



# IMPACT TECH

**Creating Market Opportunities  
In Tandem With The Global Goals**



# THE PROJECT & REPORT TEAM

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# CHAPTER 1

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# Background



## BACKGROUND

The fast pace of technological innovation and the proliferation of information and communication technology (ICT) firms lead the way to transformation of markets, delivering the present age under the effect of global conditions: the fourth era of innovation (Anthony, 2012). These global conditions are closely linked to social and environmental challenges we are facing today. Damages in the ecosystem, violence and armed conflict, social and gender inequality, poverty, hunger, and lack of healthcare systems are among the conditions that create high market uncertainty for managers. However, from a different perspective, such conditions may be addressed by businesses, particularly by ICT companies, triggering state-of-the-art innovations, contributing to social and environmental sustainability and thereby, enhancing company reputation.

Based on United Nation's (UN) Sustainable Development Goals (SDGs), Business and Sustainable Development Commission (BSDC) reported that the following market opportunities can generate up to \$12 trillion worth of business value (January 2017, BSDC report) (Figure 1):

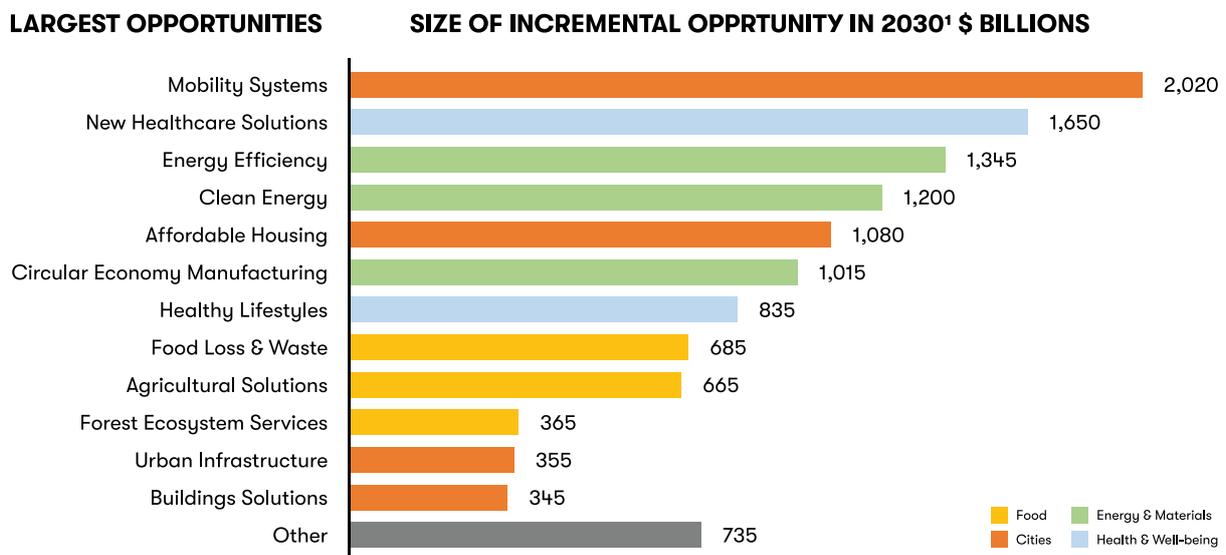


Figure 1 – Market opportunities for Global Goals

The SDGs provide ICT firms with a compelling growth strategy (January 2017, BSDC report). We argue that ICT firms can capture market opportunities, through market development and diversification, which are identified as the two major growth strategies in the literature. Market development refers to the launch of an existing product in a new market, while diversification entails the introduction of a new product in a new market. Specifically, ICT firms can rely on innovative products and business solutions when they enter a market for the first time. In other words, ICT firms that have strategic agenda linked to SDGs can grow in developing markets by addressing consumers' needs and unexpected shifts in consumer behavior, creating meaningful value propositions through their innovations (Hurley and Hult 1998; Im and Workman 2004; Sood and Tellis 2009). Indeed, the majority of businesses successfully targeting sustainable market opportunities are built on digital technologies (January 2017, BSDC report). For example, TransferWise developed an online platform for peer-to-peer money transfer which allows individuals in developing countries to transfer their remittances to their families in all over the world. In collaboration with the nonprofit International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Microsoft provided smallholder farmers with the AI sowing app, which uses sophisticated forecasting models to determine the optimal time to plant, the ideal sowing depth and how much farm manure to apply. Hack Reactor,

<sup>1</sup>United Nations Development Program (UNDP) defined the Sustainable Development Goals (SDGs), otherwise known as the Global Goals as "a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. These 17 Goals build on the successes of the Millennium Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another." (<http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>)

a coding trainer firm based in the US, partnered with Moringa School, a Kenya-based coding school to identify children with a strong tech potential and give them top-notch web development training, creating a future talent pool for its partners, including a leading mobile network operator in Kenya (Safaricom) and Barclays Bank of Kenya. The evidence suggests that firms that develop business objectives associated with SDGs are likely to introduce innovative products and service solutions and seize the market opportunities.

Moreover, BSDC reported that digital industry groups and policymakers collaborate (1) to understand how and where digital technologies can speed the progress towards the Global Goals and (2) to develop an enabling policy. In many industries including ICT, the collaboration is likely to be a powerful driver of the rapid change in developing markets. For example, in agriculture, digital solutions may increase yields, cut food waste, and transform water management. In the healthcare industry, on the other hand, ICT firms may partner with biomedical firms to develop a remote product that helps to diagnose or monitor a patient's condition, or to make a surgery from a long-distance. Policy makers, on the other hand, may create regulated environments in which creating and testing state-of-the-art technologies are welcome (e.g., subsidizing the SDGs oriented ICT firms to introduce affordable innovations in developing countries).

Existing and emerging technologies such as the Internet of Things (control and optimization of integrated systems such as public infrastructure and environmental management systems, energy management, healthcare, operations optimization), robotics (which has already transformed many sectors including healthcare, closely related to IoTs), artificial intelligence (pattern recognition, complex problem-solving including medical diagnostics), collection and analysis of big data (education, environmental management, food security and sustainability, health indicators including diagnosis of epidemics), smart grid technologies (environmental management, reducing carbon emissions), open data and cloud technologies (education, healthcare, crisis management) and monitoring systems (early warning systems, crisis management, environmental management) have profound effects on major development problems including access to healthcare services, information, learning opportunities and finance.

As the current developments already signal, proliferation of AI tools has the potential to bring about significant progress in reaching SDGs. AI has revolutionized the way companies do business and will keep doing so as the equity financing for the AI space has risen from \$282 million in 2011 to \$2.4 billion in 2015 (Accenture Technology Vision, 2017). Integrated into the core business functions and creating new digital value chains, AI is also changing the markets, creating a new workforce marketplace through the digital transformation of labor. They also bring about opportunities in finding better solutions to problems such as emerging market unemployment and skills development (SDG #1 – No poverty and SDG #8 – Decent work and economic growth). Furthermore, current uses of AI have already proved its potential to contribute to various SDGs including:

- SDG#2** – Zero Hunger (sustainable agriculture through maximizing yields, empowering small farmers, minimizing food loss and waste)
- SDG#3** – Good Health and Well-being (quick diagnoses, better treatment plans, preventive care),
- SDG#7** – Affordable and Clean Energy (demand and supply prediction in support of the renewable energy sources),
- SDG#4** – Quality Education (bridging the skills gap, adaptive learning)
- SDG#9** – Industry, Innovation and Infrastructure (better projection and forecasting, optimized sourcing, eliminating waste)
- SDG#11** – Sustainable Cities and Communities (safe, accessible and sustainable transportation systems, disaster management)

In order to improve AI's contribution to SDGs, a human-centered approach and collaborations between different stakeholders of the new digital ecosystem is needed when designing new AI technologies. Through this perspective, AI is considered as a major component of the tools that will enable companies to seize the market opportunities with a strategic agenda linked to SDGs.

Considering these opportunities for creating economic and social impact for ICT firms, this research examines four of the market opportunities, exploring how ICT firms, using emerging technologies and innovations, can

collaborate with the firms in various industries and other stakeholders in the ecosystem in order to significantly accelerate the progress on the SDGs.

Specifically, it examines the market opportunities in:

- (1) new healthcare solutions,**
- (2) energy efficiency,**
- (3) education, and**
- (4) agricultural solutions.**

### **RESEARCH QUESTIONS**

- 1** - How can the emerging cutting edge technologies -in particular, AI- contribute to business goals and SDGs, specifically in emerging markets? What potential challenges will the proliferation of these technologies bring about, and how can these challenges be minimized or eliminated?
- 2** - How can ICT firms collaborate with the firms in various industries to accelerate a progress on the SDGs while creating market opportunities?
- 3** - What would be the internal (firm-related) and external (industry or market-related) factors that may influence such collaborations?
- 4** - What are the actions needed to further invest, develop and deploy these technologies to accelerate the market opportunities?
- 5** - How would ICT firms partnered with other stakeholders (companies, government agencies, universities and non-governmental organizations) engage with public policy?

### **METHODOLOGY**

In order to answer these research questions, we conducted a two-stage research:

#### **1. DESK RESEARCH - LITERATURE REVIEW:**

We extensively reviewed the literature, including academic research, grey reports and case studies from different countries, to provide insights into successful firms operating in the selected market opportunities in the developing countries, to address the challenges and success factors and to identify the actors and collaborations between these actors in the deep-tech ecosystems. We also conducted a literature review in academic resources to investigate the theories of market development in the technology markets, which also showed the gap in the academic literature on deep technology and market development process of these cutting edge technologies.

