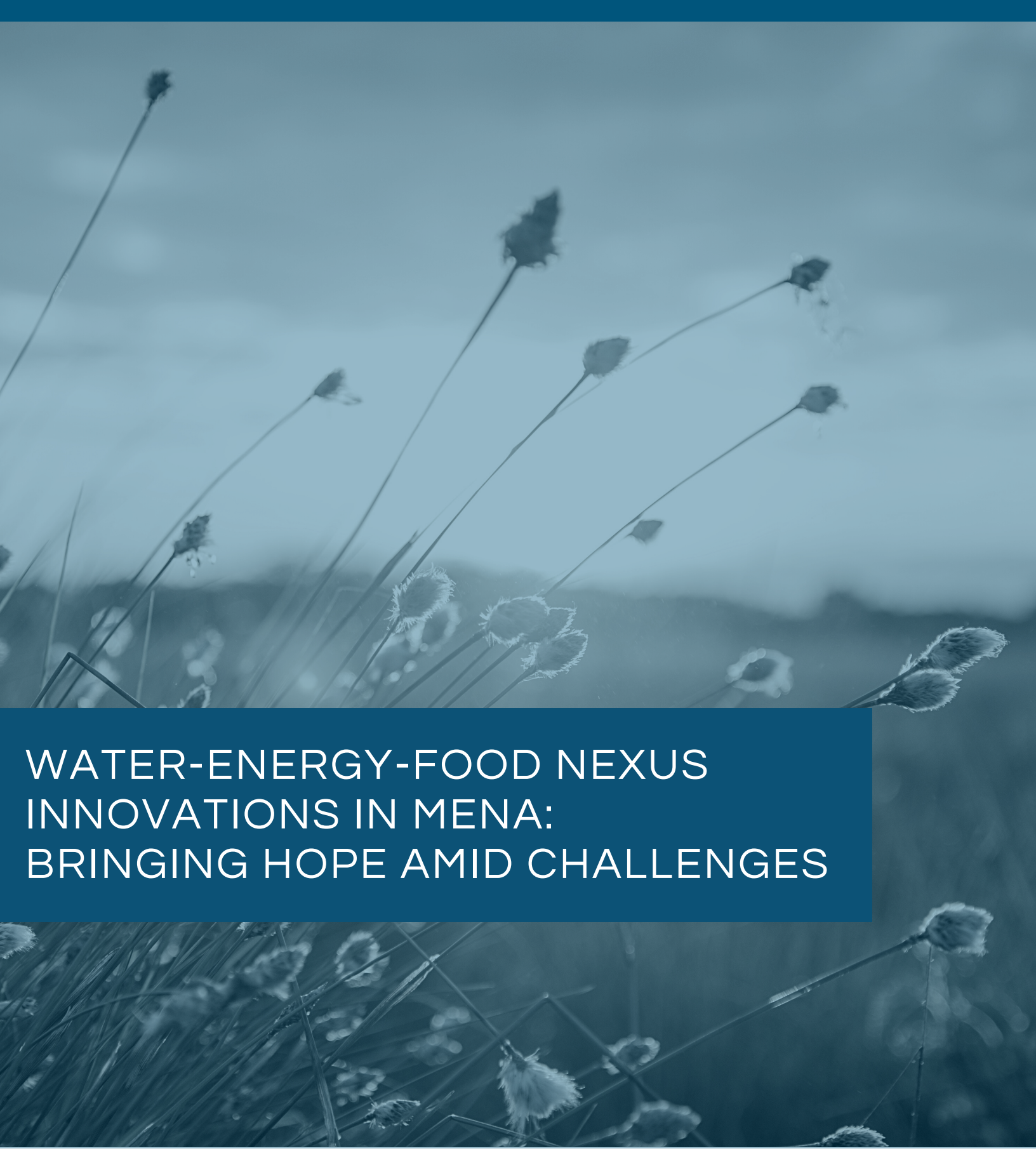

WATER-ENERGY-FOOD NEXUS INNOVATIONS IN MENA: BRINGING HOPE AMID CHALLENGES

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SETTING THE STANDARD

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Executive Summary

The Middle East and North Africa (MENA) region is currently facing multiple challenges related to the Water, Energy and Food sectors, such as water scarcity, drought, population growth, urbanization and political instability. Food-Water and Water-Energy Security are core to the Sustainable Development Goals' (SDGs) targets and indicators in the region. The MENA region faces significant challenges in reaching the SDGs, particularly SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 7 (Affordable and Clean Energy), although unique challenges vary between countries. The challenges in these sectors cause negative health impacts including malnutrition, water related diseases, and pollution due to use of fossil fuel energies.

However, social innovation and entrepreneurship has been growing steadily in the region, with initiatives aiming to support achievement of the SDGs, such as reducing energy and water usage in agriculture, improving drinking water security, food security, and more. In collaboration with the American University of Beirut, Engineering for Change aimed to analyse the ecosystem of innovation within the water-energy-food nexus by identifying enabling factors and barriers that innovators encounter in the region.

To investigate the social innovation sector in the MENA region, we chose to combine findings from desk research and expert insights from semi-structured interviews with active social innovators. Participants for interviews were selected for the study based on the criteria that their innovation had to address issues related to at least two of the sectors within the Water Energy Food nexus in the MENA region. The interview participants included innovators representing 27 startups from 9 countries across the MENA Region.

Using the Business Model Canvas, the interviewed companies' business models, organization characteristics, value propositions, and motivations are classified. Furthermore, company challenges, obstacles, and enablers for success are described in an effort to identify needs and opportunities to improve the enabling environment for entrepreneurship in the region. Importantly, sustainability and health impacts for the innovations are highlighted.

The final aim of the report is to provide recommendations on how to approach innovation in the water energy food nexus in the MENA region. For example, R&D should be promoted by policy-makers and universities to support innovation, bureaucracy and administrative burdens should be made leaner and friendlier towards innovators, improved access to finances and markets should be made possible for entrepreneurs, social innovation should be encouraged and innovators properly recognized in their home countries, proper education and awareness about sustainability issues should be promoted and spread in the region, and policies supporting entrepreneurship should be developed and further implemented.

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Acknowledgement

We would like to thank all the innovators and entrepreneurs who participated in this research collaboration. Special thanks to the Mediterranean Youth Water Network for their great support, Berytech, and the Issam Fares Institute (IFI) for public policy and international affairs.

Introduction

The Middle East and North Africa (MENA[1]) region is currently facing multiple challenges related to the Water, Energy and Food sectors, such as water scarcity, drought, population growth, urbanization and political instability. Known as an arid region, water availability is expected to drop by around 50% by 2050 across MENA[2]. The threat of water security creates conflicts, increases food insecurity, and pushes populations to migrate. Food insecurity in the region requires countries in MENA to rely heavily on imports[3], for instance, the region is considered as one of the largest importers of wheat[4]. Concerning energy, it is worth mentioning that the region is mostly relying on fossil fuels despite the high potential of solar power use. Climate change is further aggravating these water, energy, and food issues causing conflicts and insecurities in the region[5]. These increased insecurities are hindering progress in human rights and regional development[6]. These three sectors are interlinked and have an impact on each other, thus potential innovations and solutions should consider the intersections, such as Food-Water Security and Water-Energy Security[7].

Food-Water and Water-Energy Security are core to the Sustainable Development Goals' (SDGs) targets and indicators in the region. The MENA region faces significant challenges in reaching the SDGs, particularly SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 7 (Affordable and Clean Energy)[8], although unique challenges vary between countries. The challenges in these sectors cause negative health impacts including malnutrition, water related diseases (e.g., Hepatitis) and pollution due to use of fossil fuel energies.

Water-Energy-Food Nexus in MENA

As the Water Energy Food Sectors are significantly interlinked, they should be considered as a Nexus to drive sustainable development in the region. The nexus approach provides a definition for Water-Energy-Food security where the three sectors are considered in relation to each other. For instance, agriculture and food processing are directly related to water and energy consumption; in MENA, the agriculture sector comprises 80% of the region's water consumption. An integrated approach towards the challenges in the three sectors is therefore recommended and used in this analysis. Initiatives addressing multiple sectors include the Integrated Water Resource Management (IWRM) approach and Sustainable Energy for All (SE4ALL). Such initiatives, which introduced an integrated approach to the challenges in these sectors, paved the way for the NEXUS framework and offer a holistic strategy to tackle these issues in the region.

[1] World Atlas, What are the MENA countries, 2019
[2] The Middle East and North Africa Regional Water Outlook
[3] https://blogs.worldbank.org/arabvoices/food-security-arab-world
[4] Emerging Security Threats in the Middle East
[5] Haddadin, Munther. (2001). Water Scarcity Impacts and Potential Conflicts in the MENA Region. Water International - WATER INT. 26. 460-470. 10.1080/02508060108686947.
[6] UNESCWA, The Water, Energy and Food Security Nexus in the Arab Region
[7] Hameed, Maysoun, Hamid Moradkhani, Ali Ahmadalipour, Hamed Moftakhari, Peyman Abbaszadeh, and Atieh Alipour. "A Review of the 21st Century Challenges in the Food-Energy-Water Security in the Middle East" *Water* 11, no. 4 (2019): 682
[8] SDG INDEX AND

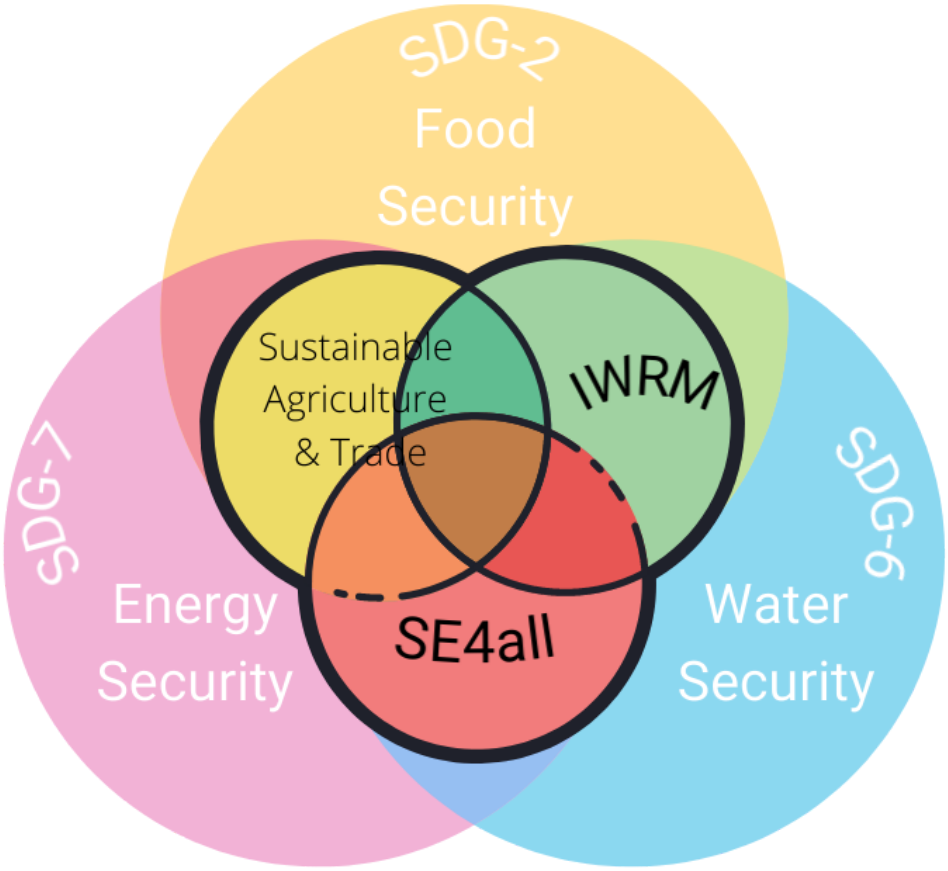

Figure 1. Water Energy Food Nexus links with other initiatives around sustainability adapted from UNESCWA report[9]

Innovations Addressing the Water-Energy-Food (WEF) Nexus

To tackle the issues related to the three sectors by considering the nexus approach, social innovation initiatives are being pursued in MENA. Human centered approaches are one a key asset to help solve those issues. Novelty, creativity, and state-of-the-art technologies are introducing innovation to create simple affordable, disruptive solutions to the most common issues of the communities in the region while being mindful of the product footprint on the environment. The use of different technologies is tailored to the available resources and to the needs of the communities. A new wave of innovation in the WEF nexus is emerging in the region. This innovation is however not fully harnessed and its potential not fully recognized in MENA. The aim of this report is to analyse the ecosystem of innovation around the WEF nexus by identifying enabling factors and barriers that innovators encounter in the region. The conclusion will include recommendations to improve the environment and enable innovation in the WEF nexus in the MENA region.

