

Landscape Analysis for Creating WEF-Nexus Driven Open Living Labs in Mediterranean Countries

Original
Article

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ABSTRACT

WEF nexus refers to using natural resources to address water, energy, and food security in the context of social and economic needs. The demand for WEF resources in Mediterranean countries increases with the ongoing growth in population and transition toward more prosperous economies. In this regard, the involvement of all nexus ecosystem actors in innovation and policy-making processes gained more attention over time. In this context, a methodological approach, such as living labs, emerged as a platform to achieve inclusivity and participation in addressing WEFN challenges in Mediterranean countries. Due to the concept's relative newness, this paper explores the implementability of WEF living labs in Mediterranean countries. In this line, the paper seeks to identify the needs and potential domains of support for WEF living labs by investigating the external landscape of the WEF ecosystem in 7 MED countries: Egypt, Spain, Italy, Tunisia, Jordan, Lebanon and Cyprus. This investigation aims to build an understanding of the environmental context through extended PESTEL analysis and explore the strengths, weaknesses, opportunities and threats as well as necessary actions to be taken by conducting extended SWOT and SOR analyses per each involved country. The findings show the MED countries share many similarities regarding the external and internal context of creating WEF living labs. MED countries could pursue various innovative system improvements targeting WEF challenges. However, many challenges still exist in the current WEF nexus environment, particularly on the WEF-innovation policy framework level and the difficulty of achieving alignment and orchestration of WEF ecosystem stakeholders. These results ensure the significant role the WEF living labs approach could play in addressing WEF challenges in MED countries.

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INTRODUCTION

Climate Change, WEF challenges and Living Labs

Water, energy and food (WEF) are the most important primary resources supporting the development of human society. 10 out of the 17 Sustainable Development Goals SDGs endorsed by the United Nations are related to the three sectors (Bieber et al., 2018). Managing the three sectors in an integrated way is essential due to their inseparable link (Okonkwo et al., 2023). Thus, the WEF nexus emerged to emphasize the interconnection between water, energy, and food systems and the challenges that arise from managing these systems in a sustainable and integrated manner (Hogeboom et al., 2021). The NEXUS concept seeks to optimize such interlinked relations among the three sectors and improve the overall efficiency's usage of resources (Okonkwo et al., 2023). Water, particularly for irrigation, is recognized as the cornerstone in framing the WFE nexus (Cai et al., 2018, Liu et al., 2019). Water is an input for producing agricultural goods; energy is needed to produce and distribute water and food. As the most

significant water consumer, irrigation accounts for about 70% of global water withdrawal and is responsible for 40% of total grain production (Ringer et al., 2013).

The Mediterranean region (MED) is particularly vulnerable to the impacts of climate change, including increased temperatures, reduced rainfall, and more frequent droughts (IPCC, 2022). These countries face unique challenges due to their arid and semi-arid climates, increasing population and tourism pressures, and vulnerability to climate change impacts such as water scarcity and drought (Bazzana et al., 2023). This can have significant implications for the WEF nexus, requiring new strategies and policies to manage these interlinked systems in a sustainable and integrated manner (Radwan and Sakr 2018, Ramadan, Radwan et al. 2019).

Some of the specific challenges faced by Mediterranean countries in managing the WEF nexus include:

1. Water scarcity: Water resources are limited in many Mediterranean countries, making it challenging to meet the increasing demands of agriculture, industry,

and tourism. This can lead to conflicts between different sectors and users of water resources. Tunisia, for instance, lays under the water scarcity threshold set by the Food and Agriculture Organisation of the United Nations (*Bazzana et al., 2023*). In Spain, 11 out of the 15 river basin districts are under water stress due to the increasing demand for agriculture (*Ali, et al., 2022*). In Egypt, the flow of the Nile river is under pressure due to the continuous building of dams in the Nile basin area.

2. Energy security: Mediterranean countries, except for Egypt, heavily depend on imported fossil fuels to meet their energy needs, which can be costly and subject to price volatility. Increasing renewable energy sources such as solar and wind can help reduce dependence on fossil fuels and enhance energy security.

3. Food security: Agriculture is a crucial sector in many Mediterranean countries but is often vulnerable to water scarcity and climate change impacts. Improving water use efficiency in agriculture and promoting sustainable land management practices can help enhance food security in the region (*Tanyeri-Abur, 2015*).

Addressing the WEF Nexus' challenges cannot be undertaken by one organization or nation; it requires collective efforts at national, regional, or international levels (*Boersma et al., 2022*). In this regard, the "Living Labs" approach was established in Europe to bring all stakeholders together on one specific problem. The approach was re-interpreted based on the advancement in open and user-centred innovation, and the EU policy support gave the movement a head start. Generally, the construct of "living labs" is interchangeably used with "citizen innovation labs," "GovLab," "Policy Sandbox," and "Urban Innovation Labs" in both mainstream and academic discourse. Living labs could be defined as "spatial and methodological infrastructures in which users enter into an open innovation process together with central stakeholders of the value chain in semi-realistic environments. To chart to main constituents of living labs, *Leminen and Westerlund, (2016)* underscored that literature variously portrays living labs as an approach, method, context, environment, experimentation, network, business model, and intermediary. They highlight key characteristics of living labs as i) real-life environments; (ii) stakeholders; (iii) activities; (iv) business models and networks; (v) methods, tools, and approaches; (vi) innovation outcomes; (vii) challenges; and (viii) sustainability. For instance, Urban Living Labs (ULLs) are widely believed to provide a safe environment for experimentation, co-creation, and evaluation of innovations in real-life settings (*Afacan, 2023*). In the innovation policy domain, living labs constitute an essential instrument in operationalizing pre-commercial procurement (PCP), public procurement of innovation (PPI), and Strategic Procurement (*Fuglsang and Hansen 2022*). Thus, the notion of "Living Labs" finds increasing adoption by Smart City Governments (*Nguyen, Marques, and Benneworth 2022*) as an institutional instrument that achieves the following goals

1. Space for participation and co-creation by citizens in cities
2. Lowered risk for trials of innovative urban solutions not possible in traditional channels of procurement

