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Toward a systemic decision-making tool of territorial resilience based on multicriteria methodologies:

The case of the DHDA Project

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Abstract— *The purpose of this research work is to propose a territorial resilience assessment methodology, based on Multi-criteria decision-making (MCDM) methods. Mobilizing a multidisciplinary research approach that encourages interactions between the theoretical concepts and the field practices, we propose a framework of evaluation criteria illustrating the phenomenon of territorial resilience and enabling to observe how it manifests. This methodology is currently implemented at the scale of the French Grand Est-Lorraine Region through a specific case study: the DHDA project (supported by the French government through its program "Plan d'Investissement d'Avenir - Territoire d'Innovation". Through this case study, we aim to highlight a way to pilot territorial resilience at a local scale, by observing, analyzing and understanding field practices in real context.*

Keywords — *territorial resilience, MCDM tool, case study, DHDA project*

I. INTRODUCTION

Over the last decade, the notion of resilience has been popularized among academics and policy makers. This concept, initially developed in an ecological research field is increasingly attracting researchers in regional and local studies [1, 2]. In fact, the concept of resilience has very quickly become a conceptual and analytical framework that explain how spatial economic systems react to shocks and disturbances while preserving their configurations and functions [3, 4]. Despite this growing interest among researchers, the definition of territorial and regional resilience remains unclear and there is still no consensus on the processes and the indicators that can be used to measure it. Moreover, the role of local and regional development policies on the capacity of regions to recover, adapt and renew has been less studied [4 – 7]. Thus, some authors argue that robust evaluations are required to help the decision makers in planning resilient policy decisions [8]. In this respect, this

research work focuses on the role of decision-making tools to guide the territorial resilience planning.

Multi-criteria decision-making (MCDM) is a decision support approach consisting of a set of methods to structure and formalize decision-making processes. It aims to capture the decision maker's choice behaviour and the systemic nature associated to the decision process by modelling and structuring a coherent picture about complex decision problems [9]. The use of MCDM methods allows decision-makers to find the best compromise among a set of possibilities by assessing these possibilities simultaneously according to multiple dimensions (criteria), both qualitative and quantitative [10]. Moreover, it takes into account the interests of all the actors and stakeholders involved in the decision problem. So, MCDM is considered as suitable to deal with complex problems (such as economic shocks, health crises, social problems...) which require multidimensional solutions [11]. Therefore, the mobilization of MCDM approaches for the development of resilient activities in the territory seems relevant. However, the design of tools that take into account the nature of the territory, its activities, its actors and the challenges they face is necessary. Consequently, the research question raised in this paper is how to address the systemic nature of territorial resilience using Multi-criteria and Multi-level decision-making tool?

In this context, the purpose of this research is to develop a territorial resilience assessment methodology, based on a multidisciplinary approach. We propose to mobilize multi-criteria analysis methods from engineering sciences to model a systemic vision of territorial resilience supported by regional and economic sciences. This approach proposes a co-designed systemic and MCDM tool [10, 12] enabling to identify activities with positive impacts on territorial resilience and aiming to facilitate strategic decision-making for public actors.

From policy making perspective, innovation and territorial resilience have been identified as crucial issues for the future sustainable development of territories, and many initiatives supporting this dynamic are emerging [7, 13]. At the French government scale, the program "Plan d'Investissement d'Avenir - Territoire d'Innovation"¹ (PIA-TI) aims to promote the emergence of new territorial development models in France that are propitious to sustainable economic development and the improvement of people's living conditions, while enabling local economic players to be successful. To achieve this, all the actors in a territory are encouraged to work together to propose collaborative and participative approaches and to co-construct innovative and resilient territorial development strategies.

So, this research work was implemented within the framework of the DHDA (Des Hommes et des Arbres) project - supported by the PIA-TI program and carried out at the scale of the Southern Lorraine region in France. This project involves more than 100 public and private stakeholders and aims to boost the territorial economy, accelerate innovation and strengthen resilience around the "tree" resource and the forest industry while mobilizing citizens in a Living Lab (LL) approach [14]. Because of its transversal and complex nature, it is necessary to bring to this project a global and integrative vision of all the actions and activities carried out, through the proposal of an integrative evaluation dashboard. Through the evaluation of the impacts of these actions, the tool will enable public decision-makers to steer and plan future strategic actions to support the most innovative actions/activities with the most positive impact on the territorial resilience. in the scope of action research.