#### **2. FIELD RESEARCH - IN-DEPTH INTERVIEWS:**

We conducted 30 in-depth interviews in Turkey with top managers or owners of deep technology developer or heavy-user companies operating in education, health, energy and agriculture sectors, and other actors of the deep-tech and entrepreneurship ecosystem including investors, accelerators, not-for-profit organizations which work in these domains and government representatives. The companies for the interviews were selected according to sector and size, considering their roles as being either technology developer or heavy-user companies and the scope of the business (including big international companies, national companies, small and medium sized companies (SMEs) and start-ups).

In light of the literature review and the findings derived from the field research, we outlined a set of

recommendations on the actions needed to further invest, develop, and deploy technologies to accelerate the four market opportunities, on possible collaborations between the actors in the deep-tech ecosystem and on develop an enabling policy to improve and speed the contribution of new technologies in the way to reach the Global Goals.

## **MARKET DEVELOPMENT IN TECHNOLOGY MARKETS**

Considering the potentiality of deep tech in achieving sustainable development goals, a challenging yet most necessary step to take is to work on how to transfer, disseminate and use these new technologies, in other words, creating and developing impact tech markets. In this regard, a theoretical understanding on the actors and practices that are influential in the creation and shaping of markets may help in drawing up a roadmap.

One of the major theories in this domain, the market system dynamics theory, seeks answers to the question of how markets are formed as complex social systems, how actors and institutions shape the markets and how they are shaped by the forces of the market in return (Giesler and Fischer, 2017). In addition, the theory argues that a systems approach is needed to understand the functioning and emergence of markets, which draws attention from parts to whole, from objects to relationships, from structures to processes and from measurement to mapping.

Markets are not given or static structures. They are constantly re-created, changed and re-shaped by their actors. In addition, finding an unmet need and developing a viable solution to meet this need does not necessarily lead to the creation of a market; as markets are macro structures that interact with a wide range of cultural, social and political factors (Humphreys, 2010). Furthermore, markets are shaped not only by the intended but also the unwanted interactions between the actors and their practices which are, in many cases, not foreseen.

Related to the desirable and undesirable interactions between the actors, a sociological perspective towards market creation suggests that markets are constituted by “**shared understandings**” (Rosa, 1999; Humphreys, 2010; Lusch and Watts, 2018). Market outcomes can be described in relation to the degree to which this understanding is shared across actors, and market processes in relation to the rate at which this “sharedness” is changing in the time (Lusch and Watts, 2018). With a similar point of view, market formation process can be defined as a series of conflicts between opposing stakeholder groups, where *groups with different interests become compatible with each other* and concrete exchange structures occur between producers and consumers (Giesler, 2012).

Another remarkable perspective in market creation studies is the sociocognitive perspective which considers markets as socially constructed information structures. According to this perspective, not only producers and consumers but also the various forms of interactions between them are essential in the formation of a market. While product markets are unstable, incomplete and discrete conceptual systems for market players in the first place, they become consistent as a result of the understanding of the behavior of consumers and producers (Rosa et al.,1999). Ultimately, a market exists because the actors in the market agree on its existence and the reasons of this existence, which once again points out the importance of developing a shared understanding among the actors.

Studies on the creation and development of deep tech markets in the academic literature are very limited. When defining deep technology, previous work especially focused on what distinguishes it from technology in the traditional sense. Deep technologies offer far more important advances than currently available technologies and they have the power to create their own markets while disrupting existing industries. Furthermore, these technologies have the potential to produce solutions for global problems. In terms of business, three key features characterize deep technology: (1) These technologies are disruptive and can have major impacts on the current market dynamics, (2) market readiness of these technologies take time and (3) they require substantial capital (BCG and Hello Tomorrow, 2019). In this context, even though very limited in number, studies focusing on the creation and development of the markets where breakthrough innovations emerged are gaining importance.

Some of the previous studies in the domain of deep tech market creation refer to two challenges that innovators face: the first is the need to systematically resolve the current status quo of the market system. The second is the

obligation to create a new status quo that many players in the market accept and adopt. Chakravorti (2004) offers a framework that can be useful in this process:

- *Reason back from a target endgame:* The success of the innovator's strategy will depend on other players' initial and counter-reactions. Therefore, when defining an innovation strategy in the market, managers need to analyze possible responses of the players to see where each option may lead the company to.
- *Complement the power players:* In order to achieve their goals, innovators need to define and consider the reactions of the powerful groups of companies and consumers in the market. Strong players can help increase the benefits of innovation due to their connections to and relationships with other players. Innovators can collaborate with these players to reach a large number of participants and convince them to change their behavior.
- *Offer coordinated switching incentives:* Although the innovator has a better product or service than other players in the market, it has no special power to resolve the status quo. Most managers focus only on changing the behavior of early adopters and then on to mainstream consumers. However, if the innovator cannot create a change of behavior among other players, the market will return to the self-empowering status quo.
- *Preserve flexibility:* Innovators base their potential games on their expectations of the events to take place or on the behavior of other players that create uncertainty. Therefore, the innovator's plans must be flexible. Ideally, organizations should create product and marketing plans covering a variety of situations.

Current studies regarding the technological innovations and their market development show that the active management of the new market formation process is not common. Usually, this process is not systematically addressed. Instead, companies rely on the market itself (O'Connor and Rice, 2013). Managers should consider the process of market creation and development as a multidimensional and chaotic process, and should actively engage in systematic efforts to affect these processes through strategic connections with key players.

As discussed previously, understanding the role of the actors in the ecosystem and their interdependent relationships is a key component in managing the process of market creation. Companies, suppliers, employees, government, competitors, consumer advocates, special interest groups, media and consumers each have various implications in this process. Some of the previous studies revealed that the complex framework of political and individual stakeholders appears to be impeding the market development process. For example, strict security regulations and inconsistent technological standards may hinder the implementation of innovative technologies (Kohlbacher and Rabe, 2015). Considering these impeding factors and based on the theories discussed, it is possible to mention about some key findings for managers:

- **Markets are constantly developing and changing; they are not given or static structures.** As each of the actors involved in market networks are constantly changing, markets should also be considered as ever-changing structures. This perspective is critical for executives to correctly understand the expectations of each actor in the market and the changing relationships between these actors and institutions.
- **There are many actors with different interests in the process of market creation and it is possible that each actor has more influence than expected in this process.** Beyond businesses and consumers, a wide range of stakeholders such as governments, special interest groups and the media are highly likely to influence the process of market creation. In addition, interrelationships with other markets that are likely to be relevant and supportive may also influence the creation and development of markets.
- **An attempt to comprehend the process of creating markets from a micro-perspective will cause misconceptions.** Understanding markets require a macro perspective, not only because of the interrelations of the actor networks involved, but also because they are structures that contain economic, political, social and historical elements.
- **Since markets are not self-evolving structures, the process of creating markets should be**

**proactively managed by managers.** Managers should accurately analyze the stages of market creation and plan tactical and strategic actions to be followed at each stage. The process of legitimizing and adopting a product, service or idea is basically a managerial process. Instead of trusting the market itself, businesses should take the lead in these processes.

- **Creating markets is a long-term and investment-intensive process.** The development of the “**shared understanding**” and **legitimacy**, understanding the changing roles, relationships and goals of the actors in each stage of the market development process, and identifying the hindering factors and bottlenecks all require proactive and systematic management efforts, including time and capital investments.

Considering that deep-tech markets are continuously shaped, designed and re-shaped by the actions of the actors in the ecosystem and their changing understandings, goals and relationships, it is of critical value in market development studies to identify:

1. Current actors in the ecosystem and the roles they are taking in the market creation process
2. The interdependent relationships between these actors and the collaborations established between them to reach a shared understanding

Through this research, we reveal the current situation regarding the actors in the selected markets and their interdependent relationships with each other in a developing country setting in order to identify the gaps and to recommend solutions to fulfill these gaps in the way to more developed deep-tech markets which serve the SDGs.

**THE SHOWCASE:  
ACTORS AND COLLABORATIONS IN IMPACT TECH MARKETS**

We conducted an extensive literature review, including grey reports and academic resources, in order to identify the actors, their roles, established connections and shared understandings in the best cases and examples for deep-tech SDG market development. In light of our findings, below tables showcase best cases, actors and collaborations established in impact tech markets, first in general, and then in energy, education, health and agriculture sectors respectively.