[9] UNESCWA, The Water, Energy and Food Security Nexus in the Arab Region

Methodology

To investigate the social innovation sector in the MENA region, we chose to combine findings from desk research and expert insights from semi-structured interviews with active social innovators. Participants for interviews were selected for the study based on the criteria that their innovation had to address issues related to at least two of the sectors within the Water Energy Food nexus in the MENA region. Furthermore, the solution selected had to have a clear innovation (e.g., technology, process, business model, etc.). We considered innovation as any creative and novel method or technology while contributing directly to sustainability and development in the region[10]. The goal was to cover as many countries in the MENA region as possible and to include a fairly gender balanced sample in the study. We also targeted a balanced coverage of the three sectors and their intersections.

To identify and recruit interview participants, we used a bottom-up approach that started with a search for available databases of startups in the region, such as WAMDA and MAGNITT. Then, a country-specific search was conducted to identify local incubators and accelerators. For instance, in Lebanon, the incubator Berytech with its Agritech program was used to find relevant companies. Other sources included award programs from WEF, or acceleration programs such as the MIT Enterprise Forum Pan Arab (MITEFAB). Another useful network was the Professional Social Network LinkedIn to reach out to founders or co-founders of innovations already identified through the previously mentioned databases. Through these methods, we initially identified and reached out to 55 innovators across the MENA region and interviewed a total of 27 innovators (49% response rate). Several of our interview participants that were not part of the original 55 innovators were identified through snowball sampling, where we asked each innovator to introduce us to other relevant innovators working on similar projects; we identified 6 additional innovators using this method.

The selected participants were interviewed between August 2020 and September 2020, each for approximately one hour. We used the same interview protocol and adapted the questions according to the stage of development of the enterprise and its main purpose. The interviews were conducted following the same interview protocol and were structured in 5 sections: (1) Product general information and background, (2) Technological insights, (3) Business models, (4) Product impact and scaling, and (5) Obstacles, challenges and future plans. The research protocol qualified as “Exempt” and was approved by the Institutional Review Board of the American University of Beirut .

[10] A more detailed description is in page 8

Study Participants: Innovators in MENA

The interview participants included 27 innovators from 9 countries in the MENA Region. While we were able to connect with a variety of innovators based in different locations, this sample is not considered as fully representative of the WEF nexus start-up ecosystem in the MENA region. The full list of the companies interviewed is presented in the Appendix .

Participant Sectors

Interviewees represented a variety of combinations within the WEF nexus. The distribution of the interviewees according to the sectors of their innovation is shown in Figure 1. The numbers shown at the borders of the intersectoral sectors represent the number of interviewees at the intersection. We chose to represent those numbers at the borders (i.e. water, energy, or food) that we considered the primary sector of the innovation. The primary sectors are defined as the sectors for which the innovator specifically designed a solution. For example, Figure 1 shows that a majority (11 and 5) of the innovations in our sample address the intersection between Food and Water with a greater primary focus on Food production. It was more difficult to find innovators primarily serving the Energy Sector or the Water Sector because they usually address the most pressing needs they identify in their communities and these are mainly related to Food Security and Agriculture water inefficiency. Some innovators also had several products serving different sectors, which were discussed in interviews. The counts in Figure 1 refer to the number of interviewees and how they self-identified as an organization, not projects or innovations.

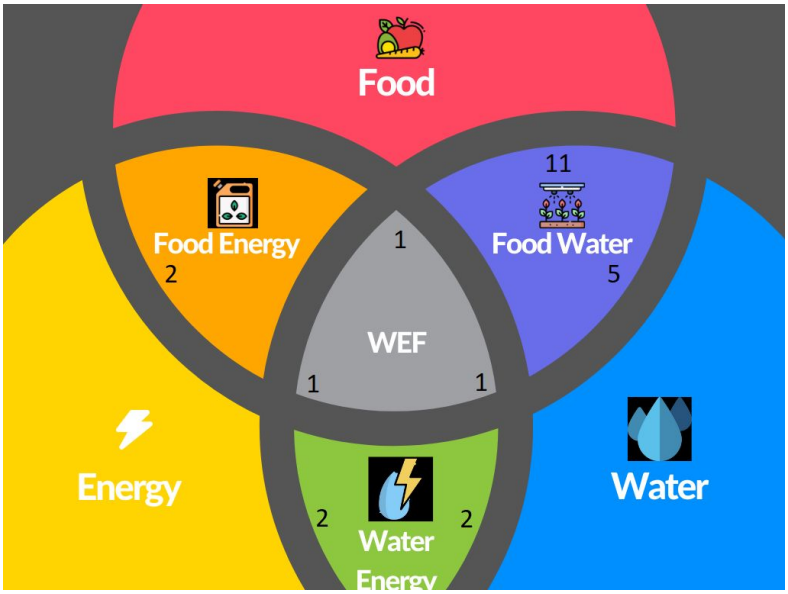

Figure 2. Distribution of innovators according to their WEF Nexus contribution by Sector.

Participant Countries

The innovators interviewed were from or established in 9 countries in the MENA region. The complete distribution is presented in Figure 2. Some of the innovators are established in multiple countries but we

represented only the country they are formally based in. Of the 27 innovators, most (23) were from the country they are currently established in.

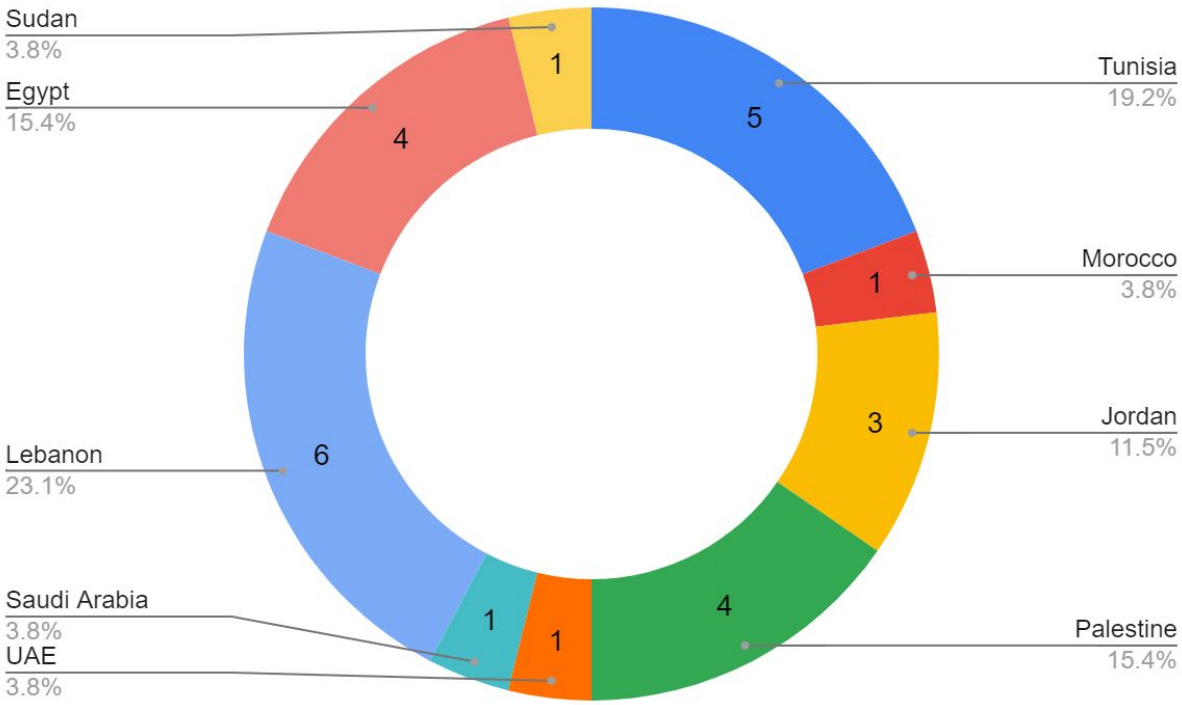

Figure 3. Distribution of the innovators by Country.

Participant Technology Categories

For innovation in the WEF nexus, two groups of technologies stand out: Agri-tech and Clean-tech (sometimes referred to as Green-tech). Agri-tech is the application of technology to agriculture[11]. Agritech uses different types of technologies for multiple applications, such as methods for reducing water usage, applications of machine learning and AI to improve yield, save water in agriculture, adapt irrigation to weather conditions, inform farmers on the latest agriculture successful trends nearby, and design robots that act as weeders; among others. Clean-tech (or Green-tech) is the application of innovative technologies with the ultimate goal to create an eco-friendly technology[12]. Examples of Clean-tech applications in the WEF Nexus include waste management, water treatment, and the use of renewable energies. Innovators in this study represented both Clean-tech and Agri-tech innovations. Figure 3 presents the distribution of the innovators according to the domains Agritech versus Cleantech.

