

Transformative Innovation Policy: Towards An Integrated Approach For Managing Sustainability-Based Transitions In Public Policy (The 2030 Sustainable Development Agenda As A Model)

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Abstract

This study aims to investigate the extent to which transformative innovation policy contributes as an integrated approach to achieving transformative change in managing transitions towards sustainability, in light of the need for public policy making to achieve the Sustainable Development Goals (SDGs).

The study concluded that despite the crucial role played by transformative innovation policy (TIP) in the process of shifting towards sustainability in the context of the 2030 Agenda, its adoption as an integrated approach for systemic transformation requires addressing numerous practical and political challenges. Furthermore, this policy needs to be integrated within a broader regulatory and political framework as part of the overall policy mix.

Keywords: Transformative innovation policy, transition towards sustainability, Sustainable Development Agenda, transformative change, integrated approach.

Introduction:

Fulfilling the Sustainable Development Goals by 2030 necessitates new strategies and solutions to address the complex problems they emphasize and to accelerate present progress across all goals. In this context, the field of Science, Technology, and Innovation (STI) has been adopted as one of the seven primary areas of action to fulfill the Sustainable Development Goals (SDGs), in light of the raising recognition in policy studies and innovation policy domains that sustainability

transitions require new approaches. This is because modern societies are mainly supported by different socio-technical systems (for instance, transportation, energy, food, water, healthcare, and communications), which increases the need for radical and coordinated changes in their fundamental mode of operation.

Socio-technical transitions, such as those resulting from transitions towards sustainability, have become a focus of increasing global attention necessitating special consideration from political sciences. When moving from traditional priorities like economic growth and competitiveness to new challenges such as social inclusion and environmental sustainability, political variables become significant as policy-making processes become more complex. This demonstrates the need to change how governments apply Science, Technology, and Innovation (STI) policy as a driver of growth, development, and well-being, going beyond simple concepts of economic growth or the pursuit of pure science. On this basis, policymakers and researchers increasingly frame innovation policy as a field that can and should contribute to addressing societal challenges, driving transformative change, and integrating social, economic, and environmental sustainability in an effort to tackle the ambitious challenges embodied in the Sustainable Development Goals.

The connection between innovation policy and the transition towards sustainability is explicitly explained through Transformative Innovation Policy (TIP), which is often referred to through concepts such as "mission-oriented" or "challenge-led" in the context of recognizing the intersecting and dynamic nature of societal problems and potential solutions.

In light of the need for a scientifically-based analytical framework for public policymaking that fulfills the Sustainable Development Goals (2030), this study suggests the transformative innovation approach as an emerging policy model that can be adopted in translating major societal challenges into actionable policy agendas. This is within the context of evolving theoretical frameworks in the field of sustainability transitions and transformative innovation policy. This research paper aims to identify the extent to which transformative innovation policy contributes to supporting transitions towards sustainability, encompassing the Sustainable Development Goals, by responding the following primary question: To what extent can transformative

innovation policy contribute as an integrated approach to creating transformative change in managing transitions towards sustainability, including fulfilling the Sustainable Development Goals 2030?

Analyzing the previous problem statement necessitates adopting the descriptive method to describe and analyze the relationship between the study's three variables. By examining the conceptual and theoretical context of transformative innovation policy within the framework of transitions towards sustainability, clarifying the different justifications and dynamics of policy interventions sought at creating transformative change that responds to the major societal challenges raised by the 2030 Agenda, and then interpreting the policy capacity of the transformative innovation approach in fulfilling the Sustainable Development Goals during the policymaking process.

First Section: Transformative Innovation Policy as an Emerging Policy Model for Transition Towards Sustainability:

A policy model can be identified as "a shared model of reality that guides problem-solving activities for policymakers." This concept is grounded in Hall's pioneering work, defining a policy model as "A framework of ideas and standards that not only define the goals of policy and the types of tools that can be employed to fulfill them, but also specify the nature of the problems that are supposed to be addressed." (Diercks, 2017, p.09). Therefore, the paradigmatic change in the policy agenda in line with the Sustainable Development Goals (2030) necessitates determining a policy model that responds to the nature of societal challenges by relying on a broader concept of innovation that encompasses not only technological innovation, but also social, institutional, and behavioral innovation. This is in light of the need, according to Christian Bason, to change the traditional policy paradigm from a "rational man" approach to a "sense-making" approach in increasingly complex environments (The Brookfield Institute for Innovation, 2018). Therefore, transformative innovation policy is regarded as an emerging policy model that introduces a reformulation of public policy objectives, fields, and justifications from the perspective of transition theory, providing a set of guiding principles that help design policies facilitating shifts towards sustainability.

