T.C. SANAYİ VE TEKNOLOJİ BAKANLIĞI

İSTANBUL KALKINMA AJANSI

Deep Dive into Deep Tech

Deeptech Entrepreneurship in the World and Turkey

DEEPTECH ENTREPRENEURSHIP

Deepte

teknopark istanbul

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Executive Summary

The outbreak of the Coronavirus epidemic in China at the end of 2019 and its transformation into pandemic by spreading out in a short period of time has led to, along with other serious problems and concerns, a much stronger sense of perception as to the rising technology revolution worldwide. This process has highlighted that the most critical card that the world holds to battle against such kinds of challenges is technology. Especially deeptech.

COVID-19 test kits that came to our rescue in the very first days of the pandemic, the ventilators of which importance we came to understand as the hospitals reached their full capacity at the later periods of the epidemic, and the vaccines, on the point we have reached today, being produced quite fast so as to be presented to the world societies and on which we set our hopes to save the world from the pandemic are all gifts of the technology to the world.

Creating solutions for not only health but also for all other sectors, deeptech have breakthrough impacts just as the radical changes like the unmanned air vehicles technologies had on defence strategies. From this aspect, leading the Fourth Industrial Revolution as well, the deeptech is critically important for the governments.

Within this context, by figuring out such critical technologies, it is of great significance to identify the problems and needs of the developers as well as to create solutions. Thus the purpose of this study is to present solution proposals for such problems and needs by analysing the existing circumstances of the deeptech.

In this respect, 'Deep Dive into Deep Tech', which is the first study on deeptech entrepreneurship in Turkey, is at the same time one of the very limited numbers of studies worldwide.

Istanbul Development Agency

Istanbul Development Agency (IDA) was established with the Decree of the Council of Ministers on the "Establishment of Development Agencies in Some Level 2 Regions" dated 10.11.2008 and numbered 2008/14306, based on the Law No. 5449. Secretary General of IDA was appointed in August 2009 and IDA actively launched its operations in December 2009 with the employment of experts and support personnel. Development agencies continue their activities within the scope of the "Presidential Decree on the Organization of Institutions and Agencies Connected, Affiliated or Related with Ministries and Other Institutions and Agencies " numbered 4, published in the Official Gazette dated 15.07.2018. The purpose of the establishment of development agencies is identified as "to accelerate regional development, provide sustainability and close the interregional and intraregional development gaps in line with the policies determined by the President, by improving the cooperation between the public sector, private sector and non-governmental organizations, ensuring proper and effective use of resources and activating the local potential." Pursuant to the Article 187 of the referred Decree, the Ministry of Industry and Technology is responsible for the coordination of agencies at national level.

Teknopark Istanbul

Neighbouring Sabiha Gökçen International Airport, Teknopark Istanbul is a technology development zone having been founded with the partnership between the Presidency of Defence Industries (SSB) and Istanbul Chamber of Commerce (ITO) in order to incentivize domestic and foreign entrepreneurs to contribute to the technology development capacity of Turkey. As an eco-system that fosters R&D activities, innovation and technological production, thus being a driving force behind the entrepreneurship and economy, Teknopark Istanbul hosts both domestic and foreign high technology companies and pulls attention towards itself thanks to the great support that it provides to the leading R&D projects.

Cube Incubation

Having been designed as to be Turkey's first and only deeptech focused incubator, the Cube Incubation, as the incubator of Teknopark Istanbul, constitutes an ecosystem in which entrepreneurs, investors and other stakeholders coming up with innovative and deeptech oriented business inspirations. Providing international opportunities to entrepreneurs by adopting "Incubation Center for Deep Tech Entrepreneurs" motto, the Cube Incubation offers acceleration programs to support entrepreneurship depending on the scope of stages, vertical levels and internationalization to overcome the problems of the ecosystem by bringing science, technology and entrepreneurship together in the guidance of a broad vision.

What Is Deeptech?

The term "Deeptech" was first used, as by Swati Chaturvedi, the CEO of VC Firm Propel (x), and designed as to differentiate the initiatives which develop deeptech from more general technological initiatives which handle Internet, mobile and e-commerce practices based on a business model innovation, increased service improvements or the use of standard technologies.[1]

As a term deeptech defines the initiatives that develop products driven out of notable scientific leaps or engineering novelties. Deeptech gathers enterprises with different needs in different sectors together by employing similar characteristics such as development periods or financial requirements. Cultivating in deep knowledge, such enterprises make use of the competitive advantage.[2]

Deeptech ventures stand for companies that develop products based on science or R&D. Such technologies generally have a potential for transformation. If they prove to be successful, they can result in a paradigm shifts in the working styles of business, in protection of the national security or in the overall discovery field that they have an impact upon. A number of deeptech companies consisted of pathfinders that venture to cross over a very long way in order to offer solutions to the largest challenges of the world.[3]

You can envisage deeptech as a sort of entrepreneurship club that scientists and engineers with PhDs or Master's degrees come together with an aim of solving some problems that the world encounters such as global warming, struggle against cancer and traffic congestion. Video games, messaging applications or media portals are not allowed to enter this club. Deeptech may be regarded from the perspective of Industry 4.0 by means of which we witness rapid developments in both physical technologies (such as autonomous vehicles, new materials, 3D printing, advanced robotics) and biological technologies (such as genetic engineering, neuro technology and bio-printing). [4]

Deeptech starts from science and then flourishes on research and development (R&D). It uses a scientific discovery or invention, upon which it constructs a robust building. Such type of science can possibly start from anywhere, however it typically requires much more than a laptop and wireless connection. It needs more sources such as laboratories, testing facilities, unique resources, special devices and machines, a strong information processing infrastructure, data, capital and a holistic thinking style.[5]

New technologies rank in the core of the story that narrates the development of humankind. Transforming information into technology has increased human lifespan and ensured higher levels of living standards. Radical changes brought by technology, including the genetic engineering which has paved the way for producing more enduring crops and put forth a number of efforts to alleviate the world hunger, are quite rare and worthwhile.

[1, 4] *SGI, Deeptech Investments: Realising the Potential, 2019.*

[2] *Grow Ventures & IVC, Israeli Deep-Tech Overview, 2020.*

[3, 5] *Different, Deeptech Investment Report, 2020.*

Such types of technologies are now known as the 'deeptech' and are considered to possess these three features: They create a substantial impact upon the world; they need a long development process and sustainable financial investment before getting ready to be presented to the market.[6]

The majority of such technologies deal with large-scale social and environmental challenges, and it is likely that they will make significant contributions by coming up with solutions for some urgent global problems in the future. Such technologies are powerful enough to create their own market and disturb some of the existing industries. The newly-formed basic intellectual property (such as patent, petty patent and so on.) does not yield easily to their reproductions or such intellectual properties are well protected. Therefore, they generally feature a valuable competitive advantage or put forth an entry barrier.[7]

An initiative based on deeptech are slower and more expensive than a digital initiative, a situation that can be explained with some reasons such as:[8]

• **Strong research base:** Product development in deeptech depends on fundamental research and/or advanced R&D, which requires support from a series of robust skills, knowledge and infrastructure, and thus necessitating longer periods of time before the presentation of the products into the market.

• **Heavy industrialization process:** Apart from deeptech that are based on information and communication technologies, most of the products in this area constitute physical equipment. They generally rely on advanced materials and sources that require highly advanced industrial skills for supply, production and scaling. The scaling process of such products is much more difficult than the one required for products related with internet and mobile technologies.

Such technologies are powerful enough to create their own market and disturb some of the existing industries.

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• **Large-scale investment need:** The infrastructure, skills and sources that a deeptech initiative needs can only be ensured by providing a considerable capacity of finance for a long period of time.

• **Still-unspecified commercial application:** It is possible that final product specifications not have been defined properly as the process continues. For example, blockchain technology which was developed as a special technological solution for Bitcoin has opened a door to a new market of finance that the developers had not foreseen.

Besides, deeptech may entail novelties based on solely advanced computer programs however they are required to feature serious break-through technologies, several scientific leaps and/or ongoing R&D processes so that they could be counted as a part of deeptech. The active use of some machine learning for a software or internet application is not sufficient on its own to be accepted as deeptech. Despite the fact that this was regarded as a true leading and advanced technology 10 years before, in our day it is perceived as a much wider and more ordinary technology.[9]

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[6] *Cicada Innovations, Australia's Deeptech Opportunity: Insights from the Cicada Innovations Journey, 2020.*

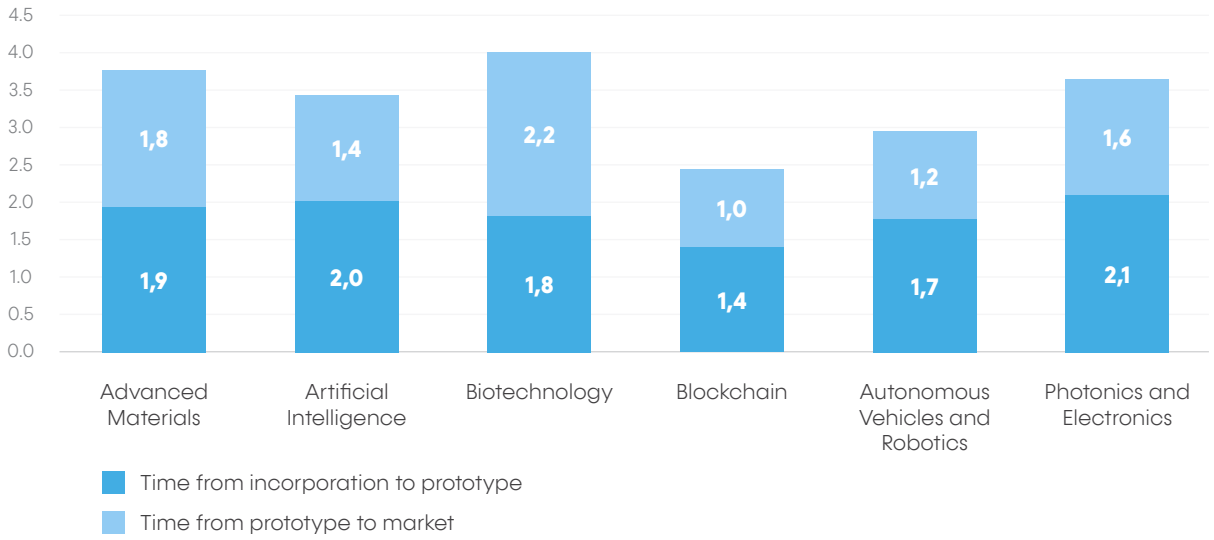
[7] *BCG ve Hello Tomorrow, The Dawn of the Deeptech Ecosystem, 2019.*

[8] *Hello Tomorrow ve BCG, From Tech to Deeptech: Fostering Collaboration Between Corporates and Startups, 2017.*

[9] *Different, Deeptech Investment Report, 2020.*

Time to Industrialisation

Table 1: Industrialisation Time on the Basis of Technology[10]



The analysis, conducted with 'the Boston Consulting Group'(BCG), of the best 1.500 deeptech startups which were identified by Hello Tomorrow in 2016, 2017 and 2018, examines the periods of time spanning from the establishment to the prototype production and from the prototype production to the market presentation of 7 different deeptech waves. As expected, the industrialization process for all deeptech categories in question vary from 2,4 to 4 years, and thus it is rather long.