[11] Medium, What is Agritech: A brief explainer, 2018
[12] http://www.cleantech.org/what-is-cleantech/

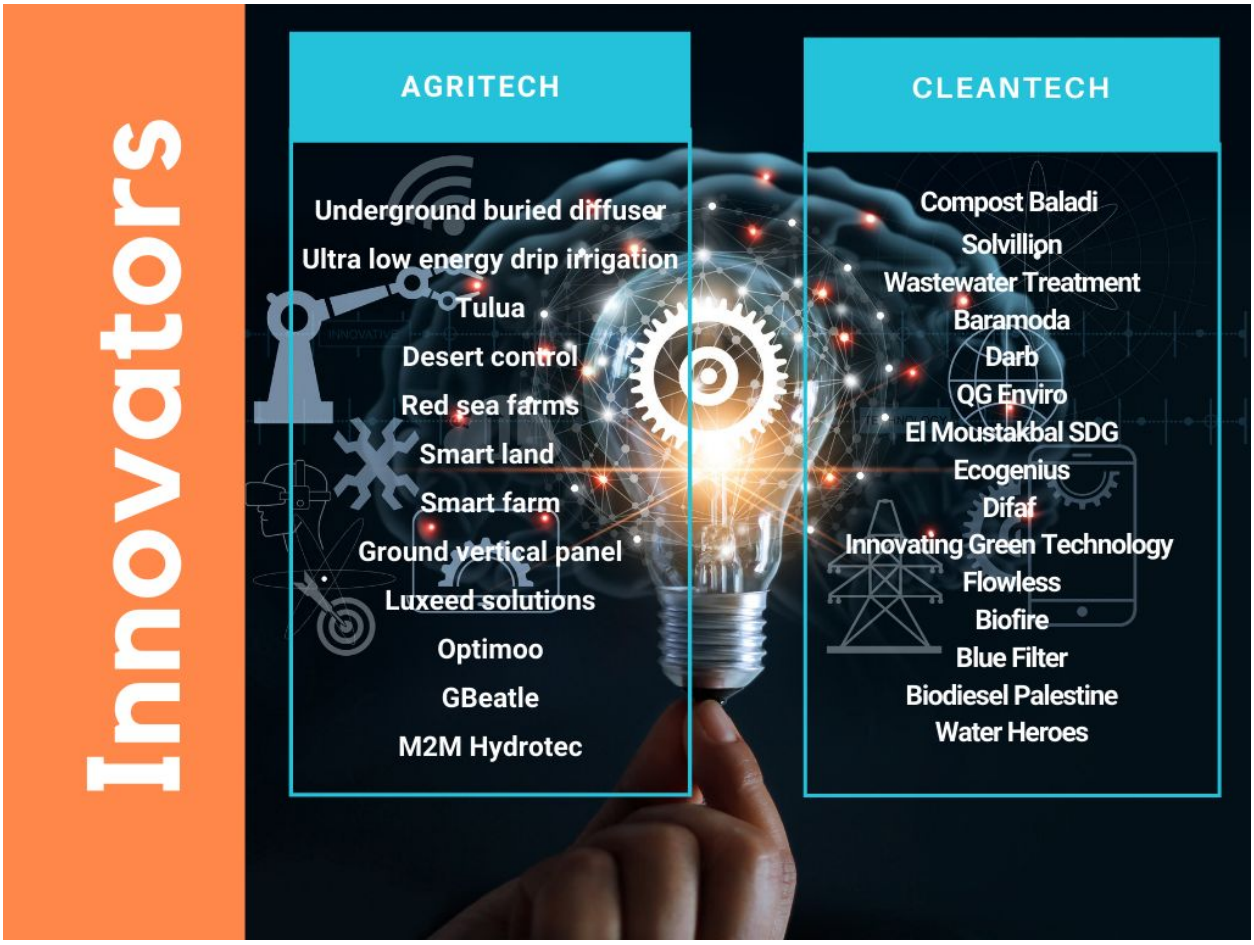

Figure 4. Distribution of the innovators by domain.

Participant Organization Models

This research represents insights from interviews with 27 companies in the MENA region, ranging from startups to more advanced Small Medium Enterprises (SMEs), the companies were represented by females in 7 out of the 27 interviews. Most organizations were small and early-stage with an average of 5 employees, with the smallest being 2 and the largest being 11. However, one interviewee represented a research institution with a reported 250 employees, which was not included in our calculation of average company size. Based on a short survey administered after the interviews (20 out of 27 responses received), participants defined their organizations as follows: 16 out of the 20 innovators who responded, self-identified as startups and only one considered his organisation as an SME. An interesting finding is that several innovators self-identified as startup and another organisation (e.g., research project or social innovation). Their perception of the organisation varies according to their understanding of the different organisation types and to their environment.

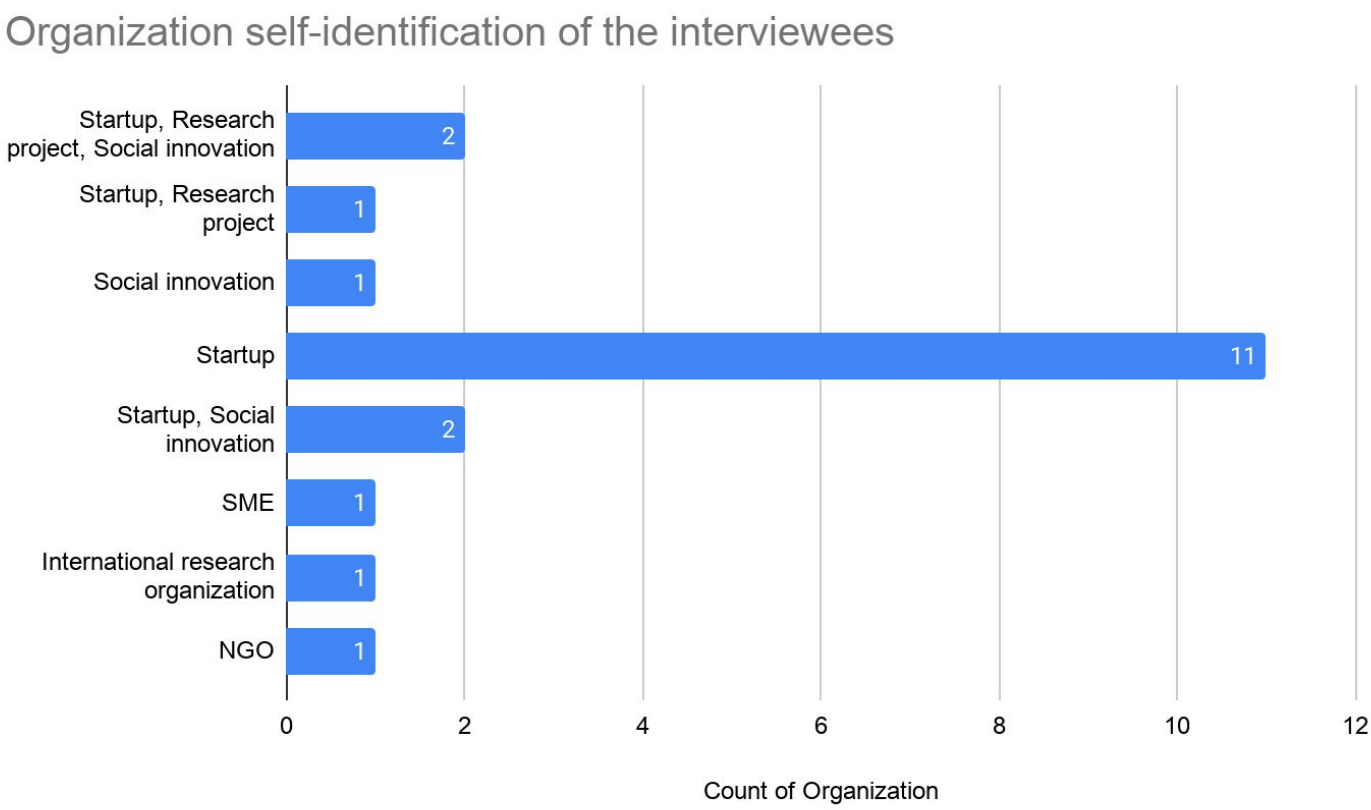

Figure 5. Representation of the interviewees' company organization.

Innovation Trends in MENA

Innovator's Motivations and Foundations

Most of the participants were motivated by an issue they experienced in their community, especially related to water scarcity in the region. Four participants were not originally from the region but were motivated by a challenging situation in the region and they wanted to develop a solution to the most pressing needs of the region. A common theme was the inefficiency of water usage for agriculture. This common theme motivated the innovators to bring a water-efficient solution to an agricultural application, for example, one innovator in Jordan saw how the water usage was inefficient to clean solar panels and designed an automated solution to perform the cleaning. Another motivation was the concept of a circular economy, which inspired some of the innovators to consider solutions that reuse waste. Overall, the interviewed social innovators had developed a variety of different projects within the WEF nexus, for example, linking circular economy with efficient water resource management. Mostly coming from an engineering background (e.g., environment, ICT, Agriculture, electrical engineer, mechanical engineer), innovators had tested the feasibility of their technical solution and were in most cases able to integrate it into a successful business. Some innovators were already experienced engineers or researchers who had started their own project (e.g., a representative from Compost Baladi from lebanon had several years of experience in compost treatment while working in the US, an innovator from Jordan had years of experience working on large solar energy projects) while some others had only recently graduated from university and were on the verge of creating their own project (e.g., GBeetle from Egypt, or Luxeed Robotics from Lebanon). More experienced innovators were often inspired by experiences in their previous jobs. The start of each innovation endeavour appeared to be unique and depended on a lot of factors. Some have started with an idea and their own funds, some others have enrolled in incubation programs and could attend bootcamps to boost their ideas, one innovator from Egypt has participated in a TV show promoting entrepreneurship in the country and could attract a renowned angel investor through that show.

Approaches to Innovation

Most of the innovators used a design thinking approach, which, according to Tim Brown the CEO of IDEO is a "human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success."[13] although the concept was only specifically named by one innovator, other innovators actively applied the approaches and principles of design thinking as well. For example, a representative of the company for Underground Buried Diffuser in Tunisia was inspired by his grandfather using a clay jar to save water when irrigating, while working on the initiative, the innovator focused intently on incorporating the actual needs of his community into his business. Another example is the innovator from Blue Filter in Palestine, Gaza Strip, who emphasized the community needs and the local resources to develop an efficient and affordable solution to filter water with azolla plant. Furthermore, a Biofire representative said he discovered a biochar in China and chose to adapt it to the needs of rural communities in Tunisia. In some cases, importing an exact technology seemed to be inefficient, but adapting the technology to the needs of the community and to the environment is one of the approaches several innovators adopted.

[13] Tim Brown, IDEO Design Thinking

Business Models

Across the initiatives, multiple business models are used. Depending on the product or service they are providing and where they are based, innovators have adopted different strategies to define the customer segment and to find the most appropriate ways to reach out to them. Nevertheless, some common features were identified and will be introduced in this section organized by key elements of the Business Model Canvas (BMC). The BMC is defined as "A shared language for describing, visualizing, assessing and changing business models"[14]. To assist innovators in building a suitable business model, the BMC has 9 building blocks: Customer Segments, Value Proposition, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, and Cost Structure. While the innovators did not always characterize their business model in these terms, we could draw some elements of the BMC by the questions we asked around this specific topic.

Around 73% of the interviewed innovators have a Business to Customer (B2C) model, targeting direct sales to customers and drawing revenues from that. A (Business to Business) B2B model was less prevalent with 27% but we noticed that some innovators are already starting a B2B model or aspire to do so. Figure 6. is a representation of a typical Business Model Canvas summarizing the popular trends for those innovators based on the data collected from the interviews.