1. The Conceptual Context of Transformative Innovation Policy:

Innovation policies are a relatively new component on policymakers' agendas. For a long time, innovation was a neglected subject in the social sciences, with the notable exception of the Austrian-American economist Joseph Schumpeter. A hundred years ago, Schumpeter developed a theory of innovation as a driving force for long-term economic and social change. He made a clear distinction between invention, referring to new ideas about how to do things, and innovation, which is the ability to apply these ideas in practice. As Schumpeter indicated, "As long as inventions are not practically implemented, they remain economically insignificant. Turning any enhancement into a practical reality introduces a completely different task from inventing it, and necessitates entirely different skills" (Fagerberg, 2018). Therefore, innovation policy can be defined as public sector initiatives sought at rising the quantity and effect of innovation in society.

According to Schot and Steinmueller, public policies, encompassing innovation policy, "arise from an understanding of past experiences with actions, reflections on contemporary challenges, and perceptions of future action potentials." These shape the policy frameworks that guide policy analyses and actions. Three frameworks for innovation policy have been determined: the first framework (innovation for growth)*, the second framework (national innovation systems)*, and the

* Also known as the Science and Technology Policy Model, this framework has been influential since World War II. It views innovation as an effort directed towards economic growth and competitiveness. This framework is primarily influenced by neoclassical economics and subsequent new growth theory, where innovation is seen as a linear sequence of stages: research leads to development, development leads to production, and production leads to the market. The main reason for policy intervention is market failures, where governments need to intervene to fix markets by investing in areas characterized by positive or negative externalities, information asymmetry, and capital market failures. For more information, see: (Haddadden, 2023, pp. 01-02).

* The early 1980s were marked by the emergence of evolutionary economics and the concept of interactive innovation processes, which led to a broader view of innovation and an increased focus on "opportunity-enhancing" innovation policies. While this did not directly affect the justifications for innovation policy, it did increase attention on policies aimed at enhancing cooperation and technology

third framework (transformative change). They are associated respectively with post-World War II science and technology policies, innovation systems policies developed since the 1990s focusing on building innovation networks and clusters and enabling entrepreneurship, and finally transformative innovation policies that foster socially responsible innovation and fulfilling sustainable development goals, which are prevalent in current policy discourses (Zheng and Cai, 2022). The new approach in science and technology policies deals mainly transforming socio-technical systems rather than focusing on technological innovation in specific industries or sectors (Chataway et al., 2017).

Schot and Steinmueller presented the concept of "Transformative Innovation Policy" (TIP) in 2018, a term brought forward by Steward, describing it as "a third framework related to contemporary social and environmental challenges such as the sustainable development goals and advocating for transformative change." It is a strategic and proactive approach to forming innovation in ways that lead to considerable and positive changes in society, the economy, and the environment. TIP goes beyond traditional innovation policies that concentrate solely on economic growth and technological progress. According to Schot and Steinmueller, this third framework is different from the previous innovation for growth (framework 1) and national innovation systems (framework 2), by always viewing innovation as positive and overlook the inherent directionality, which can lead to "creative destruction" (Haddad et al., 2019).

While this new framework partially depends on previous ideas about science, technology, and innovation policy, it determines a broader perspective. According to Diercks, it introduces "an emerging policy paradigm that redefines policy objectives, fields, and the implications of innovation policy to address not only economic issues but also broader social and environmental challenges." This requires additional justifications for government intervention to fulfill transformative change, beyond market and system failures (Zheng and Cai, 2022, p.16). It represents changes in the policy agenda and the innovation process.

transfer between companies and other actors. For more information, see: (Haddad, 2023, p. 02).