We therefore build our reasoning on empirical observations through a case study approach [15], as an opportunity to illustrate the phenomenon of territory resilience at a local scale, by observing, analyzing and understanding field practices in real context and in a longitudinal perspective.

II. CONCEPTUAL FRAMEWORK

A. Multicriteria Decision-Making and territory management

In the context of territories management, organizations are directly confronted with complex problems to be managed. According to reference [10], MCDM appears as a widely used and popular method to support decision processes in territory management, mainly at a strategic level. The strategic level of decision-making being the basis for tactical and operational decisions [20], it seems particularly crucial to support this decision process through the use of MCDM tools. The use of MCDM methods in the context of territorial management is widely addressed in the literature. The main thematics considered in the decision-making models analysed are related to sustainability as an objective to be achieved in future territorial development projects [21 – 24]. Other studies focus on the concept of smart city implementation and management [25, 26] as well as the relationship with the economic activity of the territory through the notion of business-friendly cities [27]. Some researchers analyse logistic and operational thematics of urban organization: transportation [28], mobility [29] or

waste management [30]. The risk management is also addressed through studies conducted on urban flood resilience [31, 32] or air quality [33]. Finally, strategic urban development or urban planning are also considered [34] as well as territorial resilience assessment [35].

The decision-making process in territorial management includes some particular features related to the human side as well as the territory context. For example, many approaches have contributed to emphasize the importance of involving stakeholders, in particular users and citizens, in the development of collaborative decision-making processes. The participatory approach is usually mobilized in the MCDM approach used [36] to improve the acceptability of changes induced on the territory. Moreover, the concept of Group Decision Making (GDM) is also widely mobilized to describe a decision-making process involving different stakeholder, with the aim to reach a consensus that reflects the opinions of every group member in order to be acceptable by everyone [37].

B. Territorial resilience: a literature review

In the physical and engineering sciences, resilience refers to the ability of an element to return to its original form after being subjected to a shock or a stress [42]. Here it is the resistance and reaction of materials as well as the speed of its recovery after the shock, that are considered. This purely technical approach was applied by reference [43] to ecological ecosystems, according to which a resilient ecosystem is capable of absorbing the effects of a disturbance and returning, after a certain period of time, to its initial state of equilibrium. Ecological resilience is therefore linked to both the time and the speed of return to the previous state. In the light of this reasoning, several definitions have been proposed, such as that of Reference [44] according to which "resilience is the capacity of a system to absorb disturbances and reorganize itself while undergoing changes in order to maintain essentially the same function, structure, identity and feedback".

From a social point of view, resilience in relation to humans conveys to the capacities that are necessary for his adaptation in the face of hazards that threaten him, such as extreme natural disasters [45]. In this same idea the notion of resilience has been used for the understanding of the modalities of management of disruptive or destructive risks (natural, industrial risks etc.) faced by societies and local communities [46].

Resilience has also found its place in the conceptual and analytical framework of regional and urban economic studies. This socio-economic vision, which aims to understand the reaction of local and regional economies to different crises (political, monetary, technological, climatic, etc.), includes the territorial dimension of resilience. The effects of these crises (of national or global origin) directly affect local ecosystems (cities, territories, regions...) generating societal consequences (recessions, unemployment, pollution, relocations...) [3, 4]. Several specialists in territorial economics have therefore taken up the issue by focusing their analyses on the capacity of territories to recover from major economic crises. For example, [47] examined the role of economic structure and

¹ <https://www.banquedesterritoires.fr/territoires-dinnovation>

competitiveness. Others such as [48] have shown the importance of diversification of local economic activities (especially of the related variety) in reducing these recessions and consequently strengthening territorial resilience. The notion of resilience thus seems to be relevant for analyzing how regions and local communities react to and recover from shocks. In this context, it is transposed to a more systemic scale, that of a territory. Jonas [49] considers "resilience as an internal property of a territory, which "must always be juxtaposed with the external risks to which places and regions are exposed, posed by global investment flows, and environmental and economic risks."

