Understanding Just Transition Governance: A Comparative Study Using Fuzzy Cognitive Mapping in Coal Regions

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Abstract

Background: Coal-dependent economies are confronted with a rapid transition to sustainable energy systems, a complex process that requires end-to-end governance models that integrate economic, social, and environmental policies. In the course of structural change of coal-dependent territories, governance institutions have to orchestrate a just transition that minimizes socio-economic disruption, promotes spatial equity, and encourages participatory decision-making (Stevis & Felli, 2020). The transition involves active participation of various stakeholders, comprising government agencies, industry actors, civil society, and universities, that form the long-disputed quadruple helix model (Carayannis & Campbell, 2012). The stakeholders have a significant role in informing policy development, facilitating resource allocation, and ensuring equitable results in economies transitioning away from coal. The transition to clean energy is not only a technological transition, but a deeply political and social transition that needs cautious governance arrangements. Just transition policies should respond to the legacy of reliance on coal industries that have shaped the local identity, working culture, and socio-economic relations (Heffron & McCauley, 2018). The current research aims to analyze the effectiveness and fairness of governance approaches in the transition towards a post-coal economy. As coal-dependent regions move towards sustainable energy sources, governance arrangements that incorporate equity, spatial justice, and deliberative democracy are becoming ever more crucial to study. This research applies a comparative model in three significant coal regions—Western Macedonia (Greece), Stara Zagora (Bulgaria), and Silesia (Poland)—in order to examine governance strategies and their impact on spatial justice and local involvement. To this end, extensive field

work has been conducted, including 42 expert interviews with quadruple helix model members and utilized Fuzzy Cognitive Mapping (FCM) with more than 20 experts in order to identify key just energy transition governance determinants.

Theoretical Framework: The Just Transition Mechanism and European Green Deal are policy frameworks that are essential policy instruments assisting regions in pursuing a just transition (European Commission, 2019). Despite the provision of funding and strategic directives, nevertheless, existing disparities in governance effectiveness, institutional capacity, and the extent of stakeholder engagement persist, resulting in divergent transition results among regions. A central argument in ensuring good governance in regions that previously depended on coal is the concept of spatial justice which involves efforts to reduce disparities between areas and ensuring economic and environmental gains are equitably distributed (Soja, 2010). In these regions, economic transitions can exacerbate prevailing social and economic inequalities if the governance structures fail to address local concerns and engage individuals in decision-making processes (Bouzarovski & Simcock, 2017). Moreover, deliberative democracy models, in which open decision-making and stakeholder participation are emphasized, have been advocated increasingly for just transition governance (Dryzek, 2002). Through the inclusion of participatory governance models, territories can enhance social acceptance, legitimacy, and policy effectiveness of energy transitions (Newig & Fritsch, 2009). Fuzzy Cognitive Mapping is a participatory modeling approach used for the study of complex systems in the sense of capturing expert knowledge and causal relationships within decision-making contexts (Kosko, 1986). The FCM allows uncertainty and subjectivity to be expressed and for this reason it is best suited for governance research where different, sometimes contradictory, opinions dominate (Papageorgiou & Salmeron, 2013). Since the Just Transition policy is concerned with harmonizing economic, social, and environmental goals and adopting a range of various stakeholders' perceptions, FCM presents a solid methodology to capture perceived interdependencies between components of governance. It has a mechanism for theories such as deliberative democracy and spatial justice in using stakeholder-sensitive perspectives and the application of scenario analysis (Giordano et al., 2020).

Empirical Methodology: Fieldwork in the three coal-transition regions to capture the situation of just transition governance structures. 42 in-depth, semi-structured interviews with experts representing government departments, industry, civil society organizations, and academics—key actors of the quadruple helix model were conducted. The selection of interviewees was based on a purposive sampling strategy for inclusive representation of perspectives towards just transition governance. Thematic coding was applied to the transcripts of interviews to identify governance challenges and best practices. FCM workshops were subsequently held with more than 20 governance experts following the interviews. The participants were asked to plot causal maps of causal connections among primary governance variables, including policy frameworks, stakeholder participation, economic incentives, and spatial justice considerations. Consolidated cognitive maps provided a graphic and analytic overview of governance types perceived, covering commonalities and issues present in different regions. Scenario simulation was then

undertaken to estimate the likely impact of alternative governance forms on balanced transition outcomes.

Findings and Discussion: The initial results demonstrate significant regional governance performance imbalances. More specifically in Western Macedonia there exists a good institutional framework but there are low levels of public engagement, whereas the region of Silesia has an industrial diversity plagued by socio-economic disparities. On the other hand, Stara Zagora, the findings show fragmented governance structures, which translate into fragmented decision-making and a slow process in the just energy transition. Through the FCM analysis some key leverage points for enhancing equity have been identified, such as strengthening participatory governance arrangements and aligning policy incentives with local agendas. These findings emphasize the contribution of spatial justice and deliberative democracy to guiding sustainable transitions. The system through the FCM modelling demonstrates a moderate level of interconnectivity where business capacity and monitoring mechanisms are essential but the awareness activities have to be bolstered. Through the structured setup of the system, focused interventions in targeted regions can trigger impressive improvements in energy transition outcomes with a well-proportioned, robust, and sustainable system. One key observation is the system's complexity score of infinity, indicating that the relationships between components may be highly nonlinear or unpredictable. This indicates that the system is prone to feedback loops or cascading effects, where changes in one factor can create ripple effects across multiple elements. Taking this complexity into consideration, policymakers should prioritize stable and adaptive strategies that allow for flexibility in addressing unexpected challenges. For strengthening the resilience and performance of the system, economic components such as income support and regulation of energy prices should be made robust because they carry the most weight. In addition, local mechanisms of energy self-sufficiency and job creation can be enhanced to offer greater resistance to risks of variable energy prices and demand as well as cultural and public acceptance must be taken into consideration since public acceptance and long-term sustainability of energy policy depend on them. Additionally, there must be a move to stabilize employment through the training of human resources and diversification of the economy in order to reduce its reliance on external economic trends. In conclusion, this analysis emphasizes the underlying significance of economic and energy-related determinants in shaping employment outcomes and system stability as a whole. The extremely high complexity of the system suggests the need for a multi-dimensional, flexible policy approach to address interdependencies in an optimal manner. If these the key influencing factors such as economic stability, energy prices, and employment creation measures could be effectively addressed, policymakers can create a more sustainable and equitable energy transition while achieving long-term workforce resilience.

Conclusions: This study contributes to just transition research by applying FCM to the study of governance arrangements in coal-transition regions. Through the integration of participatory modeling and expert insights, this research provides a more in-depth insight of governance processes and their implications for equity and spatial justice. Future research is invited to expand FCM applications to other transitioning economies to scale up governance models and inform policy interventions for facilitating equitable energy transitions.

Extended Abstract References

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