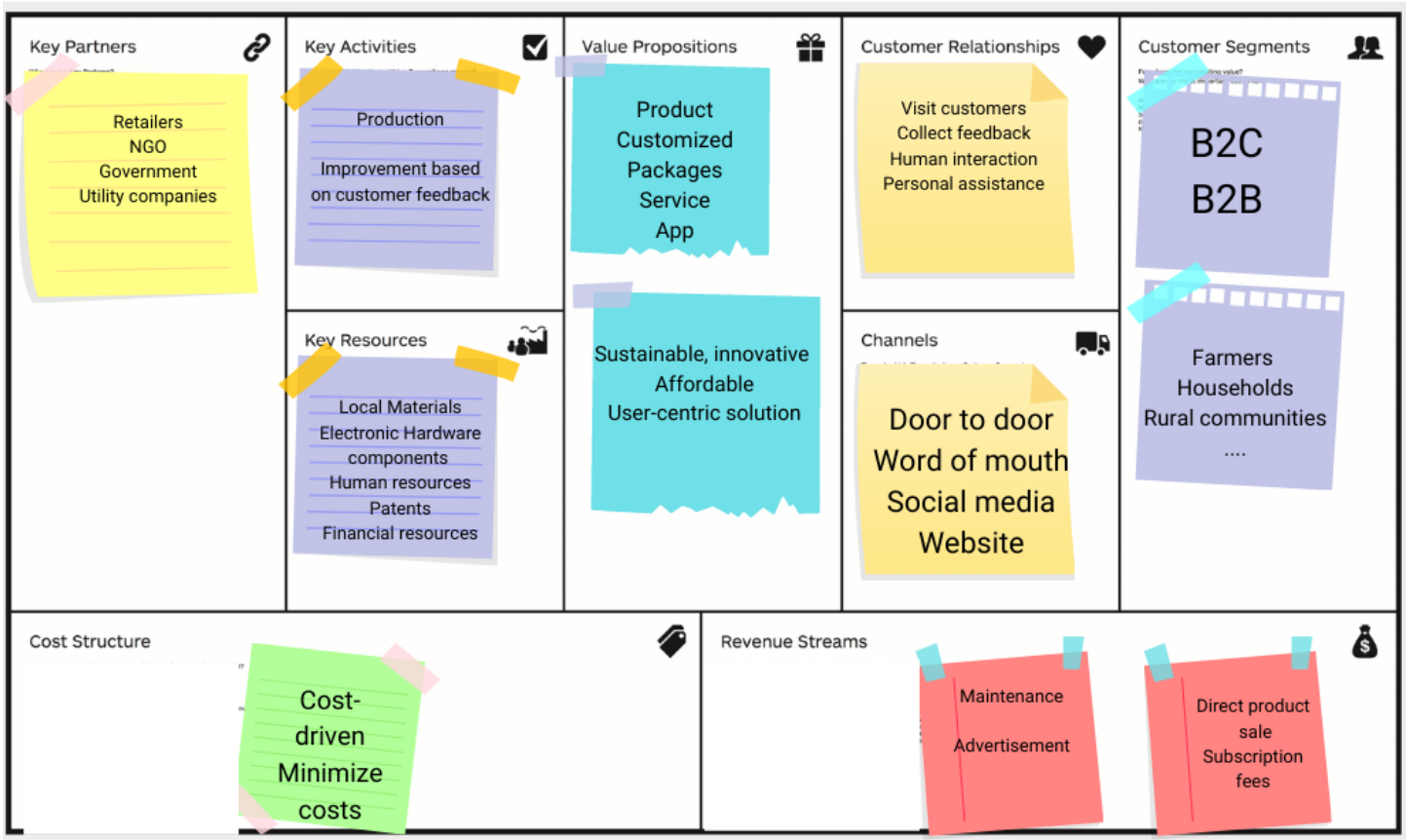

Figure 6. Business Model Canvas summary

[14] Osterwalder, Alexander, and Yves Pigneurx. *Business Model Generation*. Weinheim: (Wiley)-VCH, n.d.

Customer segments

We identified two main groups of customer segments. Innovators in the Agritech sector were targeting common customer bases such as farmers. The reach of the innovator would first depend on the affordability and the scale of the product. For example, a simple irrigation solution could be offered directly to small farmers but an automated expensive robot will be of more use to large scale farmers covering much larger fields. Some innovators have tailored their solutions to different customer segments covering smallholder farmers and large scale producers by offering customized packages. This flexibility was cited as being appreciated by customers and generally led to more growth potential. Depending on their value proposition, Cleantech solutions had a more diversified customer portfolio. The observed customer segments included households, restaurants, solar farms, farmers, schools, and utility buildings, with the targeted customer segments varying based on the solution proposed, for example, for larger scale farms, larger and more technological solutions were desired (e.g., the robot weeder from Luxeed Robotics). Plans to expand geographically were also mentioned by several innovators. Overall, based on the different types of customer segments introduced in the BMC[15], we categorized encountered segments in this study within "segmented" and "niche" markets.

Value proposition

Every innovator was aware of the value proposition he or she was providing. This value proposition ranged from a single product or service to multiple products, packages, or services tailored to the need and budget of the customer. Most value propositions were oriented towards affordable, new, and more sustainable solutions. Some have opted for an improvement to a traditional solution while others have brought in a new product. In defining their value propositions, most of the innovators were leaning towards a user centric design approach where user knowledge is the main motivation behind the product or the service.

Channels

The channels cited by the innovators were hugely dependent on the stage of the enterprise and the environment they were evolving in. "Word of mouth" was very common among the innovators, as they relied on networks to spread the word regarding their product development. Some innovators even reported knocking on customer doors to deliver the product or the service. Another channel mentioned by the innovators was social media, such as Facebook or similar platforms. Some also created official websites where they could collect customer orders (this was cited as a challenge for those with connectivity issues in rural areas). Some others relied on indirect channels through partners selling their products. It seemed also that, depending on the stages the innovators were in, they had the channels thought through and seemed, in some cases, to have planned after sales channels. Innovators in early-stage development relied on more simple channels (e.g., word of mouth, door to door) whereas more advanced innovators were using websites or social media.

Customer relationships

The innovators seemed to maintain solid and sustained relationships with the users. Through a variety of different channels, many innovators first reached out to potential uses to validate their product or service. Many innovators discussed their efforts towards building direct customer relationships, such as conducting regular visits to ensure the proper function and to collect feedback to improve the product.

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[15] Osterwalder, Alexander, and Yves Pigneurx. *Business Model Generation*. Weinheim: (Wiley)-VCH, page 21

Revenue Streams

For 70% of the interviewed participants, primary revenue streams came from direct product sales. Some have also reported adding subscription fees when they provide an additional service or when they provide the system free of charge and they charge a monthly subscription fee. One innovator has reported having revenues additionally from advertisement on the app he is providing with his system.

Key Resources

The resources used by the innovators were materials, financial, human, and intellectual resources[16]. Regarding materials, most of the innovators aimed to source their materials locally. However, for some materials, innovators reported having difficulties procuring them in the region, such as raw materials like Aluminium or certain electronic components. In some specific cases, the innovators mentioned that it could be less expensive to import some materials compared to procuring them locally. Human resources were also reported as crucial by the innovators. Although the number of employees was generally not high, the innovators cited the importance of appropriate competences and dedication of the team members. Another key resource mentioned by all the innovators was finances, discussed in detail later in this report. Overall, self-funds and bank loans were usually brought in as a first investment and initial guarantee for the growth of the business. Finally, intellectual resources were also cited for some innovators, especially concerning patents they already own or in other cases, patentable features in their products.

Key Activities

The main key activities cited by the innovators were production and design improvement. Some innovators reported having already-sufficient production capacity while others were in early-stage planning and financing for production. The second key activity cited by the innovators is the constant improvement and iteration following customer feedback.

Key Partnerships

The main partnership cited by innovators was with bigger retailers. Such partnerships would enable innovators to limit risks and increase their chances of success in the market. Furthermore, partnerships with non-governmental organizations were considered by some innovators to be valuable for a variety of reasons, such as customer visibility.

Cost Structure

In general, business models were mostly cost-driven for the startups and SMEs and more value-driven for the social innovators. Overall, innovators aim to drive down costs and increase revenue streams.

Technological insights and innovation

We observed that there were specific technology sectors which are relevant to the nexus approach. The representation of the different tech sectors is shown below:

[16] Osterwalder, Alexander, and Yves Pigneurx. *Business Model Generation*. Weinheim: (Wiley)-VCH, page 35

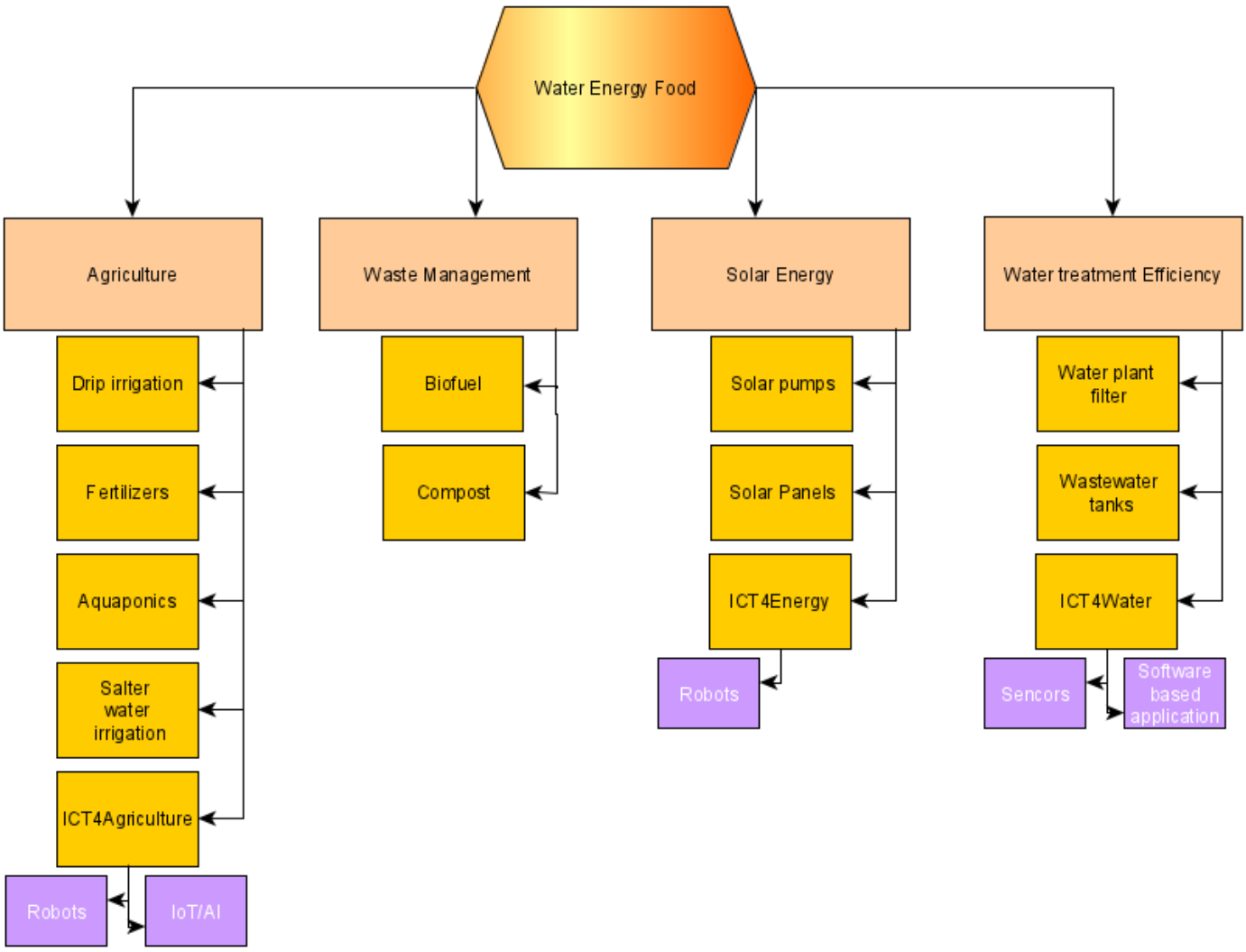

Figure 7. Tech categories of innovation in the WEF Nexus

Nearly all the innovators used Information & Communication Technology (ICT) in their initiative. Agritech initiatives incorporated smart sensors, such as M2M Hydrotech using sensors to monitor the water quantity in the soil or Smart Farm using a weather radar station to fine tune the irrigation according to the weather conditions. Those technologies ranged from innovative irrigation methods, fertilizers, Aquaponics, to ICT application using IoT and Artificial Intelligence. Other technologies included solutions for water treatment using plant filters or water usage efficiency using IoT and AI. Waste management solutions were also present but less popular among the interviewees. Solar Energy, widely available in the region, was commonly integrated as a power source.