Research Context

Nex-Labs Project

This paper is a part of the EU-funded project called NEX-LABS. NEX-LABS targeted territories, characterized by water scarcity/irregular rainfall/population distribution, reflect agriculture as the largest user of water (70-90%), while future global warming projections ($\approx 2^{\circ}\text{C}$) involve summer precipitation (-10/-30%) threatening water availability (-2/-15%) and agricultural productivity (-12/-40%). The latent conflict between energy efficiency ($\approx 60\%$) and water production also increases the energy footprint/m³ of water used to produce food. The predicted future water/Energy/Food (WEF) shortfalls require a NEXUS approach. In this context, NEX-LABS aims to support the implementation of clean technologies for a sustainable and resilient increase of agri-food sector production based on more efficient use of energy (renewable/solar solutions) and water (wastewater treatment, water harvesting or reuse solutions) in MPC region thanks to the contributions of ICT such as blockchain technology, Internet of the Things (IoT), Artificial Intelligence (AI), Machine Learning and Big Data. Henceforth, adopting the living labs' approach, the NEX-LABS project came with a primary objective: establishing two cross-border living labs around the WFE challenges in the Mediterranean countries i.e., Nexus Driven Open Living Labs (hereinafter referred as NDOLL). NDOLLs in European-Mediterranean Partnering Countries (EU-MPC) will serve as linking hubs for scientific-industry/business communities and society to interact and innovate by matching innovation demands and offering technological solutions for such issues. This paper covers one activity conducted to examine the landscape for NDOLL through identifying and validating the external and internal context in Egypt for better planning of implementing policies to support the technology transfer and commercialization of research results (*Ghinolfi, El Baz et al. 2014, Radwan 2018*).

Research Method

Establishing living Labs around a specific WEF nexus challenge is a strategic action that requires diverse and extensive information regarding internal and external environmental circumstances. This always includes running a strategic analysis of potential opportunities and threats from the external environment. Based on that analysis, organizations can develop the best possible scenarios that fit the surrounding conditions, considering the internal organizational strengths and weaknesses. We follow a mixed-method approach in three phases: exploratory document analysis and qualitative and quantitative primary data collection steps (Figure 1).

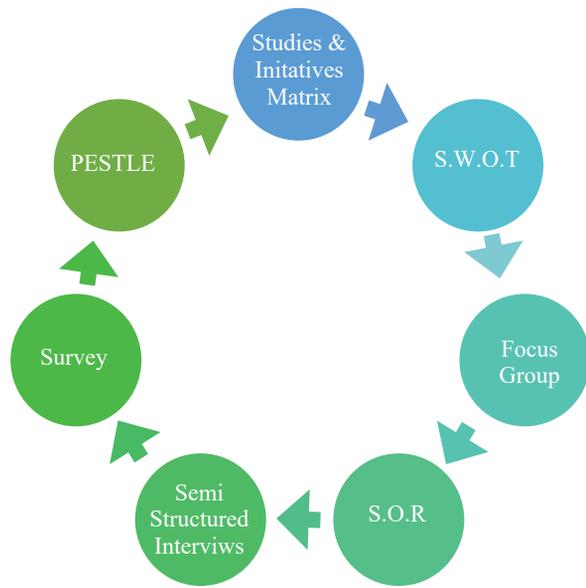


Fig.1: Research Method

Phase 1: SWOT Analysis

SWOT analysis (or SWOT matrix) is a strategic planning technique used to help organizations to identify strengths, weaknesses, opportunities, and threats related to project planning. The design, development and implement a SWOT analysis was carried out to identify, weigh and examine external (Opportunities & Threats) and internal (Strengths & Weaknesses) factors that influence NDOLLS’ implementation and NEXUS stakeholder’s ecosystem. Accordingly, identifying the best practices when facing NEXUS challenges to be proposed for optimal support to NEXUS-ecosystem’s stakeholders. The gathered information will support the creation of a NEXUS Joint Action Plan as a base for SWOT analysis, a set of topics has been advised through a detailed guideline to collect the following information.

- Current Inclusive growth support available in the country for the primary target group
- General characteristics of the inclusive growth services & practices identified
- Trends of the inclusive innovation process and the practices identified

Information has been extracted from the most promising studies and initiatives matrix. In this regard, each country has identified 20 different publications such as Case studies, initiatives, Projects, White papers, and PhD theses, leading to a collective of almost 90 studies. These identified practices gave a broader and deeper perspective of the local WEF-NEXUS ecosystems in the EU-MPC regions.

Phase 2: Exploratory SOR Analysis

Based on the findings of the first phase, an exploratory research study was performed using focus group discussion with WEF ecosystem experts to validate and prioritize

identified aspects of the SWOT analysis and perform the SOR analysis. The SOR acronym means “strengths, opportunities, and roadblocks,” derived from the SWOT components (strengths, weaknesses, opportunities, and threats). The SOR Analysis is a hybrid of SWOT analysis usually used to assess the business positioning of an organization. SOR examines internal strengths (S) and external opportunities (O), and it combines internal weaknesses (W) with external threats (T) to formulate roadblocks (R).

Phase three: PESTEL Analysis

Finally, a mix of semi-structured interviews and a survey has been conducted to conduct a comprehensive PESTEL analysis. PESTLE is a mnemonic which, in its expanded form, denotes P for Political, E for Economic, S for Social, T for Technological, L for Legal, and E for Environmental. It describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. It is part of an external analysis when conducting a strategic analysis and gives an overview of the different macro-environmental factors to consider. It is a strategic tool for understanding market growth or decline, business position, potential and direction for operations. All these steps allowed us to iterate while we go further in our activities and to transfer the outcomes and the recommendations into the action plan. This will later explain WEF’s ecosystem’s needs and delineate business support services based on Open Innovation Penta Helix models for more significant innovation.

RESEARCH ANALYSES

SWOT and SOR

A separate extended SWOT and Sperate ROR analysis has been conducted per each country, and the results are presented in (Appendix A)

PESTEL Analysis

To run a PESTEL analysis, a quantitative methodology was implemented using a structured survey and interviews with a handful of experts. The survey included twenty statements to be answered on a Likert scale from 1-5 as follows:

1	2	3	4	5
Strongly disagree	disagree	Neutral	Agree	Strongly agree

The survey would tap into the main PESTEL components, namely external environmental factors (i.e., Political, Economic, Social, Technological, Environmental and Legal) while considering the primary outcomes of the SWOT and SOR analysis. While SWOT and SOR analyses were on the innovation systems level, the PESTEL analysis survey was designed to cover innovation system components regarding the WEF challenges. Therefore, the survey also covered other ecosystem aspects such as WFE national strategy, partnership, human resources, clusters and collaboration, technology, and infrastructure. The analysis relied on 65 responses from ecosystem experts.

Political Factors

In this survey, we included some enquiries covering the political environment related to resolving the WFE challenges and establishing an NDOLL.

National Strategy

(Figure 2) below shows that around 36 % (33% + 3%) of the respondents agree that there is a comprehensive strategy to deal with WFE challenges, yet 39% (30% + 9%) disagree.