Sectors and technologies involved in deeptech are quite varied and they go through a constant change. Some of such technologies include agriculture technologies, biology/synthetic biology, bioinformatics, artificial intelligence/ machine learning, augmented reality or virtual reality (AR/VR), autonomous vehicles and drones, cyber security, clean technologies/energy, internet of things, material science, microelectronics and nanotechnology, neurotech, robotics, quantum computing, sensor and space technologies. However, even such a long list does not explain the whole scope of deeptech. Life science (such as pharmacy, therapeutics and medical devices) are mostly categorized under deeptech, and typically have several commercialisation ways. While some classifications incorporate blockchain technologies into deeptech, most classifications do not accommodate such technologies.[11]

The scope and structure of this study have been constituted by taking as references, from among many other classifications made so far, the 6 main technology waves and 12 main sectors used in the joint study by BCG and Hellow Tomorrow, and the startups assessed within this study have been sorted out based on such classification.[12]

[10] *BCG ve Hello Tomorrow, The Dawn of the Deeptech Ecosystem, 2019.*

[11] *Different, Deeptech Investment Report, 2020.*

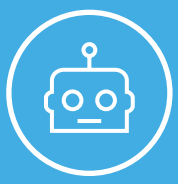
[12] *Hello Tomorrow ve BCG, From Tech to Deeptech: Fostering Collaboration Between Corporates and Startups, 2017.*

Technology Categories

Artificial Intelligence Data and Image Processing

Augmented and Virtual Reality (AR/VR)

Biotechnology



Autonomous Vehicles Robotics and Mechatronics

Industry 4.0, Internet of Things, Sensors and Electronics

New Materials and Nanotechnology

Main Sectors

- Agriculture
- Automotive and Transportation
- Consumer Products and Services
- Defence and Aviation
- Energy
- Environment and Water
- Finance
- Food
- Health
- Manufacturing and Construction
- Mobile and Telecommunication
- Retail

Deeptech Worldwide

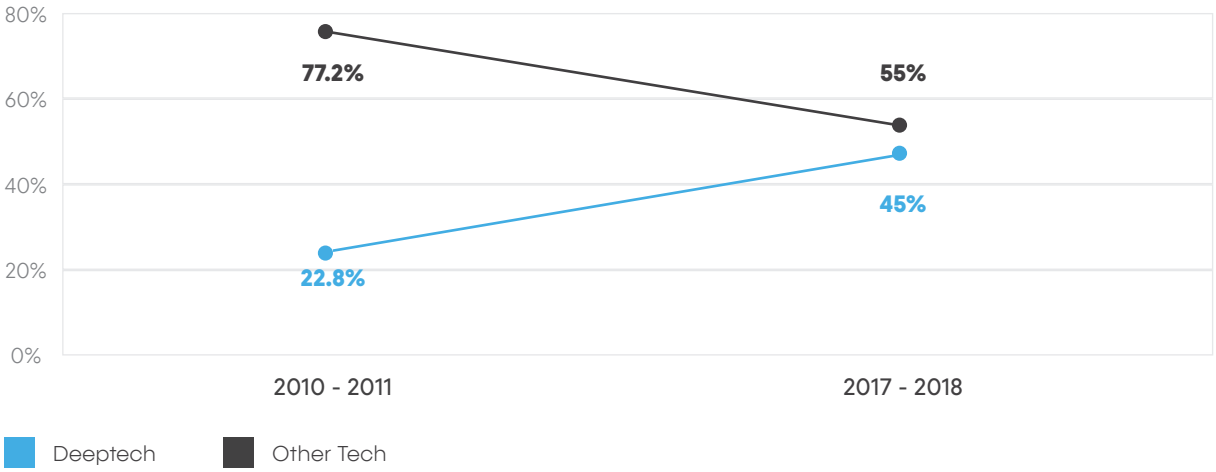
Having a value of approximately 3 trillion USD, the global entrepreneurship economy produces value as far as the GDP of a G7 country. 7 out of 10 biggest companies of the world as well as a majority of the big global companies operate in the technology industry. Venture capital investments in the entrepreneurship ecosystem in 2019 almost reached 300 billion USD worldwide.[13]

Globalization, urbanization and digitalization have proved to be factors shaping the world economy in recent years, but at the same time they have led to new insecurity forms by being oppressive on the surroundings we live in. Despite the global growth, a considerable number of people still have to continue their battle against poverty as a result of income inequalities. COVID-19 pandemic has underlined the fact that innovative medical technologies are of great importance and that there still exist quite a number of diseases that necessitate effective treatments. In this context, it is obvious that deeptech will play a remarkable role in efforts to solve today's global issues.[14]

The global Entrepreneurship Ecosystem Report estimates that the next Silicon Valley will not resemble the Silicon Valley which is familiar to us, but will grow upon completely different innovations and that deeptech will be the key of such growth. According to the report, an outstanding increase in the number of newly-established deeptech startups was observed between 2010 and 2011 as well as 2017 and 2018.

The intensity of the deeptech companies within the young technology startups doubled during the period of time in question.

Table 2: The Share of Deeptech Startups Within All Technology Startups[16]



[13, 15, 16] *Startup Genome, The Global Startup Ecosystem Report, 2020.*

[14] *Cicada Innovations, Australia's Deeptech Opportunity: Insights from the Cicada Innovations Journey, 2020.*

Giant firms, which actively operate in information and communication technologies, have increasingly begun to shape their innovation strategies towards deeptech as well. Google formed, not long ago, "Verily" which is the Google Life Sciences unit. Google, Facebook, Amazon, IBM and Microsoft formed a partnership so as to do research on artificial intelligence. Both Uber and Apple as well as Google are conducting studies on autonomous car technologies. Facebook increasingly allocates a higher share of investment on artificial intelligence, unmanned tools and virtual reality technologies. [17]

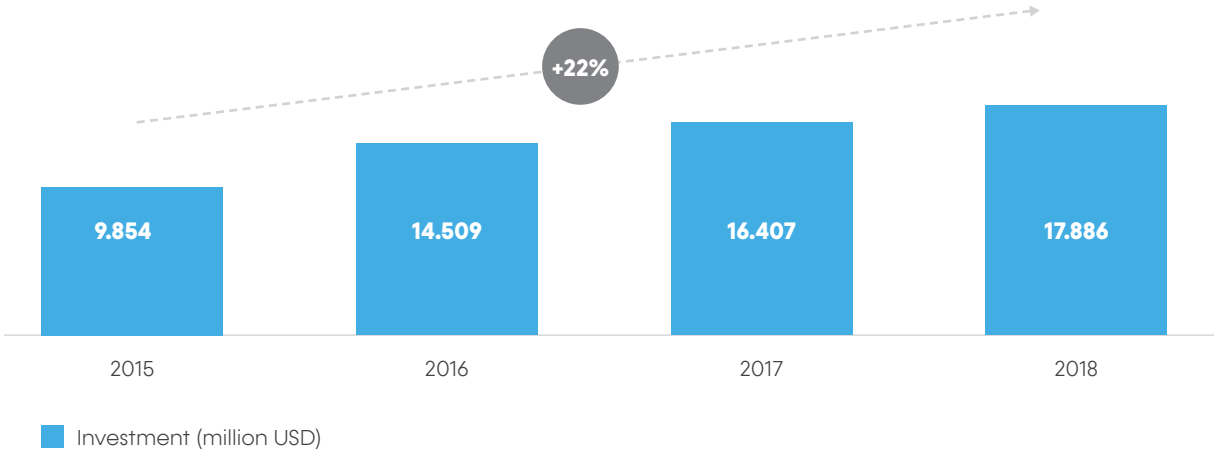
Venture capital investments have increased considerably around the world in the recent 20 years, however such investments have been mostly canalized towards initiatives with possibly short-term returns. The technologies that need considerable amount of finance and longer time in order to eliminate the possible risks have received relatively less share from such investments in the last years despite urgent social issues. This situation is especially relevant for deeptech startups which are built on science and R&D but do not have a well-defined market. [18]

[17] Hello Tomorrow ve BCG, From Tech to Deeptech: Fostering Collaboration Between Corporates and Startups, 2017.

[18] Nanda, R., Financing Tough Tech Innovation, 2020.

Still, investors gradually have been paying more attention to the companies conducting authentic scientific research. Global investment amount in sum for the deeptech categories has almost seen 18 billion USD with an increase of higher than 20% between 2015 and 2018.

Table 3: Global Deeptech Investments[19]



It is observed that photonics and electronics are the most heavily invested categories worldwide whereas quantum computing receive the minimum share of investments. 51 different countries and 1.305 different cities worldwide have invested in deeptech.

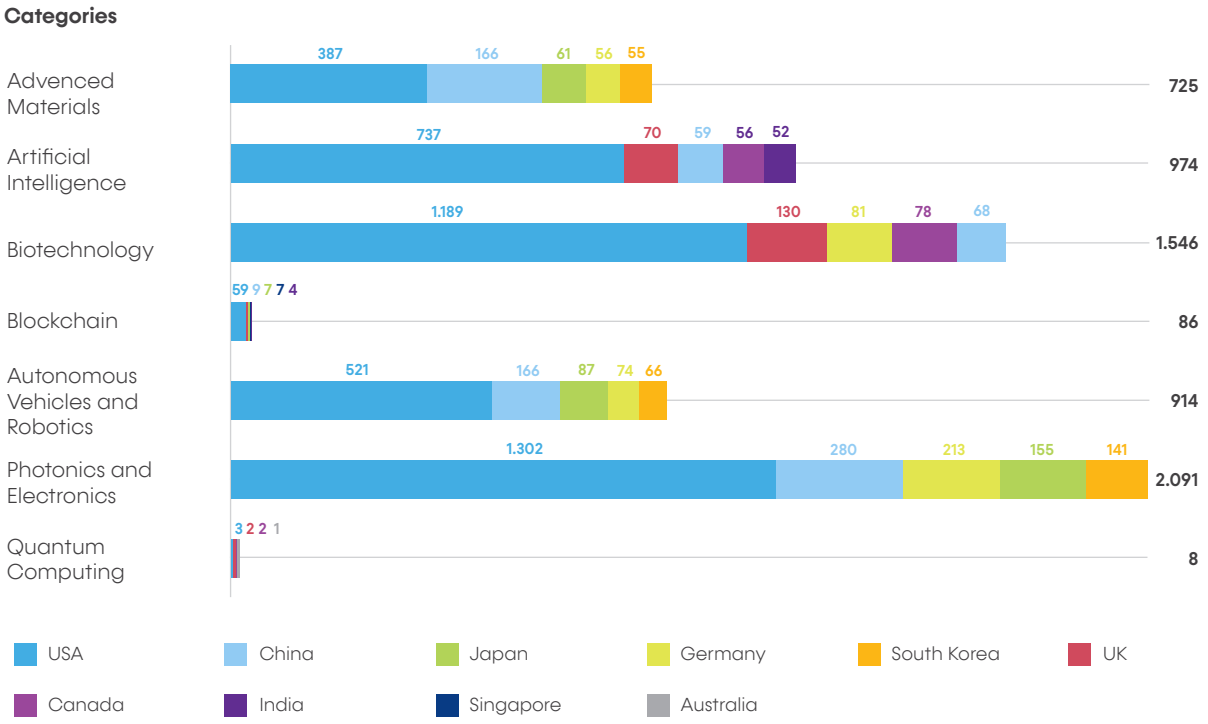
Table 4: The Prevalence of Deeptech Investments[20]

Category	Companies	Countries	Cities
Advenced Materials	987	38	545
Artificial Intelligence	1.302	48	401
Biotechnology	2.028	42	757
Blockchain	121	20	65
Drones and Robotics	1.326	40	697
Photonics and Electronics	2.910	51	1.305
Quantum Computing	8	4	8

[19, 20] *BCG ve Hello Tomorrow, The Dawn of the Deeptech Ecosystem, 2019.*

When the deeptech investments are examined country by country, as expected, the dominance of the big global players stands out. Approximately 81% of the global investments on deeptech companies were realized by the USA and China from 2015 to 2018. Within this time period, deeptech investments were equivalent to 32,8 billion USD and 14,6 billion USD in the USA and China respectively.

