Design of a Cookbook to Boost Energy Community Deployment Across Europe

Ashtynn Trauth
email: ashtynn.trauth@tecnico.ulisboa.pt
Instituto Superior Técnico,Universidade de Lisboa, Portugal May 2023

***Abstract*—Energy communities are gaining popularity as a strategy to support the energy transition by allowing citizens to take an active role in shaping their energy future by promoting local ownership, collective decision-making, and mutual benefit. Every energy community is different and must be designed to serve the needs of said community. On top of this customizable quality, the convoluted regulations across the European Member States render the creation of citizen-led ECs rather challenging. A literature review of the state-of-the-art tool repositories and one-stop-shops was carried out; concluding that there is a lack of interactive tools and resources that guide the user through each step of the process. Most one-stop-shops tend to list resources, failing to provide the user with a clear direction on what they should be doing and in what order. This paper presents the methodology to create a Cookbook, or roadmap, to help users at any stage in the EC creation process progress by providing them with user-friendly, interactive, and relevant tools. This was accomplished by conducting an extensive search to leverage existing tools and catalog them according to the applicable step. Missing steps will be developed by the project team. Once launched, this tool will facilitate the complex process to create an EC throughout the EU.**

***Index Terms*—Energy community, one-stop-shop, technical assistance.**

I. Introduction

THIS study aims to promote energy community (EC) deployment across the European Union (EU) by developing a "Cookbook", or a roadmap, for project promoters to use to overcome common barriers. Currently, more than 9000 EC initiatives exist across Europe [1].

The Renewable Energy Directive (RED II) defines a **renewable energy community** (REC) as an autonomous legal entity based on open and voluntary participation effectively controlled by shareholders or members located in the proximity of the renewable energy project owned by the legal entity. The primary purpose is to provide environmental, economic, or social community benefits rather than financial profits [2].

The European Commission is encouraging the implementation of ECs to continue decentralizing the EU energy systems with the Clean Energy for all Europeans package along with the RED II and IEMD [3]. With these directives, the EU has opened the door to remove the regulatory barriers at a national level. However, the efficiency and enthusiasm of the RED II transposition varies significantly across the Member States.

Apart from regulatory hindrances, the development of an EC can be a confusing and overwhelming process due to the bottom-up nature. Community members and project promoters are not necessarily technical nor legal experts. A plethora of resources and tools exist but they are often rendered irrelevant or useless due to the specific country and type of project for which the resource was designed.

A. Problem and Research Objectives

Many resources including guides, one-stop-shops (OSS), tools, and case studies exist to facilitate the deployment of energy communities across the EU. While these resources are helpful, they fail to provide a simplified, universal method to take the project promoters from start to finish with easy-to-use tools tied to each step. There is a need for an all-encompassing, user-friendly toolkit to help projects navigate from the formation of a group to the construction of the actual energy community.

To address this need, the following research objectives were defined to identify the features this tool must incorporate to ensure a user-friendly interface with meaningful content (for *every* user) spanning the entire life cycle of an EC.

Research Objectives

1) Extract best practices from past EC-related projects.
2) Catalog existing tools useful at any step in the EC creation process.
3) Develop a toolkit to streamline the process of establishing an EC (EU-wide).
4) Brainstorm and implement innovative ways to add value and differentiate this toolkit from existing ones.

B. Structure of the Paper

This document will provide an overview of energy communities' role in the energy transition, followed by a description of the EU-funded LIFE-BECKON project. Then, a literature review highlights the best practices and shortcomings of past EC-related projects to account for when designing the tool. Next, the proposed solution is described in more detail with the methodology followed and the final results. Then, wireframes of the tool are presented to illustrate the user interface. Finally, the paper concludes with limitations and next steps.

C. The Energy Transition

In 2015, the United Nations Member States adopted 17 sustainable energy goals with the intention to eradicate poverty, reduce inequalities, and restore the earth by 2030. Sustainable development goal 7 aims to ensure access to affordable, reliable, sustainable and modern energy [4]. Even though the

global electricity access rate and global share of renewables in the final energy consumption are steadily rising, bottom-up initiatives are necessary to more effectively meet this goal at a community level.

Energy communities are democratically owned, by principle. This attribute drives transparent energy bills and contracts, enabling informed decision-making regarding when to consume (dynamic pricing) [3]. Historically, shareholders in energy communities do not expect the same degree of returns as typical investors, allowing more flexibility for financial schemes [5]. Energy communities also support local economies, increase social acceptance, and help reduce energy poverty [6] [7].

II. BECKON as a Framework

Simply stated, the project consists of developing various tools and platforms to foster initiatives from start to finish, all over the EU. The first, and primary focus of this paper, is the Energy Community Cookbook. The Cookbook will highlight the key steps and provide tools to bring an energy community from the ideation to the operational phase. This Cookbook will be as simple and efficient as possible to streamline the research process.

The Cookbook will be featured on the virtual One-Stop-Shop (OSS). Along with the Cookbook, the OSS will offer a database of tools, a matchmaking service to connect project promoters to investors, and training opportunities. The OSS will then form a part of the Technical Assistance Office (TAO). The TAO is a physical office that provides custom capacity building programs to kick-start EC deployment in that region, on top of general advising services.

By the end of the project and subsequent 5-year upscaling period, LIFE-BECKON expects to have incited investments exceeding 38 M€, to have saved 20 GWh/year of primary energy, to have added 12 GWh/year of renewable energy generation, and to have reduced greenhouse gas emissions by 4,500 tCO2/year [8].