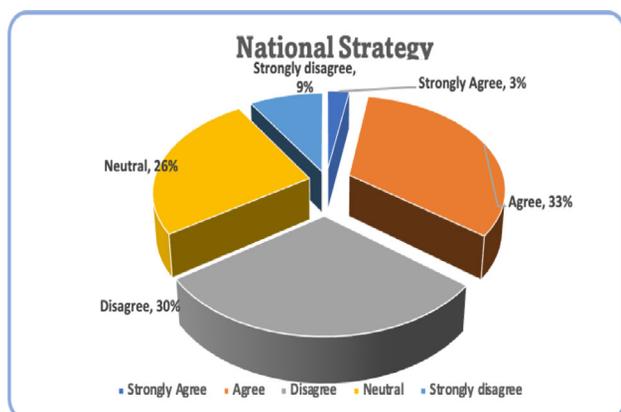


Fig. 2: Existence of National Strategy to deal with WFE challenges

Government Human Resources

About the skills, 36% (30% + 6%) of the respondents agree that the government has enough qualified human resources to manage WFE challenges, while 34% (25% + 9%) disagree (Figure 3).

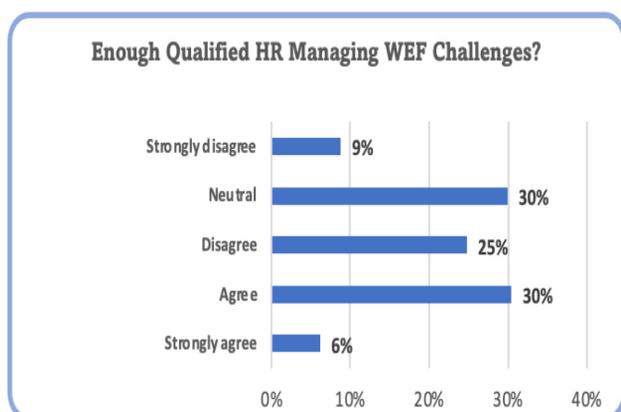


Fig. 3: government's human resources

Ecosystem Partnership

(Figure 4) shows that 30% of the respondents could not agree or disagree with whether the current political context support building NDOLLs in MED countries. However, the second-largest proportion, 47% of the surveyed sample, agree that the current political context supports building NDOLL, and 22% (16% + 6) disagree with that.

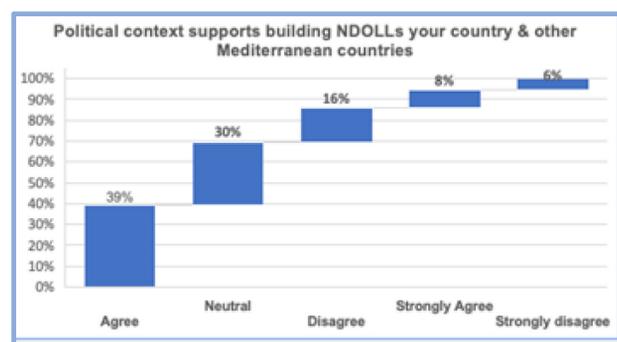


Fig. 4: Political context supports building NDOLLs

Below as per (Figure 5), is an attempt to remove the “neutral count from the mix and although it confirms the above observations where the political context supports NDOLLs with a percentage of 68% (56% = 12%); we cannot guarantee that if taken the neutral option what would be the respondents’ opinion with or against?

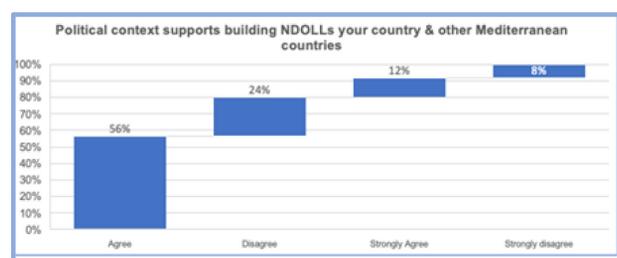


Fig. 5: Political context supports building NDOLLs - Neutral Excluded

Overall, results indicate that the government does not have a solid, comprehensive strategy to deal with the WFE challenges and does not have enough qualified resources to manage the problem.

Economic Factors

In an attempt to comprehend the economic and environmental dynamics of WFE Nexus, the survey included four statements to shed light on some aspects that might influence establishing NDOLLs.

Overall economic situation

Results strongly show that economic development is hardly getting better over time. In this regard, 41% of the respondents disagree and strongly disagree (25% + 16%) that MED countries are making economic progress over time (Figure 6)

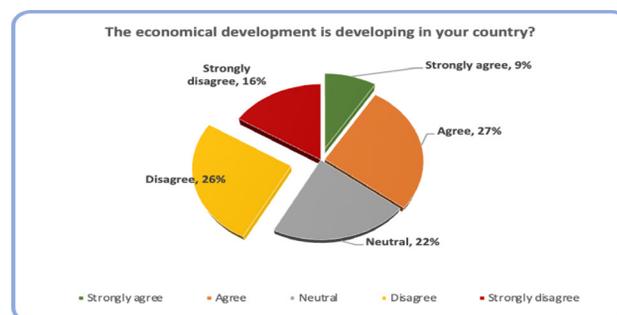


Fig. 6: Overall economic situation

Investment in R&D

Trying to get a clear view regarding the investment in R&D, we can see in (Figure 7) that the most significant proportion of the respondents, 47% (39% + 8%), agree that private and public sectors invest in R&D to solve the WFE challenges.

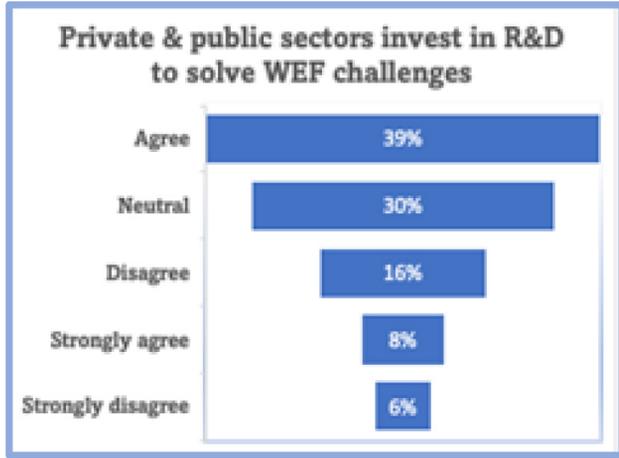


Fig. 7: Private and public sectors are investing in R&D

Social Factors

To get a direction of the social aspects of WFE challenges, the survey tackled four issues about WEF challenges' public awareness and the public-private partnership. The survey also enquired about the culture of collaboration with immigrant talents, and the results are presented in (Table 1) below.