Table 5: Distribution of the Deeptech Investments by Countries[21]



The uniqueness of the USA in terms of deeptech entrepreneurship stems from its rich ecosystem. Investors and entrepreneurs have been investing in both deeptech and other initiatives for decades. They master a deep level of knowledge, technological skills and expertise when deeptech are concerned. Above all, the investors have considerable amounts of funds that they can allocate to this area.[22]

3 important factors that bring an important advantage to the USA for its scientific inventions and novelties can be listed as such:

- It is among the first three countries globally that make the highest number of patent applications, and that such patents could be turned into products and services;
- A number of institutions ranked among the world's best universities are established in the USA;
- It has a rooted network of relationships bringing students, academic staff and industries together.

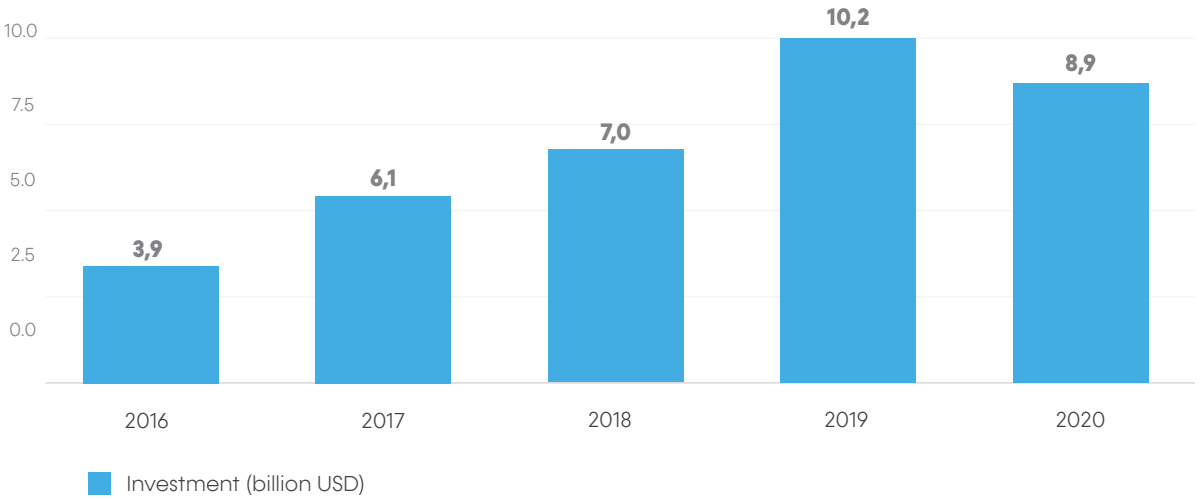
[21] *BCG ve Hello Tomorrow, The Dawn of the Deeptech Ecosystem, 2019.*

[22] *SGI, Deeptech Investments: Realising the Potential, 2019.*

Although it is a controversial topic whether it is China or the USA more advanced in the areas of artificial intelligence and life sciences, it is an indisputable fact that China is among the countries which lead such scientific areas globally. Rapidly-growing entrepreneurship ecosystem has helped artificial intelligence innovations move even further. Besides, a huge population consisting of 1,3 billion people provide a fertile domestic market potential for deeptech initiatives. Furthermore, the Government of China is consistently expanding its activities of deeptech into all categories by investing in advanced production and robotics, blockchain, agriculture technology and new food manufacturing technics, and continues to contribute financially in large scales to support these technologies.[23]

Nevertheless, the world's deeptech ecosystem is not made up of solely these two giant countries. In a similar vein, a number of countries keep recording progress and growth in this area. In recent years, Europe has seen a significant amount of investment increases in deeptech. According to Atomico's "The State of European Tech" (2020) report, deeptech investments for European companies accounting for 3,9 billion USD in 2016, hit the top in 2019 by reaching a level of 10,2 billion USD, and by the first nine months of 2020 it has been recorded as 8,9 billion USD. The cumulative investment directed to the deeptech companies in Europe as from 2016 has been more than 36 billion USD.

Table 6: Investments in European Deeptech Companies[24]



The most critical advantages of Europe in the area of deeptech emerge to be the talent pool and market size. Germany, England, France and other countries all have the world's most successful educational institutions which graduate countless talents in the fields of science, engineering and mathematics.[25]

England is the leading deeptech investment destination of Europe as it invested in deeptech 2,9 billion USD in 2019, of which cumulative investment as from 2015 has come close to 10 billion USD. The other two principal centers of deeptech in Europe are France and Germany, with both countries' investments in deeptech corresponding to 2 billion USD totally in 2019.[26]

[23, 25] *SGI, Deeptech Investments: Realising the Potential, 2019.*

[24] *Atomico, The State of European Tech 2020.*

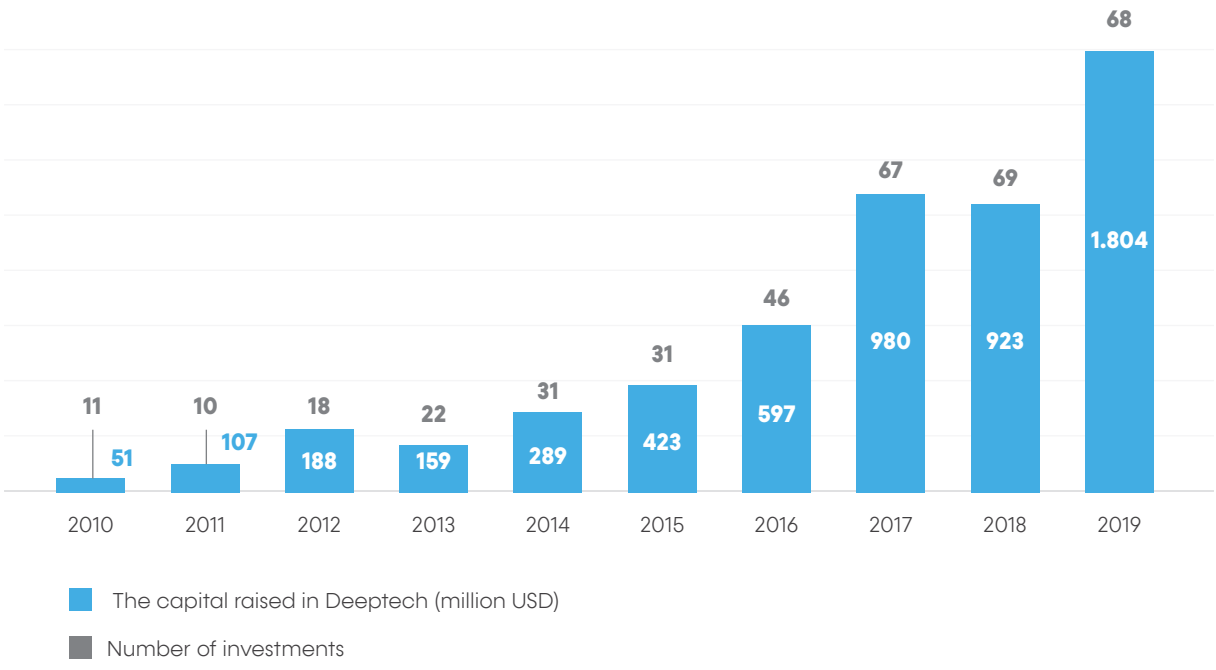
[26] *Atomico, The State of European Tech 2019.*

The progress pace of deeptech investments recorded in the other regions of Asia is quite slow when compared to that of China. Japan, still showing up as an important player in electronics and robotics, has fallen short of important moves in other the deeptech categories. In Southeast Asia, deeptech ecosystem is still in the phase of formation. Even in Singapore, despite it houses the most advanced entrepreneurship ecosystem of the region, deeptech investments still account for a very small share and it is only possible that such investments be made at very long intervals.[27]

Israel emerges as another influential player in the area of deeptech. As of 2020, there exist more than 150 Israel-based technology companies that produce products developed out of deeptech. Besides, the Israel Deeptech ecosystem is not among the recently-emerged areas. "Israel Deep-Tech Overview" (2020)[28] states that Israel deeptech startups raised an investment amount of 5,5 billion USD in sum during 373 investment tours between 2010 and 2019.

The most critical advantages of Europe in the area of deeptech emerge to be the talent pool and market size.

Table 7: Deeptech Investment Amounts in Israel[29]



[27] *SGI, Deeptech Investments: Realising the Potential, 2019.*

[28, 29] *Grow Ventures and IVC, Israeli Deep-Tech Overview, 2020.*

Deeptech Patents Worldwide

To identify the present situation of deeptech worldwide, the patent data are another kind of source that could be referred to. Regarding that statistical analysis as to the patent applications is included among important parameters which are used to compare the technological development levels of different countries and institutions, it is possible to make worthwhile assumptions about global innovation trends by starting from some fundamental details such as the number of patent applications, publications and registration.

Within this scope, patent data about 6 deeptech categories have been examined in a general framework by the use of Patent Effect data in order to specify the positions that active players in such categories hold, and to identify trend technology groups. Because of the insufficient patent data, agriculture and food&beverages sectors are accepted as a single category among the other 12 sectors taken into consideration in the report, and thus the analysis has been conducted upon 11 sectors.

First of all, when global patent and petty patent applications for each technology category spanning from 2001 to 2018 are analysed, it is observed that New Materials and Nanotechnology rank the number 1, with approximately 2,5 million patent applications. Yet, having analysed the applications in terms of their increased proportion for the last 5 years (2014-2018), it is seen that Autonomous Vehicles, Robotics and Mechatronics emerge as the categories which have recorded the most considerable increased with a rate of 341%. When we examine the increase proportion of the patent applications for the last 1 year (2017-2018), we come to the conclusion that the most substantial increase has occurred in the categories of Artificial Intelligence, Data and Image Processing, with a rate of 27%.