Energy communities bring many benefits to local communities while simultaneously helping them decarbonize. However, due to an ever-changing legal environment across EU Member States, and the technologically complex nature of energy communities, deployment has been relatively slow.

Through this combination of services and tools that span different levels of interactivity, the LIFE-BECKON project will address and supply solutions to common obstacles felt by ECs in the EU. This framework will be deployed in three pilot TAOs: Sofia, Bulgaria; Copenhagen, Denmark; and Ávila, Spain. These sites were chosen because they represent different geographic conditions (rural/urban), different levels of market maturity, different regulatory environments, and different levels of citizen engagement.

III. Best Practices

The Energy Community Platform (ECP), Energy Community Repository (ECR), REScoop, and Smart Cities Marketplace platforms were reviewed to extract the best practices and identify weaknesses that the BECKON platform can improve upon. It was determined that the placement test feature of the ECP substantially benefited the user to orient their actions. The tools in the BECKON OSS will also be divided into various phases, but these phases will not overlap like the ones in the ECP so the usefulness of the tool is not degraded. These phases will be broken down into individual steps to recommend more specific tools. The ECR would be more useful if it could be filtered by language, country, stage, and specific step; these improvements will be made in the Cookbook. A matchmaking hub will be included to help with financing and other technical questions. The current organization methods of these resources requires the user to spend time sorting through reports and irrelevant tools. The Cookbook improve upon this by extracting information from the long, tedious reports, or the report will be cut down to solely pertinent information. The BECKON Cookbook aims to provide a more interactive guide rather than just a repository of tools (which it will also produce), to present a simple roadmap from the initial idea to the operation and maintenance of the community. There is no existing tool that can draw a straightforward step-by-step blueprint of how to found and run an energy community.

IV. Design Methodology

The objective of the Cookbook is to provide energy community initiatives all over the EU with an efficient, user-friendly, interactive roadmap to guide them through every step of the process. To make the BECKON project more manageable, the Cookbook is tailored to ECs powered by solar photovoltaic (PV) generation. This allows the Cookbook to specialize in one technology thereby providing more specific tools while still maintaining applicability to the majority of EC initiatives. Unique to all other EC platforms, the Cookbook will include a feature to input information as the user moves along the roadmap. This information will be used to automatically generate documents that could be presented to potential investors or stakeholders. The Cookbook was designed by first defining the most important steps to create an EC, assessing existing resources, and pairing these tools to the applicable steps while simultaneously performing a gap analysis.

A. Define the Steps

Firstly, the action steps to create an Energy Community were divided into two separate initiatives: establishing the EC as a legal entity (this entails more administrative tasks like legal, regulatory, and financial work), and the construction of the PV installation (more technically focused). Specific steps were outlined for each of these categories to be performed in parallel. To ensure both parts progress in tandem, the steps are grouped into four different stages: Initiation, Design, Implementation, and Operation. Fig.1 shows the basic tasks to accomplish at each stage for both the technical and administrative workflows.

B. Assess Existing Resources

Over 200 tools, documents, and resources were catalogued into a database to later be categorized by where they would be

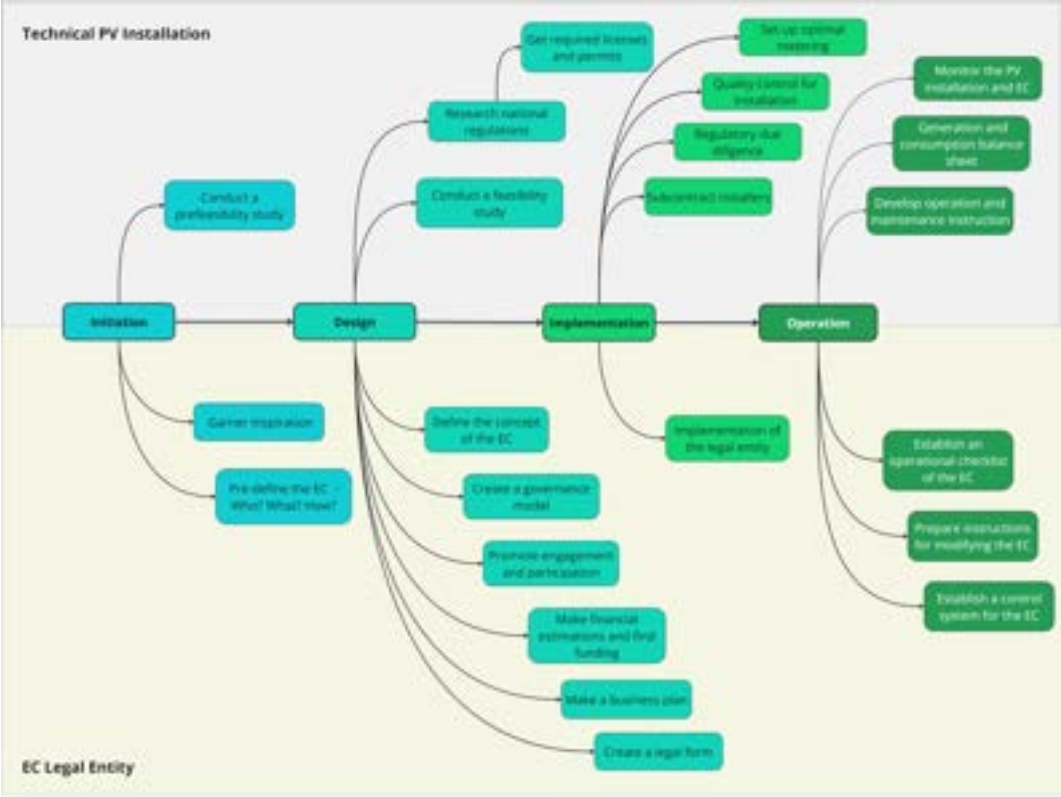

Fig. 1. Steps for the technical PV installation (top) and to create the legal entity (bottom) throughout all four stages of EC development. These selected steps are justified in the full length thesis based on many resources [9]–[15]