- Collaboration with immigrated talents at solving WFE
- Public-Private Partnership is a well-known concept
- The culture of cooperation and NDOLLs
- Public awareness of WFE challenges.

Table 1: Social Aspects related to WFE and NDOLLs

SOCIAL ASPECTS RELATED TO WFE & NDOLLs				
INPUTS	Collaboration with immigrated talented helps resolve WEF challenges	National Social Awareness of PPP Concept	The collaboration culture supports building NDOLLs	Public awareness regarding the WEF challenges
Strongly Agree	14%	4%	4%	8%
Agree	62%	46%	27%	34%
Disagree	1%	19%	19%	23%
Neutral	21%	29%	47%	32%
Strongly disagree	1%	3%	4%	3%

The social context seems to be supportive of solving the WFE challenges and building the NDOLLs. In this regard, 76 % (14% + 62%) of the Respondents agree that

collaboration with immigrated talents would be highly effective in solving the WFE problems. While there is a satisfactory level of awareness regarding the PPP as a concept, 50% agree, the overall public awareness regarding the WFE challenges could use a boost as the percentage of agreement is 42% (8% + 34%) agreed on that.

Technological Factors

To capture some aspects of the WFE technological innovation system, the survey addressed four statements around the level of ICT progress, knowledge creation, collaboration and technology transfer between industry and research institutions, and the expected role of NDOLLs in enhancing innovation in the WFE sector. (Table 2) below summarizes respondents' replies regarding the technological context of WFE and NDOLLs

- ICT and technological progress in your country facilitate solving WFE challenges.
- Universities and scientific research generating valuable knowledge to solve WFE challenges?
- Is there a lack of cooperation between research and industry in facing WFE challenges?
- NDOLLs be crucial in enhancing the overall innovativeness level related to WFE challenges.

Table 2: Technological Aspects related to WFE and NDOLL

TECHNOLOGICAL ASPECTS RELATED TO WFE & NDOLLs				
INPUTS	ICT and tech. development helps solve WEF challenges	NDOLLs would enhance innovation related to WEF challenges	There's a lack of cooperation between Industry & Research	Universities & research centres generate knowledge to solve WEF challenges
Strongly Agree	7%	11%	24%	16%
Agree	47%	68%	43%	59%
Disagree	14%	1%	13%	6%
Neutral	30%	19%	20%	18%
Strongly disagree	2%	1%	0%	1%

Results demonstrate that the technological development is promising in support of solving WFE challenges 54% (7% + 47%) agree it would. Accordingly, 79% (11% + 68%) of the respondents agree that NDOLLs would play a crucial role in enhancing the overall level of innovation related to WFE challenges. However, Respondents alerted that there is a lack of collaboration and knowledge transfer between research institutions and the industry 67% (24% + 43%) agreed to that, which could be seen as an opportunity for improvement to be considered. Lastly, 75% (16% + 59%) of the Respondents agree that ICT advances knowledge creation at the universities and research institutes; respectively, it is adequate to facilitate solving WFE challenges

Environmental Factors

Moving forward with the PESTEL schema, the public environmental awareness of WFE challenges and related global crises such as (climate change, global warming and its outcomes, be it drought, hurricanes, wildfires, air pollution, and the ultimate output of hunger, poverty, and collective health decline) those were evaluated to get the respondents. Results in (Figure 8) indicate that there is public awareness of the problem 42% of respondents agreed that public awareness is high.

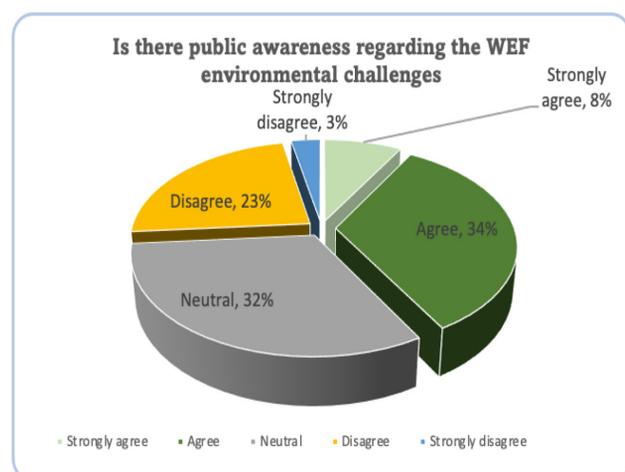


Fig. 8: Public awareness regarding the WFE challenges (e.g., climate changes, global warming, etc.)

Legal Factors

This is an attempt to understand the legal ramifications and hurdles related to WFE challenges and how this environment would eventually represent an “Opportunity” or a “Threat” to NDOLLs’ activities; the survey incorporates three enquiries around this subject:

- The existence of legislation/laws that address solving WFE-related challenges
- Enforcement of the currently available policy mix related to WFE challenges
- Legal environment, e.g., IP regiment protects innovations in WFE sectors?

Table 3: Legal aspects of WFE NEXUS

LEGAL ASPECTS RELATED TO WFE & NDOLLs			
INPUTS	Various legislations/laws are solving WFE challenges	The current policy mix addressing WFE challenges is enforced	Does the legal environment protect innovation in WFE?
Strongly Agree	3%	3%	5%
Agree	34%	19%	31%
Disagree	25%	23%	13%
Neutral	35%	50%	47%
Strongly disagree	4%	6%	4%

In General, the results in (Table 3) demonstrate that the legal environment of WFE-Nexus is not promising and represents some Threats to solving the WFE challenges. 29% disagree that enough legislations exist to address the problem, but with 35% of the samples as “neutral”, the situation doesn’t favour it. On the other hand, 29% disagreed that the currently available policy mix is enforced, 50% were neutral, and only 22% agreed. In reference to the legal environment and if it helps protect innovation in WEF, 36% agree that it does, 47% are neutral, and 17% disagree it does.

RESULTS AND DISCUSSION

The findings show the MED countries share many similarities regarding the external and internal context of creating WEF living labs. MED countries could pursue various innovative system improvements targeting WEF challenges, such as allocating additional finance for creative solutions, developing national and regional networks, international collaborations, improving endogenous knowledge bases, and mobilizing researchers in the diaspora. However, many challenges still exist in the current WEF nexus environment. These challenges include the lack of coordination and the mismatch between governmental strategies, insufficient public-private partnership, human resources technical skills gap, and ineffective transformation of scientific outputs into innovation. Although MED countries also made progress in changing the institutional framework for innovation, such as the SMEs innovation Law 2017, financial inclusion in Tunisia, and education reformation in Cyprus, the WEF-innovation policy framework is still underdeveloped. In this regard, countries share a critical need for evidence-based strategy and actions. There are also matches in the dire need to Transfer research results into economic value and the fragmented activities done in the region. The results show that WEF-Living Lab would help policymakers in tackling WEF challenges by providing a space and methodology to bring all WEF ecosystem actors earlier in the innovation process, to define a clear directionality of high-level strategies, develop innovative solutions and test them in a real-life context before the actual implementation on a large scale. The results also indicate that LLs may allow better use of respondents’ feedback, implying an ameliorated incentive system and better incorporation of developed products/technologies. LLs will also address the lack of practical evaluation and monitoring schemes and the economic and technological impact. Building this living lab should follow strict principles of openness, inclusivity, participation, experimentality and scalability to ensure future success.