DEEP TECH	ACTOR	TYPE/ROLE
<b>GENERAL</b>		
General	<b>Gates Foundation, the Chan-Zuckerberg Initiative, Omidyar Network and the Skoll Foundation</b> (eBay’s Pierre Omidyar and Jeff Skoll), <b>Obvious Ventures</b> (Medium’s Ev Williams), <b>the Allen Institute For AI</b> (Microsoft’s late Paul Allen), <b>Kapor Capital</b> (Lotus’ Mitch Kapor), <b>the Case Foundation</b> (AOL’s Steve and Jean Case), <b>Khosla Impact</b> (Sun’s Vinod Khosla), <b>Norrskan</b> (Klarna’s Niklas Adalberth), <b>Zennstrom Philanthropies</b> (Skype’s Niklas Zennstrom), <b>Schmidt Futures</b> and <b>the Schmidt Foundation</b> (Google’s Eric Schmidt).	Foundations formed by entrepreneurs, specifically focusing on technology
General	<b>Elon Musk, Mike Butcher (TechCrunch-Techfugees)</b>	Initiatives launched by entrepreneurs in the field of technology
General	Examples include <b>Katapult</b> (Norway), <b>ImpacTech</b> (Singapore, Thailand), <b>Zinc</b> (UK), <b>BitsxBites</b> (China), <b>SenseCube</b> (France), <b>CeHub</b> (Nigeria), <b>Norrskan</b> (Sweden), <b>Ship2B</b> (Spain), <b>Liberte</b> (France), and players who have been active for over 10 years such as <b>Unreasonable</b> (US), <b>Bethnal Green Ventures</b> (UK), <b>VentureWell</b> (US) and <b>Village Capital</b> (US).	Tech Incubators, Accelerators, Company Builders, Bootcamps

DEEP TECH	ACTOR	TYPE/ROLE
<b>GENERAL</b>		
General	<b>TechStars</b> (US) and <b>Rockstart</b> (Netherlands) are successful examples of accelerators that launched programs on social issues like energy, food, and social impact. Another tech company is <b>Y-Combinator</b> (US) which improves its efforts and investments in carbon removal moonshots.	Companies in the technology sector
General	Powerful and large foundations such as <b>Ford Foundation</b> and <b>Rockefeller Foundation</b> contribute to the solution to social problems. In the UK, <b>Comic Relief</b> and <b>Hamlyn Foundation</b> are examples of such foundations. Newly established foundations, like <b>PRIME Coalition</b> , also provide financial support to address climate change.	Foundations created on different subjects but interested in technology
General	<b>WWF</b> has partnered with several companies to develop conservation technologies. <b>Amnesty International</b> focuses on human rights and is working with satellite imagery providers and VR technologies. <b>FHI 360</b> has established a technology laboratory that directs its attention to developing health and welfare-related interventions. There are also companies such as <b>CAST</b> that help traditional charities to build digital services and capacity.	<b>Collaborations among NGO's, Nonprofits and tech firms*</b>
General	International organizations launched tech-based units to produce solutions for social problems like <b>UNICEF Innovation</b> and <b>GIZ Blockchain Lab</b> . <b>The World Bank Group</b> has a set of initiatives to focus on technology for development. <b>ITU</b> is another example that creates a solution for reaching Global Goals by using ICT. National Development Agencies such as <b>DFID Frontier Technology</b> and <b>Ideas to Impact Programs</b> , <b>AFD Africa Tech Fund</b> , and <b>USAID's Global Development Lab</b> have discovered the potential of technology for helping countries' problems.	International organizations and development agencies
General	Social Entrepreneurs and their ideas have great potential to make a positive impact on solutions to social problems. <b>Kiva</b> which provides financial support for low-income entrepreneurs, <b>Khan Academy</b> which is an online education platform and <b>Code For America</b> which works with governments for better digital services are successful examples.	Social Entrepreneurs

## THE ENERGY SECTOR

DEEP TECH	ACTOR	TYPE/ROLE
<b>ENERGY</b>		
Solar Home Systems and Solar Lamps	East Africa is the center of most important actors for tech-based solutions to solar energy. <b>M-Kopa</b> (Kenya), <b>Zola Electric</b> (Tanzania), <b>BBOX</b> (UK), and <b>Mobisol</b> (Germany) are among the successful examples in this domain. <b>Kingo</b> is using a similar model in Central America.	Business / Startup
Clean Energy Microgrids	An Indian company <b>Husk Power</b> is the leading actor in the microgrid sector and uses hybrid solar-biomass units to generate power with low-cost. <b>PowerGen</b> and <b>Steamaco</b> are other operators that focus on microgrid systems.	Business / Startup

Continues 

DEEP TECH	ACTOR	TYPE/ROLE
<b>ENERGY</b>		
Solar Photovoltaics (PV)	Companies like <b>OxfordPV</b> (UK), <b>Sunew</b> (Brazil) and <b>Heliatek</b> (Germany) use PV cells to convert light into electricity. This material and technology boost the efficiency of silicon panels.	Business / Startup
Wind Energy	One of the most prominent players in wind energy is <b>Vestas</b> . The company acquires <b>Utopus Insights</b> which uses real-time data analytics and machine learning to boost the output of wind farms.	Business / Startup
Marine Energy	Oceans are one of the most important resources in nature. New generation companies such as <b>Eco Wave Power</b> (Israel), <b>EEL Energy</b> (France) and <b>Calwave</b> (US) show great interest in using this resource with tech-based applications.	Business / Startup
Hydrogen	<b>HyTech</b> (US) developed a better technology to pull hydrogen from water more effectively.	Business / Startup
BioEnergy	Several companies focus on bioenergy. <b>Waga Energy</b> (France) and <b>Enerkem</b> (Quebec) work with tech-based methods and applications to benefit more from this type of energy.	Business / Startup
CO <sub>2</sub> -to-Fuels and Solar Fuels	<b>LanzaTech</b> (NZ/US) is a pioneering firm that focuses on gas fermentation technology to utilize the process. To extract hydrogen from water, <b>Carbon Engineering</b> (Canada) uses solar power. <b>Opus12</b> developed a catalyst to produce biofuels and biochemicals more efficiently.	Business / Startup
Electrochemical Storage	<b>CATL</b> , <b>LG</b> and <b>Tesla</b> show interest in Lithium-ion (Li-ion) technology which is the main focus in the battery market recently. Companies like <b>Form Energy</b> (US) and <b>Solid Power</b> (US) are trying to achieve higher energy density with low-cost by advancing and differentiating this technology.	Business / Startup
Thermal Storage	Companies like <b>Airthium</b> (France), <b>Ecovat</b> (Netherlands), and <b>Malta</b> (US) try to develop advanced heat pump systems to create seasonal and grid-scale thermal storage. And some other initiatives like Gates' funded <b>Breakthrough Energy Ventures</b> also focus on this issue.	Business / Startup <b>Collaboration between Business/Startup and Investors*</b>
Solar Energy App for Africa	Free and web-based <b>IBM Research Empower Solar</b> app is developed by IBM scientists in South Africa and enables its users to create personalized solar systems. These systems include panels and batteries for homes and businesses.	Tech Giant
Renewable Energy	To control and share their locally-produced renewable energy, <b>The Jouliette</b> created a blockchain-based energy token for individuals and communities.	Business / Startup
Renewable Energy	A community-driven initiative <b>Brooklyn Microgrid</b> (US) redesigned the traditional energy grid model and created a new one called communal energy network.	Community driven initiative

## THE EDUCATION SECTOR

DEEP TECH	ACTOR	TYPE/ROLE
<b>EDUCATION SECTOR</b>		
Digital Classrooms	<p><b>Meghshala</b>, an Indian Charity, to create alternative pieces of equipment for public school teachers for teaching, uses mobile apps.</p> <p>By using low-cost tablets, <b>Rumie</b> (Canada) enables students access to community-curated content in 20 countries.</p> <p><b>Literator</b> (US) and <b>Lalilo</b> (France) empower teachers for creating more personalized literacy education through progress monitoring.</p> <p><b>Bridge</b> utilize technology for designing low-cost education for the poor children. <b>Endless OS</b> contributes to generating educational content with a free PC operating system with 100 free apps and tools.</p>	<p>Charity</p> <p>NGO</p> <p>Business/Startup</p> <p>Business/Startup</p>
Learning by Making	Several companies such as <b>Amino Labs</b> (US), <b>Dext</b> (Ghana) and <b>Lab4Physics</b> (Chile), provide useful tools for classrooms like biology kits, electronic tools and the experiment guiding apps	Business / Startup
Digital Platforms for Lifelong Learning	The system called Massively Open Online Courses is in the spotlight. <b>Coursera</b> and <b>EdX</b> are prominent platforms in this area. Some of them focus on professional pieces of training and business skills like <b>Udacity</b> and <b>OpenClassRooms</b> . <b>Khan Academy</b> is another important platform that offers mostly academic content.	<b>Collaboration between Business/Startup and Universities</b>
Virtual Education	<b>Kennisnet</b> (Netherlands) focuses on virtual education since 2005.	Foundation
AI for Grading	<b>GradeScope</b> is utilizing computer vision and machine learning to grade students' work. The system memorizes the teacher's initial decisions and grades, subsequent students, quicker than a teacher.	Business / Startup
VR Training	<b>Ericsson</b> launched a Project in Myanmar called <b>Connect to Learn</b> . By using tech-based tools like virtual reality training tools, more than 30,000 students and 310 teachers benefited from the program. This program contributes to the teachers for designing and using more student-centered methods.	Tech Giant

## THE HEALTH SECTOR

DEEP TECH	ACTOR	TYPE/ROLE
<b>HEALTH</b>		
Awareness Raising on Healthcare and Diseases	<b>Accenture Labs</b> and <b>Maya Healthcare</b> work as a partnership to design Tech4Good solutions to raising awareness about health-care and diseases in rural India.	Collaboration between Business / Startup and Foundation
Disaster Risk Reduction	<b>OneConcern</b> utilizes machine learning technology and data to provide a better plan for cities to reduce the risk of natural hazards.	Business / Startup