Table 8: Patent Applications Worldwide on the Basis of Deeptech Categories

Categories/Years	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Patent Application Increase Rate for the last 5 Years	Patent Application Increase Rate for the last 1 Year	Total Number of Patent Applications (2001-2018)
Autonomous Vehicles, Robotics & Mechatronics	5.224	54.969	5.415	5.706	6.459	6.796	7.453	8.112	8.558	9.440	10.563	13.123	15.655	18.781	29.432	49.356	69.508	82.898	341%	19%	357.448
Augmented And Virtual Reality	529	490	484	587	576	618	710	904	1.227	2.478	2.532	2.653	3.362	3.964	5.025	10.030	11.392	10.909	175%	-4%	58.470
Artificial Intelligence, Data And Image Processing	40.443	33.040	32.967	34.120	37.058	39.022	41.816	40.984	29.623	41.876	47.407	54.423	61.095	67.256	78.744	104.946	136.291	173.655	158%	27%	1.104.766
Industry 4.0, Internet Of Things, Sensors And Electronics	36.697	38.792	42.085	46.522	49.924	51.235	54.466	58.918	61.543	68.522	82.330	96.167	108.300	117.554	146.290	182.186	214.237	226.160	92%	6%	1.681.928
New Materials & Nanotechnology	76.937	77.462	79.812	83.503	90.325	92.922	94.867	99.908	107.046	118.294	134.742	151.298	163.394	170.158	190.053	239.944	267.051	287.219	69%	8%	2.524.935
Biotechnology	24.815	26.849	27.017	24.541	26.060	26.885	28.979	30.584	31.749	34.493	36.574	38.652	43.176	44.519	51.311	59.106	64.010	69.637	56%	9%	688.957

At the same time, the 6 analysed technology categories have been examined as to their situations in 11 different sectors, and this has revealed out the sectors which patent and petty patent applications involved in each technology groups worldwide are centred around. As an example, patent applications made about biotechnology are centred around "health", "food and agriculture", "environment and water", and "energy" respectively.

Table 9: Patent Applications Worldwide on the Basis of Deeptech Categories

Categories/Sectors	Environment and Water	Consumer Products and Services	Energy	Finance	Food	Agriculture	Defence & Aviation	Automotive & Transportation	Retail	Health	Mobile & Telecommuni-cation	Manufacturing & Construction
Autonomous Vehicles, Robots & Mechatronics	30.800	155.000	73.150	2.000	21.000	76.000	114.000	3.300	45.000	53.200	36.250	54
Augmented And Virtual Reality	1.100	62.750	3.500	860	322	1.620	23.000	3.000	7.100	27.500	1.475	3
Artificial Intelligence, Data And Image Processing	70.500	1.515.000	85.000	177.500	25.500	12.300	111.400	300.500	145.000	333.000	43.300	34
Industry 4.0, Internet Of Things, Sensors And Electronics	325.350	923.000	495.450	12.500	104.500	40.000	433.000	14.000	185.300	353.800	254.000	88
New Materials & Nanotechnology	1.020.000	942.000	350.000	2.100	89.000	27.000	302.000	2.500	190.000	67.500	1.002.300	54
Biotechnology	120.000	34.500	98.300	240	193.000	820	3.000	420	374.000	3.250	26.000	5

Deeptech in Turkey

Having a large and young population with more than 83 million of people and an age average of 32,4, Turkey ranks as the 19th biggest economy of in the world.[30]

This young population, which continues to increase, is highly active in the digital world. Turkey is the 10th largest global market for Facebook, the 8th for Youtube, the 6th for Instagram and Twitter, and the 3rd for TikTok. Besides, based on the total number of downloaded applications, Turkey holds the largest 7th market within mobile applications.[31]

From a technological perspective, Turkey's development lies in the important moves that it took towards science and technology in the early years of 2000s. Whereas the total number of universities in Turkey was 77 in 2003, 53 of which were state universities and 24 of which were private foundation universities. Such figures saw 207 by the end of 2020, 129 of which were state universities, and 78 of which were private foundation universities.[32]

In a similar fashion, "Law on Technology Development Zones" paved the way for the formation of technoparks in 2001. Through technoparks which have been granted with legal status based on such law by the state, tax reductions have begun to be provided to technology-based entrepreneurship by designing several incentive mechanisms as regards to the R&D and technology development. Therefore, the early years of 2000s can be identified as the period during which technology entrepreneurship, began to record growth and come close to the levels observed in developed countries, thanks to the potential offered by technoparks.[33]

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[30] *Turkish Statistical Institute, https://www.tuik.gov.tr/*

[31] *Startups Watch, The State of Turkish Startup Ecosystem: An in Depth Analysis and Evaluation, 2019.*

[32] *YOKSIS, https://yoksis.yok.gov.tr/*

[33] *CANSIZ, M. 2017, 2023'e Doğru Türkiye Teknoparkları, T.C. Kalkınma Bakanlığı, Ankara.*

Within the next 19 years as from such a critical point, substantial progress has been recorded, and under the current situations the number of Technology Development Zones established in Turkey corresponds to 84. Out of these zones, 70 technoparks have already started operations while the rest of them are going through the establishment stage. By June 2020, some figures and numbers which were observable at technoparks in operation were as follows: the number of companies conducting R&D activities - 5.846; the number of employed personnel - 58.922; and the number of completed R&D project - 36.535.[34]

In addition to the incentive mechanisms provided at Technology Development Zones, several institutions such as the Ministry of Treasury and Finance, the Ministry of Industry and Technology, KOSGEB (Small and Medium Enterprises Development Organisation), TUBITAK (Scientific and Technological Research Council of Turkey), Development Agencies and Turkey Technology Development Foundation execute support programs as to the innovative entrepreneurship. In this sense, development agencies, despite having been recently established, have contributed to the birth of an important dynamism in their respective regions, and come to the fore as supporters of entrepreneurs, SMEs and local stakeholders by means of monetary support programs.[35]

Among these development agencies, Istanbul Development Agency (IDA) emerges as the best and most active one, executing programs and supporting multiple projects and activities designed to foster and empower the technology ecosystem so as to incorporate Istanbul into the leading global entrepreneurship centers.

Considering that deeptech are costly and necessitate long periods of time to develop, it is of great importance to identify the correct commercialization way for deeptech initiatives. Both incubations centers and accelerators have become more and more effective in commercializing deeptech startups. Such structures are highly influential in offering contributions for the development of new startups by providing the entrepreneurs with opportunities for access to finance, business contacts, qualified workforce, special equipment and facilities.[36]

84 Technopark

5.846 Company

58.922 Staff

36.535 R&D Project

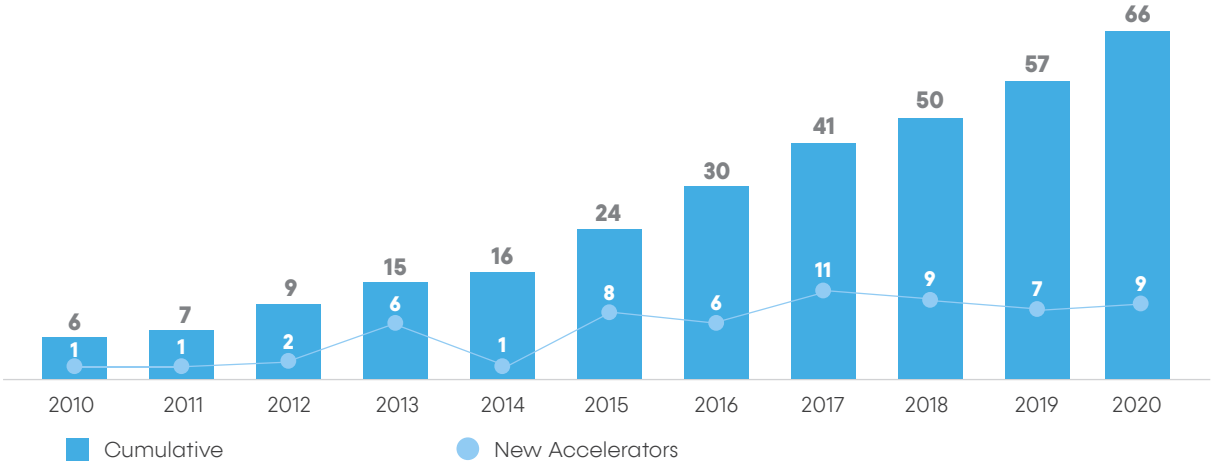
[34] TGBD, https://www.tgbd.org.tr/turkiyede-teknoparklar-icerik-35

[35] CANSIZ, M. 2017, 2023'e Doğru Türkiye Teknoparkları, T.C. Kalkınma Bakanlığı, Ankara.

[36] Cicada Innovations, Australia's Deeptech Opportunity: Insights from the Cicada Innovations Journey, 2020.

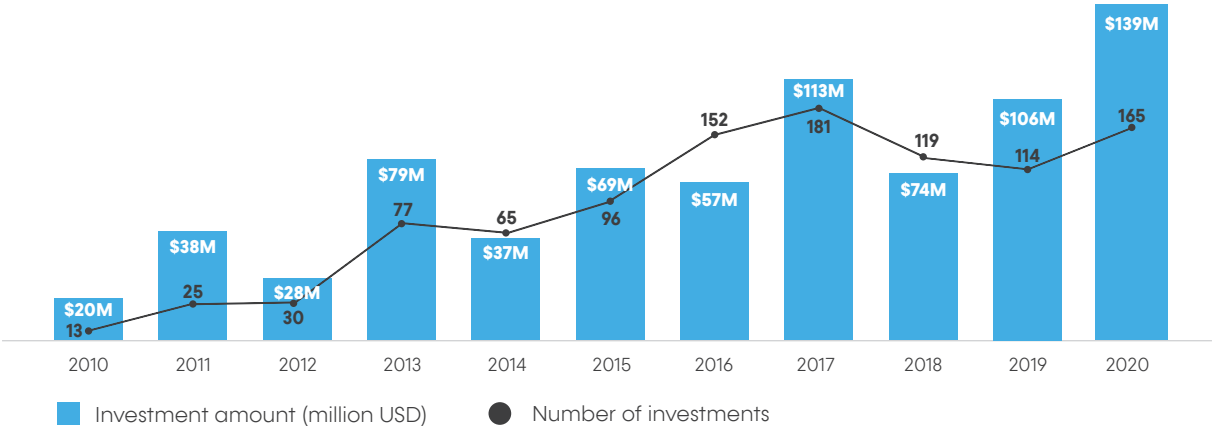
Led by universities, technoparks, chambers and commodity exchanges as well as corporate companies supportive of entrepreneurs, a number of incubators and accelerators have been established and started in Turkey in the last 10 years, and entrepreneurship activities have been recording a constant growth thanks to the support of such institutions. As can be inferred from the Table 10, while there existed 6 accelerators in Turkey in 2010, such figure multiplied and reached 66 by 2020. The Cube Incubation, operating within the Technopark Istanbul, differentiates from other centers as being the only incubator and accelerator that offers services solely to deeptech startups.

Table 10: Change in the Number of Accelerators by Years in Turkey[37]



Another key growth has occurred in the startup capital funds within the last 10 years in Turkey. According to the data obtained from Startups.watch, currently there exist 29 funds which are based in Turkey, and such funds all correspond to approximately 650 million USD in sum. The total size of 8 funds raised within 2020 is more than 200 million USD.[38] As can be seen in the Table 11, the number of venture capital investments and their respective amounts have recorded a general growth by years in Turkey. As of 2020, it reached a record level with the investment amount of 139 million USD.