RECOMMENDATIONS FOR PRACTITIONERS

Living labs are considered a relatively new concept that can generate many synergies activities between different actors in the ecosystem and can be extended beyond regions and even countries. Our analysis portrayed the critical need for implementing NDOLLs in MED

countries. As a new ecosystem actor, NDOLL should work closely with the MED governmental representatives to develop comprehensive evidence based-strategy targeting WEF challenges on the national level. NDOLLs should also improve human resources skills for those working in governmental bodies that lead the coordination and implementation of the WEFN strategy. A second domain of engagement of NDOLLs is to come up with various instruments to leverage the utilization of researchers, innovators and entrepreneurs in the diaspora and changing domestic policies to attract more talents to engage in tackling WEF challenges. In this regard, NDOLL has to provide a space for collaboration and promote a culture of cooperation between WEF ecosystem actors. The recent advancements in the ICT sector in MED countries should be deployed for increasing knowledge transfer, information availability, digital innovation, connected networks and clusters. While the current innovation ecosystem in MED countries focuses on entrepreneurship activities, NDOLL has to advocate for more industrial policies supporting established SMEs who could play an essential role in solving WEF challenges, whoever they face a different bundle of innovation obstacles, such as technological transformation, low-skilled labour, the fixed mentality of the first generation of the owner, as well as technological and technical barriers to catching up.

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CONFLICT OF INTERESTS

There are no conflicts of interest.

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الملخص العربي

تحليل بيئة الابتكار في دول البحر الأبيض المتوسط بهدف انشاء مختبرات ابتكار مفتوحة لمعالجة مشكلات رابطة المياه والطاقة والغذاء

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يشير مفهوم تداخل علوم ومجالات المياه والطاقة والغذاء إلى ضرورة استخدام الموارد الطبيعية لمعالجة التحديات الخاصة بقطاعات المياه والطاقة والغذاء معاً، نظراً للتأثير المتبادل بينها، وذلك في سياق الاحتياجات الاجتماعية والاقتصادية. ويزداد الطلب على موارد في القطاعات الثلاثة في الدول البحر الأبيض المتوسط مع النمو المستمر في السكان والانتقال نحو اقتصادات أكثر ازدهاراً. في هذا الصدد، يتصاعد اهتمام جميع الجهات المعنية بقطاعات المياه والطاقة والغذاء بالمشاركة في عمليات الابتكار وصنع السياسات اللازمة لمعالجة مشكلات هذه القطاعات معاً. في هذا السياق، ظهر مدخل مختبرات الابتكار المفتوحة كمنصة لتحقيق الشمولية، والمشاركة الفعالة في مواجهة تحديات المياه والطاقة والغذاء في دول البحر الأبيض المتوسط. ونظراً للحدثة النسبية لهذا المدخل على منظومة الابتكار في هذه الدول، يستكشف هذا البحث مدى قابلية تنفيذ فكرة انشاء مختبرات الابتكار المفتوحة لدعم جهود حل المشكلات الخاصة بالمياه والطاقة والغذاء WEF-Nexus Open Living Labs WEF-NDoLLs، أخذاً في الاعتبار السياقات الاجتماعية والاقتصادية والسياسية في دول البحر الأبيض المتوسط. وفي هذا السياق، يسعى البحث إلى تحديد أنواع الدعم المطلوب وكذلك المجالات التي يجب أن تنشط فيها مختبرات الابتكار المفتوحة، وذلك من خلال تحليل بيئة الابتكار في سبع دول في البحر الأبيض المتوسط وهي: مصر، إسبانيا، إيطاليا، تونس، الأردن، لبنان، وقبرص. يهدف هذا البحث إلى بناء فهم للسياق البيئي من خلال تحليل المتغيرات السياسية والاقتصادية والاجتماعية والتكنولوجية والقانونية من خلال تحليل PESTEL، واستكشاف نقاط القوة والضعف والفرص والتحديات، وكذلك تحديد الإجراءات الضرورية التي يجب اتخاذها من خلال إجراء تحليل SWOT و SOR لكل دولة مشاركة. تظهر النتائج أن دول البحر الأبيض المتوسط تتشابه في العديد من في العديدي من المتغيرات التي تشكل بيئة منظومة الابتكار المحيطة بإنشاء مختبرات الابتكار المفتوحة. وعلى الرغم من التحسن الملحوظ في بيئة الابتكار في دول البحر الأبيض، لا تزال هناك تحديات كثيرة في بيئة الابتكار الخاصة برابطة المياه والطاقة والغذاء، خاصة على مستوى إطار السياسات الداعمة للابتكار، وصعوبة تحقيق التنسيق الفعال بين أصحاب المصلحة في منظومة الابتكار الخاصة بالقطاعات الثلاثة، مما يؤكد على الدور الهام التي قد تقوم به مختبرات الابتكار المفتوحة في معالجة مشكلات رابطة المياه والطاقة والغذاء في الدول محل الدراسة.

Appendix A. SWOT & SOR analyses per each partnering country

Egypt

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Availability of good research and knowledge base - Well-educated human capital - Good scientific system infrastructure - Funding and partnerships - Evolving national recognitions of the negative impacts of climate changes 	<ul style="list-style-type: none"> - Human resources system failures - Less infrastructure usage and discontinuous upgrading of the facilities - Poor private R&D infrastructure - Fragmentary funding system - Unclear strategic-technological directionality - Absent of innovation policy coordination - Challenges in policy implementation and innovation diffusion
Opportunities	Threats
<ul style="list-style-type: none"> - The potential positive impact of well-trained experts and better influence of accumulated knowledge base - Application of nation-span WEF approach - Utilization of international knowledge and financial resources - Growing availability of financial resources - Toward more consolidating national innovation system through institutional rearrangements and political support 	<ul style="list-style-type: none"> - Misuse and loss of qualified human resources - Continuous research system structural problem - Disability to internationally catch up - Failure in innovation system collaboration and alignment - Innovation policy failure