most applicable. These tools were sourced from a variety of established databases including the Energy Community Repository, the Energy Community Platform, Compile, Modelos SueloSolar, amongst others.

The OSS Knowledge Hub will feature a large database of useful resources for users to browse a more extensive list of tools. This bibliography is not restricted to the previously defined steps. It will catalog all tools and resources that are handy for any stakeholder at any stage of the EC creation process. There are also tools available for individuals wanting to assess the energy efficiency of their home or install PV panels apart not involved in an EC. The bibliography will provide a description of the tool, the language, the applicable countries, date of last update and what type of support it offers. Tools and interactive resources were emphasized and prioritized over long, cumbersome reports. In the reports included, specific key chapters are noted to reduce the searching time for the user.

The bibliography lists the link to the tool, a short description explaining the contents and any particular chapters of interest, the type of tool (tool, guide, manual, webinar, etc.), the applicable countries, the language, if it is free, the type of support it provides (financial, operational, legal, regulatory, technical, etc.), and in what stage of EC development it is most useful. As of now, it holds over 100 resources and will continue growing throughout the project.

C. Assign Resources to Steps and Perform a Gap Analysis.

After all the steps of the Cookbook were defined, the resources were categorized into each associated step. Each step was classified as having existing tools that serve the purpose, having existing tools that must be modified meet the needs of the step, or missing. The missing tools were noted and sent to all the project partners in an effort to locate existing tools as quickly as possible. In the case of nonexistent tools, the BECKON team will develop them. Some of the missing tools are less interactive and entirely depend on the location of the EC: for example, various templates, grid and regulatory checks, and legal framework assessments.

For the more region-specific tools, priority will be given Spain, Bulgaria, and Denmark (the pilot site locations), but the finished product shall include resources for all EU Member States.

D. Placement Quiz

After the steps were defined, a placement quiz was written based off the main milestones from both the PV Installation process and the Legal Entity creation process. This idea came from the Energy Community Platform. Their quiz informs the user the stage of the initiative to filter their tools. The Cookbook tool will go one step further to check off the steps the user has already completed.

The quiz starts by asking the location of the EC and if it is on an island to adequately filter the tools. The next User

Experience section will delve into the how this quiz will work in practice.

V. User Experience

The user will first be asked to complete a questionnaire to evaluate the status of the EC and filter the tools based on the location. This survey informs the Cookbook which steps the EC has already completed and therefore, should hide.

If the user chooses not to take the placement quiz, or is starting a project from scratch, they will be directed to the entire cookbook, illustrated in Fig.2 at the end of this document. The figures are placed at the end of the document to increase their legibility.

If they choose to take the placement quiz, the recommended option, they will see a window pop up, shown in Fig.3. This quiz is structured to ask a few main questions to place the user in the proper stage. The logic behind the quiz aims to minimize the questions the user has to answer. When the user indicates that they are in a certain stage, for example, that are in progress of registering the EC, they will be asked a series of more detailed questions to pinpoint what steps they need to complete. In total, a bank of approximately 20 questions based on the key milestones characteristic of the EC creation process, although most users will only answer a few questions.

After these questions are answered, the user will be directed to their personalized roadmap, see Fig.4. The completed steps will be shown in gray, however, the users can access the tools and materials associated with completed steps. It is recommended to complete all of the steps in the current stage before proceeding to the next one.

A. Start the Journey

Once the project is placed in the appropriate stage, they can begin completing steps. The steps are split with the Technical PV Installation steps on the left side and the Legal Entity Creation steps on the right side. If the user clicks on a certain step, a window will appear with the associated tools and resources. Fig.5 and Fig.6 illustrate the user's view of the tools associated with the step "Evaluation of Strengths and Weaknesses". The user will first see a brief explanation of why the tool is important with additional links if the user wants to learn more. Then the tool structure is shown with examples, followed by textboxes for the user to input their own answers. This information is stored to later be used to generate specific documents. Some steps are more interactive than others. The steps will be made as interactive as possible with this feature included to store information. For the steps that are more literature related, it will be trimmed to only the most pertinent information to save the user time.

Wireframes are already developed for steps with existing tools. The tools the BECKON team is developing will fit into this format to give the user an interactive and streamlined experience.

B. Unique Value Offering

As mentioned previously, the key feature that distinguishes the BECKON Cookbook from others is the ability to guide the user, take their results, and create personalized professional documents for them. After completing the Design phase, the user will have, perhaps unknowingly, completed a business plan. From the Initiation and Design phases, the goals, scope, activities, participants, main stakeholders, strengths and weaknesses, governance model, and financial estimations will all feed directly into a business model template. They will all have input boxes like in Fig.5 and Fig.6.