Table 11: Venture Capital Investments by Years in Turkey[39]



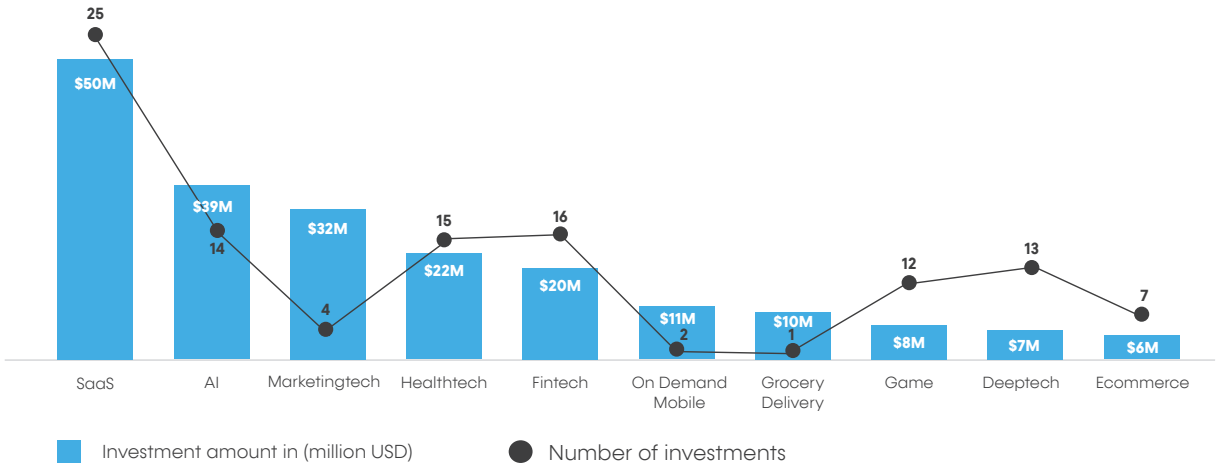
[37] Startups Watch, The state of Turkish Startup Ecosystem: An in Depth Analysis and Evaluation, 2019.

[38] Startups Watch, Turkish Startup Ecosystem Monthly Report, November 2020.

[39] Startups Watch, Turkish Startup Ecosystem Annual Report - 2020 Year in Review, February 2021.

Despite the recorded increase in the number and total sizes of the funds, the share of investments allocated to deeptech is highly low within the referred investments. Requiring a higher amount of investment because of their structure as compared to normal technology startups, deeptech startups could not create sufficient attention among investors within 2020. As can be observed in the table 12, only 7 million USD was transferred to deeptech startups among the investments made at the end of 2020. Deeptech investments are accepted as too risky among investors; that it requires longer periods of time for return on investment, and that there exist no deeptech focused investment funds in Turkey are some of the main reasons explaining such situation. As the entrepreneurship ecosystem in Turkey is still in the phase of growth, it is only recently that specialization among the ecosystem's stakeholders has begun taking place. Multiple entrepreneurship support mechanisms such as technoparks, incubators, accelerators, investment funds and subventions have been in general established in order to support all kinds of entrepreneurs. Besides, the last years have seen the establishment of specialized technoparks, accelerators and investment funds which focus on different technologies. And yet, the number of institutions that especially concentrate on the deeptech startups is quite insufficient. For that reason, although it is not difficult to obtain data on general entrepreneurship in Turkey, when deeptech entrepreneurship is concerned, it poses great challenges to obtain relevant data.

Table 12: The Top Invested Areas in Turkey by Year 2020[40]



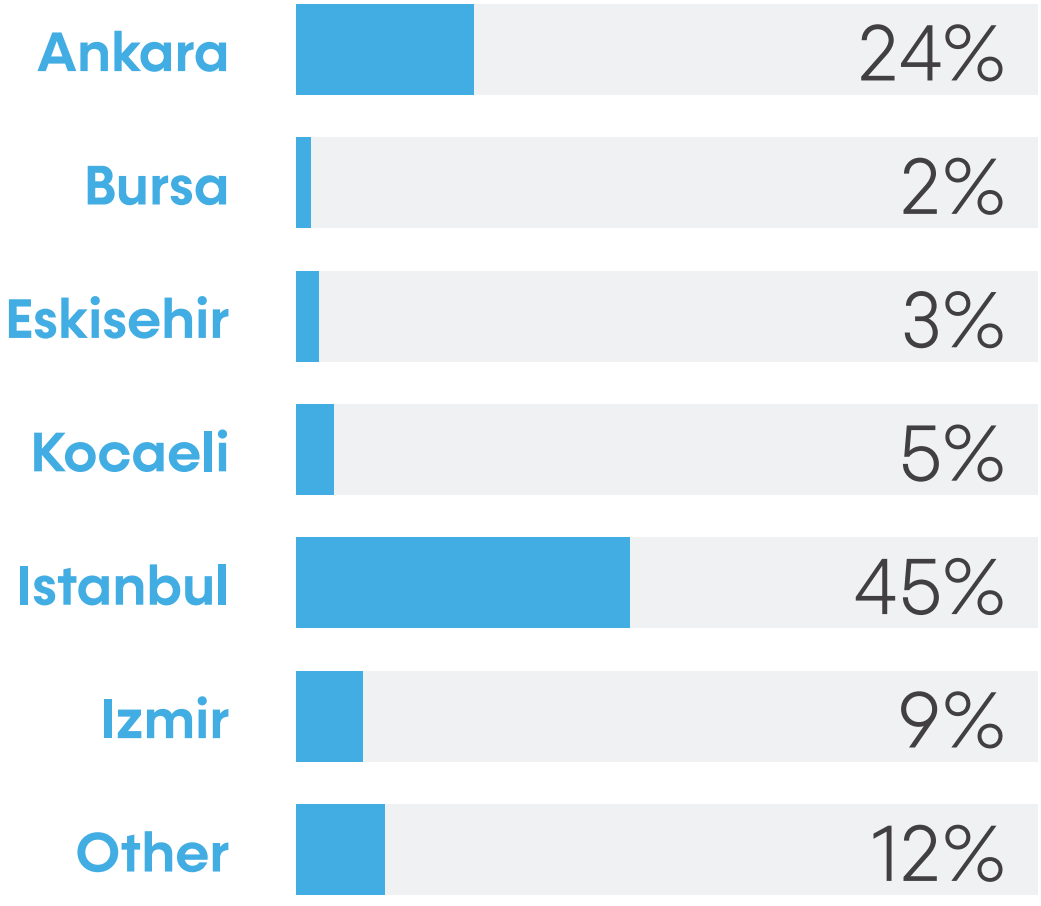
$650m

[40] *Startups Watch, Turkish Startup Ecosystem Annual Report - 2020 Year in Review, February 2021.*

Deeptech Entrepreneurship in Turkey: Key Figures

Before writing this report, a number of entrepreneurship data were gathered together and having examined each attained startup individually, the deeptech startups in Turkey were attempted to be identified. For this process, chambers of commerce, TUBITAK (Scientific and Technological Research Council of Turkey), KOSGEB (Small and Medium Industry Development Organisation), technoparks, incubators and Startups.watch, all of which feature the largest entrepreneurship database of Turkey, were scanned for relevant data, and subsequently all attained startups were included in a single list along with the detailed information about them. Having examined more than 10 thousands of startups individually, 1.307 deeptech startups were identified and such startups were categorized by 6 main technology waves and 12 main sectors.

As the categorization was conducted, content published in the official web sites of the relevant startups were used as another resource in addition to the detailed information attained from data bases. Thus, for the first time in Turkey, a data base which contains Turkey's 1.307 deeptech startups together with their detailed information was formed. It was discovered that 107 startups within the 1.307 startups in the list stopped their operations, and therefore these startups were not included into the analysis.



Almost half of the 1.200 deeptech startups which continue their operations actively are based in Istanbul where they currently maintain their operations. Ankara, Izmir, Kocaeli, Eskisehir and Bursa follow Istanbul, as cities that startups are centred around.

When the startups in question are analysed by their age, it is observed that a majority of them, which is equivalent to 63%, were established in 2015 and the following years. 22% of the startups were established between the years of 2010 and 2015 whereas 15% of them were established in the years preceding 2010. In the light of such data, we can easily come to the conclusion that deeptech entrepreneurship in Turkey has gathered an important momentum within the last 5 years.

Table 13: The Distribution of Deeptech Startups by Sectors in Turkey

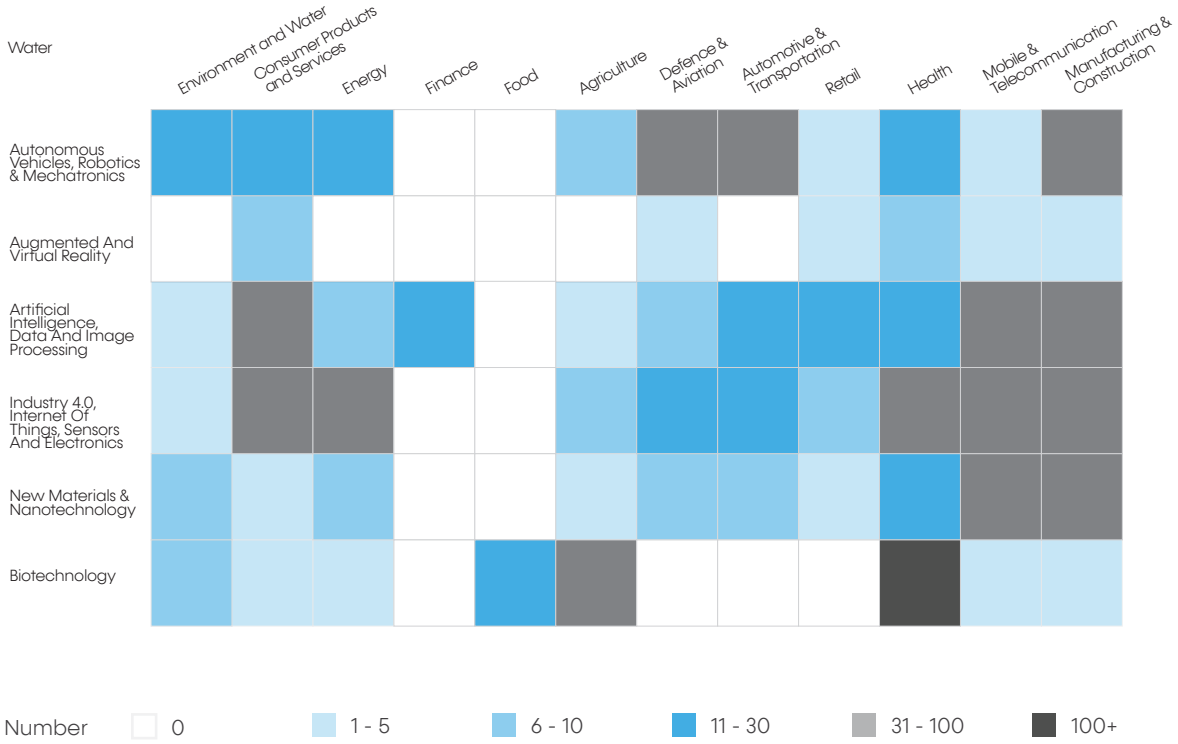
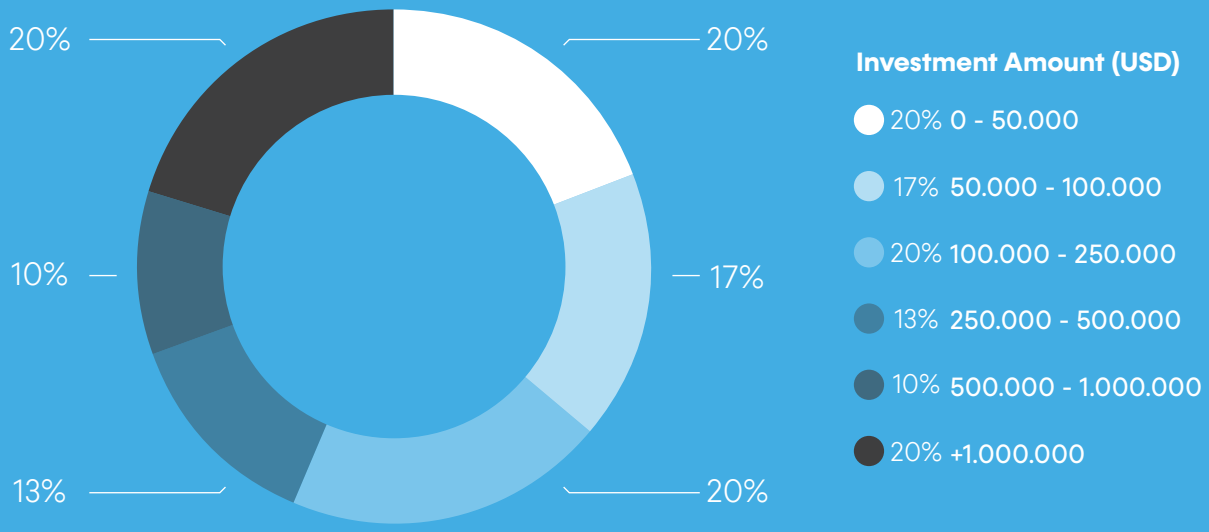