Continues 

DEEP TECH	ACTOR	TYPE/ROLE
<b>HEALTH</b>		
Disaster Risk Reduction	Chinese drone leader <b>DJI</b> and <b>UNDP</b> work in collaboration to determine the risky areas in islands coasts in the Maldives by using aerial risk mapping.	<b>Collaboration between Business / Startup and Int. Org.*</b>
Digital Health for Pregnancy and Childcare	<b>Healofy</b> in India, <b>GiftedMom</b> in Cameroon, and <b>MOBicure</b> in Nigeria are digital platforms and social networks that focus on pregnancy and childcare issues.	Business / Startup
Genomic Vaccines	By developing and using Genomic Vaccines technology, two US biotech companies <b>Moderna Therapeutics</b> and <b>Synthetic Genomics</b> have the potential to produce low-cost and faster-designed vaccines.	Business / Startup
Gene Drive	<b>Gates Foundation</b> is one of the most important actors which fights against Malaria. Gene-editing techniques and related projects aim to eradicate communicable diseases.	Foundation
Diagnostic Tech for Infectious Diseases	To diagnose malaria in a simpler and better way, <b>Matibabu</b> , a mobile application is a useful tool. Similar to this, Stanford scientist <b>Manu Prakash</b> developed a cost-efficient centrifuge which could be a revolution for diagnostic tech.	Foundation+
Diagnostic Tech for Chronic Diseases	<b>iBreast Exam</b> (India) and <b>Damae Medical</b> (France) are companies using new medical technology to design non-invasive cancer diagnosis. US startups <b>Grail</b> and <b>Freonome</b> take this technology further and utilize machine learning to detect cancer easily. <b>echOpen</b> is a community-based and low-cost approach to diagnose diseases by using echo-stethoscope connected to a smartphone.	Business / Startup Community Based Project
Patient-Centered Healthcare	<b>PatientsLikeMe</b> (UK) provides a platform which connects patients with others who have the same rare medical conditions. <b>WeFight</b> (France) allows an interface for cancer patients to communicate with their doctors via chatbot called Vik. <b>Baobab Circle</b> (Kenya), is a mobile platform that provides useful insights and supports for those suffering from diabetes and hypertension. <b>Tommi</b> (Italy) focus on children to support them by using VR experience while they get painful treatments in hospitals.	Business / Startup
Data-Driven Epidemiology	A collaboration between <b>Senseable City Lab</b> and <b>the Alm Lab</b> produce a project called the <b>MIT Underworlds</b> and this project focuses on surveillance of urban health patterns in real-time.	<b>Collaboration between Business / Startup and University*</b>
Digital-Enabled Last-Mile Healthcare	<b>Living Goods</b> (US) uses a network created by local entrepreneurs called "health promoters" to provide life-saving products for the poor in East Africa. In India, an information app related to vaccine stocks and flows is developed by <b>eVIN</b> .	NGO <b>Collaboration among Business / Startup, Government and UNDP*</b>
3D Printed Prosthetics	<b>Andiamo</b> (UK), as a social enterprise, provides affordable prosthetics for people with disabilities thanks to 3D printing technology. <b>Open Bionics</b> (UK) and <b>MuHumanKit</b> (France) are also two companies that use 3D printing to develop prosthetics. Jordanian NGO <b>Refugee Open Ware</b> is a NGO that utilize this technology for war-wounded people and refugees.	Social Ent. Business/Startup NGO

DEEP TECH	ACTOR	TYPE/ROLE
<b>HEALTH</b>		
Regenerative Medicine	Organs and bones can be produced artificially as well. <b>Epibone</b> mainly focus on artificial bones, while <b>Prellis Biologics</b> is working as an organ production platform.	Business / Startup
Microbiome Therapies	<b>Eligo</b> (France) uses technology for designing microbiome therapies which are not harmful like antibiotics.	Business / Startup
Nanomedicine	Thanks to technological advancements companies like <b>Nanoly Bioscience</b> (US) and <b>Nanobiotix</b> (France) use nanotechnology for developing healthy practices. The first one designed a shield that protects vaccine proteins while transportation. The latter uses this technology for cancer radiotherapy.	Business / Startup
Precision Medicine and Big Data for Medical Research	Collecting data is valuable for making medical improvements. <b>NYU Human Project</b> and <b>Verily's Project Baseline</b> collect data to realize their objectives related to precision medicine. From a bigger perspective, <b>the Human Cell Atlas</b> project aims to map all human cells for medical research.	<b>Collaboration between Business / Startup and University*</b>
Connecting Health	Tech-based telementoring techniques are developed by <b>Dr. Sanjeev Arora</b> to treat patients with complex diseases. Now, these techniques are precious examples for all over the world.	<b>Collaboration between Social Ent. and NGO*</b>
Children's Cancer Care (DELL)	<b>Dell</b> launched a platform called <b>Dell Genomic Data Analysis</b> that mainly focus on fighting against rare pediatric cancers, in partnership with <b>TGen</b> .	<b>Collaboration between Business / Startup and University*</b>
Advancing the Quality of Health Information	To create innovative solutions that are helpful for healthcare, <b>IBM Health Corps</b> work with nonprofits and academic organizations. IBM Health Corps helps to advance the quality of information for health professionals to serve communities.	<b>Collaboration between Big TECH, academic and nonprofit</b>
AI for Drug Development	<b>Exscientia</b> (UK) uses big data sets and AI capabilities to develop new drugs. This advanced technology allows low-cost and faster processes for drug development.	<b>Collaboration between startup and a company*</b>
Mobile Health Insurance	<b>Bima</b> (Sweden) develop a mobile platform to provide its users affordable health insurance.	Business / Startup

## THE AGRICULTURE SECTOR

DEEP TECH	ACTOR	TYPE/ROLE
<b>AGRICULTURE</b>		
Postharvest Food Preservation	Tech-based solutions in agriculture is recently spreading. <b>Inspira Farms</b> (UK/Kenya) and <b>Coldhubs</b> (US/Nigeria) reduce losses in agribusiness by creating storage solutions. Producing ideas for small African farmers, <b>Wakati</b> (Belgium) has developed a solar-based, low-cost protection unit.	Business / Startup
Food Science and Genomics for Nutrition	<b>Nuritas</b> (Ireland) is one of the companies that try to combine AI and genomics to discover healthy solutions for food ingredients.	Business / Startup

Continues 

DEEP TECH	ACTOR	TYPE/ROLE
<b>AGRICULTURE</b>		
Smallholder AgTech	<b>Ignitia</b> (Sweden) creates in weather forecasting for African farmers. <b>Peat</b> (Germany) developed a mobile app to determine crop diseases by using image recognition and machine learning. <b>SoilCards</b> (UK) uses simple paper tests to analyze soil.	Business / Startup
Smallholder FinTech	Technology-based financial solutions are used by smallholder farmers. <b>FarmDrive</b> (Kenya) develops an alternative credit scoring system by using mobile data and machine learning. <b>Crowde</b> (Indonesia) and <b>FarmCrowdy</b> (Nigeria) creates a system that matches investors and farmers.	Business / Startup
Smallholder Networks	<b>M-Farm</b> (Kenya) is a platform that connects farmers and buyers directly. <b>WeFarm</b> (UK) and <b>Digital Green</b> (India) have communication platforms for smallholder farmers in which they can share their knowledge and experiences.	Business / Startup
Data-Driven Regenerative Agriculture	<b>Sony Computer Science Lab</b> creates complex systems by using software and data tools for data-driven agriculture methods. These systems include biodiversity database, machine learning, and virtual farm management.	Business / Startup
Small Farm Robotics	Robotic technology can create significant advantages for agricultural processes compared to heavy machinery. Developed by the <b>Small Robot Company</b> (UK), the robot contributes to increased productivity with less energy consumption and fewer chemicals. <b>BlueRiver</b> and <b>Rowbot</b> (USA), <b>Naio</b> (France) and <b>Agrobot</b> (Spain) likewise benefit from the possibilities of robotic technology in agricultural improvement processes. The EU-funded <b>ROMI</b> project also conducts projects for open source robotics development for farms.	Business / Startup Project supported by Int. Org.
Precision Agriculture	The precision agriculture approach means the use of sensors, drones, and satellites to provide farmers with insights into issues such as soil, crop, and weather. <b>Agrosmart</b> (Brazil), <b>Kilimo</b> (Argentina), <b>aWhere</b> (US) and <b>Parrot Airinov</b> (France) are among the companies that use this approach.	Business / Startup
Soil Microbiome Testing	<b>Trace Genomics</b> helps farmers with DNA testing to understand the health and structure of the soil.	Business / Startup
Biopesticides and Biostimulants	Companies such as <b>Pivot Bio</b> (US), <b>Azotic</b> (UK), <b>Micropep</b> (France), <b>Indigo</b> (US), <b>Pheronym</b> (US), <b>Elephant Vert</b> (Switzerland) and <b>Aphea.Bio</b> (Belgium) seek healthy solutions for plants and nutrients through biopesticides and biostimulants.	Business / Startup
Gene-Edited Crops	<b>Calyxt</b> , <b>CIBUS</b> and <b>Benson Hill Biosystems</b> are among the most important actors in gene-edited crops area.	Business / Startup
Connecting Farmers	<b>HARA</b> operates as a blockchain-based data exchange system between farmers and other players in the agriculture sector providing a big amount of data for each player.	Business / Startup
AI Helps farmers test their soil	<b>IBM Research-Brazil</b> offers farmers quick and simple methods to test soil and water. <b>AgroPad</b> allows determining the level of chemicals on the sample in the card and analysis can be performed with a smartphone application.	Tech Giant

According to our investigations on these successful cases from different markets, actors seeking technology-oriented solutions for SDG-related purposes and their roles in the impact tech ecosystem are as follows:

- The interest of the **big companies and entrepreneurs**, especially in the technology sector, to social issues is increasing. These major actors play a critical role because of their capacities to create resources, realize ideas and produce result-oriented solutions for SDGs.
- In addition to the major players in the industry, **newly established businesses and start-ups** are increasingly focusing on technology-based products and services to solve social problems. The importance of start-ups and newly established businesses stems from the fact that they are the most active, flexible and agile organizations in the ecosystem.
- **Non-profit organizations and NGOs** contribute greatly to impact tech market development thanks to their in-depth knowledge about the field, the context and the communities who are at the center of the SDGs related problems. In addition, they also act as a source of trust for individuals or communities at the center of the problem.
- **Community-based projects and initiatives** also play an important role in the creation and operation of effective social networks.
- **Social entrepreneurs** focus on technology-based solutions to achieve a more widespread social impact. Social entrepreneurs are important actors in raising awareness about social problems and creating fresh ideas and solutions to SDGs related problems.
- **Foundations** formed by big players in the field of technology are also an important part of this ecosystem. These foundations and charities are among the most important actors who strive to solve social problems through fundraising and supporting collaborations.
- **International organizations and governments** serve as enablers and have the potential to increase the impact of these technologies significantly through improvements in infrastructure, awareness raising, public funding and most importantly developing and enacting enabling policies.
- **Universities, research institutes and laboratories** are key actors in producing technology-based solutions to social problems. In particular, the universities have the most critical role in terms of their potential to solve the talent and skills gap problems, and their contributions in developing new ideas, technologies and solutions to real-life problems by designing research and producing knowledge.
- **Incubators and accelerators** emerge as key partners for technology developer start-ups in prototyping, business model development, access to investment and education opportunities and commercialization processes.
- **Collaborations** are the most decisive and critical factor in finding technology-based solutions to SDGs related problems as they have a multiplier effect on impact. In this context, it is seen that there are strong relationships especially between academia and start-ups. Besides, projects and start-ups supported by foundations established by large enterprises constitute a great majority of these collaborations.