The interviewees brought different types of innovation bringing novelty and creativity to their initiatives. To categorize the various innovations, we used the approach of Tim Brown[17] for 4 types of innovation:

[17] https://designthinking.ideo.com/

- Product or functional innovation related to novel, cutting edge and disruptive technologies for the region while still making the product simple to use by the customer, this type encompasses also patented solutions or the ones having patentable features, examples are Darb from Jordan and Blue Filter from Palestine.
- Emotional innovation related with the reuse of already existing technologies by adapting them to the needs of the local communities and making them usable and affordable to them, having empathy towards the users, examples are Biofire from Tunisia and Ground vertical panels from Lebanon.
- Process innovation based on disruptive business models, examples are Flowless from Palestine and Eco Genius from Sudan.
- Experience Innovation as a combination of all the above mentioned types, M2M Hydrotech as an example from Tunisia.

Enabling environment for Innovation in MENA

Innovators described various obstacles, such as issues preventing scaling or growth, and challenges, such as various hurdles that slowed down development or scaling. Innovators also described a variety of enablers that helped and assisted their innovation scaling and growth. Using the Entrepreneurship Ecosystems Strategy,[18] which includes six key domains for self-sustaining entrepreneurship, we categorized challenges, obstacles and enablers. Additional factors were also included particularly related to the Covid-19 pandemic and its impact on the innovators in the region during the first half of the 2020 calendar year.

1. Finances

Financial factors play a major role in defining the pathway to scale up for the innovators. They all mentioned different sources of funding at different stages. Figure 8, adapted from a USAID report[19] describes the different funding sources correlated with the development stage of the enterprise.

[18] http://www.innovationamerica.us/images/stories/2011/The-entrepreneurship-ecosystem-strategy-for-economic-growth-policy-20110620183915.pdf

[19] USAID, Powering Agriculture Access to financing, 2020

<table>
<tr><td>Milestones</td><td colspan="3">Pre-revenue stage company</td><td colspan="3">Revenue stage company</td></tr>
<tr><td>Technology stage</td><td>Idea</td><td>Prototype</td><td>Pilot</td><td>Revenue generating: early manufacturing runs</td><td>Recurring revenue: mass manufacturing</td><td>Profitable: further product development and expansion plans</td></tr>
<tr><td>Market stage</td><td colspan="2">Market opportunity identified; customer discovery ongoing</td><td colspan="3">Confirm product market fit</td><td>Market validation and scale</td></tr>
<tr><td rowspan="6">Funding Type</td><td colspan="2">Friends and family (personal debt or equity</td><td colspan="5"></td></tr>
<tr><td></td><td colspan="3">Angel capital (convertible debt or equity)</td><td colspan="3"></td></tr>
<tr><td colspan="2"></td><td colspan="5">Venture capital (equity)</td></tr>
<tr><td colspan="2"></td><td colspan="5">Strategic corporate investors</td></tr>
<tr><td colspan="4"></td><td colspan="3">Revenue based financing</td></tr>
<tr><td colspan="7">Capital grants</td></tr>
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Figure 8. Overview of capital stages and innovator development milestones adapted from PAEG report [20]

Different funding sources were mentioned by the interviewees according to their stage of development and their strategies, generally aligning with the USAID model presented in the figure. In early stages of development, some innovators relied on self-funding which ranged from small sums of money[21] to bigger personal investments from selling or having mortgages. Several innovators reported also enrolling in Hackathons or entrepreneurial sprints to receive additional funds and advance their innovation. Funding for the pre-revenue stages of the company included grants, subsidies, awards, and incubator financial support. For the innovations which have transitioned from startup to SME, there were more funding opportunities in comparison with the others, e.g., Baramoda from Egypt. The funding when available appears to be one of the incentives for innovators to scale up. Several innovators mentioned grants from organisations like USAID, CMI (Center for Mediterranean Integration), MEDRC (Mediterranean Desalination Research Center). Government subsidies were never cited as a direct funding source. They are usually given indirectly to farmers to invest in water efficient agriculture but not as an incentive to R&D and innovation apparently.

Almost all of the innovators mentioned funding as the main challenge or obstacle to their scale up. Angel investment was also only cited by a single innovator. Innovators described their difficulty in finding and attracting angel investment, including angels' general interest in revenue and profit and less in development and sustainability. Seed funding was also only cited by a single innovator. What seems to be challenging is the availability of angel investors in some countries or even the access to them. We were told that for example this infrastructure was not sufficient to cover the large number of startups in some of the countries such as Tunisia.

Furthermore, some reported having difficulties attracting investors' interest for a solution to bring more awareness on water issues in the region. This was the case of the Founder of Water Heroes, an online game for

[20] From report (14) Powering Agriculture Access to financing
[21] One interviewee mentioned a 500 USD starting self-fund

children to learn about water issues in Palestine. The founder reported that the investors often prioritized revenue and profit maximization, and were more interested in Fintech apps as compared to an educational game.

Since finding investors proved to be difficult, innovators dedicated a lot of time and energy to securing grants and external funding. This challenge was mentioned by the representative from M2M Hydrotech, who outlined the complicated and time-consuming issue of getting funds or investment in Tunisia from abroad. Another constraint was that certain grants have restrictions for how the funding can be used. In one instance, funding could be used only on the project but not to pay the founder's salary.

The early stage innovators have also mentioned cash flow issues. Some have reported low to no revenue in some cases. This seems especially the case in the current situation with Covid-19. This low revenue situation has pushed some of them to have several jobs and not be fully dedicated to their innovation.

Two innovators shared another finance-related obstacle around growing their business model. Indeed, they aspire to start a hybrid business model based on a user subscription scheme. They encountered two major aspects: on the one hand, such a model could guarantee them revenues on a defined period with less risk, on the other hand, such ambitious plans require funds to do the installation of their system and maintain it for the first period.

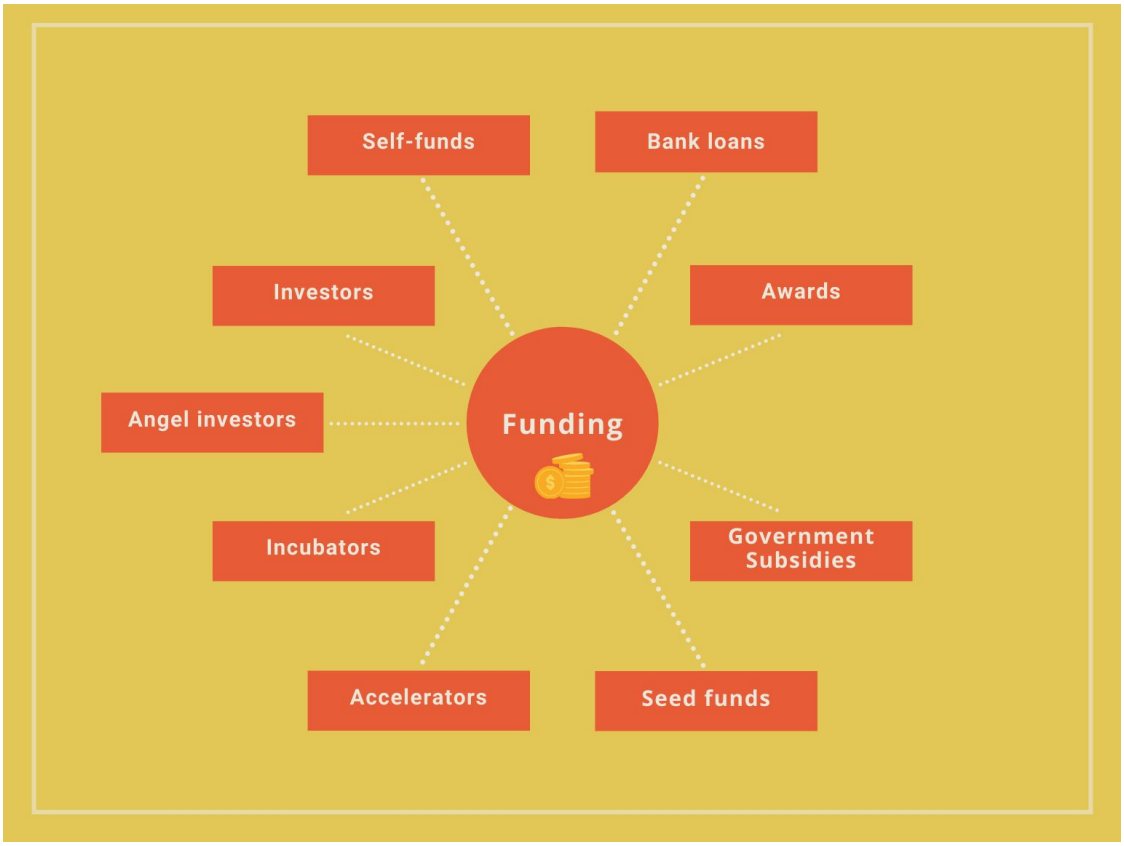

Figure 9. Summary of funding sources.

2. Market

Factors related with integration of the innovation into the market have proven to be quite helpful to the entrepreneurs, starting with integration and access to networks. Eco-genius representative mentioned the advantages she gained from joining the Impact Hub[22] in Sudan. Access to networks proves to be very helpful for innovators to get the visibility and support they need. Once they have identified the customer basis, several innovators reported doing feasibility studies and taking time to do extensive research and testing before prototyping or further developing their product. The representative from Biodiesel Palestine reported that she is now taking time to do a feasibility study to re-open her factory.

Additionally, contact with customers was cited by several interviewees as fundamental for the entrepreneurs to validate their assumption, identify the need, and continue to improve the product. An Optimoo IoT representative in Egypt told us that what helped them get the product adopted by the farmers was establishing direct contact with the farmer's councils representatives. They have introduced their product and counted on the endorsement by the representatives who will further introduce the product to the farmers and explain its use and its impact. This approach appears to be very successful and has proved as an efficient means to introduce their product into the market.