Among the factors that increase a territory's resilience to shocks, four have been identified [7, 50]:

- Resistance, identified as the ability of a territory to withstand exogenous shocks
- Recovery, which measures the speed with which the territory rebounds after a negative shock
- Reorientation, which measures the degree of change achieved by a region after a shock (by modifying its economic sectoral composition, for example)
- Renewal, which is the capacity of a regional economy to innovate and renew its growth trajectory.

A resilient territory is thus characterized by a multidimensional capacity to absorb shocks, adapt or move to a new path of sustainable development [7].

Otherwise, the resilience of a territory can be weakened by factors that oppose all forms of innovation and learning. Excessive power and excessive centralization of decision-making can run against the principles of resilience [42]. The dynamic and evolving, multidimensional and multi-actor character of territorial resilience goes hand in hand with the presence of a shared governance and decision-making system that takes into account the components of the territorial ecosystem and their interactions (economic actors, institutions, regulations, policies, technologies...) in order to plan and manage in a collective and interdisciplinary manner the transition towards more innovative and sustainable development paths that respond to the crises that territories face [51, 52].

C. Literature gaps

Despite the growing interest of researchers in the concept of territorial resilience, there is still ambiguity about what exactly resilience means and there is still no consensus on the processes of its implementation and the indicators that can be used to measure it. Moreover, the role of local and regional development policies on the capacity of regions to recover, adapt and renew has been less studied [5 - 8]. Some authors argue for the need to develop robust assessment tools to help policymakers plan resilient policy decisions [8]. In order to bridge this gap, recent studies have focused on the role of MCDM tools in strengthening territorial resilience and accompanying territories towards the development of a dynamic and shared governance facilitating the planning and management of resilient local systems [52]. However, this research dynamic is still less addressed. Consequently, to fill the research gaps we mobilize the theoretical and empirical corpus around MCDM analysis and explore its potential in territorial resilience. Our objective is to design an MCDM

tool intended to guide public policies in territorial resilience planning. this tool will be applied at the scale of the French Grand Est- Lorraine Region.

III. METHOD

Our methodological framework involves a multidisciplinary background and exploits the resultant synergies by mobilizing multi-criteria analysis methods from engineering sciences (1) to model a systemic vision of territorial resilience supported by regional and economic sciences (2).

We choose to implement our research in the scope of action research. We build our reasoning on empirical observations, collected since several years through the mobilization a solid background in Living Lab approach (Figure 1). The DHDA project represents a valuable research field enabling the qualitative analysis of a context-dependent phenomenon in a specific period of time, in order to understand how it manifests [15]. Therefore, we adopt a practice-oriented approach to illustrate the general principle of territorial resilience [53].

A. Case study description: The DHDA project

The DHDA project was launched in April 2019 will last until 2026. DHDA stand for (Des Hommes et des Arbres – meaning Humans and Trees – the roots of tomorrow).

Southern Lorraine benefits from the services provided by a great diversity of tree-covered ecosystems. It indeed represents a large forest capital, covering nearly 900,000 hectares. It also includes a vast array of natural grasslands, gardens and orchards. The Lorraine wood sector has a complete production and processing supply chain to which the profession is highly structured: inter-professional organizations, competitive clusters, leading timber construction groups, furniture SMEs and start-ups, as well as numerous support bodies [54]. However, the Lorraine region face specific threats. It is obviously concerned by the effects of global warming and land use and must initiate the transition of its productive and industrial system, in harmony with natural balances and citizens' expectations. Moreover, it must cope with public attention increasingly focused on the societal and environmental issues of the forest, to the detriment of a more global perception that also includes economic issues [54]. In this context, the main ambitions of the DHDA project are to boost the territorial economy, to accelerate innovation and to strengthen resilience around the "tree" resource and the forest industry adopting a Living Lab approach [14]. So, it mobilizes researchers, companies and citizens in a societal, economic and environmental approach in order to show how a territory and its partners can experiment and propose new forms of cooperation.

Thus, during the next 7 years, the stakeholders involved in the project DHDA will carry out local actions on the territory, in relation to 5 axes of resilience identified as strategic for the DHDA territory:

- Valuing the services provided by trees
- Fostering sustainable and resilient tree ecosystems
- Accelerating innovation in a sustainable and high-performance forest/wood industry

- Using wood and natural materials for the living environment and well-being
- The augmented factory aiming at Mobilizing and integrating citizens and users into a global innovation network.