Regarding the Policy Agenda:

- Transformative innovation policy surpasses the idea of economic growth and traditional innovation systems, advocating instead for guiding innovation studies to address "grand challenges."
- It targets policy fields that go beyond traditional economic and industrial policies toward a mix of policies.

Regarding the Innovation Process:

- Transformative innovation policy is often identified in terms of socio-technical system change within the context of sustainability transition literature, emphasizing that transformative change includes not only technological change, as facilitated by adopted innovations, but also changes in user practices, markets, and institutions.
- Transformative innovation policy also encompasses multiple actors beyond the "triple helix" of university-industry-government relations, extending to societal actors.
- It includes fostering both supply-side and demand-side policies, as viewed in the innovation system approach, and emphasizes the need to entail policies that address the disruption of existing systems (Haddad, 2023, p.03).

2. Guiding Principles for Transformative Innovation Policy in the Context of Sustainability Transitions

Transition theory provides a serious attempt to offer a new framework for innovation policies sought at transformative change. Transition studies offer several guiding principles to assist policymakers in designing policies that facilitate sustainability transitions. The core research area in sustainability transitions recognizes that many environmental problems, including climate change, biodiversity loss, and resource depletion, pose major societal challenges which arise due to unsustainable consumption and production patterns within socio-technical systems such as electricity, heating, buildings, mobility, agriculture, and food. Addressing these problems cannot be fulfilled through incremental improvements and simple technological solutions; rather, they necessitate radical shifts towards new types of socio-technical systems, called "sustainability transitions."

Thus, the main goal of transition research is to explain how radical changes occur in the way societal functions are achieved. Accordingly, the unit of analysis is mainly at the

"meso level" of socio-technical systems. This meso-level focus of sustainability transitions research is different from ongoing sustainability discussions at the "macro level" (such as changing nature-society interactions) or the "micro level" (such as changing individual choices, attitudes, and motivations) (Köhler et al., 2019, pp. 01-02).

In this context, transition studies provide numerous analytical concepts that help in comprehending sustainability transitions. The most prominent of these concepts include:

- **Socio-Technical Understanding of Innovation:** It is based on a social constructivist approach to technology, considering that social and technical systems change through processes of co-evolution and mutual adaptation. Technology forms its social environment and is formed by it in return, with each affecting the other. This dynamic applies at multiple levels, whether it is basic research through the social construction of scientific facts, or entire technological structures through the social construction of functional system needs (Diercks, 2017, p. 40).

- **Socio-Technical Systems:** A socio-technical system is typically depicted around a functional field (such as housing, transport, food, etc.). It encompasses interconnected human and material components including technology, policy, regulation, science, culture, markets, and infrastructure. The coordination among these interconnected components in a socio-technical system leads to stability, with changes usually being incremental in nature, involving minor adjustments or improvements in the function or performance of its technological configuration.

- **System Innovation:** System innovation refers to large-scale transformations in how societal functions are met. These transformations include not only technological substitutions but also changes in broader societal elements such as user practices, regulation, industrial networks, infrastructure, and cultural values. This multi-phase concept is connected to sociology, evolutionary economics, environmental studies, governance studies, and policy studies. It suggests an imbalance model where slow, gradual changes are followed by rapid transformation, with co-evolutionary processes being reinforced, leading to a new and relatively stable dynamic equilibrium (Diercks, 2017, pp. 40-42).

Based on the above, the Multi-Level Perspective (MLP) offers a methodology for comprehending system innovation through interconnected processes at three levels: niches, regimes, and landscapes. Socio-technical systems are demonstrated as shared, stable, and harmonious sets of rules that guide the behavior of actors in a given system. Radical alternatives to systems are developed in spaces called "niches," which are application areas dominated by specific selection criteria that protect emerging new and unstable technologies from direct market pressure. Meanwhile, the "landscape" introduces macro-level external forces, such as wars or demographic changes, that form niches and regimes but are not shaped by them in the short and medium term. (Kanger, Sovacool and Noorkõiv, 2020, p03)

This emerging model of innovation policies mainly focuses on encouraging innovation that addresses specific societal challenges and is viewed as part of a broader social and technical transformation process, where existing systems are replaced by new, more sustainable and equitable systems.