A prominent feature of the collaborations within the ecosystem is that actors support or become partners in solutions developed by academies and startups rather than developing technology on their own. In this context, it can be stated that especially universities and startups play an important role in the emergence and development of solutions. Ideas are developed by research units and laboratories, which are then turned into feasible projects and business models by startups. These models and innovations can be supported by various actors (foundations, large firms and entrepreneurs) within the ecosystem, or developed on an industrial scale by relatively large enterprises. Technology-based solutions, together with international organizations, governments and civil society, have the potential to make greater impact<sup>2</sup>. Some of the collaborations that play an important role in the development of impact tech markets can be grouped as follows:

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<sup>2</sup>Podder, S. and S. K. Singh, (2018). "Technology for Good: Scaling Up Social Transformation in the Fourth Industrial Revolution", Accenture Lab Report, Retrieved from: [https://www.accenture.com/\\_acnmedia/pdf-75/accenture-tech-4-good-pov.pdf](https://www.accenture.com/_acnmedia/pdf-75/accenture-tech-4-good-pov.pdf)

- Foundations, charities, and investors support enterprises and startups in implementing an idea that has the potential to be successful in producing technology-based solutions for social benefit. Small businesses or startups that have an idea, a proper design, and great potential, but have limited access to resources, can show their potential by collaborating with these organizations. Besides, in areas where social problems exist, businesses can benefit from the experience and competence of these institutions to reach a better understanding on the dynamics of the context and the target market.
- Collaborations between universities and businesses/startups are among the most common. Universities, research centers, and academics play a role in testing and developing the ideas of businesses/startups. Collaboration between these actors provides solutions at the stages of transferring and commercializing ideas that have the potential to create social benefits. Businesses/startups are key actors in designing and implementing appropriate business models. Moreover, they play the most important role in the ecosystem in making technology-based solutions that create social benefits profitable and sustainable.
- Collaborations between international organizations and businesses play an important role in meeting ideas and projects with the right target audience and on a larger scale. International organizations increase the ability and capacity to influence technological solutions developed by businesses. International organizations also contribute to the efficient management of the resources of enterprises for social problems. Government and international organizations play an important role in establishing networks and establishing links for local entrepreneurs to take action. The ability of these actors to make regulations and produce policies contributes to the achievement of more effective solutions by combining the capabilities and resources of different enterprises and entrepreneurs.
- Technology companies use their knowledge and resources in their sectors in the production and development of technologies that provide social benefits. These companies play a role in the creation of the infrastructure related to technology, which is likely to produce solutions to the social problem, and the design and delivery of the necessary services. These companies cooperate with non-profit organizations that do not have sufficient resources to provide the infrastructure but are focused on solving social problems. As a result of these collaborations, support is provided through the equipment, products, and infrastructure needed in processes that will create social benefits.
- Social entrepreneurs are also important actors for their cooperation. Since social problems are the focus of social entrepreneurs, they generally cooperate with non-profit organizations with a similar focus. These actors contribute their resources to solve problems. At the same time, social entrepreneurs can make use of the networks and connections of non-profit organizations to spread their ideas to a wider audience.
- Larger technology companies, with their resources and experience in the sector, are among the most powerful actors in using technology for social benefit. Collaborations with non-profit institutions and academic organizations are important for developing innovative solutions and making processes more efficient. Such collaborations help to produce technology-based solutions that will create social benefits at lower costs and to reach an accurate and broader target audience.

Actors in the impact tech ecosystem and the collaborations established between these actors are shown in Impact Tech Ecosystem Map (Figure 2).

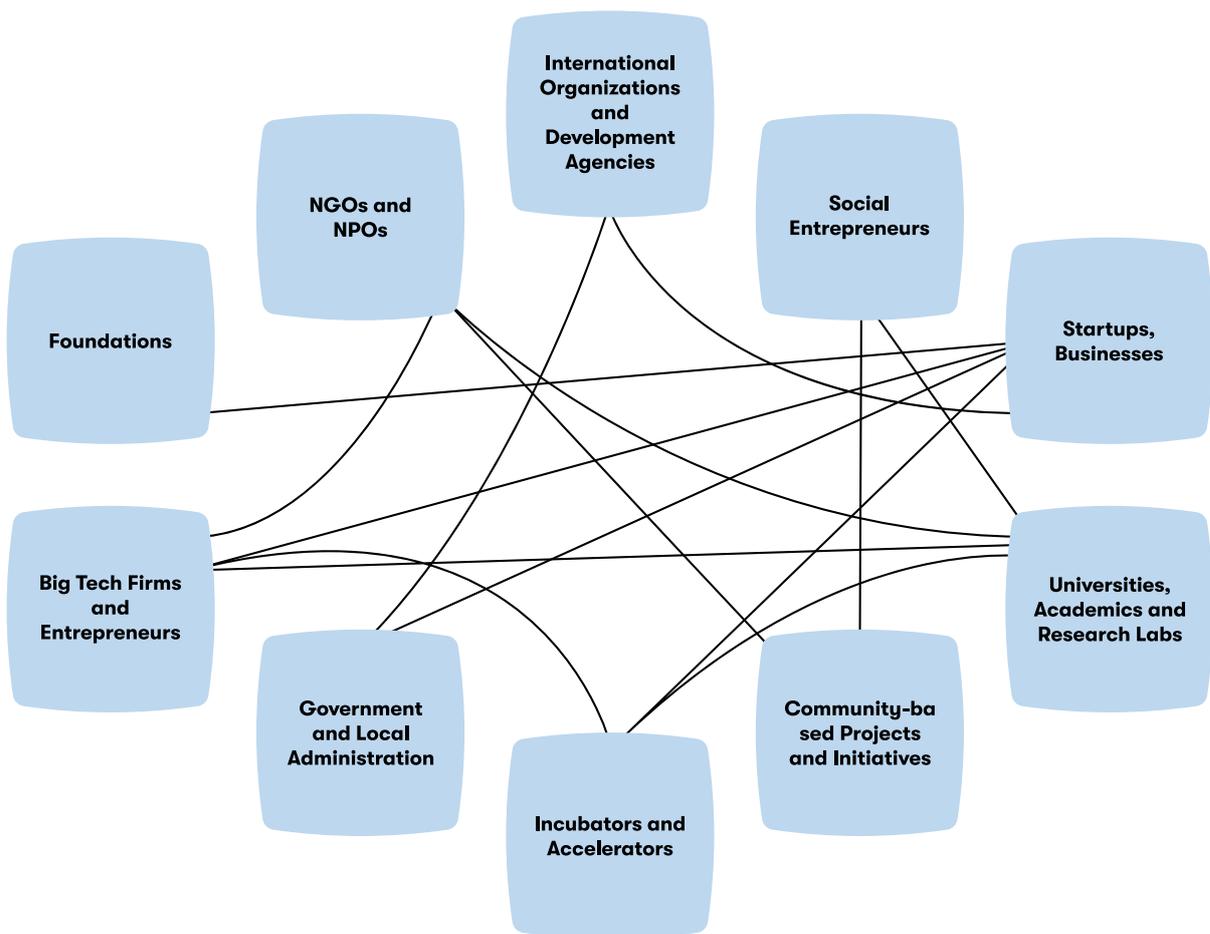


Figure 2 – Impact Tech Ecosystem Map



## CHAPTER 2

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# Findings



## **FINDINGS**

### **IMPACT TECH MARKET DYNAMICS**

This section includes findings derived from the in-depth interviews conducted in Turkey with different actors in education, agriculture, health and energy sectors to shed light to the current technologies developed and used, the actors and the roles they are taking in the current market conditions, and the challenges and bottlenecks that need to be eliminated to develop the impact tech markets.

#### **1. EDUCATION**

Both the research and field research findings direct us to the high growth potential of applications of AI in the education sector. However, it is also possible to argue that, currently education is one of the least mature sectors in terms of the awareness, adoption and usage levels of impact tech. Some of the most widely used tools implemented in the education sector around the world include adaptive learning platforms which enable a personalized learning experience, gap identifier algorithms which shows the gaps in students' knowledge, digital classroom applications, tools for teachers to predict student success and drop-outs as well as the ones which learn patterns in grading and save time in both academic and administrative work and finally collaborative platforms for students and teachers for knowledge sharing.