Once the product is introduced into the market, what seems to aid in their survival is the establishment of Memorandum of Understanding (MoUs) or contracts with customers. This was the case of Smart Land Lebanon, who reported to have signed 8 Memoranda of Understanding (MoUs) with farmers. Those MoUs are a guarantee for the innovators of business continuity by the commitment of the customers to purchase the product.

Another success factor emphasized by some innovators was the flexibility the startup organisation offers them. In fact, in such an organisation, quick adaptation to the market is easily feasible. Fast changes and integration of new markets is one of the characteristics of such an organisation. M2M Hydrotech founder in Tunisia stated that during a discussion he had with a representative from a big corporate, he was told that what he was doing with his startup model is quite innovative and that a big firm could not do the same because flexibility is more problematic in larger firms. Having flexibility and the ability to quickly adapt to the market proved to be important for innovators.

While all innovators interviewed seemed to have a clearly identified target market, as most of them already had their first customers,. one issue was the introduction into the market for early stage products. This is one issue mentioned by the representative for the Ultra Low Energy Drip Irrigation in Morocco. The project is currently still in the testing phase and they expect a difficult market integration as the product is still unknown and the market is already dominated by big industries. However, he added that an existing partnership with an irrigation manufacturer will help their product get into the market.

3. Human capital

Skills, resources, training institutions, and investment in innovation all help growth and scaling. The interviewed individuals all showcased intrinsic motivation and passion when discussing their solutions and initiatives. They all exhibited strong beliefs and personal investment in their selected technology, often situating their project as a main pillar of their careers. Some of the innovators were also surrounded by a motivating environment, especially from academic institutions. Some have spoken about university programs supporting their initial

[22] A huge network that supports entrepreneurs by connecting them and creating a platform to support them.

research or even providing them the training they needed to launch their innovation. KAUST University in Saudi Arabia and the training program Nilepreneur in Egypt were mentioned as providing support around Food and Water innovation with the proper R&D funding and infrastructure and as being an enabler for entrepreneurship.

Another important factor was the previous experience and knowledge some innovators had already gained in the field prior to launching their company. For example, the representative from Darb discussed the specialized knowledge he had around the innovation prior to launching his company. He has worked several years on solar energy projects, developing experience and expertise of what works well in the field and what does not. In addition, knowledge around how to build a proper business plan was also found to assist innovators, who gained their knowledge by practice, mentorship, and/or coaching. These insights highlight that existing experience in the field can help the innovators avoid early mistakes and reduce their risks.

Human capital relates to the skills of the innovator and his/her team members or surrounding relatives.[23] All the innovators interviewed have training and background in the area of their innovation. Some of them admitted, however, actively needing knowledge in the following fields: IT, materials, business, branding and marketing strategies, requiring them to seek outside assistance. For some of the projects, this has been reported as quite challenging. Once the innovator wants to start in a pathway where his/her skills are not sufficient, he/she has to find the appropriate team members. One innovator called this challenge "Labour Challenge". Being a foreigner in the country, he said he encountered "Labour Challenge" and had difficulties to know how to "employ people" due to language barriers and other factors The reported challenges were usually overcome either by learning while doing the tasks or by hiring an experienced local team member.

4. Policy

In the MENA region, policies in some countries have helped innovators on the path to scaleup. Governance policies seemed to be more friendly towards innovation within the WEF nexus. For example, the Desert Control representative reported that having a Food Security Ministry in the UAE helped him bring in his innovations to UAE. A policy paper by Global initiatives[24] presents an interesting comparative study of the landscape around food security in the UAE, Norway, and Singapore. In particular, the UAE government encourages innovation based on the link between innovation development and food security goal achievement. Another ministry also from the UAE that seemed to help the innovator was the Ministry of Climate Change and Environment. These ministries may be considered as incentivizing innovation on the Nexus in the UAE, possibly reflected by the high ranking of the UAE in "the ease of doing business" score mentioned in this report's introduction.

Another enabling policy was cited by a representative from Baramoda in Egypt. The incentives to shift towards organic agriculture in Egypt have pushed the farmers to change their usual ways of working. Using biofertilizers became a crucial requirement to earn the most desired Organic Agriculture Label. This designation became even more important when the European Union and the USA requested the shift to accept agricultural produce from Egypt. A report[25] explains the Egyptian position in organic agriculture and confirms the efforts done to transform agriculture. Such policies usually provide incentives through subsidies to farmers to turn to more water efficient irrigation solutions. This is the case of the Ultra Low Energy Drip Irrigation with the Green Moroccan Plan. One of

[23] Medium, The 6 domains of the Entrepreneurship Ecosystem: Part Three — Human Capital, 2017
[24] Mohammed bin Rachid Al Maktoum, Global Initiatives, Advancing Food Security in the UAE, 2018
[25] G. Siam, T. Abdelhakim. The organic agriculture in Egypt. [Research Report] CIHEAM-IAMM. 2019, pp.37.

the pillars of this initiative[26] is the National Irrigation Water Saving Program, which aims to "reduce water consumption through the conversion of surface irrigation into drip irrigation". Overall, the government subsidies and incentives for water efficient agriculture is considered as a great enabling factor for innovation in the Water Energy Food Nexus.

Another enabling policy that assisted an innovation was Research and Development (R&D) support. A representative from Red Sea Farms reported feeling incentivized to pursue R&D in Saudi Arabia and conduct testing and validation due to various policies in the country. R&D appeared to be one of the building blocks that helped several innovators develop their proof-of-concepts and introduce a successful product into the market.

Policy-related obstacles and challenges were often cited by the interviewees. According to the stage of the enterprise and the country they are established in, the innovators encountered obstacles and challenges related with governance, political situation, and material sourcing.

Bureaucracy and governance issues

One of the first issues the innovators encounter when they start is the lack of a legal framework for their enterprise, prompting several social innovators to register as a non-profit instead of a for-profit, for example in the case of Water Heroes in Palestine. Further, Eco Genius representative reported that in Sudan there were no standards, policies or decision making support for start-up companies.

What does a legal framework for startups usually provide? It should ease the administrative process and provide incentives for the investors. We noticed clearly that the level of readiness for entrepreneurship varies between the countries. In some countries, such as Tunisia and Egypt a specific legal framework has been deployed to help startups. It is worth mentioning that this legal framework was initiated under the strong support of entrepreneurs who wanted to create the proper framework for their future peers, which is detailed in the an article published by the World Economic Forum[27].

Registering a start-up in the MENA region can take weeks to complete. In comparison, the time to register a start-up in the U.S. may only be one day[28]. For countries where there is no startup regulation, registration processes can be complicated and lengthy, which appears to be a visible trend in the region.

In general, having a look at the local scores of ease of doing business[29] in the region, we could already have a sense of the challenges the entrepreneurs encounter. Those challenges were reflected in the testimonies we received in the interviews. If we look at the the ranking of the MENA countries per score of ease of doing business[30], we can see that the UAE, ranking 16, provides an environment promoting the start of businesses inside the countries whereas Tunisia, ranking 78, and Lebanon, ranking 143, have less initiatives to promote starting a business. This was clearly reflected in the testimonials of the interviewed innovators. Indeed, it seemed that starting a business and maintaining it in Tunisia or Lebanon seemed complicated whereas in the

[26] Balaghi, Riad. The Green Moroccan Plan: A Challenge strategy for a Green Economic Growth, 2014 10.13140/2.1.4024.2249.
[27] WEF, 3 striking business trends shaping startups in the Middle East, 2018
[28] Interview with Red Sea Farms representative in Saudi Arabia, 2020.
[29] Source Ease of doing business database: "The ease of doing business score captures the gap of each economy from the best regulatory performance observed on each of the indicators across all economies in the sample since 2005. An economy's ease of doing business score is reflected on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance. The ease of doing business ranking ranges from 1 to 190".
[30] World Bank Group, Comparing Business regulations in 190 countries, 2020

UAE, it was completely the opposite, details on the ranking and the framework in the countries below. We have to mention, nevertheless, some efforts from all countries to develop frameworks for entrepreneurship and startups (e.g., Startup Act in Tunisia, Startup Manifesto in Egypt).

Country	Tunisia	Egypt	Lebanon	UAE	Saudi Arabia	Jordan
Ranking Ease of doing business[31]	78th	114th	143rd	16th	62nd	75th

Table 1. Ease of doing business ranking

Bureaucracy, no single point of entry

Another issue mentioned by the innovators concerns the bureaucracy and the multiple points of entry they face when they proceed with their business. This process entails the diverse ministries they need to address their requests to. For instance, in most of the countries in the region, there is an agriculture ministry not dealing directly with energy or water resources and vice versa. When addressing issues in the Nexus, the interlinkage between the three sectors makes it impossible to address them separately.

Co-founder of Flowless, as well as innovators from Jordan and Tunisia mentioned addressing the same request sometimes to different entities and the lengthy processes this implies.

A specific issue was reported concerning the integration of foreigners into the local business. For instance, one innovator mentioned that they needed an incubation letter to start a business in Saudi Arabia as a foreigner. Overall, visible challenges especially related to lengthy processes and governance issues were common.

Political obstacles

The political landscape appears to play a major role in determining whether the entrepreneurs are able to scale up or not. This challenge has been reported from different countries in the region, several of which have recently witnessed several transforming "Revolutions". The Arab Spring initiated in Tunisia has spread to several countries in the region. Its transformative effects are different between the countries who went through those changes. In general, a Revolution landscape was perceived by the interviewees as quite unstable for launching and sustaining a business. This was specifically mentioned in Tunisia and Lebanon. For example, one innovator in Tunisia stressed the fact that the recognition he gained before the 2011 revolution was lost with the change of regime. For some of them, it meant starting over. And now, as the situation seems to settle in the country, the very frequent changes in government meant for some of the innovators that the agreements reached previously will be questioned by the new government. This instability led to sentiments of frustration and even despair from some of the innovators. Another political issue raised by the representatives of Smart Land in Lebanon, was that the sparking revolution and protests have led to insecurities and disruption of the business. In Lebanon, the current crisis and the explosion in Beirut port have also led to several challenges for the local innovators,

[31] World Bank Group, Comparing Business regulations in 190 countries, 2020

including supply chain disruption. Such an unstable environment seemed to create a lot of conflict and was generally perceived as a huge obstacle by multiple interviewees.

Another challenge innovators in the region face is related to material sourcing. According to the country they are in, the material sourcing strategy needs to be adapted to the local import/export policies and restrictions, which is extremely time intensive. In Egypt, one innovator mentioned that some specific equipment is not allowed to be imported. For the pieces of equipment he is importing, he used the services of an office for export whose task was to organise the import process and get him the materials needed in a timely manner. Customs policies were reported as an issue in Tunisia, for example, one innovator mentioned that getting some equipment out of the customs took a long time.