SOR Analysis Recommendations

S vs O			
SO1. Spreading awareness of the emerging new private research centres (which enables higher accessibility and frees the market from the restrictive bureaucracy) and optimizing the IPR offices spread across most Egyptian universities.	SO2. Creating a shadowing system or very short-term exchange programs to engage thousands of Egyptian experts in the diaspora to efficiently transfer their info & technology and integrate it into the growing database of local researchers and those specializing in Science & Technology, especially under WEF Nexus domains.	SO3. Adopt the various public initiatives to transform research results into economic value; such initiatives should engage Egyptian experts abroad with high scientific capabilities and industrial experience, reinforced by the growing political support for science parks and new science cities.	SO4. Utilize the diversified mechanisms of public funding for R&D and raise awareness about the WEF nexus support to be the growing trend of public expenditure on R&D.
S vs T			
ST1. Mobilize the sizable number of excellence centres located across Egypt to support science parks and research facilities that are not equipped enough to perform the desired activities, laying out a roadmap for coordinating activities and incentivizing outputs.	ST2. Facilitating the engagement of more than 100,000 researchers would help restrict the continuous brain drainage and migration to the Gulf and surrounding regions. The facilitation could cover the facilities, more up-to-date policies, incentives system and IPR protection.	ST3. Improving STI policies with a focus on creating alignments between ecosystem actors, redirecting research activities towards industrial needs, focusing on direct and indirect SMEs support and creating a market for innovation	ST4. Using researchers in the diaspora as bridgers to raise more funds for R&D and increase the diffusion of domestically developed knowledge to fill out the technological gaps
W vs O			
WO1. Optimize utilizing the cooperation capacities with Europe and North Africa to help alleviate the highly fragmented national funding of scientific research and fill in the business expenditure gaps in R&D, which is lower than average and insufficient. This should also create a wider funding platform for SMEs and entrepreneurs.	WO2. Create an inventory and adopt an ERP system to track the wealth of equipment distributed amongst research centres and universities. This will ensure a comprehensive inventory mapping of all available items, specifically detailing functionality, specs, maintenance log, lifetime expectancy, physical location and utilities...etc.	WO3. Create roadmaps, policies and procedures to best utilize the growing capacities of several actors in the innovation ecosystem, including non-governmental organizations and establish a clear technological, strategic goal coordinated and communicated well between all parties	WO4. Granting talented researchers access to opportunities through improving the promotion system as well as ensuring policy enforcement in practise
W vs T			
WT1. Create national programs with tracking mechanisms to continuously assess and upgrade the research facilities to avoid establishing research facilities that are not well-equipped to serve their purpose best.	WT2. Re-vamp the institutes' workflow that doesn't encourage research and innovation, which would free the sector of the public sector dominance and incorporate modern ideas and approaches into the mix.	WT3. Consider establishing specialized institutions for science and innovation policy to minimize the market being dominated by big enterprises and a significant presence of an informal sector.	WT4. Incentivize the business expenditure in R&D to avoid the current disconnect between the industry, scientific research and academia.

Cyprus

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Existence of regional innovation clusters - Improved institutional framework - Reformation in the education and training system - Increasing promotion of social and environmental sustainability - Growing recognition of the role of citizens, end users and public-private people partnership 	<ul style="list-style-type: none"> - Lack of highly skilled human resources - Complex structural and industrial problems - Lack of effort to consolidate partnerships - Lack of funding for WEF technologies - Lack of realization of WEF technologies
Opportunities	Threats
<ul style="list-style-type: none"> - Access to EU -WEF fund - Polarization RIS networks and extend to cross-border with other LLs (e.g. ENOLL) - LLs may allow better coordination, synergies and use of the feedback of respondents, - Holistic approach for covering many NEXUS challenges - Creating new spin-offs and exploring new markets 	<ul style="list-style-type: none"> - Limited public fund - Lack of public awareness about WEF challenges - Shortage in climate education - Conflict of interest with other sectors

SOR Analysis Recommendations

S vs O			
SO1. OLLs have a non-stop flow of exploitable new technologies and enable the cooperation of different regional actors, thus contributing to the development of innovative ideas, products and services to face WEF challenges.	SO2. Efficient work and clear focus areas create high expectations for developing innovative services and products.	SO3. The availability of a secure, dependable and trustworthy infrastructure increases the coordination and synergies and enables the industry to explore new markets to increase profit margins.	SO4. OLLs enhance networking and knowledge transfer, thus raising awareness about WEF nexus and creating opportunities for spin-off consortiums to commercialize a product or service that faces the nexus challenges.
S vs T			
ST1. NDOLLs enables the cooperation of various actors and government-industry-academia partnership, overcome unbalances between participants' engagements, and avoid selecting the same people as participants.	ST2. NDOLLs can cover a broad spectrum of sustainability challenges and are situated in real-world systems and problems, eliminating the fact that sometimes there are no immediate incentives for participants.		
W vs O			
WO1. Integrating existing international networks of Living Lab research help overcome the difficult management of the user groups and the difficulties in finding the balance between new and existing relationships.	WO2. Connecting the existing research on interfaces between sustainability, innovation, and user integration helps avoid the fact that sometimes scientists who are technology experts do not have the skills to realize the real user need.	WO3. Living labs act as a cooperation platform between the various innovation stakeholders and eliminate the mismatch between governmental strategy implementation and SMEs' development expectations.	
W vs T			
WT1. Define and select the participants for future NDOLLs to avoid unbalances and avoid choosing the same participants.	WT2. Reduce the number of OLLs experiments to avoid the need for huge funding.	WT3. Implement a correct strategy to enable opportunities from the public sector and the decision-makers.	WT4. Choose the relationships strategically to avoid mismatches and guarantee a PPPP balance.

Spain

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Existence of regional innovation clusters - Good infrastructures investments and skilled human resources - Increasing demand for WEF technologies - Evolving national recognitions of the negative impacts of climate changes - Growing recognition of the role of citizens, end users and public-private people partnership 	<ul style="list-style-type: none"> - Long-lasting demonstration period OF LLs - Drop-out of end users and participants before the end of the test period. - Lack of benchmarking concepts, research parameters and interoperability standards Difficulties in getting additional structural funds to consolidate new LLs - Difficulty in implementing the LL methodology AS IT works differently in various situations.
Opportunities	Threats
<ul style="list-style-type: none"> - The holistic approach to raising awareness about NEXUS and climate change impacts. - Possibilities for the connection of RIS networks and extend to cross-border with other LLs (e.g. ENOLL) - LLs may allow better use of the feedback of respondents, - An approach for creating a suitable ecosystem to nurture future entrepreneurs to face NEXUS challenges - The potential of tailor-made services, products and methodologies with potential replication around MPC 	<ul style="list-style-type: none"> - Striving for economic growth as a priority - Constraints in securing long-term funding for sustainable LLs - Shortage of needed human resources and a considerable workload to apply LLs effectively - Old environmental laws may be subject to new judicial reinterpretation - IPR and ownership management of the generated outputs