Because of its transversal and complex nature, it is necessary to bring to the DHDA project a global and integrative vision

of all the actions carried out. Thus, our objective is to design a strategic evaluation dashboard to pilot the initiatives developed during the DHDA project. This case study is an opportunity for us to illustrate the phenomenon of territorial resilience at a local scale, by observing, analyzing and understanding field practices in real context and in a longitudinal perspective.

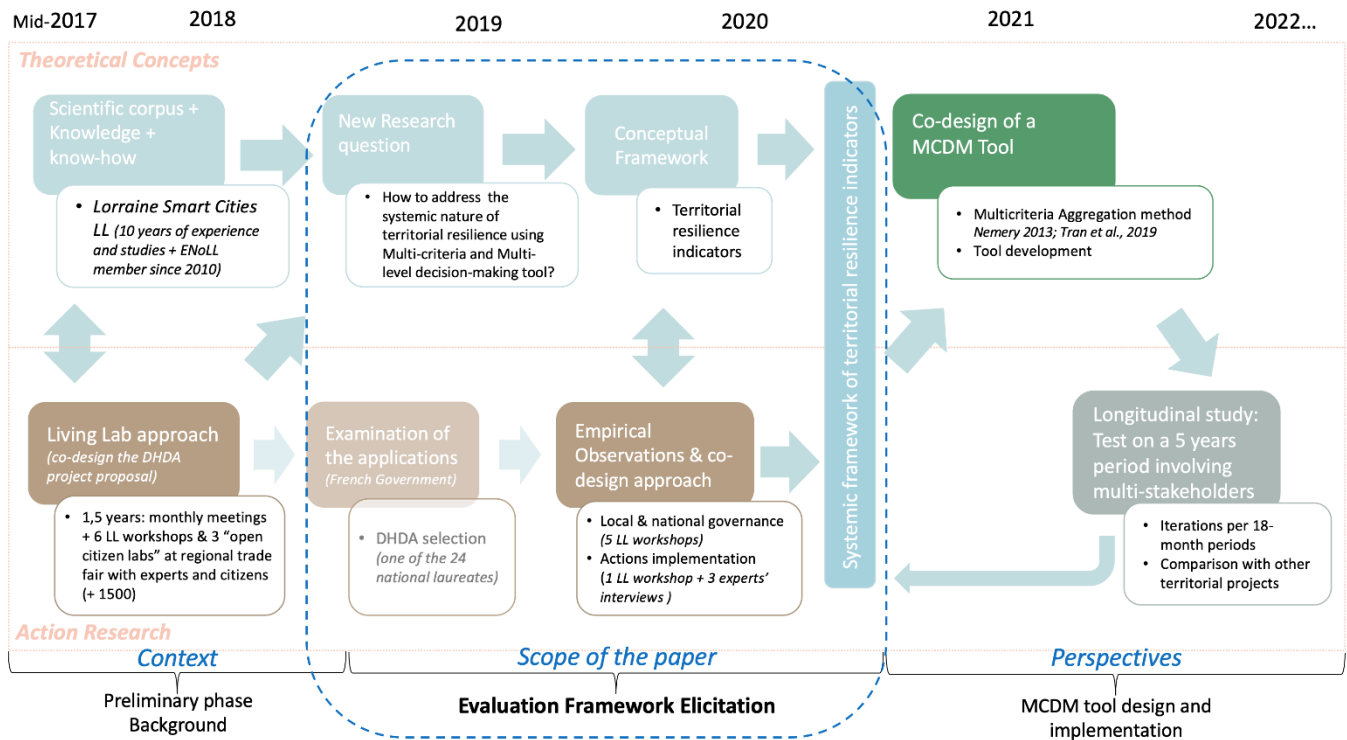


Fig.1. Research Approach

B. Research Design

Our research is based on the interaction between empirical observations from an action research approach, combined with inputs from a conceptual background that feeds the different phases of the approach (Figure 1).