According to the information provided by the participants, current uses of the new technologies in the education domain are as follows:

- Digital classrooms,
- Use of simulation technologies in education, in and out of classroom hours
- Big data analysis for personalizing education and forecasting student success, attendance and drop-out rates,
- Use of online education platforms and massive online open courses

In addition to the use of these technologies in education, participants also reveal the increasing awareness on the importance and implementation of technological skills development programs, including courses and modules for coding, IoT, blockchain, and soft skills related to tech use. In some of the private education institutions, these programs are already implemented in the curriculum starting from primary schools to graduate education. However, the case is not the same for public schools even though the government is currently working on a change in the curriculum to address these issues.

### **Gaps and Challenges**

#### **LACK OF AWARENESS ON THE DEMAND SIDE**

As both the tech developer and user companies and institutions mention, there is a lack of awareness and knowledge regarding the deep technologies used in the education system which leads to misconceptions about what these technologies really mean. In most cases, AI is simply understood as regression modelling. Secondly, there is an urgent need to showcase successful applications to increase the awareness about how these technologies can contribute to educational institutions and students in particular, and the sector in general. Investing in educational tech argued to be a risky investment due to the high amounts of investments required; which ones again shows the importance of showcasing the successful examples of "profitable" education tech initiatives which also contribute to access to education and a better, higher quality education system in general.

#### **DATA AND KNOWLEDGE SHARING**

The use of machine learning requires big data which is, yet, not available in the education sector, or very limited and of low quality in terms of standardization. In addition, as in other sectors, data governance is another area of discussion in terms of benefiting the public versus protecting the data of the individuals. On the other hand, data sharing among private educational institutions seems not possible unless enforced by the government due to harsh competition. In addition, beyond data sharing, there is a prominent need for best practice and knowledge sharing specifically in the domain of technology adoption, which can scale up the social impact created through educational deep tech significantly. Unless enforced by the governments, these types of collaborations may not be enacted in

the near future among private education institutions. However, establishing knowledge and know-how sharing platforms for public educational institutions can also trigger the tech transformation in the education sector.

### **IS THE WORKFORCE READY?**

The tech transformation should begin with the developer and users, which primarily necessitates a transformation in the perspectives and mindsets of the service providers. Digitalization and the use of new technologies have been gaining increasing attention by public and private education institutions in Turkey. However, participants reveal that the barrier which constitutes the most important challenge in the way to develop a tech-oriented education sector is the perspectives of current administrative and teaching staff. Even though there is a lack of awareness and knowledge about the definitions, use and benefits of the educational deep tech, the key barrier to change seems to be the tendency to stick to the traditional teaching methods. Therefore, a crucial step in the proliferation of these tools is to arm the users of these technologies –namely, the owners and managers of the educational institutions, teachers, parents and students as the end-users with the required skills to benefit from the opportunities brought by the technology. Yet, this means additional time and effort to devote on top of their excessive workload. On the other hand, use of these technologies is time-savers thanks to the automation tools, which itself is an incentive to start learning about and using the new technologies. In addition, showcasing the best examples can help in disseminating the knowledge about the importance of these tools in creating an effective learning experience.

### **FINANCIAL SUPPORT**

Public funding is very important in ensuring the technological transforming of the education sector. However, according to the participants, available funds are very limited and inadequate compared to the importance of this transformation for our future. On the other hand, private investments are rising, which brings in questions about deepening inequalities in education. Consequently, public funding and government support seem to be crucial in this domain, which currently lag behind other sectors, to ensure equal and high quality education opportunities for all.

### **SKILLS GAP**

A majority of the in-depth interview participants reveal their concerns regarding the skills gap that is growing in the job market, and emphasize that in order to develop the deep tech market in education, priority should be given to arming students with required skills to develop, use and implement these technologies. In addition, the importance of entrepreneurial skills is also emphasized in order to not only use but also develop these technologies. This directs the discussion to the urgent need for inclusive efforts to close the skills gap through supporting lifelong learning and MOOC platforms. In order to achieve this, collaborative efforts from the government, development agencies and private sector are needed to close the skills gap which is, under current conditions, expected to deepen with the pace of the technological shift.

Technology can contribute to closing the skills gap in various dimensions, one of which is the opportunities it provides for personalized education. Differences in pace of learning, emotional needs and interests constitute barriers in the way to effective learning in the current conditions of the education system. Adaptive learning platforms help in overcoming these barriers through personalized instruction and learning tools, which not only increases effectiveness, but also decreases the absence and drop out rates.

### **THE DIGITAL DIVIDE – ACCESS TO EDUCATION**

Even though the successful cases in the use of deep tech in democratizing education are well-known and accepted, it is not possible to claim that these technologies are widely used and able to reach masses in the developing countries. One of the most prominent reasons of this is the project-based initiatives in this domain, which mostly rely on donations as they are not financially self-sustainable. Another reason emerges as the limited impact of the pilot projects in the field which could not scale up. Infrastructure remains as a focal barriers, as the disadvantaged communities do not have the means to access these tools even if the technology is available. Low-cost, high-speed and quality broadband internet service and availability of devices to connect to these services are the barriers to access to digital education opportunities. The second problem is related to demand creation in the market as the educational institutions, teachers, parents and students have low levels of awareness and knowledge regarding the fruitful technologies that can lead to a better education. Furthermore, even if the problems related to access to new educational technologies are solved, the skills and knowledge required to implement these technologies are not available yet. There are vast opportunities for collaborations between public and private schools, private companies and development institutions to contribute to the improvement of infrastructure and other necessities which may provide disadvantaged populations with access to education.

**SYSTEMIC CHANGE IN EDUCATION**

The need for a systemic change in education to become more tech friendly (including all stakeholders: government, owners and managers of educational institutions, teachers, students, parents) predominantly emerged in the in-depth interviews, as this is seen as the basis to create a “shared understanding” among the ecosystem actors. As expected, private educational institutions with the required resources are more advantageous compared to public schools, which once again brings in the questions regarding the effect of the new technologies on creating equal opportunities for all.

**OVEREMPHASIS ON TECHNOLOGY ADOPTION**

Participants from both developer and user companies also argued that there is an overemphasis on the need to promptly invest in and adopt the new technologies such as AI. However, it will not be possible to benefit from these tools without developing the required skills of the teachers and other personnel who will be using these technologies. Therefore, as stated by the participants, the better option will be to prioritize skills development before investing in new technologies, in order to fully grasp their benefits and increase the economic and social impact.

<b>EDUCATION - GAPS &amp; CHALLENGES</b>
<b>AWARENESS</b>
Lack of awareness and knowledge on education technologies.
Need for showcasing successful applications in the sector
High investment risk perception due to unknown returns
<b>DATA AND KNOWLEDGE SHARING</b>
Data availability, quality and standardization
Data governance
Barriers to data sharing
Need for knowledge and know-how sharing platforms
<b>WORKFORCE READINESS</b>
Lack of awareness and knowledge about educational deep tech
Tendency to stick to the traditional teaching methods
Lack of time and effort to put into skills development
Need for showcasing best implementations and practices
<b>FINANCIAL SUPPORT</b>
Lack of public funding
Risk of deepening inequalities through private investment
<b>SKILLS GAP</b>
Need for skills development to develop, implement and use these technologies
Closing the skills gap through lifelong learning and MOOC platforms
Need for collaborations to close the skills gap
<b>THE DIGITAL DIVIDE - ACCESS TO EDUCATION</b>
Problems related to access to educational technologies in disadvantaged communities
Limited impact of the pilot projects in the field
Need for infrastructure development in disadvantaged communities
<b>SYSTEMATIC CHANGE IN EDUCATION</b>
Need for a perspective shift in educational institutions to become more tech-friendly
Need for creating a “shared understanding” among the ecosystem actors
Creating equal opportunities for all
<b>OVEREMPHASIS ON TECHNOLOGY ADOPTION</b>
Overemphasis on the need to promptly invest in and adopt the new technologies
Need to prioritize skills development before investing in new technologies

## **2. AGRICULTURE**

One of the greatest challenges we face is to find sustainable solutions to make farming more efficient in order to feed the world population which will increase by 2 billion by the year of 2050. In addition to the growing population, trends such as urbanization, which is expected to keep its track, and increase in per capita income will also shape the demand. Thanks to the fast pace of technological improvements, agriculture is becoming a sector in which AI, machine learning and IoT technologies are frequently used. Table 5 summarizes the current technologies used in the agriculture sector worldwide; however, it is not possible to claim that all countries are reaping the benefits of these technologies. Consequently, the focus should be on the current situation of AgriTech adoption in least-developed countries that need immediate implementation of these solutions.

With the increasing rates of awareness and adoption, our participants reveal that current uses of AgriTech include IoT and data analytics systems in collecting and processing agricultural data through IoT and cloud systems, including weather forecasts, soil and plant analysis, predictive analytics in seeds, water, smart fertilizers and smart pesticides, biotechnology in increased seed and crop productivity and in higher nutritional value and urban farming.

### **Gaps and Challenges**

#### **INFRASTRUCTURE AND NEED FOR PUBLIC FUNDING**

Even though precision farming can bring in substantial opportunities for efficiency, profitability, environmental and social impact, implementation of these technologies require significant investments in infrastructure and deep tech tools. Furthermore, it requires generation and sharing of standardized and high quality data as well as systems to ensure the two-sided flow of information to keep the actors of the ecosystem informed - from the farmers to the researchers' developing these technologies.

Furthermore, as emphasized by the participants, on the investments side, agriculture sector heavily depends on public funding instruments due to heavy reliance on developed infrastructure to reap the benefits of AgriTech. In a majority of the successful cases in AgriTech adoption, a joint effort of governments, development institutions and companies was needed to develop especially smallholder farmers' skills to be able to adopt new technologies.