Second Section: The Role of Transformative Innovation Policy in Fulfilling Sustainable Development Goals (2030):

The 2030 Sustainable Development Agenda illustrates a comprehensive political agenda sought at bringing about radical transformative changes in current economic, social, and environmental systems, in a parallel and integrated manner to address undesirable consequences from the past and to create new pathways and opportunities for the future. In other words, this agenda - which consists of 17 Sustainable Development Goals (SDGs) and encompasses 169 specific targets for concrete policy objectives and action points –refers to "the need to integrate various perspectives and recognize that sustainability is a process, not an end state." (Lundin and Serger, 2018). Therefore, it operates on identifying an approach to innovation that adopts transformative changes within the framework of strategic growth and the institutional system, presenting a challenge for national governments to reconsider and reformulate their policy orientations. This is because social and economic development requires policymakers to engage in systemic change by organizing interactions and presenting integrated sets of policy interventions. (Janssen, 2016, p02)

1- Justifications for Political Intervention to Achieve Transformative Change:

Although Science, Technology, and Innovation (STI) policies can play a crucial role in fulfilling transformation, this can only be achieved when STI policies are seen as significant in achieving all 17 Sustainable Development Goals (SDGs), rather than being isolated within SDG 9, focusing on industry, innovation, and infrastructure (as outlined in the 2030 Agenda). To realize this role, these policies need to become more concentrated on transforming systems towards new directions.

Therefore, the third framework illustrated in transformative innovation policy should be regarded as an integrated approach that can be applied by integrating sustainable development goals in three different types: (1) Sustainable development goals around social and technological systems, such as clean energy (SDG 7) or health, (2) Sustainable development goals highlighting directionality, such as Goal 10 on reducing inequalities and Goal 8 on decent work, (3) Sustainable development goals concentrating on governance, such as structural transformations in state, market, civil society, and knowledge systems, including Goal 16 on peace, justice, and strong institutions and Goal 17 on partnerships for sustainable development. (Schot et al., 2019)

Weber and Rohracher have identified several justifications for political intervention that legitimize the Transformative Innovation Policy as an emerging policy paradigm. They indicate that the market and system failure rationales supporting innovation policies within the first and second frameworks must be supplemented with policies sought at system transformation towards environmental and social sustainability. In this context, they propose that the latter should start by recognizing four types of failures:

- Failure of Directionality: For policymakers, the concept of directionality refers to making social choices on alternative development paths and prioritizing specific innovation activities in relation to significant challenges. In other words, they bear considerable responsibility in forming sustainability transitions, where directionality necessitates policymakers not only to seek for enhancing innovation rates but also to stimulate innovation in specific domains or directions (beneficial to society) rather than others, gradually phasing out unsustainable options. (Bergek, Hellsmark, and Karltorp, 2023, p. 1112)

- **Failure of Policy Coordination:** Whether at the level of governmental sectors or across multiple levels (local, national, regional, and international), transformative change necessitates a comprehensive governmental approach.

- **Failure of Reflexivity:** The ability to monitor all stakeholders and engage them in the self-governing process of transformative change. This specific type of reflexivity is connected to deep learning (or second-order learning), occurring when stakeholders question their fundamental assumptions, for instance, concerning transportation or energy consumption.

- **Failure of Demand Articulation:** Political practices of transformative change require active engagement from users and anticipatory thinking from policymakers. User engagement must go beyond increasing awareness or coordinating current demands; rather, transformative policy practices should seek active contributions and identify ways to help users build new demands, environments, and markets. (Schot and Steinmueller, 2018, pp. 1562-1564)

Based on the aforementioned, it necessitates a radical rethink of innovation policy in terms of its goals, tools, and processes. Innovation policies should not only seek to enhance the innovation system to improve economic competitiveness and growth, but also to stimulate transformative changes towards desired societal goals. This includes making crucial changes to the system, or "transformations," in multiple dimensions (economic, institutional, technological, cultural, and regulatory). This requires relying on advanced and comprehensive approaches to managing transformative changes towards sustainability within the context of a comprehensive global agenda for socially, economically, and environmentally sustainable development (Agenda 2030).