Table 13 includes the heat map that shows the distribution of deeptech startups by sectors in Turkey. Accordingly, it can be observed that technology has been developed at most in the areas of "Industry 4.0, Internet of Things, Sensors and Electronics," which are followed by "Biotechnology", "Artificial Intelligence, Data and Image Processing," and "Autonomous Vehicles, Robots and Mechatronics" technologies. It is noted that deeptech startups developing technologies in the areas of "Advanced Materials and Nanotechnology" and especially "Augmented and Virtual Reality" are less as compared to other areas.

Among the main sectors that deeptech startups in Turkey offer services to "Health" and "Manufacturing and Construction" are the most intensified ones respectively. In addition to these two sectors, "Defence and Aviation" draws attention as another sector around which intense activities are centred.

Table 14: Amount of Investment Deeptech Startups Raised in Turkey



When the startups are examined in terms of the investments, it is observed that only 172 of them could attain investments. Such figure corresponds to the 14,3% of all startups, and this is quite low especially for deeptech startups requiring extensive amounts of investment. 86,7% of the deeptech startups in Turkey could not attain any investment. Having analysed the amounts of raised investments, it is seen that 19% of the startups were invested below 50.000 USD whereas 20% raised investments varying between 50.000 and 100.000 USD, and similarly 20% of them were invested in amounts from 10,000 to 250.000 USD. And this indicates that almost 60% of the startups which could attain investments were invested below 250.000 USD.

As the deeptech startups in Turkey were listed, 60 deeptech startups were identified to be established abroad by Turkish entrepreneurs. It was concluded that these startups, 43 of which were established in the USA, 15 of which in multiple countries of Europe and 2 of which in the United Arab Emirates, have much higher performance as to the attainment of investments as compared to that of startups in Turkey. Whereas the total investment amount that 1.200 active deeptech startups in Turkey is 126 million USD, this corresponds to about 1,7 billion USD for the 60 startups established abroad by Turkish entrepreneurs. As the owner of one of the vaccines developed against the COVID-19 pandemic, Germany-based Biontech and the USD-based Samumed have greatly contributed to such success of the deeptech startups established abroad by Turkish entrepreneurs.

Deeptech Patents in Turkey

The quest to seek for product-market fit for deeptech startups means, far beyond A/B testing, to conduct continuous experiments about technology and its implementation in real-life environments, and to pursue intellectual property rights which will ensure the protection of the technology having been developed by walking over multiple scientific areas.[41]

Deep technologies are in most cases only possible to be developed following years of research and laboratory tests, and generally could be held under protection by means of owning patents and other intellectual property rights.

The deeptech startups which protect the technologies they develop by means of intellectual property rights gain several advantages such as competitive advantage, tax reductions, higher investor attention, higher levels of company assessment and prestige.

A number of academic studies conducted on this issue identified that patents and trademarks raise the amount of capital financing for startups.[42]

In a similar vein, previous studies indicate that startups with patents are invested earlier[43] and with higher assessments[44] as compared to the startups without patents.

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[41] St Different, Deeptech Investment Report, 2020.

[42] (Haeussler, C., Harhoff, D., Muller, E., 2012. To be financed or not... – The role of patents for venture capital financing ZEW – Centre for European Economic Research Discussion Paper No. 09-003), (Hsu, D. H., & Ziedonis, R. H. (2008, August). Patents as quality signals for entrepreneurial ventures. In Academy of Management Proceedings (Vol. 2008, No. 1, pp. 1-6). Briarcliff Manor, NY 10510: Academy of Management.), (Block, J. H., De Vries, G., Schumann, J. H., & Sandner, P. (2014). Trademarks and venture capital valuation. Journal of Business Venturing, 29(4), 525-542.).

[43] Haeussler, C., Harhoff, D., Muller, E., 2012. To be financed or not... – The role of patents for venture capital financing ZEW – Centre for European Economic Research Discussion Paper No. 09-003.

[44] Greenberg, G., 2010. Small firms, big patents? Estimating patent value using data on Israeli start-ups financing rounds. Work. Pap.

Research shows that startups which have already made at least one patent application before applying for venture capital financing obtain 51,7% higher finance when compared with the startups which have not made any patent applications. [45]

In a study conducted by European Patent Office and EUOIPO, it was identified that among the SMEs in Europe, the ones who have made at least one European Patent application have a 25% higher possibility to turn into fast-growing startups.

Table 15: The Number of Patent/utility Model Applications by cities

City	Applications
Istanbul	169
Ankara	90
Izmir	41
Kocaeli	20
Eskisehir	10
Kayseri	10
Konya	10
Antalya	6
Bursa	5
Elazıg	5

Once again according to the same study, the SMEs which develop high technology products and services and which have made at least one European patent application have a 110% higher possibility to turn into fast-growing startups.[46]

With the aim of analysing the deeptech startups in Turkey as to their intellectual property rights another research was conducted by using the patent databases. According to research findings, among the 1.200 startups discussed in this study which were established in 2010 and the following years and which continue to operate in Turkey, there exist 407 deeptech startups which own patent/petty patent. It is confirmed that these 407 startups are the holders of 1.100 patents/petty patents in sum. 111 (27%) of these startups are academic spin-offs which were established by academic people from different universities in Turkey. It is observed that 10 out of the top 20 startups with the highest number of patent/petty patent applications are academic spin-offs.

72 among 407 startups holding patents have raised investments at least once. While the share of startups having raised investments is 14,3% for all deeptech startups, this share is 17,6% for startups with patents/petty patents. Thus, in a parallel line with the research data referred to above, within all startups in Turkey, the startups with patents/petty patents obtain higher proportions of investments when compared to the ones who do not possess patents/petty patents. Having been analysed in terms of the cities they operate in, patent/petty patent-holder startups are observed to have centred, as expected, in Istanbul, Ankara and Izmir respectively.

[45] Zhou, Haibo., Sandner, Philipp., Martinelli, Luca., Block, Joern. (2015). Patents, trademarks, and their complementarity in venture capital funding. Technovation. 47. 10.1016/j.technovation.2015.11.005.

[46] European Patent Office ve European Union Intellectual Property Office, High-Growth Firms and Intellectual Property Rights, 2019.

Among the 407 startups having patent/petty patents in Turkey, the ones operating in the area of Biotechnology predominate. Biotechnology is followed by New Materials and Nanotechnology, and Autonomous Vehicles, Robots & Mechatronics.

Table 16: The Number of Patent-holder Startups on the Basis of Technology Categories

Technology Category	Number of patent-holder startups
Biotechnology	49
New Materials & Nanotechnology	44
Autonomous Vehicles, Robotics & Mechatronics	36
Industry 4.0, Internet Of Things, Sensors And Electronics	29
Artificial Intelligence, Data And Image Processing	18
Augmented And Virtual Reality	7

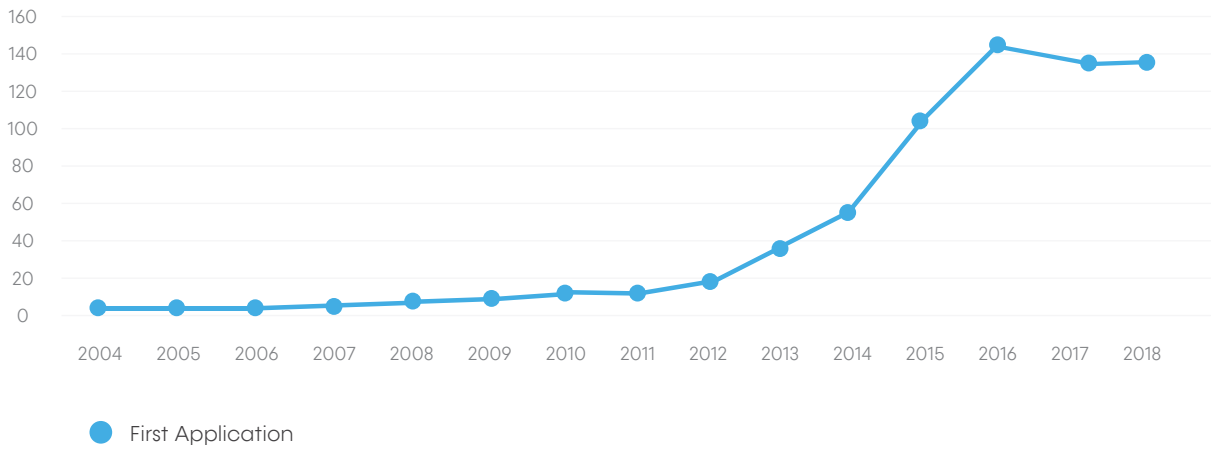
The assessment on of the sectors in which patent/petty patent holder startups function has revealed out that the relevant startups are mostly active in Health, Electronics and Energy sectors.

Table 17: Sectors and the Number of Patent Holder Startups

Sector	Number of patent holder startups
Health	91
Consumer Products and Services	56
Energy	47
Food and Agriculture	39
Automotive & Transportation	19
Defence & Aviation	17
Environment and Water	8
Retail	7
Manufacturing & Construction	5
Finance	3
Mobile & Telecommunication	1

The analysis indicates that deeptech startups tend to make more patent/petty patent applications as from 2010, as an increase in the number of applications is observable in this year. The years of 2012 and of 2015 have been recorded as the years in which increase rates hit the top.

Table 18: Number of Patent Applications by Years



Health
Electronic
Energy

A Survey on the Current Situation and Need Analysis of Deeptech Entrepreneurship in Turkey

Methodology

Having listed the existing deeptech startups in Turkey, a questionnaire study was conducted so as to understand their current situation and analyse the needs of them. Since this study would be the first example in of its kind in Turkey, the experience of team members as well as global examples were employed to design the research scale. By bringing "From Tech to Deeptech" report, which is one of the very few needs identification study on deeptech startups, together with a number of other studies on general entrepreneurship, a questionnaire the size of 29 questions was designed in a way that would allow the identification of current situation, resources and needs of deeptech startups. The questionnaire was shared with randomly chosen 250 startups out of 1,200 deeptech companies in a way that would reflect the research population, by taking into consideration the parameters of 6 deeptech technology categories, 12 main sectors as well as age and city. Analysis was conducted based on the results obtained from this study in which the founders and/or managers of different 131 startups participated.