Water and Energy policies in some countries

Restrictive entry into the Water and Energy sectors was cited several times as a barrier to some innovators. This was the case of Biodiesel Palestine, which has faced difficulty when introducing a biofuel in Palestine as an alternative energy source. In that specific region, energy topics are quite sensitive due to the protracted conflict. A representative from Biodiesel Palestine reported that the energy sector is only managed by the state and no private sector could engage in energy source distribution. Further, she told us the factory she opened with Biodiesel was forced to close, because she didn't have a partnership with the government to distribute fuel. There seemed to be a clear gap between the use of conventional energies and renewable energies in the policies for energy. Another example we came across was brought to us from the representative from Solvillion. He mentioned issues in Jordan around policies for wastewater management and illegal discharge. He stressed that those issues needed to be tackled by a change in policies. Water policies were mentioned in Egypt as well but were cited as a motivation to create decentralized solutions to address water scarcity issues. We could assume that when it comes to Water or Energy resources, the state is more present and imposes some restrictions on how far entrepreneurs can innovate. In general, there were few policies cited by innovators that encourage research and development in some of the countries.

5. Support

Support was cited by almost all the innovators as an important brick for their innovation to scale up. Well-established support was mentioned several times across different countries is the one from incubators and accelerators. This report[32] from iPark, a jordanian Technology center published on the UNESCWA website, details several schemes of support from the incubators in the MENA region. Below is a representation of those kinds of support provided by incubators in the MENA region.

[32] iPark, Selected Business incubators in Middle East North Africa, 2013

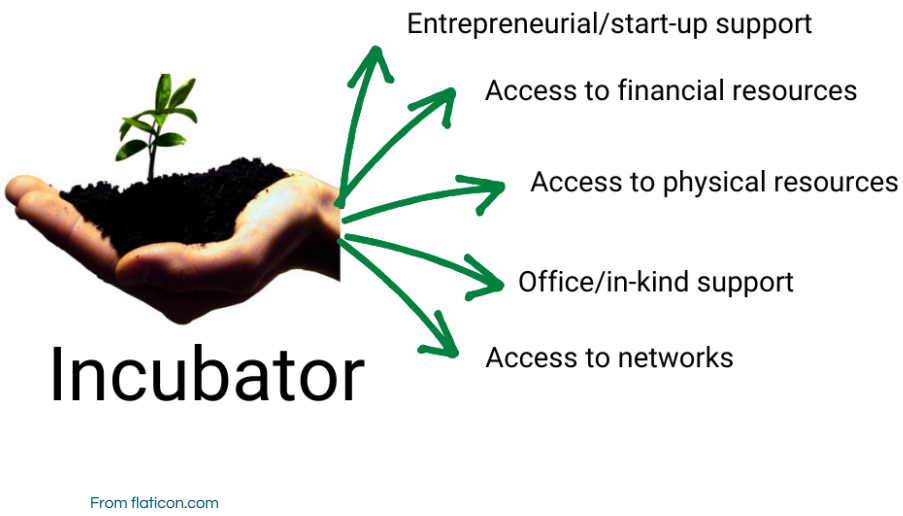

Figure 10. Incubator support in the MENA region

Most of the interviewees from Lebanon, were enrolled in a program with Berytech. They all praised the support it provides them with. From Luxeed Robotics co-founders to Ground Vertical Panel representative, they all reported the valuable support they received by signing in to the incubation programs of Berytech. Flowless representative in Palestine mentioned that Berytech could enable him to access networks with NGOs and further deploy his solution and his plans for a B2B business. Smart land Co-founders reported also being under the support of Berytech. It enabled them to find a technical advisor who provided them the most suitable technology to the idea they had to develop in Lebanon. Another incubator praised by several innovators in the region was Cewas Middle East. They all reported that the support they received was determining their further success. This was the case of the Water Heroes representative from Palestine, which received funds from Cewas Middle East to launch her Water educational game, and Innovative Green Technology Founder from Lebanon, which received support in the form of a collaboration with Cewas to assist in launching their project for wastewater treatment. The incubators seemed to play a major role in the success of the innovators.

Although no direct support from the governments was reported, only in some specific cases, such support was mentioned. This was the case of the Biofire representative, who described that his request to gather the wasted wood in the forest for his biochar was facilitated by the government who granted him the permission to use that wood. Furthermore, a representative from Baramoda, mentioned that participation in a TV show in Egypt Huna Al Shabab[33] improved the visibility of her initiative and gave her the opportunity to meet one of their soon-to-be largest investors.

None of the innovators mentioned, however, issues related with infrastructure or logistics, except some issues related with the current pandemic delaying their usual supply chain. A noticeable issue for the local support from incubators was mentioned for a specific case in Jordan. The innovator reported fearing the convertible loan schemes offered by those institutions and preferred, thus not to use their support. Concerning financial support,

[33] The Startup Scene, CALLING ALL YOUNG ENTREPRENEURS: CBC'S STARTUP INCUBATION PROGRAMME IS BACK, 2018

banks were more often mentioned as an obstacle for the innovators. They seemed to be non-flexible and were not reported as friendly towards the innovators.

6. Culture

Cultural factors and trends can influence the success or failure of entrepreneurship initiatives. For instance, due to the 2020 pandemic, cultural awareness and acceptance of improved hygiene practices has enabled the one interviewed innovator to further deploy Solvillion Wastewater treatment solutions. There is also an increasing cultural awareness and acceptance of improving local and organic produce, helping several innovators market their innovation around organic agriculture and local produce. One innovator also mentioned the impact of the openness to innovation and entrepreneurship he received in his home country. This was the case of the representative from Desert Control who reported that in Norway, his project dealing with fighting desertification was more than welcomed. His ambitions to contribute to the Great Green Wall initiative were strongly supported and promoted first in Norway, then in the UAE.

To facilitate a customer base, businesses should adapt to the local context and culture. The innovators are integrated into their community and are highly dependent on the local culture, which makes it easier for them to adapt to that context. One consideration for innovators is the misconceptions around entrepreneurship and innovation An example of this was the statement from an innovator in Jordan. He told us that the administration officials were quite confused about what processes or strategies to apply when it comes to entrepreneurship and innovation. A similar statement came from one innovator who stated that the officials were not fully used to this kind of innovative business approach. This issue seemed to translate further into a general lack of recognition. Indeed, when this kind of innovation is not well-framed or well-perceived, it seems difficult for the innovation to gain recognition. Several innovators mentioned that their product received more recognition outside the country than inside.

Another culture-related obstacle concerns the customer culture. In some cases, innovative products in the WEF nexus are targeting users in rural areas. The users in rural market segments are sometimes reluctant to purchase new, unfamiliar products. This outcome was reported by the representative of Biofire in Tunisia, who encountered difficulties getting the users to adopt biochar as they are used to charcoal and did not think another product could replace it. The same reluctance was also reported by Baramoda representative in Egypt. She mentioned farmers' initial resistance to use their Bio Fertilizer instead of using usual animal waste. In both cases, the innovators were able to address this challenge by building direct communication with the users.

A different specific cultural aspect was reported by the foreign innovators in the region. They said that the language barrier and some of the cultural differences were sometimes quite challenging to them.

COVID-19 Factors

The Covid-19 pandemic has greatly impacted business and innovation in the region. Lockdowns, initiated to slow the spread of disease, have limited access to customers and constrained business throughout the MENA region. Direct contact with customers is a crucial element of the scaleup and losing this access to customers can lead to cash flow issues. Unfortunately, to save costs, companies often layoff employees as an initial solution. The founder of Water Heroes reported that her venture's development was essentially on hold because she relied on her partnership with schools, which were closed at the time of the interview. For those in early stages of scaleup, some reported difficulties implementing test fields, e.g., Luxeed Robotics. The lockdown has also limited the free

circulation of goods and some of the innovators mentioned the travel restrictions having an impact on their business, e.g., participation in conferences, bootcamps for funding, etc. Lack of access to suppliers, issues with global supply chains, and general import and export issues have led to a variety of delays. Some innovators also mentioned delays in funding rounds or planned hackathons. A more detailed account of the impacts of the pandemic on entrepreneurship is outlined in a report by Wamda[34].

Notably, some innovators mentioned positive impacts from the pandemic, which were mainly related to the awareness around hygiene, water quality, and the need for self-sufficiency. The representative from Solivillion mentioned that following public health messaging to prevent the spread of COVID-19, people were more aware about hygiene and were thus motivated to invest in wastewater treatment and cared about water quality. Another type of awareness involved the emerging trend of self-gardening and increasing proximity to nature. For example, this has incentivized some users to turn to natural compost, as reported by the representative of Compost Baladi. One innovator mentioned that the pandemic shifted research from wastewater treatment to detecting COVID-19 in water tanks. Although the research was diverted, the innovator was still able to use their technology to address the new issue.

Health impacts and sustainability

An innovation can not be isolated from its impact. Especially in the current circumstances, while surrounded by climate change and severe health crisis, entrepreneurs need to think about their product's footprint in its context. Health impacts and sustainability are closely linked, and all innovators considered various metrics and goals for their ventures.

The first aspect emerging from most of the interviews is the link with the UN SDG 2: Zero hunger. The aim for most of the agritech innovations was to primarily introduce solutions to ensure food security in their region. By introducing innovation in the agriculture sector, innovators want to support local food production. Some promote organic food production, specifically, due to its benefits on health and the environment. For example, they encourage farmers to use new Biofertilizers instead of animal waste. Further, others make organic agriculture produce as their core business using water efficient irrigation methods.

Furthermore, innovators emphasized UN SDG 3, Good health and wellbeing, since improving food quality contributes to a healthy diet and water access leads to improved health outcomes. Similarly, there was an emphasis on SDG 6, Clean water and sanitation. For example, innovators targeted water quality (e.g., developing water filters) and wastewater treatment. Due to the nature of their initiatives, innovators contributed in various ways globally to SDG 11, Sustainable cities and communities.

We observed that the innovators overall, kept in mind their carbon footprint and aimed to consider alternative renewable energies. Solar energy was mentioned often by innovators, as it is readily available and used in the region. Water savings was also a key theme among innovators in the region, e.g., increasing awareness for efficient agriculture, water saving, and adapting the irrigation and soil treatment to the actual needs of the plants according to the weather conditions. Furthermore, innovators emphasized supporting the growth of local produce since there is a high dependency on food import in the regiont. Increasing local production of foods is expected to boost local economies and reduce reliance on foreign goods.

[34] Wamda, The impact of the Covid-19 on the entrepreneurship ecosystem, 2020

Overall, all the interviewees were aware of their contribution to sustainability but seemed sometimes less aware of their health impacts. Nevertheless, some innovators have reported potential minor safety hazards linked with their product, such as the use of plastic in components of their products, and were looking for more sustainable and affordable alternatives. Another example of a potential safety hazard was related to the installation of rooftop gardens that could lead to damage because of the additional weight. This has been assessed and then taken into consideration while developing the adequate solution to the building. Another cited safety hazard was linked with reused water. The innovators in that case clearly indicated that they instruct the users on the potential risks related with water and isolate the system in a way to avoid interaction with the user. It was clear that most of the innovators have assessed health risks and are introducing mitigations by instructing the users on those risks

Recommendations

By analysing the enabling environment in MENA for innovation in the WEF Nexus, we have identified recommendations for stakeholders in academia, government, private sector and entrepreneurship. These recommendations cover all the domains of the entrepreneurship ecosystem and point towards improved practices.

