 69. *Distribution of Industrialists "interested in engaging with academia" by workforce*

The industries having main interest in:
I/ Investing In R&D
II/ Investing With Startup
III/ Upgrading Production Line
IV/ Develop New Product Lines
V/ Npd
VI/ Hire innovative students and integrate their innovations are mainly located in Metn (75), kesrouan (35), Aley (22), Baabda and Zahle (20 each).
These 6 areas are hosting 64% of the 305 industries willing to cooperate with academia.

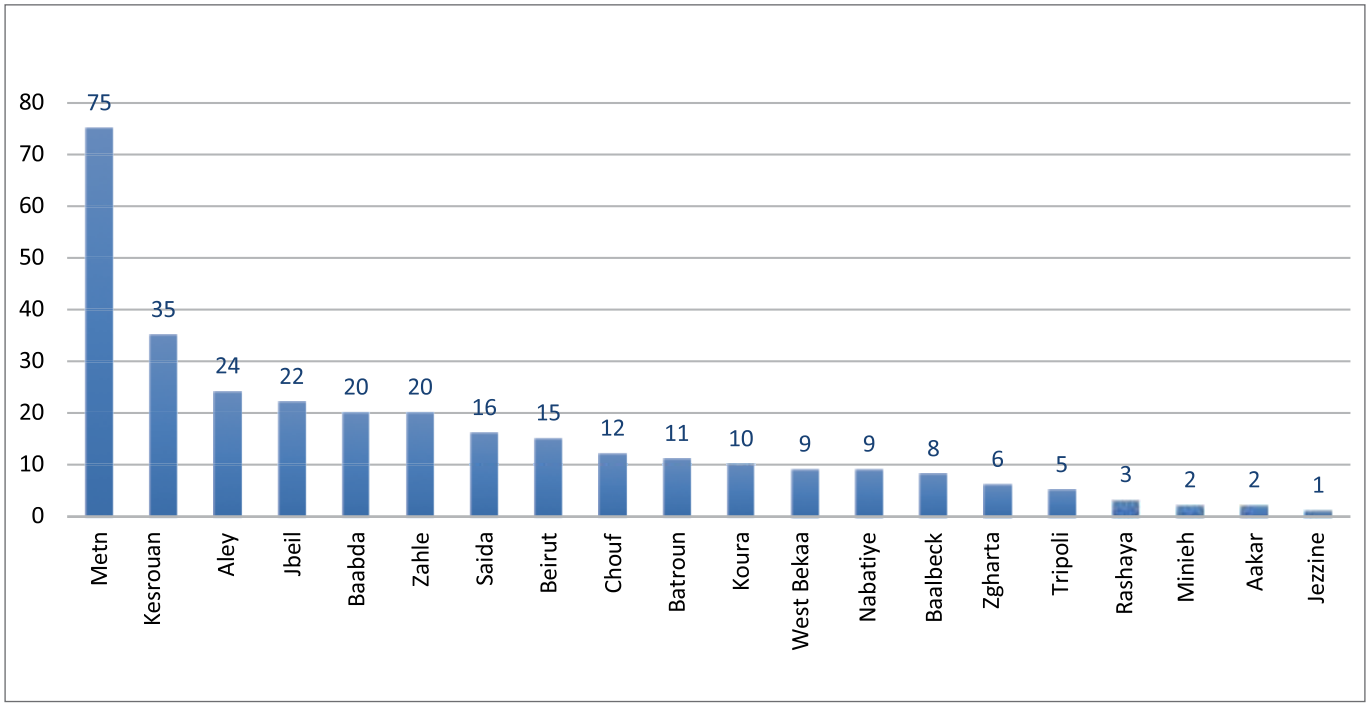


Figure 70. *Geographic Distribution of 305 Industrialists "interested in engaging with academia"*

The Food and beverage is the biggest sector hosting 38% of the industries willing to cooperate with academia followed by 10% for the chemical sector and 9% for the fabricated metals.

The geographic distribution of the 305 industries that have industrial needs from academic reserach is as follows:

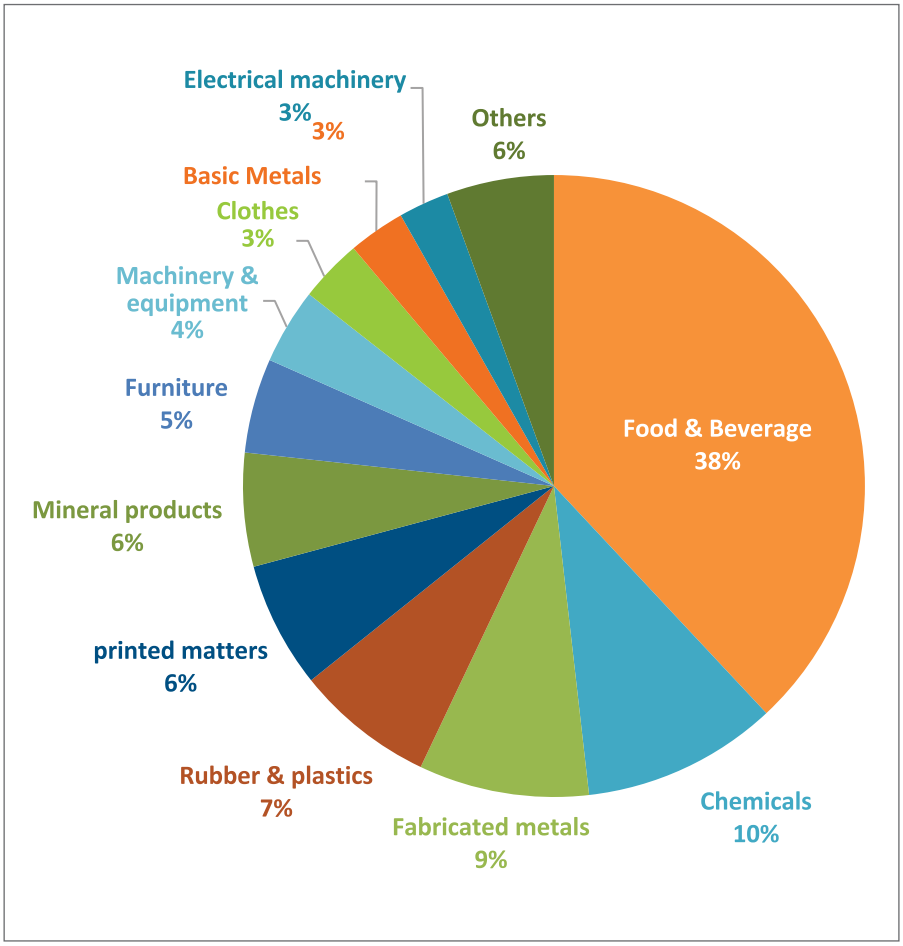


Figure 71. *Industries ready to cooperate with academia by sector of activity (305 ind)*

Out of 93 surveyed industrialists who expressed readiness to sponsor academic projects, 39 are in the field of mechanical, 34 in the agrofood, 24 in packing and packaging, 22 in electronics and 12 in chemical and other related applications.

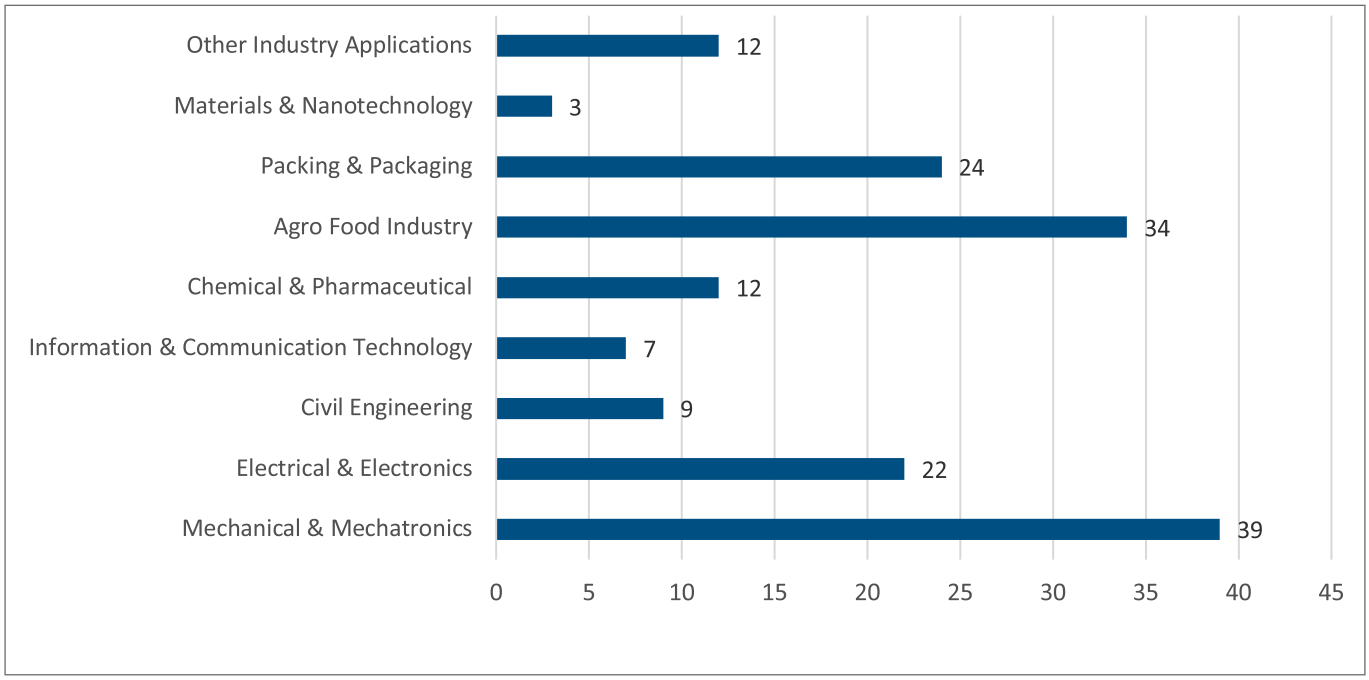


Figure 72. *The most chosen specialisations for industries willing to "Sponsor Academic projects"*

81 industrialists stated they would like to develop R&D projects with Academia related to the Food and beverage sector followed by 58 industries for machinery and equipment's and 37 industries in chemicals.

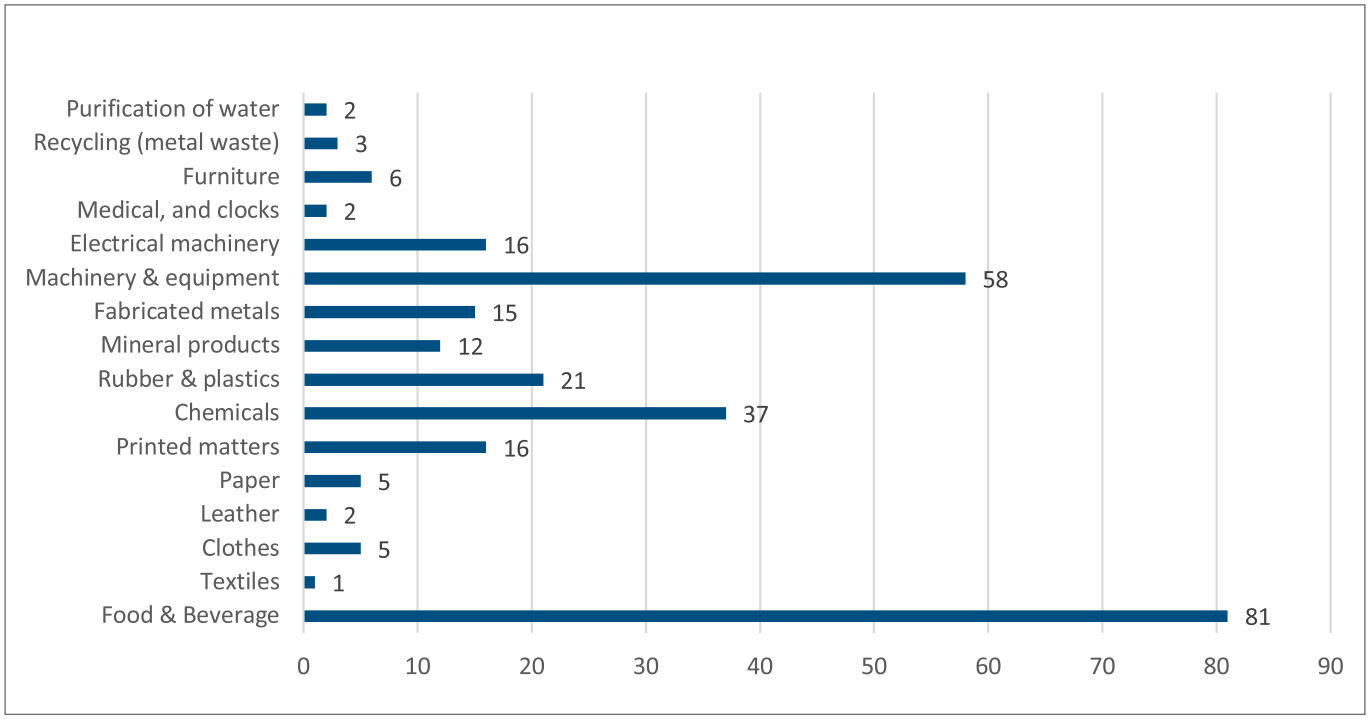


Figure 73. *The most chosen economic activities of the R&D project by Industries willing to "Develop New Product"*

The most chosen economic activities for the winning start-ups selected by 65 surveyed industrialists is as follows:

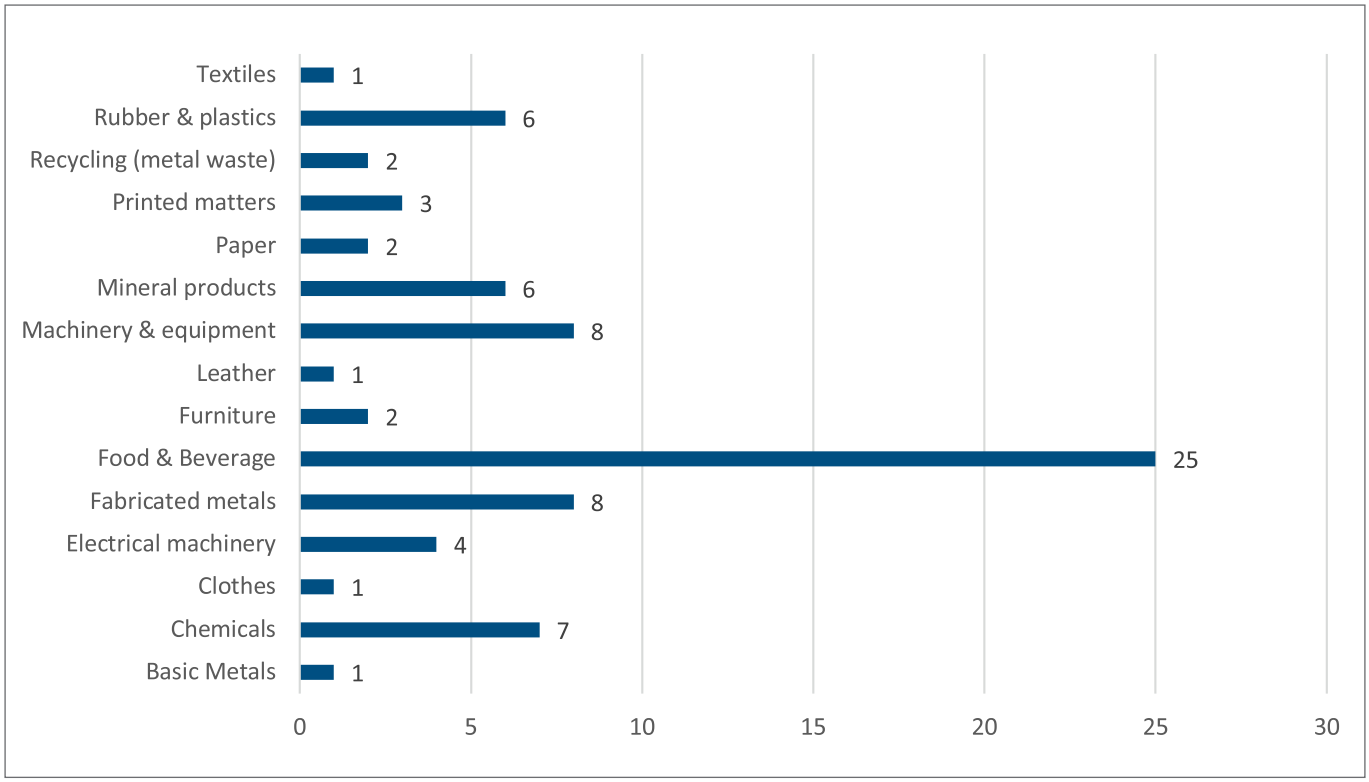


Figure 74. *The most chosen economic activity for the "winning start ups" industries are willing to co-invest in*

THE LEBANESE DIASPORA

The diaspora investors formed of Lebanese businessmen, successful entrepreneurs and civil servants are more likely to invest in their country of origin. Soliciting investments from the Lebanese diaspora could help offset the lack of funding and freezing of the banking system and can be channelled to create opportunities in Lebanon. Building database of potential industry partners with particular focus to Lebanese diaspora is critical at this stage.

The Lebanese diaspora can help in:

- Providing funding and Investment in potential start ups
- Ensuring enough grants for academic research
- Facilitating access to foreign markets for Lebanese industries
- Providing market specific expertise and technology.

> In line with the profile of SMEs, the Lebanese industrialists are keen to cooperate with academia to develop new products, upgrade or develop new product line, to foster intrapreneurship more than supporting a project or investing in a start-up

> The industrialists interested in cooperating with academia are not uniformly distributed at the geographical level

> Food and beverage industry, chemical industry and machinery industry are the most interested in cooperation with academia and in investing in start-ups

> When interested to sponsor a university project, the interest is in the following domains: mechanical, agri-food, packaging, and electrical and electronical

II. KNOW-HOW AND KNOWLEDGE TRANSFER

The Lebanese innovation ecosystem can rely on a small and dynamic research environment with relatively good number of researchers and scientific production. Although its scores in overall innovation are low, Lebanon can build on a skilled human capital and productive sectors in order to transform its economy to a knowledge-driven one. Lebanon tends to have niches of research and innovative activities in many industrial sectors.

Technology transfer that involves connecting local research and innovations with industrial sectors' opportunities is a major driver of value creation and innovation for the country. Therefore, encouraging the innovations that address the market and develop technologies via licensing, selling and spinning-off into ventures is crucial at this stage.

Lebanon has fundamental elements to move along the path of innovation. Lebanon enjoys a substantial scientific infrastructure and has the capacity to innovate and develop new products, whenever support is made available. A skilled scientific and technological community is embedded in many universities and higher education institutions, of which a least 14 include science and/or technology faculties and 6 research centres.

The development of the innovation ecosystem must profit from the resources and expertise existing in academia. Bridging university and industry is crucial in this perspective. Technology transfer forms a major tool that can serve the purpose. It allows the transfer of the know-how from a pure academic environment to the socio-economic place generating added value. It is clear from the landscape drawn in the survey that technology transfer is still not at top priority in universities. Accelerating technology transfer as needed, requires enabling policies and funding. Dialogue and raising awareness are also key elements to reach an environment conducive of technology transfer.
The Ministry of Education and Higher Education is working towards facing the challenge of employability of graduates. For this purpose, and in collaboration with international organizations the Ministry is defining policies to foster the bridging between academia and the socio-economic environment. Transferring the outcomes of R&D is supposed to benefit of the national economy and social development. Technology Transfer intends also to create an attractive and financially rewarding environment for RDIs and scientists. Providing researchers and scientists with the IPR for the outcomes arising from government or private-funded research projects, will encourage them to engage in technology transfer and to commercialise the technologies produced.

III. ACADEMIC-LED INNOVATION POTENTIALS

As shown in the survey universities have engaged several initiatives to develop and support innovation and its transformation into a socio-economic impact. These initiatives are divided into several classes.

EDUCATION LEVEL

Courses on entrepreneurship have been included in different curricula at many universities. In addition, guiding rules have been emitted encouraging the instructors to develop innovation and entrepreneurship elements in their courses.

Moreover, professionals are frequently invited to participate in the delivery of courses or parts of courses. Extreme cases also exist where industrialists are behind the development of a full programme, like the Master in packaging developed in the Faculty of Sciences branch 2 at the Lebanese University.

In most of the universities' programmes training periods are included and final-year projects are required. Encouraging students to define projects in collaboration with industry and socio-economic actors is common.
This is also measured by the level of participation to the LIRA activities.

Besides courses, training periods, and final-year projects, the survey shows clearly that the universities tend to encourage the establishment of clubs that promote innovation, entrepreneurship, and technology transfer. This proves that the university and the students understand the need to develop innovation and transforming it to become a socio-economic added value.

Finally, work-study programmes are not very common in the Lebanese context. This forms an axis where innovation and cooperation can be promoted. It is worth mentioning in this direction the interest shown in the survey by the industrialists for intrapreneurship.

The many initiatives that promote innovation at the educational level remain individual and not systemic. As shown in the survey not al universities have entrepreneurship centres and the functions of such a centre are not commonly defined. It is not systematic to have advisory boards for programmes that include industrialists and only few cases exist where industrialists participate in the definition or update of curricula.

RESEARCH LEVEL

As shown in the survey a large share of the research projects is applied multidisciplinary and has obviously an innovation component included. However, the survey also shows that no concrete systematic incentives are provided to promote innovative applied research at the university.
Intellectual property rights are not clearly defined across all the sector, and where they are defined, they seem sometimes non-encouraging to engage in innovative applied research activities as reported in the survey.

Many research projects, especially when funded by international programmes, involve both universities and industrial partners including in some cases ALI, IRI and LIRA.

However, the survey has shown that industrialists in general are less keen to support research projects if they do not directly serve the development of their products or product lines.

At the structural level, it seems that many university initiatives have also promoted the cooperation with industry.
In their rules for seed money support of research, several universities promote multidisciplinary, innovation and involvement of an industrial partner. This is the case for example for University of Balamand and the American University of Beirut among others.

Laboratories also form a domain of cooperation between the industry and academia. Many laboratories in several universities are fully or partially funded by industrialists, e.g., at AUB, USJ, LAU, UOB, USEK, ….

Moreover, the survey has shown that the industrialists in general are keen to use many of the university laboratories, and vice versa several universities are willing to grant access to their laboratories.

INCUBATION AND ACCELERATION

As mentioned earlier, Berytech is the first serious structural initiative done by “Université Saint Joseph”, to create an incubator to support transforming innovation into start-ups. By leveraging Lebanon's human capital, some other leading universities such as LAU, AUB, and USEK are also playing key roles in providing the critically needed support to nurse the new entrepreneurial initiatives in Lebanon by providing both space and coaching to the emerging new entrepreneurial ventures.
The survey has shown the limited relationships between universities and incubators/accelerators of other universities. Fostering such cooperation is needed.
Financial support driven by both local and international funding structures can support the incubation/acceleration processes. This shall push forward an innovation-driven economy in Lebanon.

IV. ASSESSMENT OF IRALEB POTENTIALS AS A HUB FOR INDUSTRIAL INNOVATION

LIRA MISSION: 25 YEARS OF EXPERIENCE IN TECHNOLOGY TRANSFER AND DEVELOPMENT OF APPLIED RESEARCH (IRALEB)

LIRA programme which is a successful initiative in the technology transfer ecosystem in Lebanon, has been institutionalised, under the name of IRALEB, in the form of a non-for-profit organization supporting research, and the transformation of applied research into marketable products. The organisation was founded by the Ministry of Industry, the Association of Lebanese Industrialists, and the National Council for Scientific Research. IRALEB regroups in its organizational structure a Board of Trustees, an Executive Board, and a Jury Committee in addition to a General Assembly. The Executive Board is formed by partner university representatives, industrialist’s sponsors, donor’s representatives, and a management team.
The goal is to provide university researchers with career opportunities that match their potential, in order to reduce the brain drain while supporting advancements in the Lebanese industrial sector and tackling innovation and challenges. IRALEB works on developing the potential of the Lebanese Youth to foster value creation and quality employment opportunities. IRALEB has officially partnered to date with 13 well-known Lebanese universities and several leading local industries.

Since its inception in 1997, the programme has supported pioneering students and research professors, in transforming scientific research into industrial applied reality. An annual exhibition is held to display the achievements of the implemented industrial research.
Developed projects are exhibited after being subject to rigorous scientific evaluation and rewarded for excellence in applied research.

IRALEB works not only on the promotion of collaborative R&D through the incubation of ideas, search for partners networking, organization of seminars and forums but also on co-financing of R&D projects through Grants.

IRALEB SUPPORT FOR INNOVATIVE YOUTH INDUSTRIAL RESEARCH APPLIED PROJECTS IN EARLY PHASE INNOVATION THROUGH L.I.R.A ANNUAL FUND FOR LEBANESE ACADEMIC RESEARCHERS (GRANTS FOR APPLIED RESEARCH).

In 2016, LIRA initiated a fund co-supported by Banque du Liban and partner industrialists to finance the costs of industrially oriented projects undertaken by academics. The purpose was to conduct joint industrial research projects (FYP, MS and PhD projects) and bind them with the industrial needs. Currently, although the BDL Fund has been suspended following the Government restrictions, IRALEB continue to co-fund industrially oriented projects undertaken by Academics with the support of industrialists in the purpose of upgrading new products and production lines or developing new production lines with their partner industries. Like previous years, the programme provides financial and industrial support for joint research projects between industry and the university.

The funds provided by IRALEB to sponsor academic industrial projects are very limited compared with the requested budgets to implement the prototypes. While an average value of 361,000 $ is requested yearly for admitted projects, IRALEB could only fund around 23% of this budget with an annual average budget of 84,000 $ between 2016 and 2022.

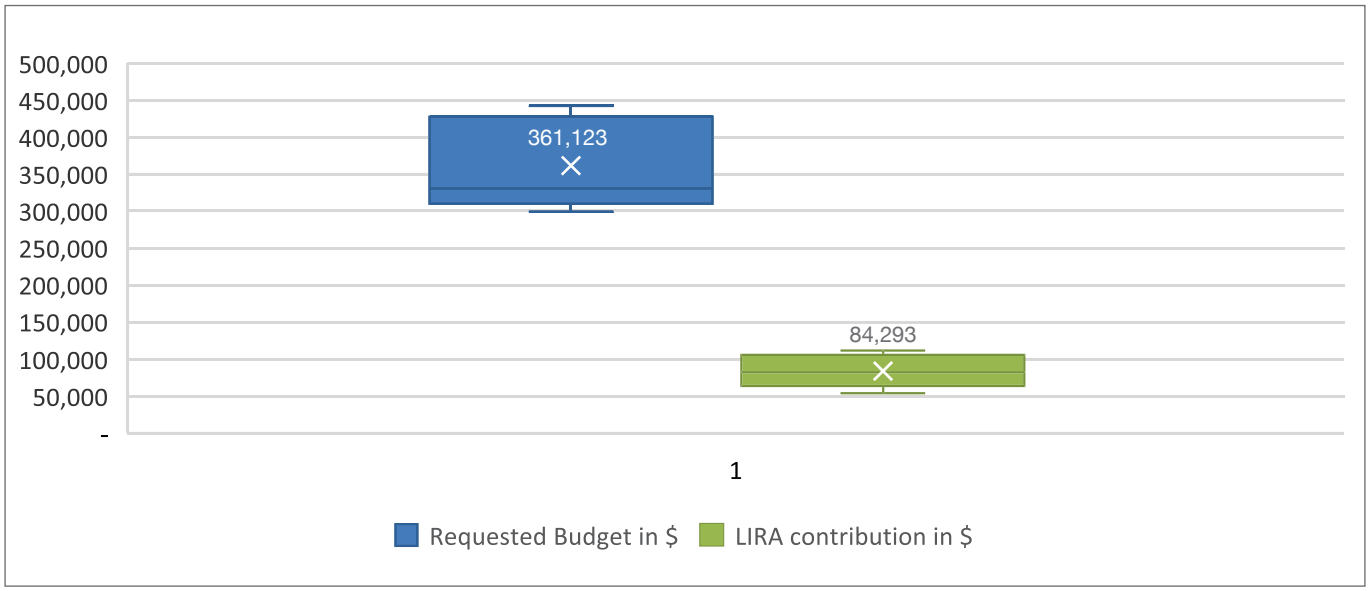


Figure 75. *Average of funds provided by LIRA to Academics per year (in $)*

The table below indicates the number of projects that have been funded since 2016 with the support of Banque du Liban in addition to the amount of yearly funds that have been provided compared with the requested ones.
Following the recent economic and financial crisis, Banque du Liban had to freeze its contribution in the benefit of industrial projects and a fundraising has been conducted near the industrialists and ALI Board members.
After two years of suspension, LIRA Funds were launched again in 2022 following the institutionalization of the programme as an NGO in the name of IRALEB.

Table 25

LIRA edition	Year	Funded Projects	Requested Budget in USD	LIRA contribution USD	LIRA share in % of total budget
LIRA 12	2016	28	299,433	53,861	18%
LIRA 13	2017	50	442,252	112,000	25%
LIRA 14	2018	46	320,104	99,400	31%
LIRA 15	2019	37	413,107	82,800	20%
LIRA 16	2022	41	330,718	73,405	22%
		202	1,805,614	421,466	23%

LIRA programme provided Funds for academic applied research (FYP, master and doctorate projects) supported by a functional prototype that would be showcased during the LIRA Forum for a total of 421,466 USD for the period between 2016 – 2022 with an average of 23% of requested budget for admitted applications.
LIRA contribution was supposed to be 50% of the prototype budget for these projects, somehow a ceiling was always fixed by the Board of Trustees due to the insufficiency of funds.