VI. Next Steps

The Cookbook will form a part of the Knowledge Hub on the OSS. The OSS will be composed of a Knowledge Hub, Training Hub, and Opportunities Hub. The Knowledge Hub will host a bibliography with useful resources along with the Cookbook. The Training Hub will include the educational materials produced in the Capacity Building effort, described below. The Opportunity Hub will directly interface with the Cookbook in the Knowledge Hub. Specific technical and financial experts in a given location are recommended at certain steps of the roadmap if extra support is necessary. Additionally, the Cookbook links to the Opportunity Hub to help the project find funding.

The OSS (including the Cookbook and capacity building program) will be validated in three supramunicipal areas in Ávila, Spain; Sofia, Bulgaria; and Copenhagen, Denmark, covering a wide range of conditions, cultural aspects, and market maturities. This diversity is necessary to ensure the robustness of the tools, maintaining its applicability throughout the EU. The technical assistance offices will educate actors local to the three pilot areas.

In general, the TAO pilots will interact with the existing local energy office to launch a call for projects. The target is to assist between a minimum of ten, to a goal of 25 initiatives in each area. This assistance includes a Cookbook introduction session, a capacity building program throughout the area, and OSS engagement initiatives. The capacity building aims to reach 150 - 200 stakeholders in each pilot area, effectively training the trainers and filling knowledge gaps.

After the launch of the pilot TAOs, the effectiveness and quality of the support mechanisms (Cookbook, capacity building, and OSS) will be evaluated for certain indicators such as ease of use, robustness of features, and areas of improvement. The validation of the tools' efficacy is the most important step to guarantee the lasting impact of the implemented activities. The pilots' evaluation and feedback of the tools will incite corrective actions to strengthen the Cookbook, Capacity Building program, and/or the One-Stop-Shop. These improvements will be implemented prior to the replication and dissemination activities to capitalize on the lessons learned from the pilot sites.

VII. Conclusion

The work described by this report laid down the prerequisite foundation to develop a robust yet simple roadmap to support EC projects from start to finish. Identifying and justifying each mandatory step and the order in which it should be completed is directly proportional to the usefulness for the user. This

scheme provides the BECKON team with a framework to order the tools and further discuss the implementation of additional innovative capabilities. While the report showed a brief snapshot of the envisioned user interface, the team will further refine this to provide the best user experience. Next steps include determining which tools cataloged in the bibliography add the most value so as not to overwhelm the user with 10+ tools that accomplish the same thing. Once these decisions are made, the scheme can be sent to the developer and launched in the pilot areas.

This tool is designed provide an equal level of support for every EU country at each step of the EC creation process. This alone elevates this platform over existing ones. The roadmap format is also a novel feature, providing users with real guidance towards which tools they should be using at which stage. Finally, automatically creating useful business documents to present to investors goes above and beyond the existing databases that drown the user in a sea of tools. Based on these key features of the BECKON Cookbook, this tool will effectively fill the need mentioned in Section 1, thereby boosting the deployment of successful ECs across the EU.

While this work is critical to the success of the LIFE-BECKON project, the LIFE-BECKON project is expected to make a large impact in the EU energy community environment. Multiple different expected impacts were estimated for project end and for five years after the project. These expected impacts were based on realistic goals set by the LIFE-BECKON team regarding number of initiatives supported, number of citizens engaged in community energy as a result of the project, investments triggered, primary energy savings, and GHG reduction.

Twenty-five EC initiatives will be supported between the three pilot areas. Fifteen more from different EU countries will receive support from the BECKON OSS platform. In the five years post project end, it is expected that each of the TAOs in the pilot areas will support 25 more bottom-up projects. The project consortium of eight partners will involve 30 public authorities across the EU, triggering a call for projects in each of these areas which is predicted to generate a pipeline of 300 projects (10 ECs per each call for projects). This sums to a total of 375 projects supported by the BECKON OSS within 5 years of the end of the project [8].

The pilot projects vary significantly in size. The Spanish pilot is expected to engage 100 citizens, the Bulgarian TAO predicts 330 citizens, and the Danish project expects to involve 2000 - 4000 citizens. The estimations are made as conservatively as possible; for that reason, it is assumed that the future 375 projects will engage 100 citizens each. This totals to 6830 citizens transforming from passive to active energy consumers as a result of the BECKON project [8].

This number of citizens engaged is used to estimate the approximate magnitude of sustainable investments induced by the project. By engaging more citizens investments will have to be made in PV panels, battery storage, and monitoring equipment to meet the electricity demand of the community sustainably. It was estimated that 7500€ per citizen to install a 5 kWp system (the typical power rating to meet the demand of a house). An estimated 1500€ is expected per citizen to install or upgrade the monitoring equipment to ensure a proper p2p exchange. A 10 kWh battery costs about 6000€. All of these components sum to a total estimated investment that an average of 15000 per citizen engaged in an EC initiative. Based on the previous estimations, this will sum to a total of 38.7 M€ [8].