2- Transformative Innovation Policy Directions within the Framework of Sustainable Development Goals (2030):

Transformative innovation policy has adopted new orientations that consider the need for sustainable transformations in determining possible transformative pathways that fulfill the Agenda 2030 goals. This approach to transformative change relies on the following:

- **Adopting a multi-sectoral perspective:** This includes a transition from singular sectoral policy objectives, such as

improving overall performance of the research and innovation system, towards a comprehensive approach that acknowledges the economic, technological, and social determinants of innovation, requiring an integrated view. This transformative change at the systemic level necessitates cross-stakeholder engagements and multi-policy frameworks, leveraging coordination aspects and designing new political and regulatory tools to improve coordination, prioritize goals, and allocate resources. It encompasses deep changes in institutional frameworks and state capacities, seeking to rise availability of specialized human capital and industrial infrastructure, enhance capability to generate and adopt new technologies, design new production and consumption patterns, and improve environmental quality and living standards (transportation, health, food supply, housing, etc.) (Ranga and Kim, 2023).

- Adopting Alternative Policy Practices: Transformative innovation policy, according to Schot & Steinmueller, includes alternative policy practices such as anticipation, experimentation, learning, and intermediation to improve interaction among stakeholders. These practices in turn necessitates a new set of policy tools and mixes (policy blends) directed towards sustainability transformations, despite the dominance of traditional tools in policy practice (Ordóñez-Matamoras et al, 2021, p. 117). Because any profound change centers around socio-technical transformations from the grassroots to the top, particularly with the appearance of new institutions at a global level, demonstrating the need for a new direction through international treaties or national laws. Therefore, transformative innovation policy prioritizes directional issues and suggests anticipation and experimentation of new approaches to innovation to satisfy social and environmental needs beyond the focus on knowledge creation or enhancing innovation system performance. It highlights sustainability as a key driving force addressing public welfare and a clean environment within the innovation process itself, assuming that economic growth will also follow (albeit in a different manner) (Chataway et al, 217).

- Establishing a Set of Acceptable Development Pathways: To fulfill transformations in socio-technical systems including energy, transportation, healthcare, and food, policymakers play a fundamental role in establishing social goals and offering support for innovators working towards these goals. This involves creating a set of acceptable

development pathways closely tied to specific social challenges, recognizing the need to balance multiple objectives, for instance, between environmental sustainability and social justice (Bergek, Hellsmark, and Karltorp, 2023, p. 1110). Policymakers must consider various determinants, such as system integration requirements, infrastructure, social acceptance, political feasibility, and identifying systemic weaknesses (often technologically determined) associated with each (Bergek, Hellsmark, and Karltorp, 2023, pp. 1114-1115).

Based on the above, achieving social and economic development in the context of transitions towards sustainability necessitates that policymakers engage in systemic change by organizing interactions and presenting integrated sets of interventions (Janssen, 2016, p. 02). This implies a more active role for governments, encompassing setting clear directions, engaging stakeholders, encouraging radical innovation, and coordinating policies across multiple levels.

Third Section: Analyzing the Policy Capacity of Transformative Innovation to Fulfill the Sustainable Development Goals 2030

The concept of policy capacity is grounded in research in public policy and public administration and is defined from the perspective of governments' ability to "mobilize the necessary resources to make intelligent collective choices and identify the strategic direction for allocating scarce resources for public objectives." In more expansive definitions, additional factors emerge, encompassing the role of government in policy implementation and decision-making (Kattel, 2022 and McLaren). In the literature associated with transformative innovation policy, it refers to the government's transformative capacities to impact the structures and processes of the system that need change to address a targeted societal challenge through a set of practices and rationales for policymaking in the context of transitions towards sustainability. However, translating the transformative innovation approach into political practice may include a range of challenges encountered by national policymakers that hinder the fulfillment of the Sustainable Development Goals, determined across various stages of the policy cycle.