LIRA share of total budget varies between 18 and 31% between 2016 and 2022.
A yearly comparison of LIRA funds provided with required budget to implement the prototypes can be found below:

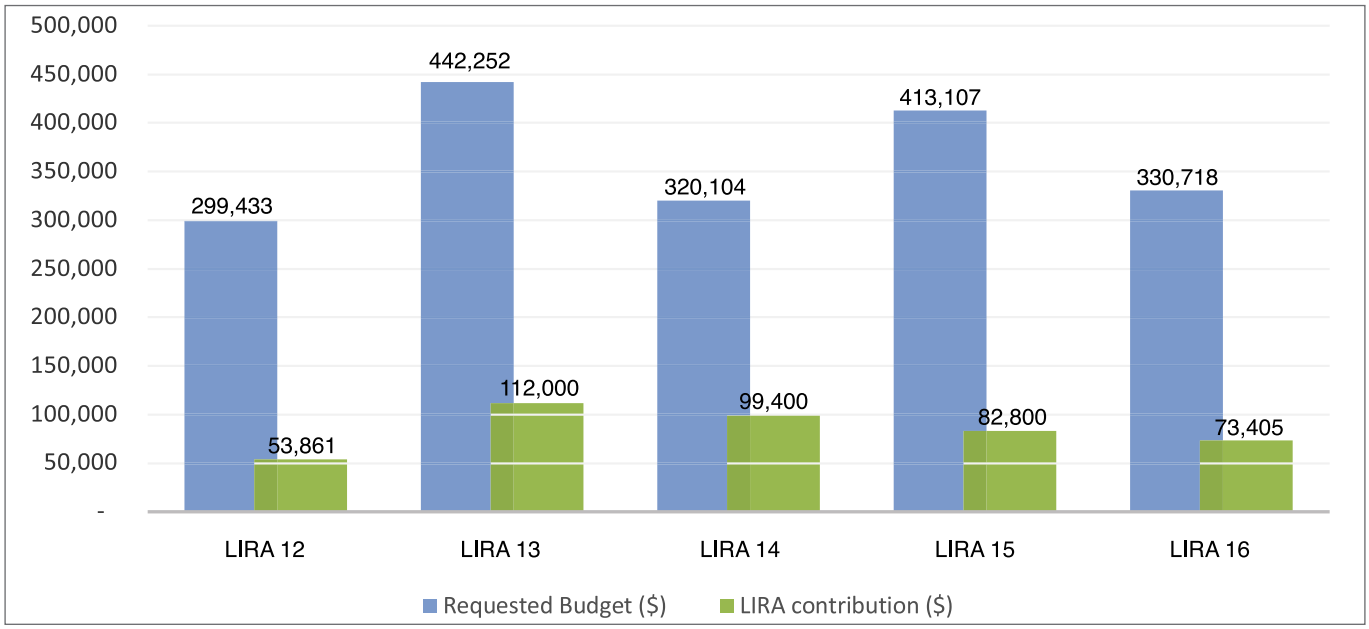


Figure 76. *LIRA allocated Funds vs requested Budget ($) 2016-2022*

LIRA FORUMS FOR TECHNOLOGY AND INDUSTRIAL INNOVATION

The national LIRA programme (recently turned into an independent organisation) brings an extensive track record of supporting local researchers and a valuable network of industrialists and academia. For the last 24 years, 14 forums and exhibitions were held. 653 projects from 15 universities, in addition to projects from professional Lebanese innovators resident in Lebanon and abroad, have participated in the competition, of which 168 projects were adopted by industrialists and 202 were funded by IRALEB (LIRA program).

Table 26

Edition	Year	Funded projects	Participating projects	Academic Institutions	Sponsor industrialists	Projects employed by Industry
LIRA 1	1997		41	2	17	10
LIRA 2	1998		50	7	21	14
LIRA 3	1999		78	6	24	20
LIRA 4	2000		53	10	13	9
LIRA 5	2001		66	10	19	11
LIRA 6	2003		50	10	22	19
LIRA 7	2004		24	7	6	6
LIRA 8	2005		39	11	10	9
LIRA 10	2010		9	3	3	3
LIRA 11	2014		34	9	6	4
LIRA 12	2016	28	51	11	26	12
LIRA 13	2017	50	85	15	50	28
LIRA 14	2018	46	73	14	46	23
LIRA 15*	2019	37		13		
LIRA 16	2022	41		11		
LIRA 1-16		202	653		263	168

** LIRA 9 included only a conference - *LIRA 15 forum was cancelled due to the strict measures imposed by the Lebanese Government with the widespread of coronavirus pandemic.*

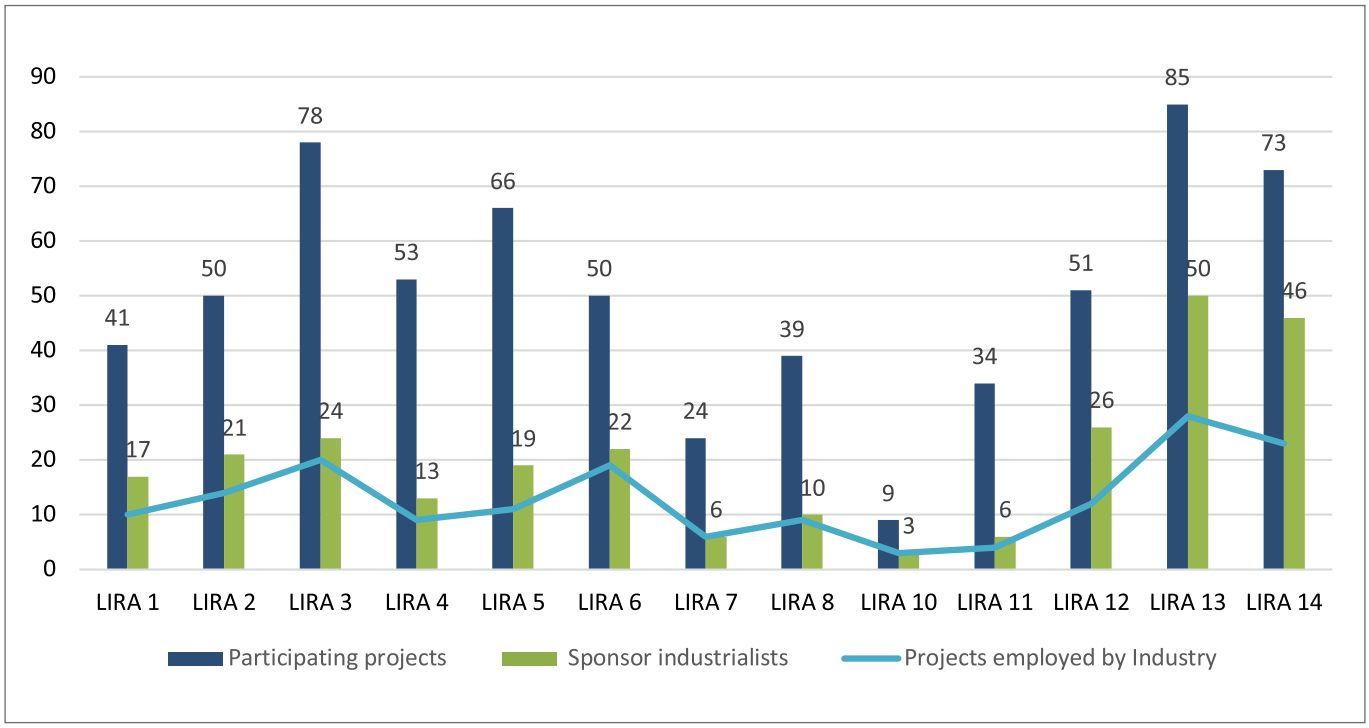


Figure 77. *LIRA Forum Exhibited projects vs sponsor industrialists*

The awards provided by IRALEB, based on the evaluation of a specialized Jury, are a combination of:
1. Monetary prizes paid by the sponsors to Doctorate projects, Master Sciences research and FYP projects that reflect a strong potential for industrial applications.
The FYP awards select top three winning teams of each specialisation from the following:

I/ Mechanical and Mechatronics
II/ Electrical and Electronics
III/ Civil Engineering
IV/ Information and Communication Technology
V/ Chemical and Pharmaceutical
VI/ Agro-Food Industry,
V/ Packing and Packaging
VI/ AI and Robotics (with focus on Gaming & E-learning)
VII/ Materials and Nanotechnology
VIII/ Other Industry Related Applications

2. Honorary awards, certificates and symbolic prices might also be granted.
3. Capacity building and Incubation awards provided by Berytech.
4. Participation in a forum for investors to present the research in front of an audience of professionals in the field (to be implemented)
5. Fund for top innovators to apply for local and international patents (to be implemented)
6. Possibility of sharing expertise with international markets in the purpose of creating collaboration agreements between local and foreign scientists or industrialists (to be implemented).

LIRA INDUSTRIAL IMPACT

The graphic below is a measurement of LIRA's industrial impact between LIRA 1 and LIRA 14 and shows the evolution of exhibited projects at the Forums of Technology and Industrial Innovation compared to number of projects that have either been employed by the industrialists sponsors or have turned into start-ups.
These industrial viable products are mainly an upgrading of the production process or an upgrading of the product itself used by the industrialist and rarely a development of a new product or launching of a new start-up.

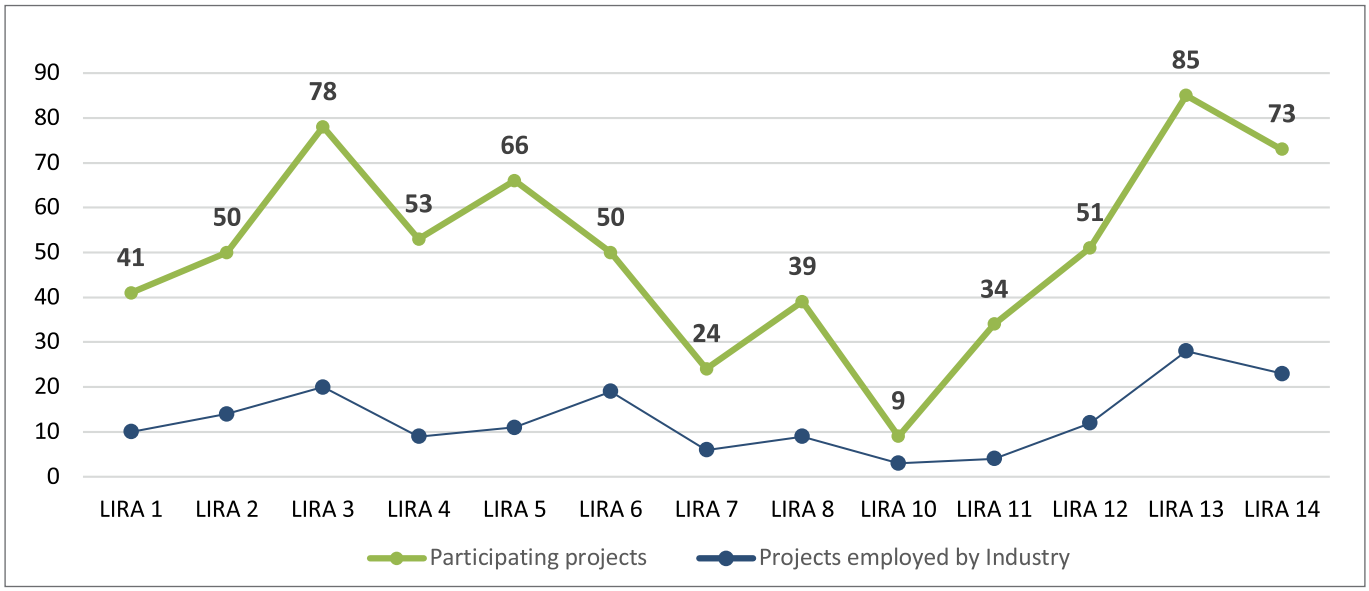


Figure 78. *LIRA Industrial Impact 1997- 2018*

Measuring Innovation is a major step towards evidence-based innovation policy making. It recognises that much more remains to be done, and points to the challenges industrialist, researchers and policy makers alike need to address.

To maximise the industrial impact produced from the collaborative research between industry and academia; IRALEB has launched a series of programmes complementary to the LIRA Fund. Indeed, after its institutionalisation in November 2021 after a forced cessation of two years with the corona virus outbreak, LIRA programme with core mission to support Youth is expanding its activities with the aim of going beyond its initial mission to support early phase innovation towards encouraging Youth to explore wider experiences and opportunities.

LIRA INNOVATION ECOSYSTEM AND PROJECT PROCEDURES: FROM CREATIVE IDEAS TO SUCCESSFUL STARTUPS

IRALEB is connecting top academic researchers, start-ups, and innovation-driven industry professionals from Lebanese industries.

After its institutionalisation, IRALEB is starting to coordinate with active partners from this network, social ventures, organizations, and institutions. These partners will bring their knowledge, expertise, networks, and support in different fields to multiply the impact of the innovation process by reinforcing the work of the start-ups and innovation driven companies.

These partners work on scaling entrepreneurship start-ups from Lebanon with innovative projects by providing them with exposure, business development, grants, access to market and funding opportunities, to grow regionally and internationally.

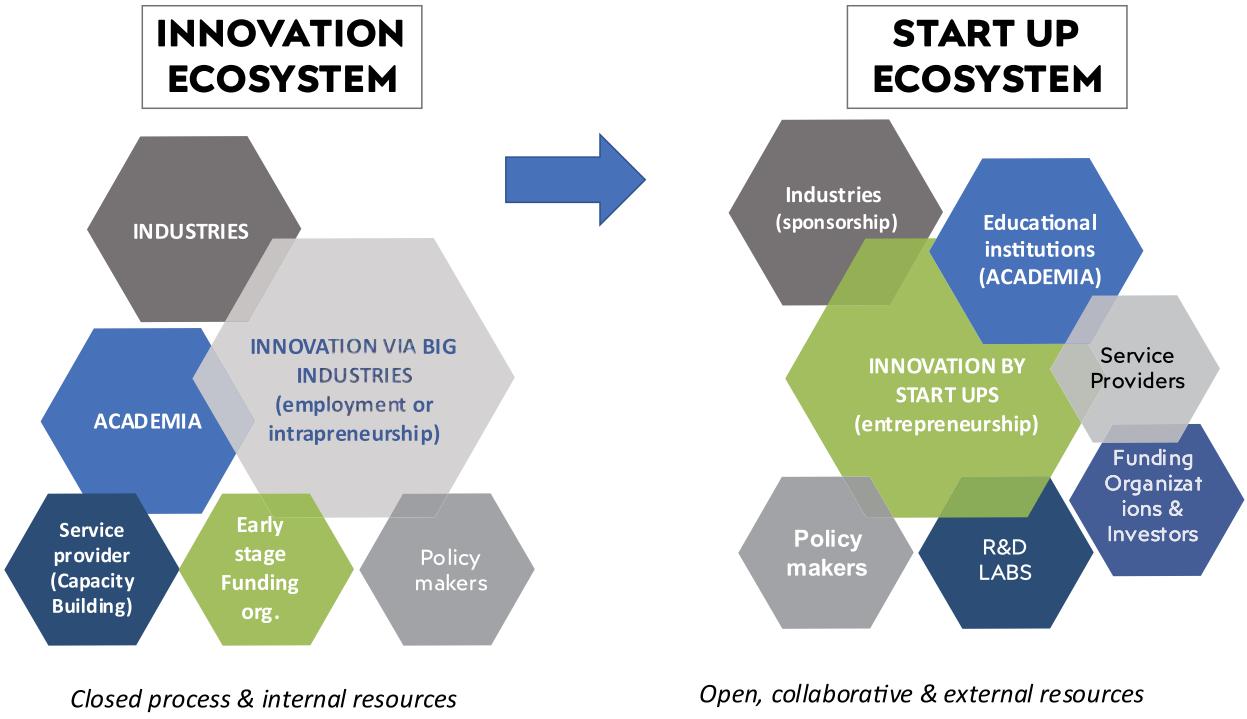


Figure 79. *Innovation and start up ecosystem*

IRALEB through LIRA programme funds research projects that are predominantly basic research for the purpose of collaboratively developing them into applied research-oriented projects.
They will be further developed into prototypes, with the technical and financial support of industrial firms. Along with this Fund, Olympic programmes are launched to select champions. Academic institutions and researchers would submit their proposals based on operational challenges, and industrial firms view the proposals and decide on which entity to collaborate with.