Primary energy consumption will also be reduced. The average energy consumption of an EU citizen is 6.5 MWh/year. BECKON's energy efficiency measures are expected to reduce primary energy consumption of EC participants by 20%. Assuming a 5 kWp PV system is installed on every participants rooftop (equalling 4.6 MWh/year) and their annual consumption is 5.2 MWh (20% less than average), each citizen is effectively saving 5.4 MWh of grid electricity consumption per year (4.8 MWh/year with the PV systam and 0.8 MWh/year from the efficiency measures). Using a conservative conversion factor of 1.5 (the lowest average of the EU countries), this amounts to 60.45 GWh/year saved 5 years post-BECKON [8].

Primary energy savings can be easily converted into GHG emissions reductions. For every kWh of primary energy saved, 230.7 gCO2 equivalents are avoided. This tallies to 13,946 tCO2-eq/year emissions avoided as a direct result of the BECKON project.

ACKNOWLEDGMENTS

I would like to cordially thank Professor Duarte de Mesquita e Sousa, my supervisor from Instituto Superior Técnico, for his continuous support throughout the past few months. This work would not be possible without the consistent guidance of Mauro Ostinelli, engineer at R2M, and Iván Aranda, the Head of Energy Division at R2M Spain. Thank you.

REFERENCES

[1] "In focus: Energy communities to transform the EU's energy system," Dec. 2022. [Online]. Available: https://energy.ec.europa.eu/news/focus-energy-communities-transform-eus-energy-system-2022-12-13_en

[2] "Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) (Text with EEA relevance)Text with EEA relevance," Jun. 2022. [Online]. Available: http://data.europa.eu/eli/dir/2018/2001/2022-06-07/eng

[3] European Commission. Directorate General for Energy., *Clean energy for all Europeans.* LU: Publications Office, 2019. [Online]. Available: https://data.europa.eu/doi/10.2833/9937

[4] "Ensure access to affordable, reliable, sustainable and modern energy." [Online]. Available: https://www.un.org/sustainabledevelopment/energy/

[5] "COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT Accompanying the document Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast)," 2016. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX\%3A52016SC0418

[6] F. Hanke, R. Guyet, and M. Feenstra, "Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases," *Energy Research & Social Science*, vol. 80, p. 102244, Oct. 2021. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S2214629621003376

[7] M. Barrett, N. Farrell, and B. Roantree, "Energy Poverty and Deprivation in Ireland," *Economic & Social Research Institute*, no. 144, Jun. 2022.

[8] "Boosting Energy Communities massive deployment by equipping local authorities with comprehensive technical assistance cooKboOk, integrated services and capacity buildiNg." [Online]. Available: https://webgate.ec.europa.eu/life/publicWebsite/project/details/101076765

[9] European Commission. Directorate General for Energy. and Tractebel Impact., *Energy communities in the clean energy package: best practices and recommendations for implementation.* LU: Publications Office, 2020. [Online]. Available: https://data.europa.eu/doi/10.2833/51076

[10] M. Walsh, M. Castanie, and S. Giovannini, *Community Energy: A practical guide to reclaiming power*, Oct. 2022. [Online]. Available: https://friendsoftheearth.eu/publication/community-energy-guide/

[11] "The Guidance Notes on the Cooperative Principles." [Online]. Available: https://www.ica.coop/en/media/library/research-and-reviews/guidance-notes-cooperative-principles

[12] "Prefeasibility Study Guidelines." [Online]. Available: https://ens.dk/sites/ens.dk/files/Globalcooperation/prefeasibility_study_guidelines_final.pdf

[13] P. Mehta and V. Tiefenbeck, "Solar PV sharing in urban energy communities: Impact of community configurations on profitability, autonomy and the electric grid," *Sustainable Cities and Society*, vol. 87, p. 104178, Dec. 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2210670722004917

[14] "Stakeholder Engagement." [Online]. Available: https://main.compile-project.eu/products/coolkit/stakeholder-engagement/

[15] J. De Vicente Lopez and C. Matti, *Visual toolbox for system innovation*. Brussels: Climate-KIC, 2016.