Research Results

As the purpose of this research is to identify the problems and needs of young startups, the sample was predominantly selected among the startups established in 2015 and the later years. The Law on Technology Development Zones (TGB) Application Regulations of the Ministry of Industry and Technology defines incubation firms as such: " [incubation firms] are project owners and young businesses, established not more than three years before, which are supported in terms of R&D, technological novelty, software and design activities or considered as appropriate so as to be supported with competition programs by state institutions and organization as well as private sector businesses, or function the mentioned activities."[48] However, as already stated in the previous sections of this report, considering that deeptech startups need longer periods of time, as compared to other technology startups, for product development and commercialization, that is for incubation process, such defined time is accepted to be up to 6 years.

[48] *Sanayi ve Teknoloji Bakanlığı, Teknoloji Geliştirme Bölgeleri Uygulama Yönetmeliği, 2016.*

83% of the startups joining the survey execute their operations within technoparks while 53% of them are residing in an incubator.

31% of the startups that took part in the survey -in a suitable way to the deeptech definitions- are of spin-offs established by academicians. 35% of the startups which took place in the survey were founded by PhD holders; the 29% of them have a Master's and 29% of them have an Undergraduate degree.

While the 25% of the startups have at least a woman co-founder or a founder, 48% of the startups were founded by entrepreneurs who had experienced entrepreneurship earlier. While 42% of the startups are managed by only 1 partner, 34% of them are managed by 2 partners, and 18% have 3 managing partners.

Table 19: Technology Waves which the Startups Focus on

Technology Categories	Percent
Autonomous Vehicles, Robotics & Mechatronics	18%
Augmented And Virtual Reality	5%
Artificial Intelligence, Data And Image Processing	26%
Industry 4.0, Internet Of Things, Sensors And Electronics	24%
New Materials & Nanotechnology	8%
Biotechnology	19%

Table 20: Sectors that the Startups Function

Technology Categories	Percent
Defence & Aviation	23%
Health	21%
Automotive & Transportation	11%
Mobile & Telecommunication	8%
Energy	7%
Agriculture	6%
Consumer Products and Services	6%
Manufacturing & Construction	6%
Finance	4%
Food	3%
Environment and Water	2%
Retail	2%

Technology Readiness Level

Another important indicator as to the situation of startups is the number of products they develop and the technological readiness of such products. Technological Readiness Levels (TRL) is a measurement system devised by NASA in 1989 in order to qualify the maturity levels of the technologies. Nine technology readiness levels were identified, among which TRL 1 indicates the lowest level while TRL 9 indicates the highest level. In "From Tech to Deeptech" report[49], the maturity levels of the startups are defined in 3 stages based on the technology readiness levels of the products they develop.

The stages are;

- Early stage (discovery stage, TRL 1-4)
- Mid stage (prototype stage, TRL 5-7)
- Late stage (commercialization, TRL 8-9)

Among the 131 deeptech startups joining the survey, 94 of which have early-stage products while 107 of which have mid-stage and 102 of which have late-stage products.

These 131 startups have 194 early stage products, 177 middle stage products and 284 late stage products in total.

As can be observed, the number of late stage products that deeptech firms in Turkey have developed are almost 50% higher than early-stage and middle-stage products. Therefore, it would be not wrong to conclude from this point that the deeptech startups in Turkey do not have difficulty in developing products.

50%

[49] *Hello Tomorrow ve BCG, From Tech to Deeptech: Fostering Collaboration Between Corporates and Startups, 2017.*

Sources of Finance

79% of the startups participating in the survey are financed through their own savings. State grants are the second mostly used finance source with a proportion of 61%. And 27% of the entrepreneurs finance their startups with the sources they provide from their families and friends. Such data point to an important problem in terms of the deeptech entrepreneurship which needs high amounts of capital. The entrepreneurs attempt to sustain their firms through their own means.

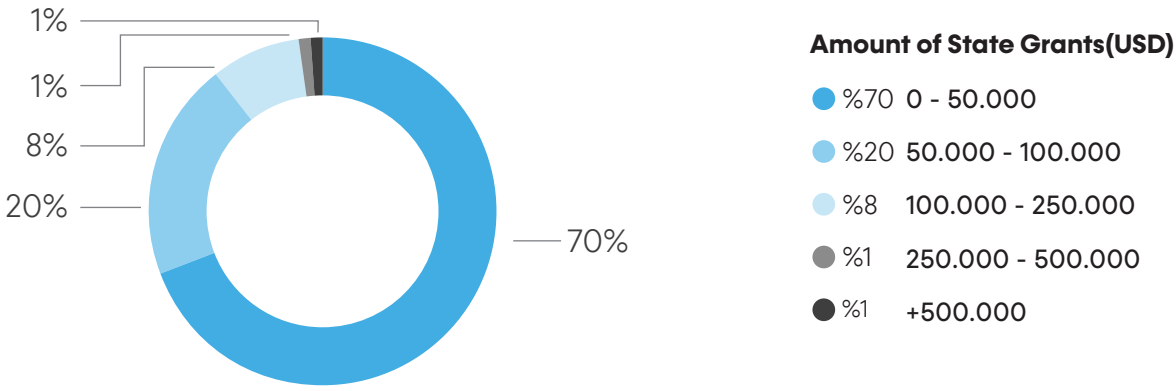
Although state grants contribute considerably, it is almost 40% of the deeptech startups that could not make use of such subsidies. Simplification of the application processes for grant support mechanisms and thus enhancement of the accessibility will make it possible for a higher number of startups to meet their capital needs. The levels of startup capital investments which have the principal potential to satisfy the intense capital needs of the deeptech are unfortunately not sufficient. It is only 14.5% of the startups in the survey that could attain funds from angel investors. As for the venture capital and corporation firm investments, they were even in lower levels and emerged to be 10,5% and 4,5% respectively. It is of a necessity for deeptech startups to be able to attain success that startup investments be increased to the higher levels.

Another remarkable data about the sources of finance is that university funds be employed at rather lower levels with a share of 7%. Considering that deeptech startups flourish on science and R&D, and that 31% of the startups are academic spin-offs, such share is quite low.

When an analysis is made on the grant supports that deeptech startups obtain from the state, it is observed that 69% of the startups benefiting from such grants could obtain less than 50.000 USD. While 20% of the startups could get a state grant varying between 50.000 and 100.000 USD, it was only 11% that could attain more than 100,000 USD state grants.

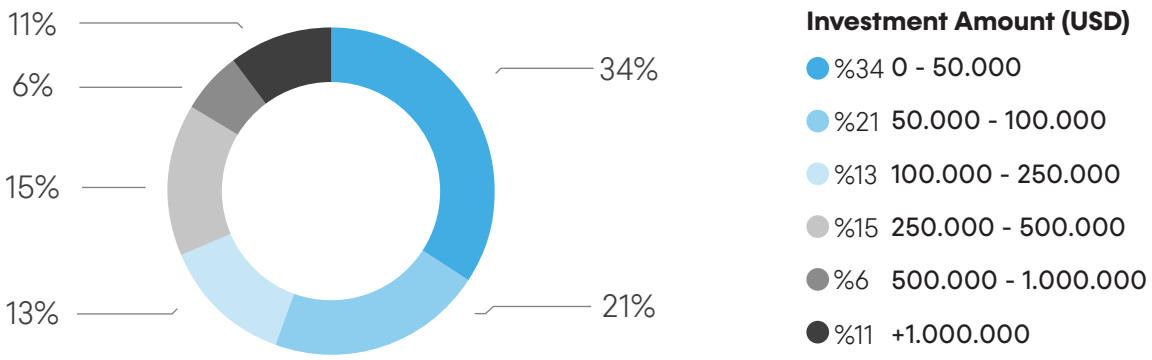
Although state grant supports are employed at high rates by the deeptech startups, the amounts of finance offered to the startups through such support mechanisms do not reach levels sufficient to answer the intense capital needs of the deeptech startups.

Table 21: Extent of State Grants which the Startups Attain



When investments received by the startups participating in the survey are examined, it is seen that approximately 30% of them could have access to the investment. That 34% of the startups, which constitute the majority of the startups having raised investments, were invested below 50,000 USD indicates that deeptech startups do not only have difficulty in finding investments but also finding sufficient amounts of investments. It is only 10,5% within all startups answering the survey that could collect an amount of investment 1 million USD and above.

Table 22: Amount of Investment Raised by Startups



That the entrepreneurs have former experience with entrepreneurship shows itself up as a critical factor in having access to investments. The rate of those which could get investments is 30% within all startups whereas 51% of the companies whose founders involve people who have former experience with entrepreneurship achieved to obtain investments. Interestingly enough, all of the companies that were invested with **1 million USD and above include at least 1 founder who has former experience with entrepreneurship.**

From the aspect of investments the results of the study point to the fact that capital funds as well as investors for startups are not sufficient in Turkey, and also the existing funds and investors do not pay enough attention to deeptech startups. It is essential that more venture capital funds be established and that the attention of the investors be attracted towards the deeptech startups.

Such necessity is at the same time observable in the sources of finance that the startups prefer to employ in the future. The entrepreneurs who answered the questionnaire were asked for to choose 3 sources of finance that they would prefer to benefit from in the future, and the most preferred 3 options emerged as state grant support with a rate of 78%, the corporate company investments with a rate of 50% and lastly the venture capital investments with 45%. Investments from angel investors became the fifth most preferred investment type with a rate of 34%.