Industry is required to cover at least 50% of the costs through providing services, materials, and equipment's. A jury of professionals from IRALEB review the proposals and the contribution of the factories to select the projects whose remaining costs are to be covered through the LIRA fund based on their feasibility and potential for commercialisation.
These projects will also be exhibited and rewarded for excellence during the LIRA forum. The prototype might be integrated by the industrial establishment and innovator may get employed there.
Successful technology transfer allows innovators at universities to achieve greater impact and revenues by bringing a new technology to market.

IRALEB is forging links between local researchers and their counterparts in industry, while working with innovative driven industries to identify research priorities and commercialize any innovative ideas.

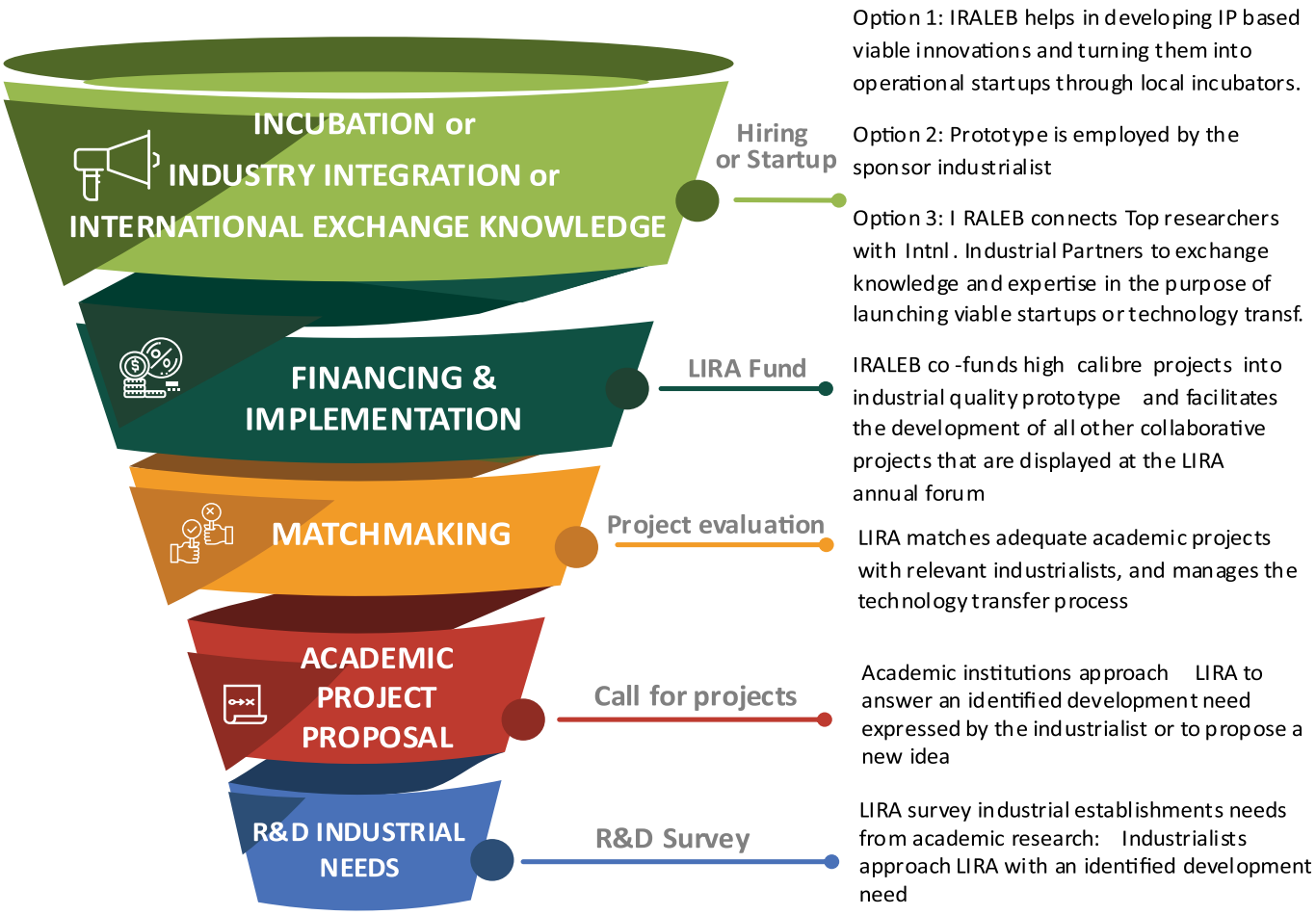


Figure 80. *Procedure of LIRA funded projectd*

IRALEB NEW APPROACHES AND PROGRAMMES

An ambitious program is currently launched to promote the development of innovative products focused on the adoption of new technologies in industries.

IRALEB aims to go beyond its initial mission to support early phase innovation towards encouraging youth to explore wider experiences and opportunities.
The Association also seeks to encourage creative students to launch pioneering start-up companies and move from the model presented in the annual forum of the program to fruitful production and integration into the industrial sector.
This can be achieved by giving them the required skills and opening the way for investors willing to cooperate with the winning students with creative projects to turn them into success stories that can turn into Lebanese products.

Therefore, IRALEB is currently scaling and expanding its horizons through fundraising. LIRA is launching calls for proposals that match its areas of interest (applied research, market-ready research, industries innovations, stakeholder collaboration, etc.) and adding activities through partnerships with key stakeholders in the innovation ecosystem.

New approaches to enhance partnership between innovation driven companies and academia or to support the creation of start-ups, are developed through the below programmes:

1- N.P.D New Product Development for Lebanese Manufacturers. This large-scale programme co-funds the process of designing a new product, producing it and bringing it to market by providing academic collaboration opportunities. The aim is to promote the development of innovative products focused on the adoption of new technologies in industries.

2- Capacity building and Incubation Support for Start-ups companies built around academic discoveries.

This business support programme implemented by partner incubators and accelerators will improve researcher effectiveness towards the creation of sustainable start-ups. A support in registering the Intellectual property will be provided.

3- Investment in Start-ups: IRALEB will map and link potential investors willing to co-invest in start-ups with their peers for the purpose of licensing or commercialisation.

4- Knowledge and Technology Transfer from University to Industry. This programme would provide Master, PHD and post doc students with valuable experience at the industry within the context of a mutually beneficial collaboration between academia and industry. University Graduates and research output must be absorbed by the industry.

5- International Exchange Knowledge: This programme will allow top innovators to share expertise with international markets in the purpose of creating collaboration agreements between local and foreign scientists or industrialists. Through this programme university researchers, as well as students might partner with international manufacturers to create start-up companies based on novel university technologies.

These new approaches will foster the transformation of IRALEB into a potential hub for emerging technologies.

The phases from identifying innovative projects until launching viable start-ups drawn by IRALeb are listed below:

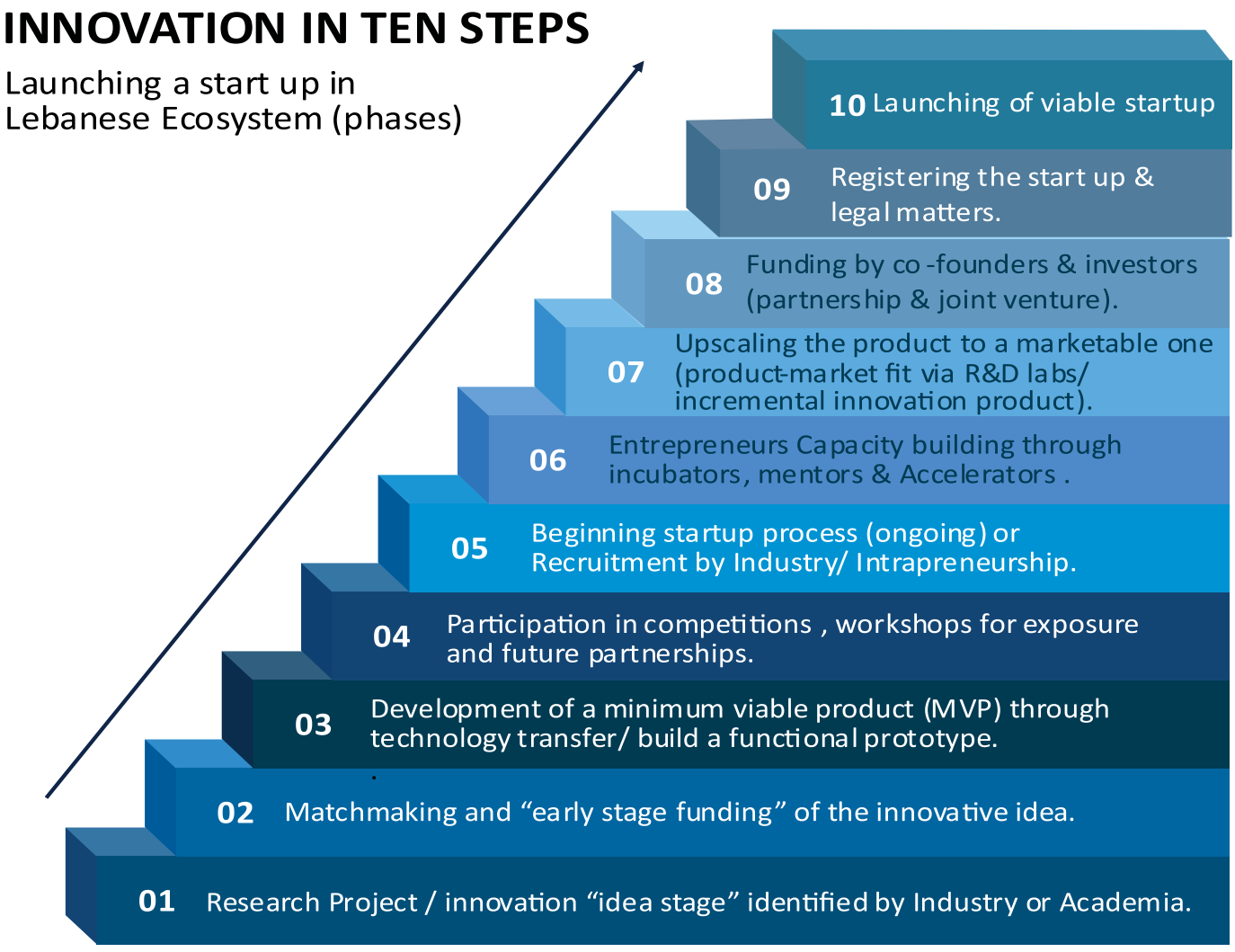


Figure 81. *Innovation in ten steps-launching a start up in Lebanese Ecosystem (Phases)*

B. THE CHALLENGES OF ACADEMIA-GENERATED INDUSTRIAL INNOVATION

The innovation challenges for students, academia and industrialists are divided as below:

I. POLITICAL CHALLENGES

Highly unstable political environment. During the last years, Lebanon faced many internal and external shocks that weakened the government and launched the country into a path of political and economic uncertainty. Due to the political instability, Lebanon is considered a fragile country that has faced several brutal violent conflicts: civil war, Syrian military presence, and the July 2006 conflict with Israel.

The Lebanese society is organized along sectarian lines of 18 recognized religious communities that each have their political leaders and parties and social institutions (schools, clinics, and charity organizations). Accordingly, citizens have historically depended on sectarian leaders for protection and provision more than on the government. Disabled by those issues, the Lebanese State has a relatively weak capacity. Despite the scattered efforts taken by the Government, the public actions/support in favour of research and innovation have been very timidly developed and there is not a clear national strategy for developing academic industrial innovation. This is mainly related to the complexity of the political and social system in Lebanon.

The Industrial sector development is hindered by this economic and political instability.

The political and economic unstable impasse coupled with the volatile currency exchange rate and highly fluctuating black-market rate is creating an extremely risky investment environment, particularly for foreign investors.

II. ECONOMIC CHALLENGES

The economic collapse Lebanon is facing is considered one of the worse recorded in modern times. Monetary and financial turmoil continues to drive crisis conditions. The exchange rate deteriorated severely over the past three years (September 2022), with the US$ banknote rate depreciating by 2474% to reach LPB 39,800/US$, compared to 1515 over the previous years.

Meanwhile, according to CAS, the inflation rate reached unpredictable scores and averaged 168% in july 2022, 155% in 2021 a 70% increase from 2020 compared to 85% for 2020 and 3% only in 2019. Inflationary effects are highly regressive factors, disproportionally affecting the poor and middle class. Lebanon has witnessed a collapse in basic services, driven by exhausting foreign exchange reserves and the high cost of the foreign exchange import subsidies on food, fuel and medication leading to the freezing of any subvention or subsidy from the government. Banque du Liban had to remove most of the foreign exchange subsidies.

The crisis started before the COVID-19 pandemic and accelerated after a huge explosion of ammonium nitrate in the port of Beirut in August 2020, killing 218 people and devastating a vast area of Beirut. Unemployment has risen to nearly 40% late 2022 from 28% in February 2020.

Access to healthcare has become limited (World bank June 2021).

III. FINANCIAL CHALLENGES

The country is currently undergoing one of the most acute economic crises witnessed globally. The amplitude of the crisis created by a deep enrooted corruption, COVID-19 and exacerbated by an unprecedented financial crisis has immersed our country in very tough challenges since financial resources had to be strained. In the short run, industrial development couldn't be available without political stability, reform of the economy and bank restructuring.