This approach began with our involvement in the DHDA project in mid-2017. This first preliminary phase aims to build a proposal for a call for projects, in order to submit the DHDA project as a candidate to the PIA-TI program. This preliminary phase is based on a background mobilising both a scientific corpus and a know-how resulting from 10 years of experience in the LL approach (Lorraine Smart Cities LL, member of ENoLL since 2010), and results in the implementation of monthly meetings with the DHDA project partners, as well as the organisation of LL workshops and open citizen labs between 2017 and 2018. This phase leads to the drafting of a shared proposal for the DHDA initiative. Moreover, it highlights the importance of implementing monitoring and management tools for a territorial project of this scale and thus opens the way to the research question at the heart of this paper: How to address the systemic nature of territorial resilience using Multi-criteria and Multi-level decision-making tool?

This preliminary phase represents the background of this study and will be addressed in a dedicated research work focussing on Living Lab approach. This paper focuses specifically on the second phase of this research approach: The territorial resilience evaluation framework codesign.

The second phase starts in 2018, following the selection of the DHDA project as a laureate of the PIA-TI initiative. It concerns the co-design of a framework allowing to evaluate the impact of the DHDA project on its territory. The aim is to combine an action research approach with conceptual contributions concerning the evaluation of territorial resilience. This theoretical approach enables some correlation between specific empirical observations and general theoretical concepts by providing a set of territorial resilience criteria to be considered. In parallel, several empirical initiatives carried out in the field allow interventions at different levels.

- The first level concerns the local and national governance of the DHDA project, through the identification of their needs in terms of monitoring and management of the project. Indeed, the proposed indicators framework must allow the local governance of the DHDA project to monitor and measure its impact on the territory in view of the strategic ambitions that have been defined (see

section III A). This stage of needs identification was carried out with the steering committee during the preliminary phase of co-construction of the proposal for the call for projects. It is based on the realization of several workshops during which the principle of evaluation was co-designed. On the other hand, the proposed reference framework must also be in line with the French government's requests concerning reporting at national level. To this end, 5 LL workshops were conducted in order to collectively identify, at the national level, the relevant reporting indicators that would be shared with all the PIA-TI laureates. These indicators should therefore be de facto included in the DHDA project's evaluation framework.

- The second level concerns the operational implementation of the actions within the DHDA project. More specifically, several interviews with experts in territorial assessment were carried out in order to highlight the relevant indicators to be included in the territorial resilience assessment framework. A LL workshop was also carried out with a panel of action leaders involved in the DHDA project in order to collect their vision of the impact of their actions on territorial resilience and how to assess it. According to the identified issues or elements that appear to be crucial during the workshops, a certain number of themes can be deepened coming back to the literature in order to guarantee both the robustness and the operational character of the resilience indicators framework.

Finally, the last step concerns the design of a decision-making tool based on multicriteria analysis methods. The objective of this phase is to transform our set of indicators in a decision-making tool dedicated to territory resilience improvement. Including a multicriteria and a multiscale dimension, this decision-making tool addresses in a systemic way the thematic with positive impacts on territorial resilience, enabling the management of a territorial project portfolio to ensure its consistency and completeness on a longitudinal perspective. This tool relies on an adaptive weighting process of the strategic thematic to be considered and mobilizes a multicriteria aggregation method based on a geographical and a temporal perspective. Therefore, it promotes a uniform distribution throughout the concerned territory in a specific period of time as well as a standardized assessment framework to provide some trade-offs while selecting the actions to be carried out. This phase also includes the implementation of the decision-making tool on a longitudinal period. Considering the specific DHDA project implemented at a regional scale and during a defined period of time, we will be able to confront the developed decision-making tool to a real context in order to experiment its applicability and its relevance in a real territorial resilience strategy implementation context. The several iterations we are going to make are opportunities to make some retroaction and propose some modifications, improvements to our set of indicators and to our mathematical model. This implementation also opens a research perspective with the

potential replication of this evaluation process, enabling to make some comparison with other territorial projects.

IV. INTERMEDIARY RESULTS

Based on the research approach presented in figure 1, the second phase of territorial resilience evaluation framework co-design has been implemented. The results are presented in order to highlight both the governance and operational levels, as considered in section III. The first outcome led to the proposal of a multi-scales' architecture for the evaluation tool, enabling to put forward the impacts of the DHDA actions on the territory (section A). Then the second outcome concerns the co-design of the evaluation framework through the building of a shared vision of territorial resilience coming both from the action leaders involved in the DHDA project and the national sponsors requirements regarding to the PIA-TI initiative reporting (section B).