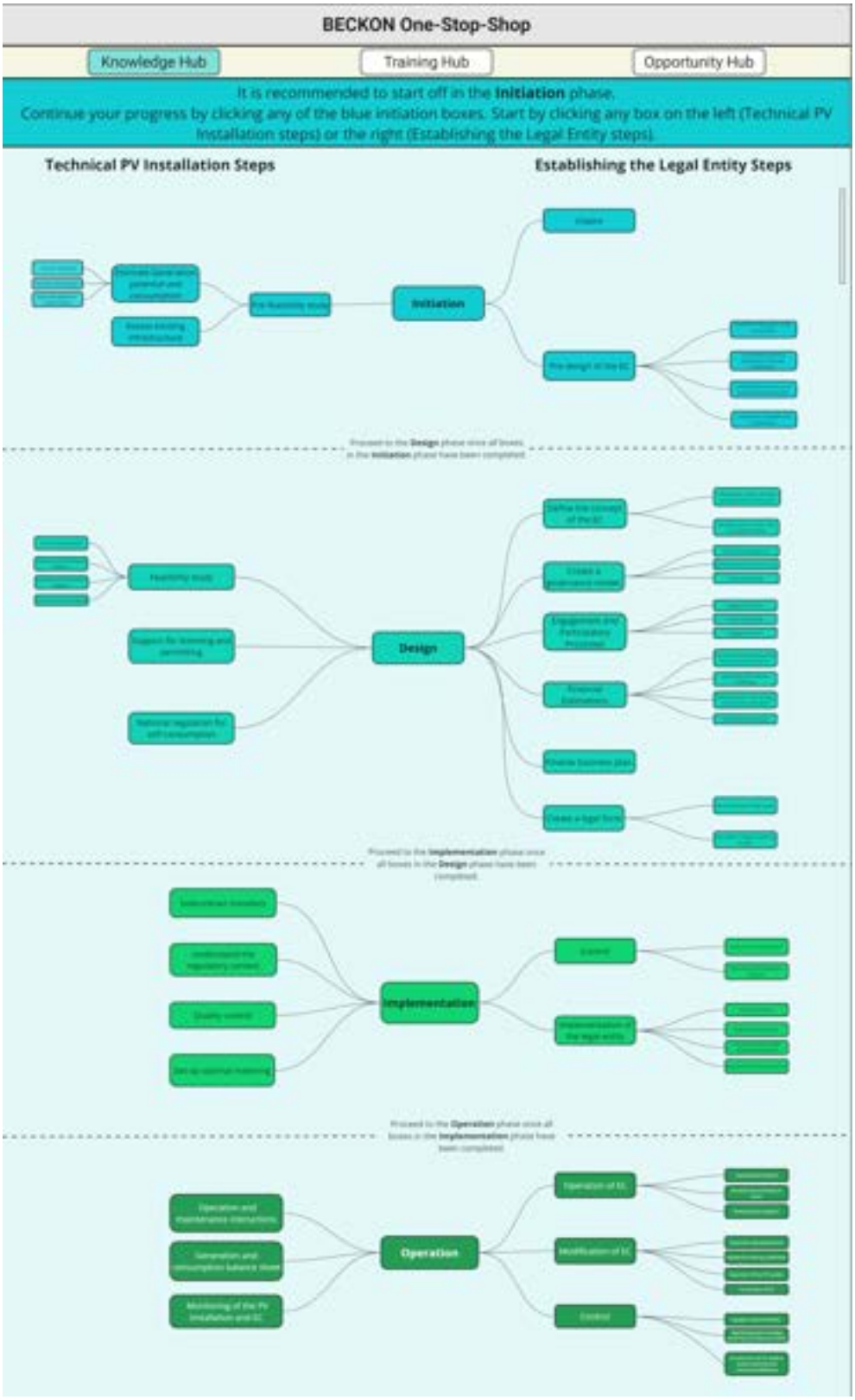

Fig. 2. Entire Cookbook structure.

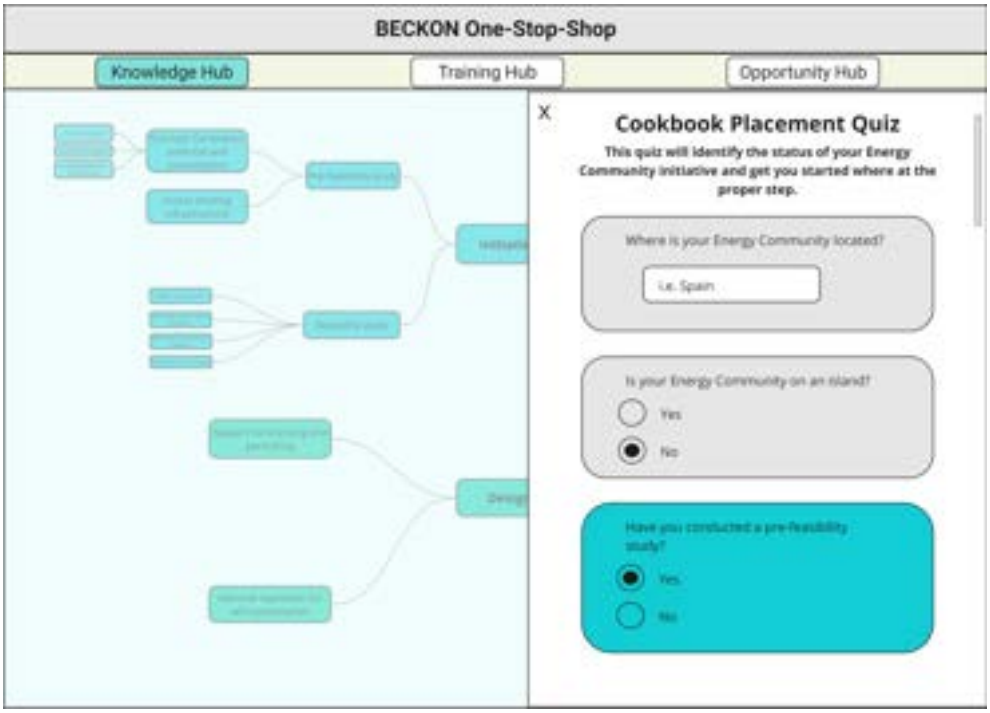

Fig. 3. Placement quiz to determine the status of the EC. This quiz will cover all of the milestones referenced in the ”Placement Quiz” section above.