Financing innovation is nowadays a challenging issue, especially in a country that was hit by the pandemic and by the most severe economic depression. Throughout the crisis, less investment is now available, with investors becoming more hesitant, selective, and risk-averse due to high levels of economic uncertainty as well as oil price huge increase.
This has had a particularly negatively effect on start-ups according to a roundtable that have been conducted by ESCWA earlier this year. Even before the pandemic, however, access to finance (equity, loans, investment) was one of the top challenges for Lebanese in the region. Difficulty in obtaining credit is a particular weakness of Lebanon nowadays.

STUDENTS

Lack of funding is hindering the research activities.

> **Inadequacy of funds provided by IRALEB** (especially in early-stage funding and inexistence of advanced funding for applied research) compared with budget needed to implement a prototype due to the insufficiency of private and public funds collected. These funds paid in national currency have a reduced purchasing power.

> **Scarcity of funding opportunities at the prototype and product development stage.** The funding available through grants throughout the technology transfer process, is targeted towards the research stage or the final commercialisation stage, with little funding available to bridge between the two stages. For the technology transfer process to fully take place, researchers and entrepreneurs must have access to sufficient funds for upscaling their prototype into a marketable product, which turns to be lengthy and costly.

> **Limited merit-based awards for applied research.** Lack of incentives and reward mechanisms. The awards given to top quality projects are very limited.

> **Limited incubation awards** provided to top projects. Only few of the top researchers benefit from a free hosting and incubation, coaching and mentoring with experts, capacity building trainings and business support prizes.

> **Limited personal and family savings** severely limits the growth prospects and reliance on informal sources of finance, while bank lending and venture capital play a very limited role in financing future entrepreneurs.

Crowdfunding and business angels, two popular ways of securing financing among start-ups globally (outside of venture funds), are less popular in Lebanon due to a general lack of favourable legislation.

> **Gap in growth-stage start-ups revealing a need for funding for potential growth support.** A large part of applied projects in Lebanese universities remains in their early stages as shown in the survey results.

ACADEMIA

> **Limited availability for internal research funding from universities.**
Projects carried out by researchers are mostly covered by external funds due to lack of internal financial resources.
This has been exacerbated lately by the lack for financing encountered by academic institutions following the economic collapse.–w
Universities usually use available external funds provided by national entities (commonly the CNRS or IRALEB), or international donors (Cedre, Erasmus, USAID and AUF), subscribe to international research funding databases that their faculties can access, or expect their researchers to find their own sources of funding.

> **Insufficient financial capacity for funding prototyping and product development.**

INDUSTRIALISTS

> Lebanon's economic and financial crisis, coupled with the Port of Beirut blast and the Covid-19 outbreak has severely crippled industrial sectors and academic institutions.
Lebanese banks have drastically restricted the banking operations that can be carried out from dollar accounts – excluding fresh money and imposed capital controls on foreign accounts withdrawals.

> **Scarcity of banks' lending.** The banking system has stopped lending and funding the economy sectors. Only few private initiatives like Oxygene Fund, LIBank Fund are supporting industrialists to fund their purchases of raw materials or the upgrading of their production lines in addition to Grants provided through international organizations for SMEs.
Banks in the country tend to provide financing to large well-known than to smaller or newer ones, with only 13% of loans allocated by banks to SMEs even though smaller companies can be more innovative or productive, adversely affecting competitiveness levels and new business creation. This situation prevails despite all attempt to reverse it.

> **Limited liquidity for banks accounts.** Industries cannot rely on company internal resources for innovation development due to the suspension of banks payments in fresh foreign currencies.

> **Lebanese industries find it harder to pursue investments and innovation and defer the pursuit of longer-term goals living in a survival mode.**
Self-funding from industrialists can be ensured by industrialists if they have the competitive advantage to access new market; only in niche market products, perspectives are good.
As the financial crisis of 2021/22 is getting worse and with the growing interest for innovation as a way to grow and build a sustainable future, Lebanese policy leaders should incentivise those industries that create a high added value and help them finance innovation to continue to innovate beyond healthcare sector, despite the economic downturn.

> **Limited readiness of the industrial establishments to cooperate, support and request research activities with universities.** Many of the interviewed industrialists consider that they are not currently ready to sponsor universities since they are operating in a survival mode and their budget is limited and that R&D is only needed for big companies. Even the industrial mapping reveals limited interest in sponsoring academic projects.

> **Limited budget allocated to R&D expenditures:** Mainly the R&D is conducted in-house and 5 to 7% of the profit is allocated to the R&D budget. Motivating these industrialists to cooperate lies in showing them the yield that such activities can generate in the short and medium term without incurring additional cost.

> **Low overall spending on R&D by companies and limited contribution of factories to R&D knowing that the development of R&D can lead to new industrial products.**

> **Inexistence of Financial Models for R&D cooperation.** According to the industrialists, investments are to be ensured by external sources and repayment will be made by either profit sharing, debt or equity.

> **Limited funding for research due to the absence of tax incentives** since the Law on exempting R&D expenditures from taxes hasn't been adopted yet by the Parliament.

> **Limited collaboration between industry and academia in research and development** due to the scarcity of funds available with the industrialists.

IV. EDUCATION, HUMAN CAPITAL AND TRAINING

STUDENTS

> **Inexistence of incentives for Researchers and academics to create spin-offs** and not only due to issues related to intellectual property rights but also due to the absence of motivation in undergoing the lengthy process of creating their own business. Innovators might prefer selling through licensing to an existing industrial establishment.

> **Mass exodus of skilled Lebanese and graduates** looking for jobs or pursuing their higher education outside the country. Economic recession coupled with job dissatisfaction, unstable and expensive conditions of living along with devaluation of the Lebanese pound led to this emigration.

> **Brain-Drain syndrome has become a major dilemma for the Lebanese community** which is constantly losing experienced and skilled talents to Arab and Eastern countries.
Lebanese are demotivated since their career path in Lebanon is less advantageous than that they may attain abroad.

> **Weak culture of collaboration** to develop common projects.

ACADEMIA

> **Limited orientation to promote entrepreneurship courses for students.**
There is a lack of entrepreneurship-oriented education and extracurricular programs at the university level. Therefore, a collective effort should be taken from stakeholders to determine how to promote entrepreneurship and entrepreneurial learning in universities.

> **Little access to experimental and practical learning.**
More practical education, specifically business skills should be enhanced at universities.

> **Limited R&D in applied research due to the absence of any incentives for students and professors** who work on this kind of research. Incentivise students to engage in industrial research projects supervised by professionals is critical.

> **Limited academic promotion rules to encourage innovative research industry-oriented** projects. Currently the main criteria for promotion of professors are the number and quality of publications and the satisfaction of the students. This approach rarely encourages the development of applied research or their integration with the industry. Few initiatives have been launched by AUB and LAU in this regard.

> **Limited awards for distinction in research for most of the Lebanese universities.**

> **Limited professional and internship programs that hinder the creation of new technologies.** Even though the internship is compulsory for engineering students and is useful in developing skills and techniques, it should include the development of a capstone project for at least 6 months for engineers in the 3rd year of specialization in addition to research program at the laboratory for at least 2 months.

INDUSTRIALISTS

> **Lack of Lebanese skills with the right experience.** Most of the industrialists claim that the Lebanese education system does not equip young graduates at their first hiring as employees with the knowledge and skills required. In general, there is a flood of university graduates with no technical skills. There is a clear need for upskilling fresh graduates by instructing them for the digital economy opening the way for additional programs and certifications. In some sector, needs goes to Calibration, and metrology, Coding for imbedded systems and others.

> **Shortage of technical specialists, technology related skills and highly skilled workforce, and shortage of vocational programmes.**
Traditional educational and professional training are focused on theoretical learning methods. The technical formation of specialists and skilled workforce is not well developed. In addition to the shortage of vocational programs and highly technical specializations.

> **Emigration of High-skilled professionals employed in the industrial sector** to seek better opportunities abroad. The interviews shows that the worse impact of the crisis has been the loss of specific skills sets having the know how seeking for better opportunities abroad.

> **Lack of entrepreneurial curriculum that promotes innovation and creativity.** The gap in academic knowledge and real business word is a major obstacle to entrepreneurship globally and specifically in Lebanon. For example, in the engineering or science fields curriculums, little place is dedicated to train students about management of SMEs or feasibility analysis for projects.

> **Weak coordination between the industrial sector, universities and scientific research centres resulting in occasional introduction of new diplomas based on real market needs.**
During the last years, many efforts were undertaken, somehow the education system remains somehow theoretical. Even educational levels in Lebanon are being competitive with international standards, many industrialists highlight the mismatch between current skills in the market and the skills needed by the industries. We observe in Lebanon relatively high levels of skills mismatch in particular the overqualification of educated Youth, compared to Arab countries (ILO 2020).

> **Lack of awareness on the importance of R&D as driver for innovation and competitiveness.** There is a need to communicate to industries the fact that university research is affordable. R&D potential in Lebanese industries is not yet fully explored performing in its limited form.

V. STAKEHOLDERS COLLABORATION/NETWORKING

STUDENTS

> **Collaborative R&D outputs conducted by Researchers in Universities are not necessarily tailored to fit the specific needs of industry.** Academic institutions research is more directed towards the development of publications and lacks collaborations with industries. Thus, the majority of R&D outputs ended up being presented in conferences, published in reports or journals rather than commercialization. As per the industrialists' point of view, in most cases R&D investments were not cost-effective and do not benefit the industries. In addition, most large companies in Lebanon are not open to collaborating with research institutions or universities, relying on in-house R&D units or outsourcing.

> **Insufficient R&D capability and access to research** and innovation resources.

> **Weak partnerships with industries through sponsorship:** Partnerships between academia and industry which are mutually beneficial collaborations that help push the boundaries of applied research, innovation and student education are still very vulnerable in Lebanon.

> **Limited guidance for researchers and innovators from the stage of validating their innovative idea, developing a minimum viable product through joining an incubator** and getting early funding and ultimately registering their startup and launching a viable product. Mentorship, workspace and legal advise are crucial during the startup process. Innovators are skipping the early seed stages and rarely participate in accelerator and incubation programs.

ACADEMIA

> **Limited collaboration between Lebanese universities compared to more developed collaborations with international universities.** Except the existence of few agreements for common masters and doctorate specializations between Lebanese academic actors, there is as shortage in that kind of collaboration.
An MOU has been signed in June 2022 between universities member of UAOB to foster this common research.

> **Weak collaborative culture between universities due to the lack of trust** and between the academia and industrial establishments.
Few efforts are being made in this regard by the lead universities. Research projects are rarely developed by several universities. Only four industrial oriented projects developed jointly by two universities got funds since the launching of the LIRA funds in 2016.

> **Lack of guidance towards high impact technologies.** Regardless of real market needs, researchers are developing projects based on their expectation of what has high impact in the market.

> **Insufficient networking at country level,** with few interactions among the different innovation stakeholders, universities, incubators, research institutions, technology transfer offices (national network) and a scarcity of international networking.

> **Limited public-private partnerships to help accelerate the innovation ecosystem.**

INDUSTRIALISTS

> **Lack of engagement between researcher and industry during research projects:** Due to the shortage of information on the exact R&D needs and capacities of the Lebanese industries, researchers choose their research topics based on their own perception of current industrial and social needs. Accordingly, they lack of engagement with the industry prior and during their research projects which are not compliant with the current industrial capacities. This leads to projects that require additional investments to be implemented by the industry.

> **Lack of advanced R&D and supporting environment for innovation.** Researchers are more geared towards the development of scientific publications and tend to develop projects that lack commercialization potential. On the other side, industrialists need innovation support to accelerate the development of products with higher added value than those available and that address market needs and meet consumers' demand.

> **Lack of efficient and effective coordination between different actors** in the innovation ecosystem. On the state level, different ministries and public bodies are involved in the formulation and implementation of innovation policies, which leads to an inefficient organisation and weak coordination.

VI. TECHNOLOGY CHALLENGES

STUDENTS

> **Limited activities focusing on technology transfer.**

> **Shortage of technology-related skills:** Lack of specialized talents especially in the technology and creative sectors.

> **Poor and disconnected information services and lack of data on the status of innovation.**

> **Fast pace technological development.** The students must always follow the latest development and not fall behind.

ACADEMIA

> **Weak incentives and rewarding prizes that can recognise the achievements of the researcher** and help him expand his network to spin off his technology.

> **Limited resources to upgrade technologies in the laboratories.** Technology is evolving at fast pace. With the present crisis it is difficult to maintain and upgrade laboratories' equipments to remain at the state of the art. The risk of losing technical skills is real.

INDUSTRIALISTS

> **Necessity for renewing machinery to reduce cost of production,** and developing human resources capabilities to improve competitiveness and increase productivity. According to the sectorial study conducted by ALI for years 2018-2021, industrial machines are old, despite continuous efforts to modernize them even during the turbulent situation in the last two years. Mean age of industrial machines is about 15.6 years in 2020 compared to average age 7-8 years for developed countries (even lower for technology field). This can lower the productivity and development of the industry. Modern technologies used in the institutions indicates some interesting findings. Few institutions (3%) apply full automation in production, while 38.5% of the institutions have partial automation. 42.5% of the respondents do not have any automation. These industries are thus slower to modernize, have higher costs as they aren't capable of economies of scale, and generally are less competitive. The need for innovative solutions that can be developed with academia is thus the key. Embracing innovation and supporting intrapreneurship within the establishment will play an important role in how industries can adapt to change, realign their focus, become more resilient, and drive growth.

> **Need to Keep up the new phase in the Industrial Revolution focusing heavily on interconnectivity, automation, machine learning, digitization** and real-time data that can be a unique chance for Lebanon within the manufacturing industry.

> **Need to introduce new products and upgrade or create new production lines** to drive growth and profits at the company.

> **Apply digital transformation along with a radical change in the structure of the industrial enterprise.** The utilization of high-tech machinery requiring less manpower, reduced costs of production. Old machinery should be replaced with automated machines in addition to producing different products.

> **Introduce digitalization in applications and e-commerce.** The new trends characterized by the expansion of industrial establishments rely on digitalization of human resources structure training, and marketing.

> **Need to upskill and/or reskill part of the employees to adapt to new technologies** and this requires extra costs and is not always available locally.

VII. ACCESS TO INTERNATIONAL MARKETS

STUDENTS

> **Limited connections to foreign markets,** innovation, and business opportunities due to the lack of enabling regulations and mechanisms that can facilitate exchange and partnerships with international stakeholders, especially in current economic crisis.

> **Abide by the international standards.** In several domains to access to foreign markets the products must abide with a set of standards. Students must be knowledgeable of these standards and must follow their evolution.

ACADEMIA

> **Inadequate market and industry knowledge and lack of collaboration with international partners.**

INDUSTRIALISTS

> **Small size of local market inducing in the necessity to explore regional and international markets.** It is critical to the industrial decision makers to access to market insights and knowledge and to seek for international funding and business growth along with market opportunities. It opens the way for industrialist to connect and build business partnerships in addition to the access to solutions and innovation providers.

> **There is no policy nor environment to attract multinationals to invest in Lebanon** which would help developing the innovation ecosystem and facilitate the access to the international market.