1- Framework of Transformative Innovation Policy to Fulfill the Sustainable Development Goals (2030)

To transform broad societal goals into actionable policies, a framework must be adopted that involves a set of general actions and tools through which governments mediate and mobilize resources towards more sustainable and inclusive socio-technical systems by improving the production, dissemination, and utilization of knowledge and innovation with a long-term perspective (Ordóñez-Matamoros et al., 2021, p. 119). The government acts as a facilitator, mediator, or enabler through the policy process, with its role defined as "Determining potential integrations between system parts and making necessary connections, while in the long term increasing ambition and pushing system boundaries to facilitate effective transition," as indicated by the OECD (2015) (Ordóñez-Matamoros et al., 2021, pp. 115-116).

In this context, Diercks, Larsen, and Steward attempted to convert societal challenges into policy agendas by shaping a vision for the transformative innovation approach based on proposals by Chaminade and Edquist, who highlight that policymakers should only intervene in innovation processes if there are reasonable expectations that the intervention will contribute to addressing specific problems. This vision involves three dimensions: (1) Policy Goal, (2) Policy Logic, and (3) Policy Domain. Furthermore, a fourth dimension is added: Policy Influence (Bergek, Hellsmark, and Karltorp, 2023, p. 1113).

Table 01: Analytical Framework

	Policy goal	Policy logic	Policy field	Policy influence
Description	Promoting innovation in areas associated with societal transformation Stimulating the adoption of innovations Capacity and skills building Creating a legislative and regulatory environment conducive to innovation Strengthening cooperation between the public and private sectors to develop innovative solutions to societal challenges Spreading awareness about innovation and its role in achieving societal transformation	Justifications for political intervention to fulfill transformative change.	Environment:These areas encompass addressing climate change, natural resource sustainability, and biodiversity conservation. Economy:Addressing poverty, inequality, unemployment, and sustainable economic growth. Society:Addressing education, health, social justice, social inclusion and social care. Technology:Applying and developing new technologies to achieve societal transformation in differentdomains. Governance:Develop effective and responsible governance systems that support societal transformation	Objectives, target system, weaknesses, transformational failures or stability needs are within the formal mandate of the makers Policies (sectors and government bodies at the national and regional levels)

Source:Bergek ,Hellsmark and Karltorp ,2023, P1114-1117

(Prepared by the researcher)

Because policy agendas are no longer aimed solely at increasing spending on research and development, creating

more entrepreneurial ventures, or improving national competitiveness in certain sectors. Instead political programs are increasingly being prepared to achieve systemic transformation towards environmental and social sustainability, transformative innovation policy entails new innovation processes, new models of partnership and governance, market creation, and behavioral, institutional, and regulatory changes. Policies are reformulated to integrate considerations around various innovation options and to raise questions about the directions that innovative pathways will actually take to address interconnected challenges. This type of thinking and design has started to appear under different labels such as Responsible Research and Innovation, Inclusive Innovation, Social Innovation, and Frugal Innovation. Despite their differences, the core themes of these approaches highlight a concern for alternative futures and the co-production of science, technology, and society. This can be applied through two main pathways:

- Establishing policy processes within a participatory framework: This requires defining the scope of the policy (project, program) and its approach from the perspective of the challenge to be addressed, analyzing current opportunities, and determining the necessary capabilities to achieve this by using a range of tools such as framing, simulation, visualization, and future-oriented methodologies like foresight. It is indicated that the matter does not stop at the availability of such tools but includes choosing and adapting those that are most suitable for implementing transformative innovation policy, regarding their ability to offer the policy process with relational information and feedback, as learning does not happen by itself. Thus, basic research and joint learning are essential. (Ghosh and Torrens, 2020)

Figure 1: Cycle of Science, Technology, and Innovation Policies: Participatory Processes in the Context of Fulfilling Sustainable Development Goals



Source :United Nations Inter-Agency Task Team on Science, Technology and Innovation for the SDGs and UNIDO.(2023). Science, Technology and Innovation for Achieving the SDGs: Guidelines for Policy Formulation, <https://sdgs.un.org/sites/default/files/2022-06>

Governance of Science, Technology, and Innovation Systems (Transformative Governance)