A. *Local Governance needs: A multi-scale evaluation Tool*

During the LL workshops and monthly meeting conducted, the steering committee of the DHDA project expressed the need of a strategic dashboard acting as a project management tool. It represents the portfolio of actions carried out and act as a guide for conducting future strategic actions. To fully meet the needs of the steering committee, this tool relies on a set of indicators enabling the evaluation of the impacts of these actions with regard to the main strategic axes of the DHDA project. More precisely, the evaluation of the impacts is provided at different scales (Fig. 2):

- MICRO scale: evaluating the impact at the scale of a specific action carried out. The impacts are assessed by the action leader, who will qualify its potential impacts on the five strategic axes of the DHDA project according to the defined evaluation framework.
- MESO scale: representing the impact aggregated at the scale of specific geographical areas from the territory, considered as beneficiary territories.
- MACRO scale: considering the longitudinal character of the project and aggregating all the impact in the considered period of time, according to the strategic axes of the project.

This multi-scale approach is particularly useful in a territory evaluation perspective, because it allows to look closely at the patterns and consequences of the hierarchical structure of the considered impacts [55]. It enables the integration of local effect measured at the micro scale which may considerably improve prospective power of the model. Moreover, a multi-scale model enables to analyze the role of external factors, depending on the geographical context of a beneficiary territory for example. This spatial aggregation (meso scale) enables to show the orientations of the actions carried out and their distributive impacts in order to identify opportunities or gaps [56]. Finally, the macro aggregation scale enables the identification of the patterns of the impacts, showing territories or axes that

have been particularly favored in a specific period of time. Taking these patterns into account, it is then possible to rebalance periodically the actions that have to be carried out, in order to reach the project ambitions.

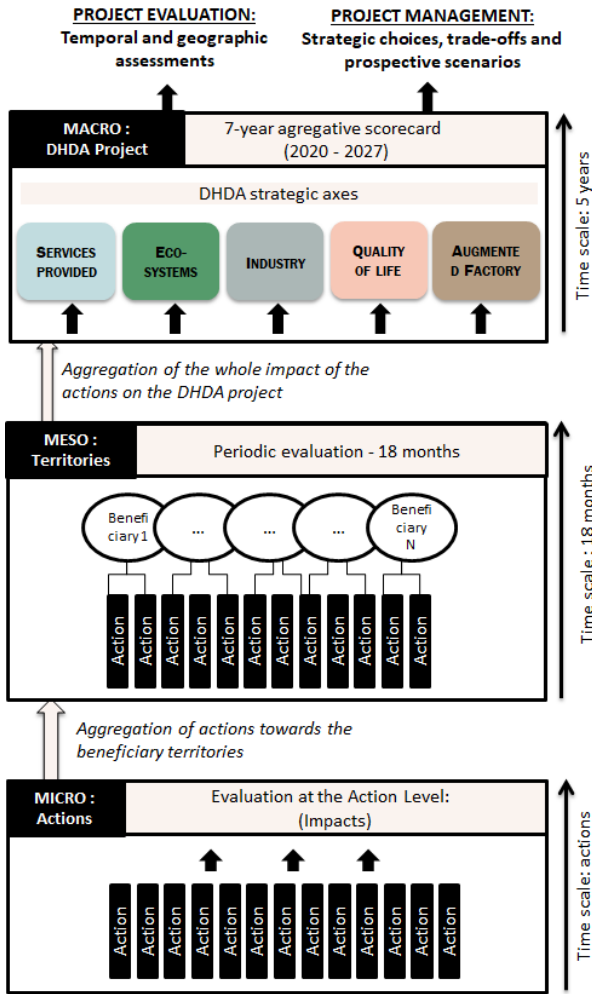


Fig. 2: Multi-scale evaluation approach

B. Territorial Resilience: Evaluation Framework of the actions' impacts

Because of its multi-scale and multicriteria character, the territorial resilience evaluation framework is built according to a hierarchical structure based on 3 levels (Fig. 3):

- the strategical axes of the DHDA projects as dimensions to be assessed.
- evaluation criteria defining the ambitions of the axes, in terms of topics to be addressed.
- operational indicators, enabling to measure each criterion according to a numerical value to be aggregated.



Fig. 3: Framework architecture

As mentioned in our methodological section, the framework design relies on different sources, combining iteratively theoretical concepts and empirical observations and confrontations.