VIII. LEGISLATIVE & REGULATORY FRAMEWORK

STUDENTS

> **Lack of incentive policies for successful start-ups** that should be sustainable. Ensure funding is not enough and start-ups require regulations, and strategies to shift them toward globalisation. Entering the global competition contributes in creating jobs, and attracting entrepreneurs, these will ensure the sustainable development of the Lebanese ecosystem.

> **Weak IP protection on the national level and reliance on international costly IP abroad.** Expensive costs for patenting an innovation in Europe and USA.

> **Duplication of patented projects.** Due to the limited access to information regarding patent databases, researchers mainly depend on scientific databases, internet search, and their own knowledge to judge the novelty of their research topics and inventions.
In addition, the shortage of information might result in undertaking projects that have existed before or that might have been patented before.

ACADEMIA

> **Weak conducive regulatory environment governing issues such as fundraising or intellectual property rights** is one of the main obstacles to the development of innovation in Lebanon.
Lebanon is currently performing below expectations given its level of development with a very limited IP support and policy framework and a lack of enabling environment and policies and skilled human resources to develop, protect and commercialize IP innovations.

> **Lack of tax incentives that encourage investment in start-ups** and innovation in general as well.

> **Lack of players involved in managing intellectual property and licensing.**

INDUSTRIALISTS

> **Limited readiness of the industrial establishments to cooperate with universities before addressing some hurdles related to the Intellectual property rights** resulting from successful developments along with confidentiality issues since any leakage in this regard would defeat the objective.

> **Inadequacy of the Lebanese existing laws on Intellectual property rights (IPR) in Lebanon.** The IPR system in Lebanon remains largely unused by entrepreneurs and academics, due in part to the costs and complexity of the patenting processes. Consequently, the companies often use alternative tools to protect their innovations.

> **Lack of a clear IPR model forms:** all IPs are studied case by case. Researchers, innovators, students, institutions, industrialists and other stakeholders are not confident and aware of the way to protect their rights.

> **Very limited IP support and policy framework and a lack of enabling environment and policies,** to protect and commercialize IP innovations along with a weak IPR enforcement.

> **Absence of a clearly stated and government endorsed national strategy for innovation in Lebanon.**

IX. INFRASTRUCTURE & FACILITIES

STUDENTS

> **Insufficient R&D capability and access to research and innovation resources**

ACADEMIA

> **Weak infrastructure due to the limited presence of technology Transfer offices in Lebanese universities,** badly needed to support researchers and start-ups, is leading to a weak performance along with insufficient resources to support researchers.

> **Insufficient knowledge and guidance to support applied researchers**\

INDUSTRIALISTS

> **Limited accessibility to fully equipped research and prototyping facilities by the Lebanese community.** Even though prototyping, product development and testing equipment can be found in universities and Fab labs, entrepreneurs don't have enough accessibility to these facilities.

> **Under-developed Transport infrastructure** such as road connectivity and Railroad. In Lebanon, electricity shortcuts, which have been prevalent for years, became even more widespread as the political and economic situation in the country reached its critical point in 2020/2021.

> **Expensive internet connections:** When it comes to ICT infrastructure, internet connections in country despite improvements as private initiatives remain relatively slow and expensive, and are not readily available, especially outside of Beirut.

> **High operational costs due to shortage in the provision of electricity** from EDL and reliance on costly fuel and maintenance of the generators.

> **Small scale of R&D departments established in most of the Lebanese industries needing restructuring.**

> **Lack of availability of e-government services.**

> **Lebanese industrialists are increasingly relocating a branch of their establishments abroad where a more advanced ecosystem is in place.**

X. COMMERCIALISATION

STUDENTS

> **Weak educational curricula to educate researchers about innovation and commercialization of research.** The scarcity of professionals and mentors, as well as technology vocational and educational training providers that educate researchers to become more aware of innovation, and the transfer of modern technologies into industry. Innovation and technology transfer are not embedded in current curriculum.

In addition, there is not enough knowledge disseminated around how research can be applied and commercialized. The commercialization process, as well as available options (spin-off, licensing, selling, renting) is a knowledge base that must be acquired by students.

> **Lack of commercialization potential of developed projects.** Professors and students undertake research that lacks commercialization potential and industrialists need innovation support to create added-value products. At early stages of prototype development, innovators neglect the feasibility studies and the marketing Information about potential buyers, partners, suppliers, and research collaborators that are critical to the process of commercialization. This leads to some non-innovative research that cannot be protected by intellectual property rights and difficult to commercialize.

> **Lack of skills to build a business model** generates one of the barriers to develop a start-up company. Developing materials that communicate the value of the company and the business opportunity to "Pitch" the start-up company and put in value its potential is critical for entrepreneurship.

> **Limited availability of Funds from investors for startups:** few industrialists, foreign and Lebanese investors will consider investing in Lebanon-based startups along with a decline of the number of innovators as the most talented will likely seek opportunities in more stable companies and markets. The survey reveals limited willingness from industrialists to co-invest in startups.

> **Weak awareness to register patented innovations.** Inventors often miss the opportunity to protect their inventions because they lack information on the necessary steps to take at the beginning of a research process.

ACADEMIA

> **Lack of awareness and knowledge of commercialization** with limited understanding of market needs and demand. The process of transforming innovations and technological findings arising from universities into market ready products is essential to driving Lebanon's economy forward and contributing to job creation.
Therefore, innovation transfer and commercialization is one of the strategic directions that Lebanese ecosystem needs to prioritize.

INDUSTRIALISTS

> **Necessity for industries to move up the value chain beyond simple production processes and products.** To foster productivity, competitiveness, and innovation potential, along with the employment of highly qualified professionals and technicians, industries should closely collaborate with academia. The doctorate students will serve as catalysts that will lead into innovation and sustainable economic growth to the industries.

> **Reticence of industrialists to share confidential information with academia inducing on internal R&D for the industry development:**

Lebanese Industrialists focused on R&D-based technological product innovation, largely produced in-house and mostly in manufacturing industries. Innovation is executed by a highly skilled employees in R&D departments.
The process leading to such innovation is considered as confidential and internal.

XI. ENVIRONMENTAL

STUDENTS

> **Not well trained to consider environmental constraints in their projects.** There is a global trend to save energy, protect environment and reduce the carbon emission.
Standards and criteria are being enforced in this direction.This offers a new field of development but is at the same time a constraint to be considered by the students in their innovative projects.
It is not clear that those issues are tackled in all the higher education programmes in the different universities.

ACADEMIA

> **Update curricula and research activities to better consider the environmental challenges.**

> **Develop clean campuses.**

INDUSTRIALISTS

> **Necessity to enhance the quality of products produced to seize foreign markets and rebuild** confidence with local ones inducing in an inevitable treatment of environmental issues and the alignment with the requirements of the International Organization for Standardization (ISO). Recommendations should include the necessity to provide grants, loans and subsidies to modernize industrial equipment and machinery for a more environmentally friendly production system.

> **Scaling up renewables to increase cost savings for the fuel consumption in addition to energy security and environmental sustainability.** The world is currently witnessing a renewable energy revolution, driven by technological advancement leading to the reduction of the cost of solar and wind power, combined with advanced storage alternatives.

> **Enhance Cleaner production and resource efficiency: In terms of environmental sustainability, the capacity building targeting academia innovators and industries should tackle promoting reduction of carbon emissions, waste reduction, and valorisation, and the adoption of sustainable and environmental practices.** Innovation tools and capacity building activities should include special methodologies to integrate principles of circular economy, sustainable impact creation, environmental measures and eco design to ensure green sustainability and compliance with the SDGs.

C. THE NEEDS OF ACADEMIA-GENERATED INDUSTRIAL INNOVATION

The needs are linked to Increased knowledge, skills, and capacities of the main stakeholders of the Lebanese innovation ecosystem on issues related to technology transfer, intellectual property, and commercialisation of research.
To foster an innovation ecosystem, stakeholders need to:
1) access innovation and business development opportunities (local-international level)
2) establish partnerships with foreign markets
3) implement tailored acceleration programs for IP based innovators and researchers
4) access tools and resources to guide entrepreneurs in the field.
5) outsource their R&D operations to talents at a competitive cost
6) explore regional markets
7) access guidance to develop, protect and commercialise IP innovations
8) access market insights and knowledge
9) access funding and business growth/market opportunities Cross-cutting need for all target groups
10) access centralized information and mapping about local stakeholders
11) access innovation knowledge and resources
12) connect and build business partnerships
13) access solutions and innovation providers

These general needs are tailored in the following with a focus on the Lebanese context. This context, its strengths, weaknesses, opportunities and risks have been identified in the survey and other studies conducted.

I. INDUSTRIAL NEEDS

IN TERMS OF HUMAN CAPITAL / CAPACITY DEVELOPMENT / R&D

1. Develop Industrial sectors with a high potential for innovation opportunities, high exports, economic growth, and job creation.
The Lebanese industry sector will become more competitive, through **the enhancement of its R&D departments,** the support of the industrial liaison services, and closer cooperation with the academia.

2. It is clear from the survey outcomes that most if not all the industrial enterprises in Lebanon are SMEs with a majority of very small companies. While this makes the sector dynamic and proactive, it constrains the long-term developments including the R&D activities that shall be mainly concentrating on short-term solutions.To cope with this, the Association of Lebanese Industrialists and its sectoral association can play a major role.
It is suggested to give the function of developing long-term R&D to the sectoral association.

3. For the same reasons in the previous point, it is important to strengthen the partnership with academia on matters related to R&D, especially those related to long-term development.

An in-depth dialogue and planning between the ALI and its sectoral associations from one side and the academic institutions from the other side, is necessary in order to structure the cooperation and define pathways allowing the academic-generated innovation to reach the marketplace.

4. Improve **the industrial sector's competitiveness**, targeting the agri-food, chemical, petrochemical, rubber and plastics and ICT sectors as the most promising sectors to drive the country's economy.

For each of this sector an association needs to be established if not with specific functions related to R&D and innovation.

5. **Define the value chain of industrial sectors to identify problems and needs.** This is better done at sectoral level and preferably also assigned as another function to the sectoral associations. Industrialists in the sector can then compete alone, in groups or through their partnerships with academia to find necessary solutions.

6. **Ensure fundamental support from the government in terms of infrastructure** in the absence of key steps toward credible economic and fiscal policy reform, and sustained official external funding support.

7. **Move forward in digital transformation.** Digital transformation facilitates the progress of the Lebanese industry towards the 4th industrial era. It opens the door for the creation of multiple SMEs to work in this direction and for externalisation of the expertisem knowledge and technology existing in the universities.

8. **Modernisation of Industrial Equipments:** Sponsor students to fund their inventions, research, and innovative projects.

9. **Collaborate with "engineering research labs" in large industrial enterprises to create products and innovate lines of production** in close cooperation with universities and researchers (ALI sectorial report 2018-2021). The interest of the industrialists in this domain is clearly shown in the survey as well as the openness of the universities.

10. **Broaden the collaboration in R&D beyond product and product line aspects.** Academic-generated innovation can improve other aspects related to one entreprise or to a sector including marketing, organisation, strategic planning etc.

11. **Initiate large-scale energy production from alternative green sources such as solar, wind, or hydropower with local and foreign producers.** Investing in renewable energy sources can be fully or partially a solution to the power crisis and electricity outages. The planning of such solutions is better done at the level of the Association of Lebanese Industrialists which might seek the support from universities.

12. **Exemption of R&D expenses from Income Tax for the industries working on innovation.**

13. **Protecting their intangible assets based on investment** in knowledge, including R&D, software and data, intellectual property, brand equity,… through a solid IPR system.

14. **Find new markets for Lebanese products.** This will generate more revenues and consequently will positively affect R&D's funding.

II. STUDENT NEEDS

WHAT IS NEEDED FOR STUDENTS TO TAKE THEIR INNOVATION TO THE NEXT LEVEL / ASSESS DIFFERENT NEEDS ACROSS THE INNOVATION PATH

Students need a more tailored approach for innovators to be able to survive the impact of the crisis preventing the launching of Lebanese start-ups and causing pressure on entrepreneurs.

1. **Support students in improving maturity level of their prototypes.** A first obstacle identified in the survey in the pathway towards externalisation of innovative idea is the maturity level of the developed prototypes, which is largely qualified as early or very early stage. The Lebanese industry as profiled has no resources nor time to help progressing early-stage prototypes, nor sufficient funds are available for this purpose.
IRALEB can facilitate the dialogue between industry (ALI) and universities to find an efficient solution to this issue by sharing expertise and resources. The dialogue and solutions may be conducted at the industry as whole or by sector.

2. **Ensure financing affecting all stages of an innovation cycle, from ideation to commercialization, expansion, and, eventually, long-term sustainability.**
Indeed, challenges facing Lebanese innovators is the mobilization of accessible financing mechanisms for all stages.
New actors, such as sponsor industrialist, sovereign wealth funds, and international donors should support innovation.

3. **Increase the visibility of the needs, challenges, and problems.** Young innovators need to know

about challenges and problems to help finding solutions to the problems and responses to the challenges. ALI can channel this information to the young innovators in universities through IRALEB.

4. **Increase the commercialisation potential of the research:** Understanding the importance of an efficient IP commercialization process and mastering the opportunities for creating new business and companies that will help the researcher create viable and commercial spin offs and valorise innovations.

5. **Develop the capacity of innovators in Lebanon, in particular to meet national or international industrial needs,** is an important asset for Lebanese clusters, which can eventually boost technology transfer. Links between Lebanese clusters and academic or researchers is an added value for a structuring action in the field of innovation, opening additional channels for synergies, links with Europe, USA and Arab countries in the context of regional value chains.

6. **Expand the network of investors and venture capitalists** in creation of start-ups, connect to head-hunters and similar international researchers.

7. Explore international markets via networking and cooperation opportunities: **Get opportunities for business development from exchange missions, matchmaking events and soft-landing programmes** with European and international innovation actors, besides identifying mechanisms to facilitate international partnerships and outsource their R&D operations to local talents.
Lebanese Industrialist will benefit from a European technology or a European Industrialist will benefit from Lebanese Research/Innovation.

8. **Increase knowledge, awareness, skills and the development of specific services related to the different types of Intellectual Property within research institutions, universities and** industry highlighting the primary role of IP in the commercialisation of technologies.

III. THE ACADEMIC INSTITUTIONAL NEEDS

COORDINATION / HUMAN RESOURCE / INNOVATION CAPACITY DEVELOPMENT / TEACHERS / ORGANIZATIONAL STRUCTURES

1. **Balance the academic and research practice between publication-centric and industry-driven.** This will allow R&D and innovation to solve some of the pressing national problems through innovation and will be helpful in driving economic progress and competitiveness.
The survey has clearly shown that no or few incentives are provided by higher education institutions to support industrial innovative projects. Providing more incentive might help in balancing the activities.

2. **Connecting local research and innovations with sectors' opportunities,** technology transfer, which is a major driver of value creation and innovation for the country.