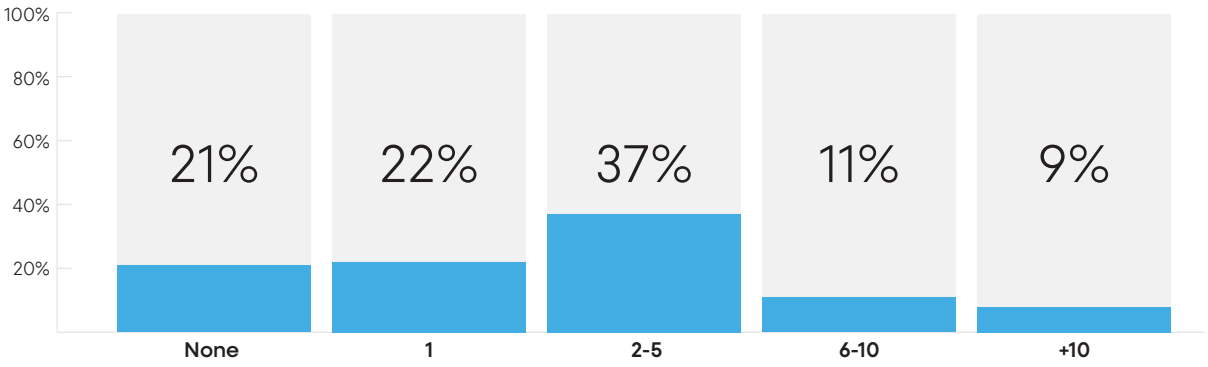
Table 23: The Sources of Finance Preferred by the Entrepreneurs

Sources of Finance	Percent
State Grants	78%
Corporate Venture Capital	50%
Venture Capital	45%
Savings of the Founders	35%
Angel Investor	34%
University Funds	15%
Family and Friends	5%
Other	2%

Sale and Marketing

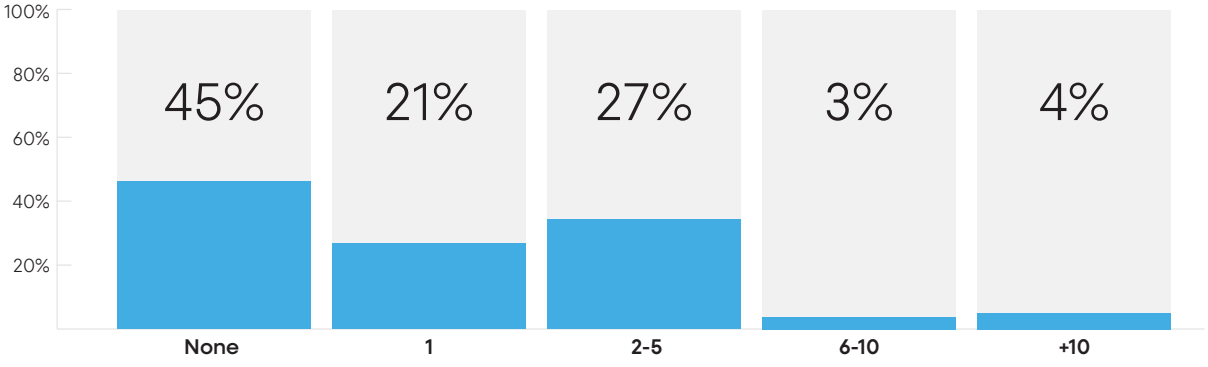
As a necessity stemming from their nature, the deeptech startups are types of R&D focused ventures which are generally established by academicians, engineers or science people. Therefore, in activities other than R&D they are mostly unable to gain achievement as much as they do in the stage of R&D, with some exception though. Yet, other activities such as sales, marketing, finance and so on are not less important than R&D processes in ensuring the success of a company. Having analysed the way in which the personnel are organized in the deeptech startups in the survey, it is identified that 21% of the startups do not employ R&D personnel apart from the partners while 22% of them employ only one R&D employee. The average number of R&D personnel employed by all startups corresponds to 4,1. Such figures are not surprising when one considers the challenges that deeptech firms have to solve in order to access to investments and also the high costs of R&D personnel qualified enough to work in this area.

Table 24: R&D Personnel Employed by the Startups



When an analysis is conducted on the personnel employed in non-R&D units, it is observed that 45% of the startups do not employ staff in other units, and that 21% of them employ only one staff in other units than the R&D area. The average number of employees for non-R&D units for all startups is equivalent to 1,7. Such figures indicate that the deeptech startups in Turkey do not or cannot allocate enough sources to the activities other than R&D processes.

Table 25: Non-R&D Personnel Employed by the Startups



According to the survey results, for non-R&D activities the deeptech startups get support, -excluding the employed personnel and partners-, from professional service providers with a rate of 47%, friends and families with a rate of 25%, and trainees with a rate of 23%. Sale and Marketing plays a crucial role among the non-R&D activities. A company who fails to sell its products is not able to sustain its existence. When it is considered that commercialization processes take longer periods of time for deeptech startups, the initial sale is an important step in the journey of a deeptech startup. While 72% of the deeptech startups have achieved the initial sale, 28% of them have not been able to cross over such a crucial stage so far. When analysed from the aspect of technology categories, it is observed that biotechnology falls behind other categories in terms of sales, a situation which is contributed by the fact that commercialization of biotechnology takes longer as compared to other technologies.

Table 26: Share of Startups which Achieved Initial Sale

Technology Categories	Percent
Autonomous Vehicles, Robotics & Mechatronics	86%
Augmented And Virtual Reality	84%
Artificial Intelligence, Data And Image Processing	79%
Industry 4.0, Internet Of Things, Sensors And Electronics	74%
New Materials & Nanotechnology	73%
Biotechnology	49%

Achievement in sales mostly depends on marketing activities. In this sense, it is expected that focus on marketing and the employment of marketing staff increase the sales. The startups in the survey were asked whether they employed full-time marketing staff, and it was only 31% of them replied in the affirmative (Yes). The analysis, which was conducted to measure the effect of marketing activities on the sales, it was observed that %90 of the startups that employ at least one full-time marketing personnel achieved to realize sales whereas for the startups that do not employ a full-time marketing staff it was only 64% which achieved to realize sales.

Another important indicator for the startups is export figures. As proving the high added values that technology ventures create, the extent of exports produced by technology ventures is also important in shaping a country's economy. The added value produced by deeptech startups is much higher than that of other technology ventures due to their intense focus on R&D activities. 31% of the deeptech startups joining the survey managed to export despite the serious challenges they have in accessing to sources of finance. This success signifies that the deeptech startups have a high potential to be even more successful and to contribute greatly to Turkey's economy.

In this sense, it is crucially important to identify the problems of deeptech startups in Turkey and undertake activities in order to solve such problems.

Challenges and Requirements

The development of an ecosystem depends on identifying the existing challenges and devising methods and mechanisms in order to come up with solutions. In this sense, by identifying the current situation and challenges of the deeptech ecosystem this study aims to compose a detailed analysis so as to devise solution proposals to the identified challenges.

Therefore, entrepreneurs participating in the survey were asked to state 3 fundamental challenges and 3 fundamental needs.

The principal problem that the startups encounter was, as expected, an intense need for capital. Intense capital requirement, which was chosen by 64% of the startups, was respectively followed by conservative market structure with 47%, access to appropriate connections with 42% and the long product development process with %41.

The capability of increasing production capacity was revealed out to be the least stated challenge with a rate of 12% since most of the startups have reached such a stage yet.

Table 27: Main Challenges Faced by Startups

Main Challenges	Percent
Intense Capital Need	64%
Conservative (traditional) Market Structure	47%
Access to Appropriate Connections	42%
The Long Product Development Process	41%
Vagueness of Commercial Application	30%
Technological Risks and Challenges	26%
Regulations	20%
Prototyping	18%
Capability of Increasing Production Capacity	12%

Having analysed the needs of the startups, it is found out, once again, that the need for finance sources is by far the most crucial requirement of the startups with a rate of %77. Long commercialization process and technological infrastructure requiring high finance are the key reasons explaining such need.

Another important need, with a share of 58%, of the startups is to have access to the market. The deeptech startups which do not have difficulty in developing products, as stated in the previous sections of the report, challenges when it comes to sales and marketing activities. The need for qualified human resources, listed as the third with a share of 35%, and the need for a co-founder, listed as the fourth with a share of 25%, is likely to contribute to the solution of the market accessibility problem. Provided that the startups have reached out qualified human resources and cooperated with experienced co-founders in non-R&D units, they will have taken an important step towards solving the challenges they face to have access to the market.

It is observed that mentorship and consultancy emerge as the least important need with a share of 5% while licencing/patenting is ranked as the least second important need with a share of 10%, a result indicating the effect of incubators, accelerator programs and technology transfer offices which have been fostering in Turkey.

Table 28: The Most Crucial Needs of the Startups

Needs	Percent
Finance	77%
Market Accessibility	58%
Qualified Human Resources	35%
Finding Appropriate Co-founders	25%
Laboratory and Test Facilities	22%
Visibility and Credibility	22%
Technical Expertise (for R&D)	18%
Technical Expertise (for industrialisation)	17%
Business knowledge and expertise	11%
Licencing and Patenting	10%
Mentorship and Consultancy	5%

Conclusion and Recommendations

Deeptech entrepreneurship promises a big potential that could change both our country and the world. New discoveries as well as products and services to be developed in this area are able to offer improvements to increase the standards of living apart from their contributions to economies. In this sense, it is crucially important to support the development of such types of technologies as well as the startups that will make it possible to develop such technologies.

Progress having been recorded in Turkey in recent years under the guidance of universities and technoparks has given birth to promising outcomes in R&D activities. Taking such outcomes forward will be possible by identifying the problems surrounding the ecosystem and coming up with ways to solve them. In this regard, the aim of this study in which the problems of deeptech startups have been identified and the possible ways of solutions are proposed has been to contribution to the development of the ecosystem.

Results of the study underline the fact that although there exist a sufficient number of deeptech startups in Turkey, under the current circumstances such ventures face some serious challenges. The most essential need and the most serious problem when it comes to the deeptech startups in Turkey, alike their counterparts worldwide, emerge to be the insufficiency of finance sources as well as difficulties in accessing to the available sources.

Such "finance deficit" arises out of two main reasons. The first reason is that a considerable number of investors do not master expertise and structures required to assess and support deeptech startups. And the second reason lies in the past experience with investments allocated to deeptech startups, which is regarded as intimidating by the investors when they consider the longer periods of time required for the commercialization processes and return on investments. Although such two factors do not apply to each deeptech startup. It is a necessity to solve this problem so that the number of funds and investors to be increased and deeptech focused large-scale funds to be established in Turkey.

When it comes to the establishment of funds and incentives for investors to allocate more investments to deeptech startups, the state also plays an important role. With an aim to gain technological independence, Turkey provides incentives by means of state mechanisms that help decrease the risks posed by these investments. In recent years, thanks to the efforts of the Ministry of Treasury and Finance, the Venture Capital Investment Funds have been improved as regards to the establishment and implementation processes, and moreover remarkable tax incentives have been granted to both such funds and individual investors. In a similar vein, along with the Ministry of Treasury and Finance, the Ministry of Industry and Technology announced important support to be granted to venture capital investments through both Scientific and Technological Research Council of Turkey (TUBITAK) and Istanbul Development Agency (IDA) by means of structuring such funds.

Another serious problem facing the deeptech startups emerges on the point of marketing the developed products. Deeptech startups, which have difficulties in accessing to the market, are unable to realize in sufficient levels the sale of the high technology products they produce. The primary reason of such a situation is, according to the entrepreneurs, conservative (traditional) market structure. The most important purchaser of the products produced by deeptech startups are mostly states. In this sense, it is essential that state mechanisms incorporate a structure that will support deeptech technologies. It has been observed that the role played by states as a purchaser who decreases market risk and also as a financier who decreases technological risks posed by early-stage inventions has proved to be influential for the deeptech startups to overcome the challenges they encounter.

Another major reason that make access to the market difficult for the entrepreneurs stems from the R&D focused characteristics of deeptech technologies. The most crucial responsibility in the alleviation of such problems falls upon the supportive institutions such as incubators and accelerators. It will turn out at an advantage if they carry out activities by devising marketing-focused training, consultancy, mentorship, interdisciplinary team-building and accelerator programs so as to compensate the deficit that the startups have in marketing strategies. Similarly, such types of supportive institutions are expected to devise solutions specifically to meet some needs of deeptech startups such as long product development periods, capital intensive structure as well as laboratory and test facilities. During the first development stages of deeptech startups, universities show up as another important role player. A considerable number of deeptech startups are established as a result of outputs based on research conducted at universities. In this sense, it matters that universities are qualified to support the entrepreneurship and that they offer their laboratory and test facilities to the use of deeptech startups.

Successful deeptech startups that will come into being as a result of such and similar kinds of improvements will both contribute greatly to the country's economy and increase our standards of living but at the same time constitute a role model and an inspiration for the future's ventures.

Authors

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