The axes level is provided by the DHDA project governance. Then, the criteria level is built combining an explorative field observation and the mobilization of a theoretical background on territorial resilience assessment (Section A). Finally, the indicators level is addressed, according to an iterative empirical confrontation of the criteria framework. It relies on expert's interviews and includes national sponsor requirements to be considered for the DHDA monitoring (Section B).

B-1 - LL workshop with action leaders

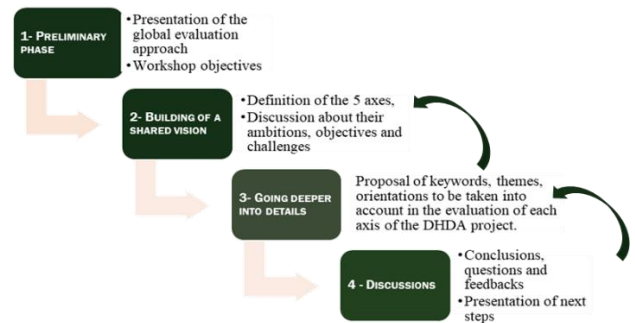


Fig. 4: LL workshop steps

In order to perceive the action leaders' point of view regarding the evaluation approach of the DHDA project, we organized an explorative LL workshop with some of the DHDA stakeholders. This workshop took place during the annual general meeting of the project and was based on a voluntary participation. It was conducted in a virtual format because of the COVID-19 sanitary situation.

Our ambitions were to initiate a co construction dynamic with them, enabling creation of a shared vision of the project evaluation approach. This explorative workshop has been conducted with 4 stakeholders of the project following different phases (Fig. 4).

After a preliminary phase dedicated to present the global evaluation approach to the participants, they were asked to express their own understanding of the several axes of the project: (1) Services provided by trees; (2) ecosystems; (3) Industry; (4) Quality of life and well-being and (5) The

augmented factory. This phase was an opportunity to validate the global structure of the evaluation framework, and to initiate the discussions about the main ambitions and goals of the project related to each respective strategic axis.

Then the third phase goes deeper into details, by letting the stakeholders propose some keywords, thematics, orientations that they consider as really important to be taken into account in the evaluation of the axes. For that purpose, we relied on a collaborative tool making easier the interactions in the group (Mural).

This collaborative phase was a way to identify some evaluation patterns to be deepened in order to build the framework. For example, the industry axis has been described through several keywords related to job creation, digitalization or innovative processes. It highlights specific orientations to consider in the criteria identification, related to the attractiveness of the territory in terms of innovation and best industrial practices. It also put forward an ambition concerning both social and economic impacts, favoring the dynamism of the region.

Finally, the last phase was dedicated to feedbacks on the workshop, and it was also a way to identify some contacts that would like to participate in the next steps of our analysis.

Based on the empirical observations provided by the participative workshop, an evaluation framework has been proposed (Table I) and confronted to the scientific literature on territorial resilience in order to go deeper into the patterns and orientations proposed by the DHDA stakeholders.

TABLE I. CRITERIA EVALUATION FRAMEWORK

DHDA strategic axes	Resilience Criteria	Sources
Services provided by trees	Regulation	[57] [58] [59] [60]
	Supply	[61] [60]
	Cultural	[62] [60]
Ecosystems	Good management practices	[63] [64] [65]
	Sustainability	[66], [67]
	Reproducibility / adaptability	[65]
	Guidance / support	[69] [73]
Industry	Diversification (related variety)	[57] [69] [6] [47]
	Attractiveness	[57] [70]
	Circular economy: <i>industrial ecology, industrial symbiosis, functionality economy, resources/waste efficiency</i>	[57] [66] [71] [67]
	Accelerating innovation/foresight	[72]
Quality of life and Well-being	Health – risks prevention	[57] [66]
	Well-being / leisure	[57] [66] [62] [73]
	Urban planning/building	[66], [73]

The augmented factory	Co-design – co-innovation – user involvement	[74], [75]
	Community – collective identity - involvement	[57] [76], [77] [66]
	Open innovation - sourcing - Citizens sciences	[78], [79]
	Dissemination of information/ knowledge - mediation/ awareness	[80], [81]
	New forms of collaboration / governance	[66], [82]–[84]

B-2 National sponsor reporting indicators

The last source of information to be exploited in the evaluation framework design comes from the national governance of the PIA-TI program. There are indeed several projects carried out in the national territory of France. DHDA is one of them and the national sponsor of the program organizes some transversal workshops with project leaders from all the French regions in order to identify the relevant indicators to measure the global impact of the program at the national level.