3. **Link Curricula to real Industrial Needs:** Universities should empower students effectively, readying them for productive careers.
Involving industrialists in the design of curricula and in the delivery some courses or part of courses would help in this direction. Developing entrepreneurship skills is also of importance.

4. **Incorporate Technology Topics in Curricula** by teaching strategic ways industries and entrepreneurs are using technology to innovate, communicate and earn money.

5. **Create Opportunities for Students to Participate in Innovation and Entrepreneurship Contests that focus on start-up ventures and commercialization of their innovations.**

6. **Establishment of Technology Transfer Offices in Lebanese universities** that do not have such offices presenting a viable plan for sustainability as well as connections with International organizations.

7. **Development and restructuring of existing currently non-operational TTOs.**

8. **Assist researchers to position research programmes;** evaluate status of inventions; or adopt the most suitable forms of protection, as well as commercialising intellectual property to existing companies or through the creation of new ones (spin-offs).

9. **Getting additional business opportunities** through the support of their TTOs, and international cooperation funds through their Grants Offices.

10. **Accompanying paths to Intellectual Property /Patents;** sensibilization and investigation on results of research projects to be protected and enhanced; activation of Intellectual Property procedure.

11. **Create sustainable links with structures that can assist in the long-term management of RD&I in Lebanon, such as professional associations and business incubators** (might be university-led incubators).

12. **Reinforce research collaboration between universities** that might create new opportunities along with equipments, data and labs sharing.

At the university level, introduce entrepreneurship and personal finance education. This will help students, at an early stage, to have a financial growth mindset. Therefore, once the student joins the university, he will have passion and interest in personal finance and entrepreneurship. This will help in the creation of entrepreneurial mindset for the new generations.

VI- PATHWAYS TOWARD THE DEVELOPMENT OF ACADEMIA-GENERATED INDUSTRIAL INNOVATION

A. ACADEMIA-GENERATED INDUSTRIAL INNOVATION FRAMEWORKS

Strengthening the Lebanese ecosystem aims to promote innovation activities bringing together industrialists, research centres and universities to enable the development of innovative products and services, the creation of new spin-offs and the empowerment of entrepreneurs. It should cover the entire value chain from university to research to business creation, demonstration, start-up incubation, marketing, communication, and commercialisation.

The set up and growth of an innovation ecosystem is conditional on engaging all key stakeholders:

- **Universities and research institutions**, responsible for knowledge creation and diffusion.
- **Industrial sector,** with its infrastructure investment having the potential to catalyse, develop and scale innovation, while also providing fertile ground for future innovation to emerge.
- **Incubators and accelerators,** providing a supportive environment for start-ups, with a physical space and access to technology infrastructure and equipment, besides business and technical assistance; They provide innovators with access to a network of business and technical advisors / mentors capable of providing guidance and assistance in product development, finance, business planning, marketing, legal consulting, and manufacturing.
- **Local and international investors,** including business angels and venture capitalists, which may provide financial support to start-ups and SMEs.
- **Government and institutions involved in funding research,** to promote innovation primarily in terms of creating a supporting policy and regulatory environment in which start-ups are encouraged and able to thrive through a tax or incentives that enable the growth of research. Obviously, the role of the government in this context is to provide the minimum support such as an adequate legal framework and a conducive business environment.
- **Start-ups and entrepreneurs,** core element of an innovation ecosystem, as they are innovative, and can adapt quickly to challenges compared to the rigid structure prevalent in larger corporations.
- **Development agencies, intermediaries, and NGO,** which may contribute to building connectivity and capacity of the ecosystem actors; Civil Society Organizations (CSOs), active at the national and international levels, including the diaspora network; Their role is to link organisations within an innovation ecosystem, and to facilitate the transfer of ideas, technology, and commercialisation.

The analysis of the academia industrial innovation ecosystem in Lebanon is driven along a 4 to 7-level frameworks covering the academic institutions, the industry, service providers and financing organizations. The framework also considers the differences at the commercialisation level between entrepreneurship and intrapreneurship.

To thoroughly analyse the technology transfer ecosystem, two different frameworks are exposed depending on the ownership of the research project idea. Indeed, the innovation is a complex process that requires an intervention from different stakeholders throughout all the stages of development.
In the entrepreneurship framework, the intellectual property is owned by academia. In the innovation framework, the innovation driven industry reserves the ownership of the research project outputs.

The following frameworks shows the interaction between the different phases of the innovation cycle, market needs, technology and production techniques, available information services, policy making and collaborations between the industry and academia.

INNOVATION AND TECHNOLOGY TRANSFER FRAMEWORK

Three processes can be identified for the commercialisation of innovation:

- Transferring technologies to established Industries through licensing or selling Intellectual Properties (Licensing)
- Creation of new start-ups (Entrepreneurship)
- Integrating the innovator within the enterprise to develop his innovation (Intrapreneurship)

Many elements other than the innovation itself impact the preference for one of the previous processes. The discussion of these elements is out of the scope of this document. In the following, the pillars of two possible frameworks are briefly presented.

Option 1:

Entrepreneurship & Intrapreneurship framework: *This framework makes a distinction between Entrepreneurship and Licensing processes from one side and Intrapreneurship process from another side.*

Entrepreneurship and Licensing subframework:

This subframework is based on seven core pillars:

1st pillar: Internal research management of innovation. This covers the infrastructure and facilities and the R&D divisions within industries

2nd pillar: Stakeholders' collaboration that can be achieved between industrial sponsorship, international universities, research institutes, R&D labs, and others

3rd pillar: Technical support from Accelerators, Incubators, mentors, …

4th pillar: Funding, finance and awards: 1. early-stage funding, 2. Start-up funding: angel investors, banking sectors, international organizations.

5th pillar: Intellectual property (technology transfer legislation, collaboration contracts)

6rd pillar: Technology commercialisation (spinoff companies or licensing)

7th pillar: Government policy and regulations

INTRAPRENEURSHIP SUBFRAMEWORK

Technology transfer to industries through upgrading of production line or product, development of new production line, new product development to support the expansion of the industry.

This subframework is based on four core pillars:

1st pillar: Internal Research management of innovation (infrastructure and facilities)

2nd pillar: Early-stage funding & awards

3rd pillar: Strategic Industry partnership with R&D divisions within universities (industry is implementing the innovation process, non-disclosure agreements)

4th pillar: Government policy and regulations

Option 2:

Generic Framework

This framework describes the five main interconnected elements for an innovation ecosystem stakeholder model:

1st pillar: Industries (demand for innovation)

2nd pillar: Universities (supply for innovation)

3rd pillar: Support organizations (intermediaries)

4th pillar: Business & finance Environment (IP, technology commercialization, Investors, banking sector..)

5th pillar: Government policy & regulations

B. INCORPORATING THE ANALYSIS OF THE ASSESSMENT INTO THE FRAMEWORK

The contribution of industrial sector to GDP is limited to 7%, it is vital to develop the industrial sector and increase its share in the local economy since this sector shows more resilience to crises than the services sector that is known to be more volatile. The "Vision for Lebanon's Economy", also known as McKinsey Report, calls for Lebanon to become a knowledge-driven digital nation, at the frontend of innovation, acting as a talent hub for technology, outsourcing, creative industries, and education".
Lebanon ranked higher than average in terms of skilled workers and firms producing more new products/services compared to main market. However, the Lebanese context requires a major shift in setting the stage for competitiveness and increased productivity that can be improved through the activation of collaborations, tools, and resources to activate the innovation support mechanisms as staged in the project design. According to a report published by UNIDO in 2022 under the UN Productive Sectors Development Program (PSDP), there is a need to provide technical assistance to industrialists, to enhance the capacities of local laboratories, to work with start-up accelerators, venture capital firms and other players to support innovation in agriculture and industry, to promote and integrate new technologies in the production process and to have an intermediary creating a bridge between industrialists and research centres/ academia.

The process of developing and scaling innovation for sustainable impact cannot be undertaken by any one actor working in isolation. The support of a wide range of actors (including technical, financial and political support from local, national and sometimes international entities) across the value chain is typically required to successfully progress any innovation across the stages of scaling.

While the two frameworks are generic, the recommendations must be tailored to better serve the Lebanese context. We recall here a summary of the main findings:

- High skilled human resources exist and are fundamental to develop the innovation ecosystem.
- Relatively important infrastructures exist in the universities and active research is being conducted in many fields.
- Active industrial sector that has shown resilience to the crises that the country is facing.
- Several incubators and accelerators have been established.
- IRALEB and other institutions are working on strengthening the links and reinforcing the innovation ecosystem.
- Most industrialists in Lebanon are small with few relatively medium enterprises with limited resources dedicated to R&D. Their activities are driven by short-term objectives and are mainly willing to support projects in direct relation with their products and products' lines.
- Due to the crisis limited resources exist at the national level to support transforming innovation into socio-economic added value.
- Individual initiatives are taken at universities at education level to better align with market needs, involve socio-economic partners in the design and delivery of programmes, and to develop entrepreneurial skills.
- Limited incentives are provided in universities to encourage engaging in industrial projects.
- Most of the prototypes developed in applied projects are considered at early maturity stage, an obstacle that may stop an innovative idea to progress towards commercialisation.
- TTOs are also based on individual initiatives and IP rights and protection are not uniformly understood and applied across the system.
- Laboratories form a point of cross-interest between industry and academia.
- Clubs for entrepreneurship and promotion of innovation exist across the system showing an existing interest in developing the innovation ecosystem.
- Value chains in industrial sectors are not studied to identify the needs, challenges and problems of the industrial sectors.
- Digital transformation is not yet engaged.

The recommendations fall under supporting innovation, business development, technology transfer, market-oriented research, Research & Enterprise cooperation, local and international networking, and dialogue and engagement among innovation stakeholders. The strategy should include activities to ensure that inventions and intellectual discoveries in scientific R&D are linked to an innovation process including incubators, rapid prototyping, and technology transfer to ensure socio-economic impact. It shall build upon the strengths and tackle the obstacles and weaknesses identified in the analysis of the survey.

The ecosystem is built upon cooperation between local enterprise development players, each of which can find their specific place in the network and fulfil their role without significant overlaps, but in a close, interconnected way.

Based on the present analysis and the study of different reports, the following guiding principles are at the basis of a proposed set of recommendations to foster the Lebanese innovation ecosystem.

- All the studies conducted in the recent years have led to the **urgent need to develop the innovation ecosystem** as a major driver moving the Lebanese economy to a knowledge-based one.
- The Lebanese industrial ecosystem is constrained by a small Lebanese market, the socio-politico-economic struggles, the crises including the latest one, the small size of the enterprises, the high emigration rates, the large share of the remittances in the GDP and few others. These constraints make it **hard to develop the innovation ecosystem without external support.**
- **Strong elements exist in the system, like some research infrastructures, a dynamic and proactive industrial sector, high-skilled human resources, active incubators/accelerators/ associations, and a large diaspora.** Any plan to develop the innovation ecosystem must build on these elements.
- **Weaknesses exist** at awareness and organisation levels to support the development of the innovation ecosystem. Therefore, **reforms are required from the two major innovation providers:** the academia and the industry.
- The regulator has engaged in encouraging innovation-based economy. These efforts are drastically reduced with the present crisis. Nevertheless, **important stimulating steps are still needed from the regulator.**

The recommendations to foster the Lebanese innovation ecosystem can be summarized as follows:

- Supporting the different stake-holders to develop the innovation ecosystem.
- Assign advanced functions to sectoral industrial associations (to be established if not existing) in the fields of i/ long-term R&D, ii/ identification of needs, challenges and problems, and iii/ dialogue with academic institutions in matters related to innovation.
- Analysing value chains in the priority sectors identified in this survey. The industrial associations operating in these sectors have the responsibility to conduct the analysis. They can cooperate with IRALEB, universities and other stakeholders to complete this task.
- Accelerate the digital transformation in order to move forward towards the 4th industrial era.
- Extend the R&D activities outside the strict products and products lines, by working and cooperating in matters related to: smart marketing, resource management, planning, etc.
- Consider global challenges like the ones related to environment, clean energy, etc.
- Strengthening Lebanon's IPR system: incentive and reward mechanisms are implemented in academia, IP policies are developed, and IP commercialisation opportunities are promoted.
- Reinforcing the Lebanon's technology transfer system: Innovation representatives from academia and research institutions are empowered with new skills, tools, and programs to manage technology transfer services and programs.
- Raising awareness about the importance of developing the innovation ecosystem.
- Encouraging universities to develop technology transfer offices and strengthen the links with incubators and accelerators.
- Identify the needed resources and procedures to advance the maturity level of the developed prototypes and implement an efficient solution in this direction based on resource sharing.
- Establishment of Linkages and structured networks with international partners and markets. Innovation/R&D opportunities are to be identified, and business partnerships are to be developed between international stakeholders (i.e.: Enterprise, industry innovation and business networks) and Lebanese innovators/researchers.

C. RECOMMENDATIONS FOR THE IMPLEMENTATION OF THE FRAMEWORK

RECOMMENDATIONS - INDUSTRY

1. Empower sectoral associations with in the Association of Lebanese Industrialists and assign them with functions related to long-term R&D and identification of needs and challenges.

2. Conduct a value-chain analysis in priority sectors to identify the needs and challenges.

3. Extend R&D activities to cover issues like smart marketing, business development, strategic planning, human resources development etc.

4. Accelerate the digital transformation and the progress towards the fourth industrial era.

5. Develop plans at the industry and sectoral levels to actively engage in achieving the Sustainable Development Goals (SDGs) stressing on global concerns like environment and sustainable energy.

6. Develop an industrial fund to support the creation of start-ups responding to the needs identified while analysing the value chain.

7. Strengthen the dialogue and relationships with academia having IRALEB as facilitator, in different aspects related to education, continuous education, internships, applied research and use of laboratories.

8. Set plans to upskill and reskill the employees.

RECOMMENDATIONS - ACADEMIA

1. Raise awareness regarding the importance of the innovation ecosystem and its requirements from universities for the sake of the socio-economic development of Lebanon.

2. Reinforce entrepreneurship components in the educational programmes.

3. Engage in structural dialogue with the industry having IRALEB as facilitator covering :
i/ the alignment of the programmes with the needs
ii/ cooperation in applied research
iii/ laboratories
iv/ sectoral needs and challenges
v/ intellectual property rights and protection.

4. Develop a policy to encourage applied research leading to innovative ideas and prototypes that can be transferred to the marketplace.

5. Develop technology transfer policies and offices.

6. Set policies allowing the use of laboratories and other resources by industrial partners.

7. Investigate the reasons behind early-stage maturity of the prototypes and derive solutions, preferably common, to improve the maturity.

8. Strengthen the relationships with incubators and accelerators.

9. Suggest continuous education programmes targeting the upskilling and reskilling of industry employees.

10. Participate actively in the digital transformation.

11. Move towards green campuses.

RECOMMENDATIONS - STUDENTS

1. Engage in clubs and associations to promote entrepreneurship, innovation, and applied research.

2. Conduct studies in the clubs and associations identifying issues and obstacles to the development of the innovation ecosystem and suggesting solutions.