SOR Analysis Recommendations

S vs O					
SO1. NDOLLs became the tool to enlarge PPPPs and build a sense of community for sustainable ecosystems that nurture future WEF NEXUS entrepreneurs and raise global awareness about climate change	SO2. To exploit NDOLLs' cost-effectiveness to capitalize on ecosystem feedback and incentivize incorporation of developed technologies / products	SO3. Replication and tailoring of NDOLLs outputs favoured as a result of engaged end user's representativeness and ideas feasibility testing at NDOLLs	SO4. OLLs enhance networking and transfer of knowledge, thus raising awareness about the WEF nexus and creating opportunities for spin-offs consortiums	SO5. The availability of good infrastructure and skilled human resources allows for achieving an attractiveness of the LL area and multiplier impacts on the local workforce and educational systems	SO6. Established and working stimulative RIS networks and communities for WEF allows to facilitate the interconnection and extend to cross the border with other LLs
S vs T					
ST1. NDOLLs as PPPPs ecosystems can cover regional context and overcome unbalances to favour scalability and replication	ST2. NDOLLs' cost-effectiveness enhances transferability to other sectors while reducing required long-term funding	ST3. RIS networks and NDOLLs replication engage larger user groups to facilitate their set-up and running	ST4. NDOLLs ecosystems allow faster and better valorization of changing technologies while ensuring linked outputs in IPR management	ST5. To reinforce regional NDOLLs capitalization to overcome youth unemployment and brain drain	
W vs O					
WO1. Capitalize on increasing demand for WEF technologies and NDOLLs ecosystem characteristics to reduce their management expenditure and guarantee long-term sustainability	WO2. IoT and recent emerging innovation technologies can cope with reduced amounts of users and even expand their findings, allowing them to extrapolate them to the market	WO3. Adapt NDOLLs size to fit the portfolio of incremental and adaptive innovation (4.0 3D, IoT) with added value and replication to ensure extrapolation to regional WEF stakeholders	WO4. Through the possibility of connection of RIS networks with other LLs is possible to overcome the lack of consolidated interactions between the RIS and communities	WO5. To unlink NDOLLs from policy timings, strategy, and colours and match with private sector expectations to benefit MPC economies and face WEF NEXUS challenges	WO6. Better respondent feedback gotten in LLs would reduce long-lasting demonstration periods and early drop-out, allowing to get an effective incorporation of developed products
W vs T					
WT1. To reduce long demonstration periods at NDOLLs to shrink their dependence on long-term funding and financial crisis	WT2. Apply FTTI approaches to NDOLLs to reduce dependence on governmental and policy strategies while balancing PP engagement and investment	WT3. Consolidate NDOLL's long-term sustainability through efficient financial management supported by structural funds to guarantee PPPPs' balance	WT4. Design future NDOLLs size to ensure incremental innovations extrapolate to market and create differential value to favour scalability and replication in the regional context	WT5. Implement sustainable capitalization, benchmarking, and interoperability strategies to overcome NDOLLs outputs IPR and ownership issues	WT6. part of the LLs investment should go to cutting-edge technologies to keep up with changing technologies and thus favour the development of incremental innovation

Italy

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Good scientific infrastructure - Good digital infrastructure - Burgeoning innovation ecosystem - Diversified public funding mechanisms - Growing number of programs and initiatives to popularising scientific culture - Strong academic and research institutions 	<ul style="list-style-type: none"> - A low number of STEM graduates and a low number of entrepreneurial universities - Underutilized research facilities and low engagement of young researchers - Insufficient capacity to exploit research outputs - Low entrepreneurial mindset - Lack of internationalization strategy
Opportunities	Threats
<ul style="list-style-type: none"> - Possibility to access EU research and innovation funds - Positive trends of investment in the WEF sector - Low investment in research and innovation after COVID-19 - A good network of cluster and technology districts - High competitiveness in the international market 	<ul style="list-style-type: none"> - Public domination of research and education - Insufficient capacity to maintain the medium and long-term roadmap - Brain drains - Absence of effective mechanism of collaboration between industry and academia - No regular upgrading of research facilities

SOR Analysis Recommendations

S v O			
SO1: The highly ranked public and private research and the wide availability of very good research fabric can support the development of new solutions to achieve the Green Deal targets.	SO2: The consolidated presence of Italian research in preeminent networks can offer unique opportunities to stimulate innovation in the national strategic areas	SO3: The growing number of actors in the innovation ecosystem and: Good presence of private research centres belonging to Italian large companies	SO4: The existence of many public initiatives to transform research results into economic value gives room to start-ups development, also targeting the WEF nexus SO5
S v T			
ST1: High-level research capacity in some key sectors such as biotechnology, material science, and renewable energy; however, the excellent level of know-how could be lost in a short period in case of lack of public funds	ST2: High bandwidth internet connectivity that supports research applications located only in central cities, the delay of high-speed bandwidth connectivity could lead to a limited development rate of rural areas characterized by a digital divide	ST3: Growing number of initiatives and programs that focus on raising scientific culture and popularization of sciences and innovation linked to the next generation EU funds available; however, due to the tight constraints in funding spending, the high availability of funds could lead to a good quality of public money spending	ST4: the leadership in research and development in the drug sectors could be lost if public administration will not accelerate its investment /modernization plan
W v O			
WO1: Low capacity to exploit research results into innovative products and services could be reversed by empowering and engaging young scholars in innovation planning and stimulating the set up of entrepreneurial universities	WO2: Liaison office structure present in the country could also be enforced using the Next Generation programme to support the start-up's development better, supporting young graduates' entry into the labour market.	WO3: Compared to other disciplines, the low number of graduates in STEM could be increased by offering them the opportunity to use the underutilized High qualified facilities and labs.	WO4: Low entrepreneurial mindset by graduates, high-risk aversion, and a low number of start-ups could be reversed by the current availability of funds and by new policies, research and innovation and internationalization strategy at the level of institutions.
W v T			
WT1: Italy is already a major importer of raw materials in all sectors, and with the current increase in the price of bare and raw critical materials, the threat is even more pressing with the absence of essential primary material produced locally	WT2: The average Italian researcher's age is 49 due to a low demographic trend. There is no capacity to attract foreign talents to bring new ideas and models.	WT3: Low capacity to exploit research results into innovative products and services due to insufficient and not fully operational mechanisms to link industry and academia.	