R&D support

Promoting an environment that encourages R&D will not only boost innovation but also give incentives to local innovators to thrive in their local communities and not look for support in other countries. Lack of R&D expertise and resources was identified as one of the pain points of several innovators. Although innovators were willing and eager to do R&D, they were usually discouraged by the lack of labs and research facilities. Therefore, it is recommended for stakeholders in academia to promote R&D and provide opportunities for students such that students may be encouraged to pursue careers in R&D. Furthermore, governments can provide proper R&D infrastructure through appropriate policies (e.g., the Abu Dhabi Authority for Research and development in the UAE) and funding mechanisms. In addition, governments can encourage and support the creation of technology innovation hubs and promote their active role in bringing innovation. The entrepreneurs should also invest time and efforts in R&D before they launch their product since these efforts will enable them to get validation of their products before getting into the market and thus guaranteeing the success of their project.

Ease the administrative burden

One of the first challenges the innovators face are the administrative hurdles and the multiple bureaucratic procedures. To alleviate this challenge, governments could ease the administrative process and create a unified approach towards innovation and entrepreneurship, which can encourage the innovators to start their projects in their local communities. Good practices of governance include a nexus approach at municipal and federal level, rather than three or more different entities (e.g., the UAE's food security ministry). There is ample opportunity for enabling policies that improve the simplicity of administrative processes throughout the region.

Access to finances and markets

Governments should facilitate access to finance and markets for innovators. It appears that entrepreneurs are often not receiving sufficient financial support. Increasing global access to finances could be made possible with, for instance, funding opportunities, ease of processes with banks and non-compelling re-payment methods. Governments should also encourage private investors to invest in innovative entrepreneurship projects. Private sector should also invest in entrepreneurship and provide funds to support sustainable innovation. Another important aspect is the access to markets, innovators struggle to find their way into the markets dominated by larger retailers. Governments should integrate the entrepreneurs and innovators into the landscape and should ensure their products have the same visibility when introduced to the customers. This can be achieved by easing, for instance, their partnerships with other actors of the markets by giving incentives to large retailers to engage into such agreements.

Encouraging and enabling social entrepreneurship

When looking at social innovation in the MENA region, we can see how important it is for entrepreneurs and innovators to be recognized and supported in their own countries. Governments should build a proper legal framework as a first step towards this recognition. The Startup Act in Tunisia is an attempt to provide this framework, which provides innovators fulfilling eligibility criteria first with the "Startup Label" and then with incentives to start their project, register and fully dedicate their time to it while getting paid a stipend for the first years and have tax exemption. The Startup Act also contains incentives for investors to fund startup projects and has supported around 250 projects since 2018.[35] The Government has included entrepreneurs in the decision making process when establishing this framework and this proved to be very effective. It is however worth mentioning that this program would be especially beneficial for new startups, which require the support financially and legally in order to establish their business. Such initiatives are encouraged and should be improved and introduced in other countries. Overall, introducing social innovation and recognizing it as such will help the local entrepreneurs and encourage them to stay in their countries.

International trade policies

Policies can be designed to ease the international trade procedures for entrepreneurs. Governments should consider making the procedures accessible and simpler to entrepreneurs while setting policies for international trade. The innovators, in some countries, have to be aware of the challenges related with material sourcing especially when it comes to importing materials. A good example from Egypt around "Import offices" whose services are very useful in this case. Indeed, they offered a service consisting in managing the full import process from order to shipping, customs processes and providing the needed outsourced materials to the entrepreneurs at the end. A first recommendation to the entrepreneurs is to become informed about the processes of importing materials while planning their material sourcing strategy. Governments and decision makers should ensure, at policy level, that the innovators get simple access to materials when they plan to import them through easier and leaner processes.

Raise awareness around sustainability and culture of entrepreneurship

Governments and communities can act as strong entities to recognize innovation and promote it. This can be accomplished first by raising awareness around the importance of entrepreneurship. Importantly, although entrepreneurship is not the typical expected career path, it should be made visible as a successful path inside the communities. A shift of mindsets towards the potential success and the huge added value of entrepreneurship would be really impactful. This requires governments to promote education around entrepreneurship and give it the visibility it needs inside the communities through different means (e.g., introduce it as a successful career path to students and encourage them to engage on this path). Improving public opinion regarding the value of entrepreneurship and sustainability is crucial for the development of future generations. Governments should properly introduce sustainability to communities by encouraging simple sustainable practices and showing their benefits. A human-centered approach to introduce those concepts in a simple, easy-to-understand way could be very helpful. The innovators should be aware about the impact of their projects and products as it will help them make informed design decisions. They should also consider the impact of their product on the environment they introduce it to. This impact also includes health consequences of a product, which need to be evaluated further.

[35] https://www.startupact.tn/rapport-annuel/#p=18

As entrepreneurs, they should consider the effects they will produce on the health and on the environment, in this context, they should ensure a positive impact on both health and environment.

Conclusion and future work

This research collaboration has led to a number of recommendations based on insights collected during interviews with 27 practitioners: R&D should be promoted by policy-makers and universities to support innovation, bureaucracy and administrative burdens should be made leaner and friendlier towards innovators, improved access to finances and markets should be made possible for entrepreneurs, social innovation should be encouraged and innovators properly recognized in their home countries, proper education and awareness about sustainability issues should be promoted and spread in the region, and policies supporting entrepreneurship should be developed and further implemented.

Limitations

Our approach to investigating innovations in the water-energy-nexus included expert interviews, however, we acknowledge that this approach may limit our findings and recommendations. For example, the sample of experts interviewed is considered as not fully comprehensive or representative (e.g., various countries of the region not covered, gender distribution, role distribution, organization representation), and potential respondent bias towards showcasing success (we can infer that some of those who did not respond had less successful endeavours and opted out of the study leading to a positive bias in the reporting of experiences).

Opportunities for future research

Future work should include a more representative sample of interviewed experts, e.g., including a broader sample covering all the countries in the region and having representative numbers of experts from each country. Research could also include more developed organizations which have already scaled, emphasizing success factors that could be promoted for future innovators. Region-specific enablers can be further explored to draw lessons learned and advise countries to adopt similar successful approaches, e.g., legal frameworks for start-ups. Further, there are various types of business models, each with its advantages and downsides, which can be further investigated. Design thinking approaches to innovation can also be further explored in the region. Government role is crucial to innovation, further investigating the ways where governments can support entrepreneurs is recommended. Finances are also very important to entrepreneurs and investigating the different funding sources during the different stages of development. Much work is still needed around enabling environments for innovation in the water energy food nexus in the MENA region.

Appendix: List of Innovators and Networks

Logo	Innovation	Description
CHAHTECH More crop with less drop	Underground buried diffuser	Representative description: “The buried diffuser is for irrigation and water injection.Water is delivered 50cm below the soil.It uses 70% less water than drip irrigation”
ICARDA Science for resilient livelihoods in dry areas	Ultra low energy drip irrigation	Representative description: “It reduces the pumping power of irrigation systems by up to 50%, and can lower the cost of solar-powered drip systems by up to 40%”
	Tulua	Representative description: “We create and manage aquaponic systems that create jobs, empower communities, regenerate the earth, and transform lives.”
flowless	Flowless	Representative description: “Providing smart solutions to help utility companies automatically manage water resources for sustainable water and resilient communities.”
DESERT CONTROL	Desert Control	Representative description: “Restore and protect land from soil degradation. Liquid NanoClay is a compound that enables sandy soil to retain water and nutrients.”
RED SEA FARMS	Red Sea Farms	Representative description: “Red Sea Farms is focused on using the abundant resources of saltwater and solar energy to empower local, sustainable agriculture.”
biofire	Biofire	Representative description: “At Biofire we collect and transform agroforestry waste into solid biofuel for cooking and heating needs.”
SMART LAND	Smart land	Representative description: “SMART land is a smart irrigation and fertigation system that irrigates according to crops’ needs and fertigate in an easy and accurate way.”

SMART FARM سانيتك بين يديك	Smart farm	Representative description: “A platform that manages irrigation in real time based on algorithms simulating water requirements by collecting data.”
GROUND Vertical Farming	Ground Vertical panel	Representative description: “We help agri-businesses optimize their agricultural space and achieve the highest yield at the best quality, all the while reducing costs”
BLUE FILTER	Blue Filter	Representative description: “Treatment of water from pollutants (Salinity, Nitrates, and chloride) by green methods eco - friendly”
BIODIESEL Biodiesel Factory For Palestine	Biodiesel Palestine	Representative description: “Producing biodiesel from used cooking oils to be used for car running and heating and cooling engine instead of fossil fuel”
	Water Heroes	Representative description: “Emerging ed-tech start-up providing tailored environmental education and awareness to school children by utilizing the power of technology.”
M2M Group IoT Project Facilitator	M2M Hydrotec	Hydrotec offers its customers Intelligent irrigation solutions. HydroTec's irrigation control systems aim to reduce energy consumption for irrigation and reduce the farmer's carbon footprint.
Compost Baladi Your waste management partner	Compost Baladi	Representative description: “Smart bin that allows for improved biowaste collection through controlled access, on-site volume reduction and contamination traceability”
SOLVILLION Infinite Engineering Solutions	Solvillion	The decentralized wastewater treatment system (DWWS) is developed as an onsite system to recycle wastewater and reuse it for agriculture. The customized treatment system targets rural households, which do not have access to the sewer system
	Wastewater Treatment	Innovative water treatment method using cactus extract
برمودة Baramoda	Baramoda	From website: “Baramoda is the first agri-tech start-up in the Middle East and Africa specialized in sustainable agricultural innovations, develops biofertilizers from agri-waste based on the land , crops needs”

	Darb	From website: “DARB specializes in solar system cleaning solutions. Solar panels in Jordan and the region face large dust accumulation, which reduces the output power of the solar systems significantly. “
	Luxeed solutions	Representative description: “At LUXEED Robotics, we are building an agricultural robot that uses a laser to kill weeds in onion fields, without the use of herbicides.”
	Optimoo	Representative description: “Opti-moo is a smart portable device that can be connected to water pipelines and water meters. Its aim is to help agriculture-sector’s users utilizing their water resources more efficiently at an affordable cost. It is available in two editions with its user-friendly interface and cloud services accessibility. “
	GBeetle	Representative description: “We help farmers adapt to the consequences of climate change, rationalize their water consumption and protect their crops through technology”
	El Moustakbal SDGs	Representative description: “1- For profit: new platform to sell specialised media content around SDGs 2-Nonprofit by conducting campaign and regular media reports.”
	Eco Genius	Representative description: “We facilitate social centered environmental solutions for communities and children.”
	QG enviro	Representative description: ”QG Enviro is a local organization from the Lecce province in Italy, innovating sustainability and environmental education”

	Difaf	Representative description during interview: “environmental consulting company with a multidisciplinary team (core group like the motor and then network of consultants from different fields - hydrology, ag, engineering, water resources management, policy)”
	Innovating Green Technology (IGT)	Representative description: “IGT develops revolutionary green energy systems that improve the efficiency of various sectors as agriculture and water treatment.”

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	MedYWat	Representative description: “The Mediterranean Youth for Water (MedYWat) is a network of young water professionals that strives to engage, connect and impact the youth in the Mediterranean region”

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