3. Attend and actively participate in proposed awareness raising sessions related to innovation and entrepreneurship.

4. Engage in industrial projects.

5. Participate to technological competitions and contests.

6. Insist on having sufficiently mature prototypes.

7. Develop communication skills and lobby for the support in setting up start-ups.

8. Get informed and inform about the incubation and acceleration opportunities.

GOVERNMENT POLICIES/ GOVERNMENT ROLE AND INTERVENTIONS/ POLICY FRAMEWORK

Policymakers need to be able to select and continuously adjust a strategic mix of innovation policies. The intervention of the government through a set of policies is critical for the success of any national innovation system.
It should maintain a competitive advantage based on continuous and rapid responsiveness to a rapidly changing economic and technological environment.
Hence, innovations and new products must emerge with solid support. Bottlenecks should be identified and adequate policies should be immediately developed.
The most appropriate features policy makers should consider for a successful innovation framework:

1. The government should work on fostering innovation through credit programs, tax incentives, grants for research projects in industries, in addition to traditional grants for research in universities and public institutes.

2. Provide sustainable statistitical data: Monitoring and evaluation of indicators that measure innovation policies generally addressing spending on R&D, innovation carried out by firms, exports of high-tech products and patenting, plus quality and quantity of graduates in technical and scientific disciplines.

3. Limit brain drain, retain and re-attract specialized talents to Lebanon.

4. Foster an enabling environment to boost innovation, increase the capacity of stakeholders especially in creating and sharing knowledge and commercializing technologies. Forming creative populations through an appropriate education system.

5. Create and maintain a general stable environment and improve the quality of the necessary basic services for Lebanon to recover its attractiveness.

6. Set policies and plans to facilitate the access of innovative products and services to international markets.

7. Set policies and plans to attract multinational or global investors to the innovation ecosystem in development.

GENERAL RECOMMENDATIONS FOR ALL PARTIES INVOLVED

1. Develop a platform for communication and networking among all stakeholders, in particular, academia and industry.

2. Agree on common policies or principles for intellectual property rights protection and enforcement.

3. Develop the relations with international partners and seek support in the development of the Lebanese innovation ecosystem.

4. Build a constructive competitive environment that promotes innovation.

5. Strengthen the climate of trust through transparency and dialogue.

VII. CONCLUSION

Undoubtedly developing the Lebanese innovation ecosystem is a major necessary tool to move out of the deep crisis the country is facing. This is commonly cited in many reports and studies tackling the Lebanese socio-economic development.

The present study has captured the landscape of the innovation ecosystem in Lebanon by surveying the main innovation production actors in the industrial domain. The analysis permitted to identify the strengths, weaknesses, and needs. Some major enabling elements exist like high skilled human resources, active research and facilities, dynamic and proactive industry, and incubators and accelerators.
Some challenging elements were identified: lack of resources, enterprises are of small and medium sizes, short-term R&D, lack of incentives, weak technicity, absence of policies, non-existing or non-enforced IP rights protection, no formal and structured dialogue.

After a thorough analysis and identification of the needs, a framework for the innovation ecosystem has been identified. To implement this framework recommendations have been formulated.
At the core of the remmendations three major needs have been identified:
I. Policies and organisational processes at both academia and industry
II. External support
III. Active regulations and governmental support.

For the industrialists, the key idea is to enforce the sectoral associations within the Association of Lebanese Industrialists and assign major functions to them: long-term R&D and identification of needs and challenges in their respective sectors.
The R&D needs also to cover aspects beyond products and product line development.
Value chain analyses must to be conducted by sector. The industrialists need to support innovative projects in universities and to assist in better alignment of academic programmes and market requirements. Organisational procedures must be adopted to allow the access of the industrialists to the laboratories of the universities.

The universities need to reinforce the entrepreneurship skills and to provide incentives to researchers and students to develop innovative applied research. It is crucial to adjust the academic programmes to better align with the market needs. Ways must to be found to improve the maturity level of developed prototypes in applied research projects.
Technology transfer offices must to be established and/or developed to facilitate the transfer of technology to the marketplace. The relations with incubators and accelerators are to be strengthened. It is important to support the students' clubs and associations promoting innovation.

The regulator must provide incentives and tax reduction in order to support the development of the innovation ecosystem. Policies should be defined to facilitate the access to the international markets. Basic services need to be improved, and stability and rule of law must be established for Lebanon to regain attractivity of investors and multinational enterprises.

Intellectual property rights protection and enforcement are needed by all parties. Networking with international partners is essential.

Finally, it is essential to foster a climate of trust and mutual understanding through dialogue and transparency. The innovation ecosystem has to be inclusive.
Networking and awareness raising are a must. IRALEB can play a determinant role in this direction.

VIII. AKNOWLEDGEMENT

This study and workshop are the result of a collaborative effort that would not have been possible without the contribution of multiple partners including the Ministry of industry represented by its Minister Mr. Georges Bouchikian and Director General, Mr. Dany Gedeon; the Association of Lebanese Industrialists through its current President Mr. Salim Zeenni and former President Dr. Fady Gemayel.
Special thanks go to the members of ALI Board of Directors and Deans of all faculties member of IRALEB for their valuable input that has been provided. Appreciation is expressed also for the members of IRALEB Executive Board and Jury Committee and the innovators and stakeholders participating in the mapping and workshop, as well as the key informants for the study.

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IRALEB bears sole responsibility for the content of this report. The findings and views expressed in the report do not necessarily reflect the views of the sponsor. The report is authored by IRALEB Executive Director, Ms. Fabienne Balaa and Innovation Expert, Dr. Chafic Mokbel with an exhaustive contribution and support from Head of IRALEB Executive Board, Eng. Ziad Chammas.

IRALEB

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Interviewee name	Position
Public Officials	
Mr. Dany Gedeon	MOI Director General
Eng. Tony Atallah	Advisor to the MOI Minister
Renowned Lebanese Businessmen	
Mr. Claude Comair	Owner of Nintendo/ President of Digipen Institute of Technology
Mr. Joe Chalouhi	Former HR VP of G.E, Schneider Electric & Pepsico Intl.
Industrialists	
Mr. Salim Zeenni	ALI President, CEO of Zeenni Trading Agency
Dr. Fady Gemayel	Former ALI President, Honorary Chairman of Gemayel Freres
Mr. Georges Nasraoui	ALI Vice President, CEO of Al Rabih
Mr. Walid Aassaf	ALI Board member, CEO of SMLC (Pepsi)
Mr. Bernard Tannoury	ALI Board member, CEO of Benta group
Mr. Chaker Saab	ALI Board member, CEO of TINOL
Mr. Maurice Zeidan	CEO of Zaidan sal
Mr. Ibrahim Mallah	ALI Board member, CEO of Usine Nationale des Blocs et Carreaux
Eng. Ziad Boustany	CEO of SAS controllers
Eng. Elias Bachaalany	CEO of Automatix, VP Neuvatix USA
Mr. Daniel Abboud	ALI Board, CEO of Topcat Industries
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Dr. Mohammad Ayache (FOE Dean)	Islamic University of Lebanon
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Dr. Joseph el Assaad (FOE Dean) Dr. Sandy Rouhana Dr. Marie Rita Hojeij	Holy Spirit University Kaslik – USEK
Dr. Mohammad Diad	Rafic Hariri University
Dr. Georges Bahr (provost-FS Dean) Dr. Rami Abboud (FOE Dean) Dr. Samer Awad	Balamand University
Dr. Antoine Nohra	CNAM, ISSAE
Dr. Michel Owayjan	American University of Sciences and Technology – AUST

IX. ACRONYMS AND ABBREVIATIONS

R&D; Basic Research, Applied Research

Research and Development (R&D), as defined by Investopedia (2016), as the "investigative activities that a business chooses to conduct with the intention of making a discovery that can either lead to the development of new products or procedures, or to the improvement of existing products or procedures. R&D is one of the means by which businesses can experience future growth by developing new products or processes to improve and expand their operations".
Under the term 'Research', a distinction can be made between Basic Research and Applied Research. According to Tarver (2016), "basic research seeks to delve into scientific principles from an academic standpoint, while applied research seeks to use that basic research in a real-world setting".

A Business Incubator

An incubator is defined as "an organization designed to accelerate the growth and success of entrepreneurial companies through business support resources and services that could include physical space, capital, coaching, common services, and networking connections".

The main aim is helping young businesses flourish, through financial and technical support services, and business incubation programs are most likely sponsored by private companies, or public institutions, including academic settings such as colleges and universities (Entrepreneur.com, 2016).

Accelerator

Accelerator and Incubator are concepts that often confused with one another. The difference between the two lies in the method adopted to help businesses move forward. Unlike incubators, accelerators can make financial investments in a startup and accelerator programs "usually have a set timeframe in which individual companies spend anywhere from a few weeks to a few months working with a group of mentors to build out their business" (Forrest, 2014).

Technology Transfer

Technology Transfer refers to the movement of know-how, skills, technical knowledge, procedures, methods, expertise or technology from one organizational setting to another (Roessner, 2000).

According to the definition of technology transfer or "the process of commercialization", is stated as "bringing technologies to the marketplace". In the context of universities, TT involves transferring knowledge and discoveries to the public by means of publications, educated students entering the workforce, conference exchanges, and relationships undertaken with industries (University of Rochester Ventures 2015).

Technology Commercialization

Technology commercialization, also known as research commercialization, refers to the valorization of research and intellectual assets by industry, or the process of taking an idea to market and creating financial value.
It implies the selling, licensing of, or contracting of technology services, intellectual assets, and related-knowledge into spinoff creation and R&D

Patent

Patent is a form of intellectual property protection that grants to the owner (a licensee) the right to exclude others from making, using, selling and importing products based on a patented invention.

Industrial Activity Indicators

Output = Value of Goods produced + Industrial and non-industrial services
Intermediate consumption = Net Raw material and supplies (consumed) + Electricity & Energy products + services and other operating costs
Value Added = Output – Intermediate consumption = wages + depreciation of equipments + interest + Gross Industrial profit.

APPENDIX A. LIST OF RESPONDENTS

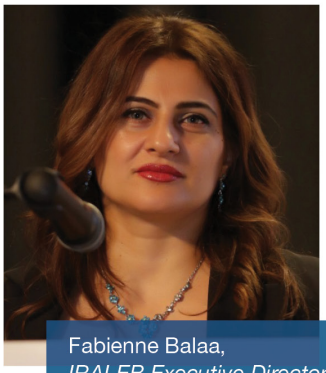
In the following table the lists of respondents to the "Descriptive and qualitative Surveys on the Structure of Innovation within Universities" is provided.

Table 27 List of the respondents to the "Qualitative and Descriptive Surveys on the Structure of Innovation within Universities"

University	Dean/ Vice President name	Position	University contributor
AUB	Dr. Fadia Homeidan, Dr. Alain Shehade,	Director of the Office of Grants and Contracts (OGC) Dean of the Faculty of Engineering and Architecture- AUB,	Ms May Awar Ammar Dr Imad el Hajj
LAU	Dr. Lina Karam,	Dean of the School of Engineering- LAU,	Dr Ali Ammouri
USJ	Prof. Dolla Karam Sarkis, Prof. Richard Maroun, Prof. Wassim Raphael,	Vice-President for Research- USJ, Dean of the Faculty of Sciences- USJ, Dean of the Faculty of Engineering- USJ,	Dr Regina Geitani Dr Nicolas Loukas Dr Hadi Kenaan
NDU	Prof. Michel Hayek, Dr. Jacques Harb,	Vice-President for Academic Affairs- NDU, Dean of the Faculty of Engineering- NDU,	
LIU	Dr. Amin Hajj Ali,	Dean of the Faculty of Engineering- LIU,	Dr Mohamad Arnaout
IUL	Dr. Mohammad Ayache,	Dean of the Faculty of Engineering- IUL,	
CNAM	Dr. Khalil El Khoury,	Director CNAM ISAE,	Dr Antoine Nohra
RHU	Dr. Toufic Hijazi,	Dean of the Faculty of Engineering- RHU,	Dr Mohamad Diab
UOB	Dr. Georges Bahr, Dr. Rami Abboud,	Provost of the University of Balamand, Dean of the Faculty of Arts & Sciences, Dean of the Faculty of Engineering- UOB, Dean of Issam Fares Faculty of Technology	Dr Samer Awad
AUST	Dr. Roger Achkar,	Dean of the Faculty of Engineering- AUST,	Dr Michel Owayjan
BAU	Prof. Adel Kordi, Prof. Hania Chmaisse,	Dean of the Faculty of Engineering- BAU, Dean of Graduate studies and Research- BAU,	Dr Semaan Amine Dr Amira Zaylaa
UL	Dr. Nadine Nassif, Prof. Fawaz el Omar, Dr. Rafic Younes, Dr. Bassam Badran,	Dean of the Faculty of Agriculture - Lebanese University, Dean of Doctoral School of Sciences and Technology - Lebanese University, Dean of the Faculty of Engineering - Lebanese University, Dean of the Faculty of Sciences - Lebanese University,	Dr Pierre Abi Nakhoul Dr Mohamamd Khalil Dr Clovis Francis Dr. Antoine Samarani
USEK	Dr. Joseph el Assaad,	Dean of the Faculty of Engineering- USEK,	Dr Sandy Rouhana


Business Strategy
Innovation
Branding
Solution
Marketing
Analysis
Ideas
Success
Management

AUTHORS



Fabienne Balaa,
IRALEB Executive Director

Holder of a Master of Science degree (DESS) in Banking and Finance, Fabienne has managed, throughout her 27-year career, IMF and World Bank supported projects for the Governorate of Banque du Liban. She was leading, in BDL, the GDDS National program while also managing a dynamic data dissemination Portal for Lebanon Statistics. She has also monitored applications of modern Information and communication technology (ICT) and web-based applications related to statistics at the Central Bank. She further contributed to "Lebanon Statistical Master Plan", a World Bank's managed Trust Fund.
She worked as a consultant with the EU & ESCWA supervising team experts and carrying out economic studies for micro-financing programs.

Fabienne has led three Industrial censuses for the Ministry of Industry in collaboration with UNIDO and GTZ. She analyzed data pertaining to micro & macro-economic indicators and conducted sector-based analysis for promoting macro-economic policies.

For the last 14 years, she has been working and managing since year 2000 the LIRA program (institutionalized as IRALEB).

Dr Chafic Mokbel,
Iraleb Executive Board member , Innovation Expert

Chafic Mokbel is a Professor of Computer Engineering at the University of Balamand.

He has a PhD in 1992 from Telecom-ParisTech.
He holds an electrical engineering degree from the Lebanese University Branch II.
He worked at France Telecom in France, IDIAP in Switzerland and in Balamand since 2000.

He served as Secretary General of the Balamand Research Council from 2003 till 2019.

He also served as chairperson of Erasmus+ Higher Education Reform Experts in Lebanon and as a consultant for many international organizations including UNESCO and WorldBank.

He participated to many European projects and managed few of them.

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https://www.kas.de/en/web/libanon