Jordan

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Excellent domestic cooperation between WEF actors - Secure, Dependable and trustworthy infrastructure - High potential in outreach work and research implementation - Broad experience in Business Incubators, Small project management - Proven ability to organize and coordinate the relationships between a wide variety of stakeholders 	<ul style="list-style-type: none"> - Weak funding base - Random work between different sectors (PPPP) - No science communication done by researchers in private and governmental sectors - Expensive management and Operating costs
Opportunities	Threats
<ul style="list-style-type: none"> - Existence of support for small projects, with funding and in the form of grants - High interest from the government to support the development of innovation incubators - There is a significant trend in the region to support the sectors of energy, water and food by private and governmental and public sectors - The existence of distinguished experts to support research and projects in the field of energy, water and food 	<ul style="list-style-type: none"> - Low entrepreneurship culture/ leaving a comfort zone - Difficult economic situation - Regional competition - Shortage of needed human resources and a considerable workload to apply LLs effectively

Lebanon

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Technical Expertise/know-how of Human Resources in the private sector - Strong academic and research institutions - Availability of different programs supporting technology transfer and communication between various stakeholders - Entrepreneurship support institutions and sector-specific acceleration programs 	<ul style="list-style-type: none"> - Degradation of essential services such as electricity and solid waste management - Lack of funding mechanisms tailored to Nexus priorities - Absence of stringent standards and lack of policies stimulating & Encouraging Innovation and cleantech incentives - Technical Capabilities and facilities and labs for Research & Development - Lack of Networking between SMEs and academia
Opportunities	Threats
<ul style="list-style-type: none"> - This sector is a rising need in the region, many rooms for improvement in terms of energy cost and efficiency - Regional collaboration, opportunities, exchange of expertise, regional programs and clustering around the nexus topic - Adequate geographical environment and climate conditions to develop and implement solutions in the sector 	<ul style="list-style-type: none"> - Economic crisis and instability in the country - Political insecurity and instability - Migrations of local talents, experts, SMEs and companies outside the country - Dependency on imported raw materials in all sectors - Local and national conflicts disrupting operations

SOR Analysis Recommendations

S v O		
SO1: Technical Expertise/know-how of Human Resources in the private sector as well as strong academic and research institutions, will lead towards improvement in terms of energy cost and efficiency	SO2: The ability to shift the business type according to market needs will allow CleanTech sectors to have more impact in the region, especially since there is a need to produce primary material in the region	SO3: Availability of different programs supporting technology transfer and capitalizing on the growing international donors' interest in Lebanon to solve financial problems of the WEF sector.
S v T		
ST1: Strengthening and developing the existing technical expertise/know-how of Human Resources in the private sector can decrease the threat of local talents migrating, as well as experts, SMEs and companies draining to outside the country	ST2: dependence on imported raw materials in all sectors can be mitigated by shifting the business type according to market needs and having different programs supporting technology transfer	ST3: The threat of migrations of local talents, experts, SMEs and companies to outside the country can also be mitigated by entrepreneurship support institutions and sector-specific acceleration programs providing an enabling environment to develop start-ups in the WEF sector
W v O		
WO1: There is a lot of room for improvement in terms of energy cost and efficiency that can be achieved if there is more focus on gathering the proper funds and better financing mechanisms tailored to Nexus priorities, all of which will increase international donor interest in the Lebanese green and environmental sector	WO2: If there is more focus on networking between SMEs and academia; providing pieces of training and certifications; and enabling support for exporting (expertise), then there will be an increase in regional collaboration, opportunities, exchange of expertise, regional programs and clustering around the nexus topic	WO3: To focus on recovery and reforms in the CleanTech sector by avoiding lengthy bureaucratic procedures when working with the government and challenging existing patency rights procedures. All of which will help in enabling opportunities to increase the competitiveness of Lebanese products and increase technical capabilities and facilities and labs for Research & Development
W v T		
WT1: Lebanon is already a major importer of raw materials in all sectors, and with the current currency depreciation, the threat is even more pressing with the absence of essential primary material produced locally	WT2: The migrations of local talents, experts, SMEs and companies outside the country are contributing to the economic crisis, and the instability in the country is a primary factor for the brain drain in Lebanon, which contributes to the lack of enabling support for exporting technical expertise and knowledge	

Tunisia

SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> - Official willingness for modernization - Good Geographic location and Skilled Human Resources - Advanced Legal and financing framework dedicated to start-ups in Tunisia. - A high renewable energy potential, especially solar energy. - An active and dynamic network of associations - Suitable research infrastructures investments and TTOs 	<ul style="list-style-type: none"> - Low competitiveness compared to closed markets (European, Moroccan, etc.) - Lack of participation in the regional clusters concerned with the WEF. - Lack of policies to finance private energy investors - Lack of entrepreneurial culture - Discouraging social & political context - Presence of the informal sector
Opportunities	Threats
<ul style="list-style-type: none"> - Benefiting from being close to Europe and valorization regional from LLs in Europe - Development of the inclusive financial solution for WEF-focused SMEs - Developing more programs for stimulating entrepreneurial competencies of digitalized generation - Building a network with international banks and multilateral donors - Opening new markets in Europe and Africa 	<ul style="list-style-type: none"> - Political and social instability - Economic crises (currency depreciation, price fluctuations, etc.) - Declination of national primary energy resources due to the increasing demand - Continuous lack of coordination between public and private actors in the ecosystem - Continuous high unemployment and brain drain

SOR Analysis Recommendations

S vs O		
SO1: Existing High-performance Competitiveness Clusters and Research Centers constitute an asset to developing Renewable Energy projects using an LL Approach	SO2: Local Banks and Micro Finances Institutions should take advantage of potential funding programs of International Donors in Tunisia	
S vs T		
ST1: Maintaining and improving the performances of Competitiveness Clusters and Research Centers would contribute to reducing the gap in scientific and technological development between Tunisia and the Developed Countries	ST2: Developing partnerships with research centres from developed countries would reduce the risk of loss of highly skilled human Resources	ST3: Optimize the use of Institutional support to encourage innovative projects would reduce the brain drain
W vs O		
WO1: Reducing the administrative and regulatory difficulties would facilitate access to international donors that are interested in investing in WEF projects in Tunisia	WO2: Developing a national strategy to implement Clusters in WEF, taking into consideration the new law allowing the production and sale of photovoltaic electricity	
W vs T		
WT1: preparing an advocacy Plan (to reduce the administrative difficulties) to face the current complex political situation and the lack of regulation regarding WEF issues	WT2: Developing a Strategy focused on the use of Solar Energy would help the country to address the scarcity of water resources in the region	WT3: Setting up a private-public strategic intelligence system in order to reduce the gap between local and international research projects/ efforts