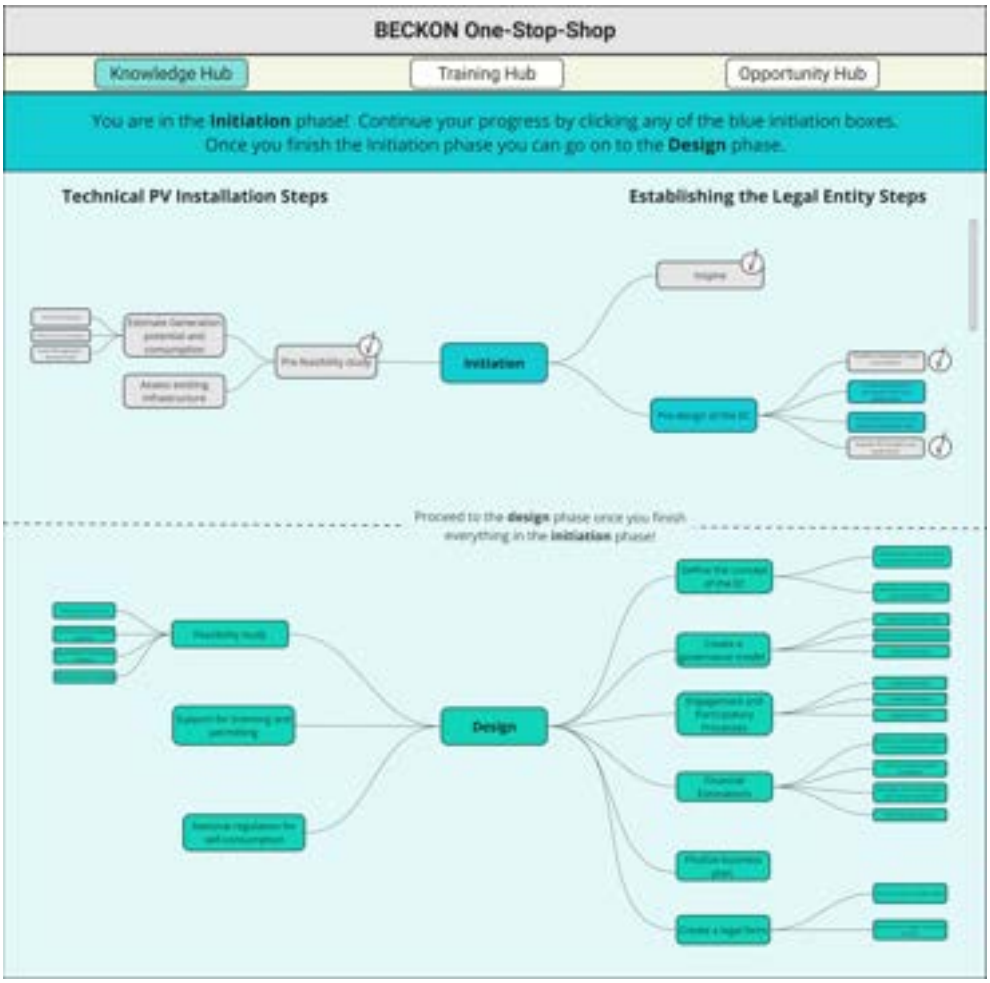

Fig. 4. Sample results from the placement quiz.