Several topics are addressed: citizens involvement, replicability, industrial supply chain, impacts on biodiversity and finally shorts channels. During these workshops, some discussions are conducted in order to choose which types of indicators are the best one or the most suitable to measure properly the topics mentioned. Each workshop is focused on one specific topic and lead to the identification of a single indicator chosen collectively. These indicators must be directly included in the evaluation framework of DHDA, because it is a specific demand of the national governance of the program.

The workshops organized at the national level enable to start identifying quantitative or qualitative indicators making possible to assess the resilience criteria of the proposed framework. This phase is currently in progress and represent a perspective to be achieved in this research work. To perform this phase, the proposed criteria framework has then to be confronted to the field once again. First, others participative workshops will be organized, enabling to both check the robustness of the framework and complete it if needed. Secondly, thematic interviews with experts are planned, in order to determine operational indicators enabling to measure each of the mentioned criteria.

V. DISCUSSIONS AND CONCLUSIONS

In this article we discussed the importance of co-designed multi-criteria decision-making approaches in the transition towards more resilient local ecosystems. In order to fill the gap in the literature on this issue we propose a decision-making tool based on territorial resilience indicators. Our contribution is twofold:

On the theoretical level, we contribute to the enrichment of territorial resilience indicators that are still relatively unexplored by academics. To do so, we mobilize multidisciplinary theoretical corpus combining territorial and regional economics and engineering sciences.

Empirically, we confront this tool to a concrete case of application through the DHDA project allowing a strong interaction with the field at the scale of the South Lorraine region, in France. This study also opens the possibility of a longitudinal analysis, based on a periodic iteration during 5 years allowing to analyze the evolution of the impacts of the project in time.

The originality of the micro, meso and macro scales of analysis taken into account in this study also opens up new perspectives both theoretically and for policy makers. The co-designed multi-scale, multi-criteria tool can be an asset for the orientation of territorial development strategies towards smart specialization [85]. Indeed, smart specialization is based on the implementation of innovation policies that enable the development and growth of the regional economy. It is a regional strategic framework that promotes the concentration of public resources in particular activities. The objective is to prioritize and preferentially support specific economic activities that are potentially promising in terms of discoveries, knowledge spillovers and structural changes [86].

These activities should be based on the existing capabilities, asset skills, and competitive advantages of a city, region, or country, and may cover a new technology, discipline, field, or subsystem [86]. It is the activities that are targeted by smart specialization (neither sectors nor a single company), and it is private actors who detect entrepreneurial opportunities, especially technological and commercial ones. Instead, public planning plays a role in guiding private sectors by providing: public investment in research and innovation, methods and means to ensure the preconditions for entrepreneurial discovery [86]. Smart specialization thus carries significant potential for strengthening territorial resilience. Its strategies improve the competitive advantages of territories by enabling them to cope with shocks and create new territorial trajectories while considering the historical anchoring of the processes (economic, political and social) that have formulated their current dynamics [5, 85].

The systemic decision-making tool will aim to identify the activities that have the most positive impacts on territorial resilience and will thus direct investment and accompaniment efforts to support them. This illustration of smart specialization on the scale of the South Lorraine region will make it possible to observe, analyze and understand field practices for improving territorial resilience in a real context.

However, our evaluation framework has some limitations, particularly coming from the empirical observation that raises many questions about the generalizability of the results. In order to highlight findings from the research work carried out on the specific territory of the DHDA project, it seems necessary to consider a comparison with other territories. This comparative approach is an interesting working perspective because it emphasizes a both theoretical and empirical paradox. On one hand, an explicit demand from the national governance of the DHDA project concerns the replicability of the evaluation process for all projects conducted at the national level. On

the other hand, a contextualization of the method appears as a crucial point in a smart specialization approach, in order to fully correspond to the specificities of a territory. Our methodology could then be replicated in several territories with characteristics more or less related to the one of the DHDA project, in order to question the generalization of the approach and the results obtained.

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