#### **ACCESS TO AGRITECH – CONTRACT FARMING**

Financial assistance for the acquisition of AgriTech is an important tool to increase the pace of the agricultural technology transformation, especially for the smallholders. Some of the participants mention fruitful collaborations between smallholder farmers and large companies in the food industry in the way to achieve the tech transformation collaboratively. Availability of funds and ease of access to these funds through a powerful collaborator significantly increases the tendency to adopt AgriTech, yet, this also requires long-term commitment of the parties. At this point, participants mention the importance of contract farming which requires agricultural production to be carried out on the basis of a long-term agreement between the farmer and the purchasing company. A special emphasis was put on contract farming by the majority of our participants from the agriculture sector, stating that this can be the most significant solution to the problem of dissemination of technology to the smallholder farmers.

#### **CONSOLIDATION OF AGRICULTURAL LAND**

Another very important policy intervention to increase AgriTech use is the consolidation of agricultural land in order to incentivize private sector investments. For example, precision farming requires the use of drones and other imaging technologies which requires substantial investments, and this necessitates operating in large agricultural land. The regulatory change on this matter and pilot projects on consolidation of the agricultural land have been enacted in Turkey, yet, the pace of the progress has been slow.

#### **AWARENESS RAISING ON THE DEMAND SIDE**

Participants of the in-depth interviews from both the demand and supply side of AgriTech argue that to get the most out of these technologies the first step is to increase the awareness on the demand side regarding new technologies and products, such as food tracking (through blockchain enabled systems), plant-based meat or GMO. According to some of the participants, this might create a pull effect in the market and force tech user agriculture companies to adopt new technologies as a result of consumer demand to ensure access to secure and clean food.

**THE NEED FOR CONSENSUS ON REGULATIONS**

Some of the participants state that before discussing the required changes in the regulatory environment, it is important to ensure that the actors in the market reach a consensus on how these regulations can be shaped in a way that both benefits the sector and the public in general. Similar to the continuing discussions worldwide, it is important to speak the same language and reach a shared understanding in order to define the path that the market will take for the best interests of all parties included. This includes the need to reach a consensus on regulations especially for gene-edited crops, food science and genomics, which is argued to be one of the main barriers to a tech-intense agriculture sector.

Biotechnology can be an affective tool in enabling farmers and countries to develop the agriculture sector, however, it is hard to reach a consensus on allowing or prohibiting the cultivation of GMOs considering the ongoing discussions on their effects. On the other hand, this also raises concerns regarding the traceability of food which is an important discussion in food security. Triggered mostly by the demand for food traceability, blockchain emerges as an important technology to secure the agricultural value chain, however, no applications of this technology is yet available in the research context.

**PLATFORMS FOR COLLABORATION AND CONSOLIDATION**

Connecting smallholder farmers through offline and online platforms emerged as an urgent need, even though there are some attempts to address this need. According to the participants, previous projects served more as knowledge sharing platforms limited to providing farmers with information such as weather forecasts, farming knowledge, market prices and ways to access to credit and insurance. On the other hand, participants claim that there is more to be done in this domain, such as creating online platforms for consolidation of buying, selling and logistics which can lead to a significant decrease in costs; for sharing market trends and up-to-date price information to ensure optimization and planning of planting accordingly. This need emerged in all interviews and is regarded as a main driving factor to foster market development in agriculture sector.

<b>AGRICULTURE - GAPS &amp; CHALLENGES</b>
<b>INFRASTRUCTURE AND NEED FOR PUBLIC FUND</b>
Generation and sharing of standardized and high quality data
Need for flow of information to keep the actors of the ecosystem informed
Heavy dependence on public funding instruments
Need for joint efforts of governments, development institutions and companies
<b>ACCESS TO AGRITECH - CONTRACT FARMING</b>
Need for financial assistance for the acquisition of AgriTech
Need for collaborations between smallholder farmers and large companies
Contract farming to ensure dissemination of technology to the smallholder farmers
<b>CONSOLIDATION OF AGRICULTURAL LAND</b>
Need for regulatory change and projects on consolidation of the agricultural land
<b>AWARENESS RAISING ON THE DEMAND SIDE</b>
Need for increasing awareness on the consumer side to increase tech adoption
<b>THE NEED FOR CONCENSUS ON REGULATIONS</b>
Need to reach a consensus on regulations for gene-edited crops, food science and genomics
<b>PLATFORMS FOR COLLABORATION AND CONSOLIDATION</b>
Connecting smallholder farmers through offline and online platforms
Creating online platforms for consolidation of buying, selling and logistics

**3. HEALTHCARE**

Healthcare is one of the leading sectors in the development and adoption of new technologies which have the potential to create immediate results and improvements. Even though there are various areas for improvement in the healthcare

sector in developing countries, the adoption of HealthTech pace is steep. Participants reveal that new technologies that have an increasing rate of adoption include rehabilitation and assistive technologies, digital healthcare platforms, diagnostics tools for early detection and prevention, tech for patient-centered, personalized healthcare solutions and biotechnology in the domains of genetically engineered organisms in healthcare and nanomedicine. All these technologies rely heavily on data for development and improvement, which emerges as a major challenge.

## **Gaps and Challenges**

### **DATA PRIVACY & SECURITY**

Participants revealed that the collection, storage and sharing of health data is a very immature domain and requires significant improvements in order to take advantage of the new technologies, specifically machine learning and AI. These technologies require the flow of big data from all actors in the healthcare market, which is called the health data ecosystem. The data producing actors (healthcare providing institutions, research institutes, biobanks, public health research, universities, health insurance actors etc.) are the members of the health data ecosystem. In developed HealthTech markets, it is seen that this ecosystem is integrated, producing standardized and transferrable data which is available to the use of various parties in line with the current legislations. The volume of the data and the speed with which this data is generated is an important determinant of the successful use of HealthTech. Considering all these points, participants of the research commented that the current HealthTech market is its very early stages of development.

Participants emphasize that the potential to develop and use deep tech in the health sector to create economic and social impact is hindered by the problems of access to data. A very prominent problem regarding the development and use of HealthTech is data privacy. In addition, data standardization, storage and sharing is very limited, which further hinders the use of healthcare technologies. On the other hand, some of the participants on the tech-developer side comment that they sometimes get the chance to reach a limited amount of data provided by healthcare institutions, yet the data quality is low and the resources are not reliable. This, points out the need for a regulatory framework on collection, storage and sharing of health data which will be the key determinant of the growth of the HealthTech market and the potential impact it will generate. One possible solution for data privacy comes as the development and increased adoption of blockchain technologies for which an integrated data infrastructure or “health data ecosystem” is needed.

### **DIGITAL DIVIDE**

Healthcare is one of the leading sectors in the adoption of robotics technologies and it is even possible for surgeons to operate patients remotely through robotic tech. In addition, even though not currently applicable in the research context, it is possible to get virtual healthcare services. Smart devices and wearables are becoming important tools in collecting and tracking health data. On the other hand, whether it is access to internet, or access to a wearable health data collector device, the use of all these technologies and the benefits they bring are bounded by the availability of resources the individuals have. Through this perspective, some participants raised their ethical concerns regarding the social impact created by HealthTech, and whether it eradicates or strengthens the borders of access between the advantaged and less advantaged.

### **ACCESS TO TECH IS COSTLY**

Participants also revealed the fact that HealthTech requires heavy investments which cannot be afforded by a significant proportion of the healthcare provider institutions. Even though a majority of these institutions are aware of the fact that these technologies have the potential to create significant impact, effectiveness and profitability, they cannot access these technologies due to their limited resources, leading us to questions regarding the sustainability of these institutions in the future.

### **EDUCATION AND TRAINING REQUIREMENTS**

The use and adoption of HealthTech requires heavy investments, both in terms of time and money, on healthcare professionals' skills development. In the research context, comments were in favor of the situation for private healthcare institutions which invest in skills development as well as the adoption of these technologies. On the other hand, especially for public healthcare institutions, the situation seems to be different. Participants once again raise their concerns and stress the importance of government support in transforming not only the healthcare institutions but also the personnel in being fully equipped to be able to benefit from these technologies.

**BARRIERS TO VIRTUAL HEALTHCARE SERVICES**

Access to virtual healthcare services can contribute significantly to reducing inequalities in the healthcare sector. The participants of the study revealed that this domain requires significant improvements to put into practice due to the current barriers including security of personal information, regulatory barriers in delivering the healthcare service and prescribing online, and the problems related to digital divide due to the problems of internet access faced by disadvantaged and rural populations.

**PLATFORMS FOR COLLABORATIONS**

Emerging tech markets face different challenges, one of which is the limited know-how and knowledge sharing due to intense competition. However, without creating a shared understanding and determining common goals, it will not be possible to reap the benefits of these technologies in the near future. Therefore, platforms for collaborations are needed between health-tech companies (especially start-ups), ICT companies, corporations, government and NGOs to scale social impact which is limited, under current conditions.

In the domain of diagnostic technologies – collaborations are needed between hardware developers, tech companies, AI and mobile solutions developers, public and private healthcare institutions to make diagnostic tech more accessible to disadvantaged populations.

**NEED FOR DIALOGUE**

Healthcare sector poses potential challenges in terms of its implications for individuals and for the society in general. Consequently, it is more prone to protectionist actions and regulations both from the demand and supply side of the market, specifically in terms of collection and sharing of health data. On the other hand, the availability of big data is the core requirement to put these technologies into practice and reap their benefits. To balance these two seemingly opposite demands, a shared understanding needs to be created among patients, public and private healthcare institutions, healthcare professionals and the government through dialogue.