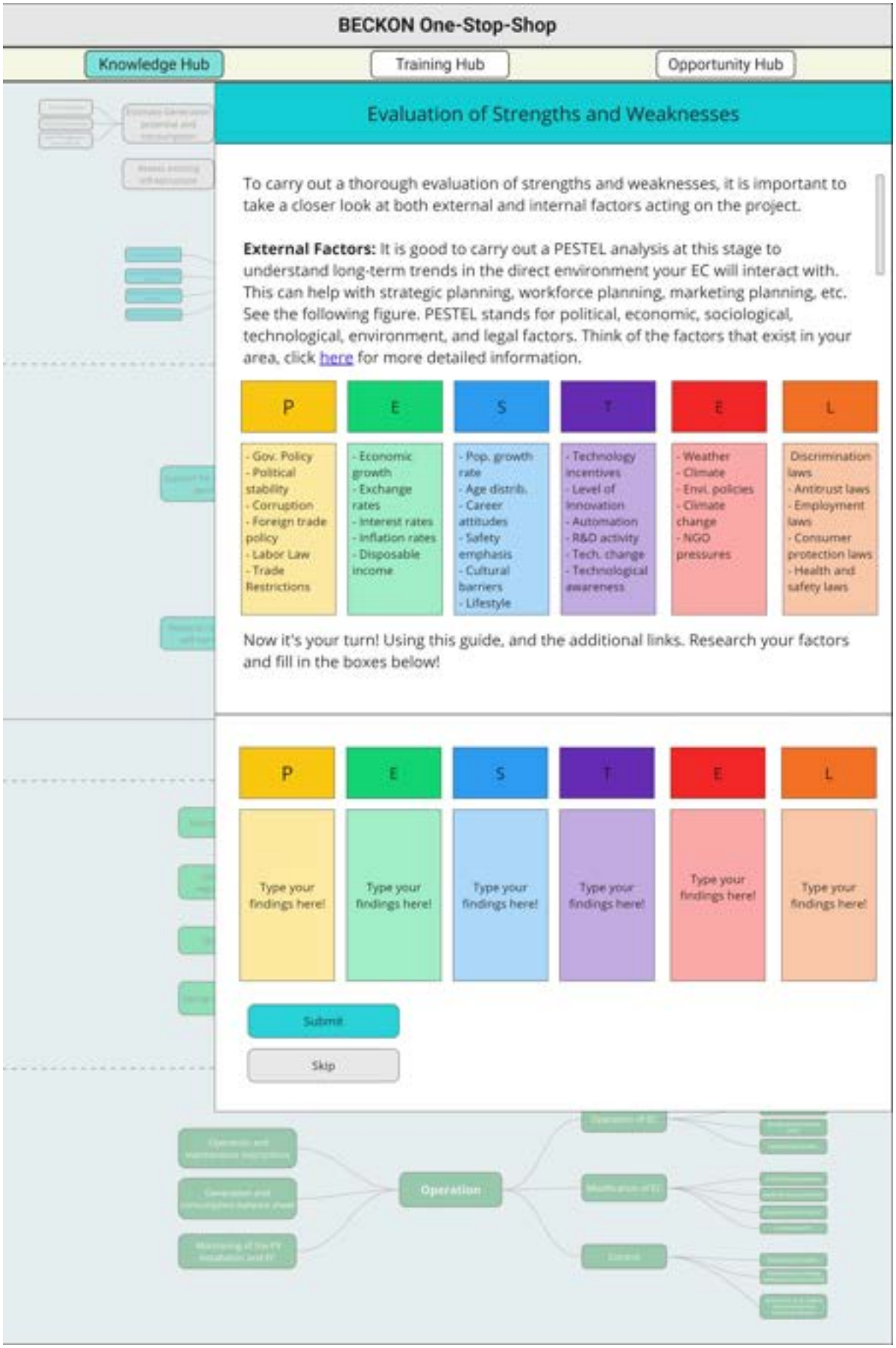

Fig. 5. External factors - PESTEL analysis.

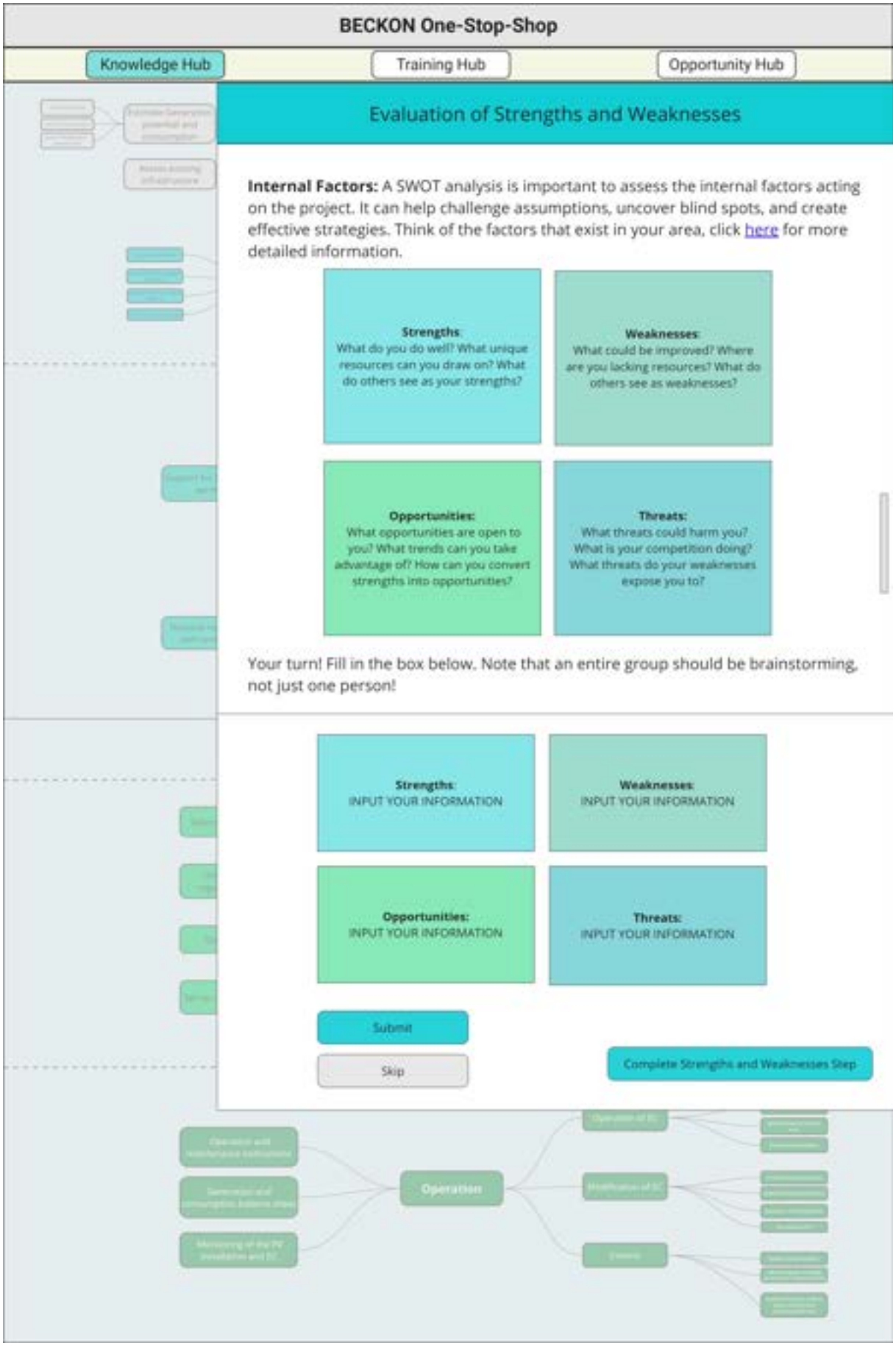

Fig. 6. Internal factors - SWOT analysis.