<b>HEALTHCARE - GAPS &amp; CHALLENGES</b>
<b>DATA PRIVACY &amp; SECURITY</b>
Very limited collection, storage and sharing of health data
Need for producing standardized and transferrable data
Problems related to access to data
<b>DIGITAL DIVIDE</b>
Use and benefits of HealthTech are bounded by the availability of resources
Risk of strengthening the inequalities
<b>ACCESS TO TECH IS COSTLY</b>
Problems related to access to HealthTech due to limited resources
Sustainability of health institutions with relatively limited resources
<b>EDUCATION AND TRAINING REQUIREMENTS</b>
Skills gap among healthcare professionals
Need for government support in transforming the workforce
<b>BARRIERS TO VIRTUAL HEALTHCARE SERVICES</b>
Problems related to data security
Regulatory barriers in delivering virtual healthcare service
Problems related to digital divide
<b>PLATFORMS FOR COLLABORATIONS</b>
Need for platforms for collaborations, know-how and knowledge sharing
<b>NEED FOR DIALOGUE</b>
Protectionist actions and regulations to protect individuals
Need to create a shared understanding between the members of the ecosystem

## **4. ENERGY**

The interviews revealed that the energy sector is among the most mature sectors in the research context with many successful companies developing and using EnergyTech. Participant companies revealed that they develop and use deep tech in the areas of demand and supply forecasting, real time data processing with IoT systems, smart grid technologies –demand side management on clean energy, grid balancing, storage and battery technologies. These applications are in the industrial domain because there are no uses at the household level due to regulatory barriers and bureaucracy.

### **GAPS AND CHALLENGES**

#### **LACK OF AWARENESS ON THE DEMAND SIDE**

Participants working in the domain of energy efficiency state that awareness levels on the demand side regarding the importance and effectiveness of using EnergyTech tools is quite low. However, both the interest and demand seem to be rising due to reduced government subvention in energy which leads increasing energy prices. On the other hand, this enforced awareness does not lead to the desired leapfrog in the market, which requires more dialogue between the technology developer and user companies, as well as the investors. Participants expressed the need to create a shared understanding between the actors of the industry and recommend development of an Energy Efficiency Act. The availability of regulations which enact adoption of energy efficiency technologies is quite important to develop the EnergyTech markets in the way to reaching SDGs and creating environmental and social impact.

#### **LACK OF INVESTOR INTEREST AND OVEREMPHASIS ON INVESTMENT RISK**

Participant tech developers reveal the hesitations of investors in investing in deep tech specifically due to the lack of awareness on the successful deep-tech companies in the energy sector, which are the tech developers. One of the potential solutions proposed for the problem is to engage in awareness raising on both the demand and investor side. Another possible solution can be establishing collaborative knowledge sharing and know-how platforms (offline and online) which will inform all parties regarding best cases for development and application of energy efficiency systems and technologies.

#### **RAISING CAPITAL FOR CLEAN ENERGY STARTUPS – INVESTOR RISK & PUBLIC FUNDING**

All participants from the energy sector state the problem of risk aversion on the investor side and reveal that this is a major problem in the way to developing the clean energy market. In order to increase VC funds, public – private partnerships are needed through government backed funding which may reduce the perceived risk on the investors' eyes. Public funding is especially critical for the tech developer startups which are in the pre-commercialization stages which prevents the flow of private sector investment. The clean energy market is capital intensive and requires public funding which necessitates long term commitment and support on the political and public levels.

#### **ACCESS TO ENERGY**

Problems related to access to energy for disadvantaged populations usually need large companies, donors, governments and development agents to step in due to the infrastructural gaps in the market. Bridging these gaps requires collaborations among companies, development institutions and governments where market-based approaches have failed. However, participants revealed that this is an untouched domain in the research context, adding that public funding will be needed to initiate potential market-based solutions to this problem.

#### **REGULATIONS AND BUREAUCRATIC FRAMEWORK**

Participants from clean energy and energy efficiency domains emphasize the need for change in the regulations on energy efficiency. As a potential solution for awareness and demand related problems, increasing the energy efficiency standards may speed up the transformation in the adoption of technology and enforce companies to transform their operations to become more energy efficient.

On the other hand, another point that requires attention is the need to develop a future vision and strategy on country level to plan for the technologies which will play a key role in the industry and business models and consumption patterns that will shape the market in the future. Policies which target removing the barriers to the adoption of clean tech, such as macro politics, regulations and technology lock-in needs to be developed and implemented with a long-term perspective in order to pave the way for the development of clean EnergyTech markets.

<b>ENERGY - GAPS &amp; CHALLENGES</b>
<b>LACK OF AWARENESS ON THE DEMAND SIDE</b>
Lack of awareness on the demand side regarding EnergyTech
Need for dialogue between tech developers, users and investors
Development of an Energy Efficiency Act
<b>LACK OF INVESTOR INTEREST AND OVEREMPHASIS ON INVESTMENT RISK</b>
Hesitations of investors in investing in deep tech
Lack of awareness on the successful implementations of deep-tech
Need for offline and online knowledge sharing and know-how platforms
<b>RAISING CAPITAL FOR CLEAN ENERGY STARTUPS</b>
Risk aversion on the investor side
Need for public-private partnerships
Need for public funding
Long term commitment and support on the political and public levels
<b>ACCESS TO ENERGY</b>
Need for collaborations where market-based approaches have failed
Need for public funding to initiate the potential solutions
<b>REGULATIONS AND BUREAUCRATIC FRAMEWORK</b>
Need for change in the regulations on energy efficiency
Increasing the energy efficiency standards
Policies to remove the barriers to the adoption of clean tech
Developing a country-level future vision and strategy for tech adoption

## **BRIDGING THE GAPS: CREATING SHARED UNDERSTANDING FOR MARKET DEVELOPMENT**

The thumb rule of market development lies in aligning the interests and demands of different actors in the market. In this regard, we recommend building bridges to create a shared understanding between actors with seemingly different but possible-to-align interests:

### **PUBLIC & PRIVATE SECTOR PARTNERSHIPS**

**Data availability and accessibility** is the key to almost every step towards improvement and development in the impact tech markets. However, it also brings in heavy responsibilities regarding data **security and protection**. In addition, “forced data localization policies” are becoming common practice, including developing economies, specifically in industries like healthcare and finance. Data protection and availability, two seemingly contradicting demands can at least be partially aligned through dialogue. On the way to create a shared understanding and a data network which will feed impact tech, we recommend following actions:

- Defining the data that needs to be **systematically collected** in different sectors.
- Developing systems which enable **data standardization** in each sector to ensure that the collected data produces maximum benefit for all parties involved.
- Setting **clearly-defined boundaries and conditions** regarding the **storage, sharing and use of the collected data** in a way that benefits all parties equally, including governments and private sector, while protecting the rights of the individuals.

### **TECHNOLOGY DEVELOPERS & TECHNOLOGY USERS**

One of the most prominent findings of this research is the need to build bridges between the developer and user companies, regardless of the industry. Unlike traditional technologies, deep tech requires heavy commitment in

the process along with the need to customize each operation to be aligned with the new technology. This can be done by the sales teams of the tech developer companies; but according to user companies specifically in health and agriculture sectors, it seems that the length of the process and the efforts needed to suit the technology to the needs of the companies may require a third party, a mediator, to step in. This role that we define as “tech mediators” has a great market potential itself and may serve as a catalyst in speeding up the process of market development.

#### **TECH DEVELOPERS & INVESTORS**

*“If you are investing in deep tech in this market, then you will definitely be called an angel investor.”* (Participant from the healthcare sector)

But is that really the case? Contrary to developing markets, the deep tech investments in developed countries tell us a different story. According to OECD (2018) report on private equity investments, AI start-ups received around 12% of all worldwide private equity investments in the first half of 2018, which refers to a steep increase from 3% in 2011. This shows that investor awareness on the potential of AI is increasing fast and AI becomes an important part of the investment strategies. However, a great majority of these investments are received by companies and start-ups in the United States, China and the European Union. On the other hand, as revealed by our tech-developer participants, developing economies seems to be away from the spotlight of investors.

One of the main reasons for the lack of interest on the investor side in developing economies is the **lack of awareness regarding the market potential of deep tech investments, and the high perceived risk** which comes as a side-effect of the awareness problem. Therefore, the main action would be to raise awareness among investors in developing countries through **showcasing success stories and building bridges between investors and tech developers** to enable them to speak the same language and reach a shared understanding on the market opportunities and potential risks of deep tech investments.

#### **TECH DEVELOPERS, INVESTORS & POLICY MAKERS**

Another prominent area of improvement in impact tech markets in the developing countries is to create the shared understanding between tech developers, investors and policy makers. Recently, China has seen a dramatic increase in the investments received in deep tech, specifically in AI, thanks to the continuous commitment to developing a long term, country-wise AI strategy. Governments’ and tech sector’s efforts paid back as the Chinese companies received 36% of global AI private equity investments in 2017 (OECD, 2018). Chinese government is committed to a masterplan in AI with significant contributions to fundamental research and education in AI.

**Governments’ continuous and committed efforts in developing the tech sector is a game-changer** which deeply impacts **country-wise awareness, skills development (availability of local talent) and tech development and usage capabilities**. In addition, having a long-term strategy and a roadmap for the development of deep tech markets lead the way to enabling policy and an appropriate mix of direct and indirect support instruments, from public investment in deep tech research and development to tax relief for founders and investors. For example, the UK offers a low 10 percent tax on gains for founders and business angels, while corporate tax rate for tech companies in Ireland is 12.5 percent. Netherlands provide companies with R&D payroll tax credit based on the number of allocated R&D hours. High tech markets flourish in countries with local talent, opportunities in access to finance and supportive tax and trade policies, which are developed in line with the demands of the market actors. In this regard, dialogue between tech developer and user companies, investors and the government is a crucial step in the way to developing deep tech markets for SDGs.

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