Innovation governance has been explored through interdisciplinary research at the intersection of innovation policy and public policy, identifying new government roles in policy formulation and application. Some examples involve the concept of transformative governance, that refers to new roles for public administration that extend beyond the boundaries of the public sector, improving the government's ability to address societal and environmental challenges, and better use of policy information to develop alternative future scenarios and more resilient transition pathways. It also includes a whole-of-government approach sought at enhancing collaboration among government ministries and levels, and a multi-level governance perspective that aims to improve the complex linkages between regional and national levels. Consequently, the design of new policies and implementation mechanisms also necessitates a new institutional mindset to deliver them within the broader governance systems in which they operate (Ranga and Kim, 2023).

Based on the above, to address major societal challenges, the transformative innovation approach suggests that the rationales, tools, and governance mechanisms

supporting science, technology, and innovation systems must be altered, embracing a radical transformation. Ongoing challenges require a new understanding of the dynamics of system change in the domain of long-term sustainable transformations. This allows policy processes to fulfill five main elements of transformative innovation policy that are widely agreed upon in the literature: (1) focus on grand challenges and inclusive growth, (2) directionality as a key feature, (3) multifaceted policy interventions, (4) involvement of a broader range of actors and networks, and (5) multi-level governance (Haddad et al., 2022, p. 32).

2- Challenges of Transforming the Transformative Innovation Approach into Political Practice for Sustainability-Based Transformation Management

While integrating policy processes into analytical frameworks applied to transformative policy can contribute in numerous ways, such as determining and forming elements of the policy mix for technological change and clarifying the dynamics resulting from interventions targeting social and technical change, transformative innovation policy encompasses a set of challenges encountered by national policymakers in attempting to transform the transformative innovation approach into political practice. These challenges emerge throughout the policy cycle and can be traced as follows:

- **Agenda-Setting:** Agenda-setting includes determining problems that deserve the attention of policymakers. Given that the ultimate goal of transformative innovation policy is to address fundamental societal challenges, such as those emphasized in the 2030 Agenda, meaning that economic, environmental, and social goals are interconnected and must be considered together (Haddad et al., 2022, p. 21). This calls for adopting multifaceted political interventions in agenda-setting. However, broadening the scope of policy areas creates a major challenge associated with the rising need for vertical and horizontal coordination between different policy areas and governance levels on one hand, and the potential misalignment of transformative innovation policy goals with the scope of government authority or its ability to intervene on the other.

- **Policy Formulation:** Refers to determining potential solutions to the problems raised in the previous stage, regarding their cost, feasibility, and effects, and choosing policy tools. From the perspective of transformative innovation

policy, policy formulation is not a straightforward process including multifaceted political interventions that may encounter potential resistance from existing networks benefiting from current systems. These networks often encompass industries, government parties, as well as users and civil society, who do not see a need to change their behavior and also believe they can handle future challenges within existing frameworks. This resistance is not only about entrenched interests and regulatory commitments but also about cognitive inertia and values, ultimately relating to the collective organizational, cognitive, and normative rules embedded in prevailing socio-technical systems. Due to the unequal distribution of power and resources, policies can become constrained by entrenched representatives and dominant controllers (interest groups and existing organizations) at the expense of potential institutional entrepreneurs who intend to initiate change of a more radical nature by presenting breakthrough innovations (Bergkvist, Moodysson, and Sandström, 2022, p. 206).

- **Legitimation:** In the process of gaining legitimacy within the context of governance processes, policymakers ensure that the selected course of action gains support from relevant stakeholders with a clear agenda for change, rather than from actors embedded in the current system. There must be a greater focus on activating stakeholders interested in fulfilling transformative goals, rather than viewing the next generation of innovation policies as merely another political game among actors and policy topics (Haddad et al., 2022, p. 23-24)

- **Implementation:** This includes implementing and embodying policy tools according to the previous plans. In the context of sustainability transitions, the lack of implementation structures at different governance levels can hinder execution. In these new and "open" approaches, part of the policy implementation responsibility is delegated to other stakeholders, combining "central guidance" (dirigisme) with a more integrated and delegated governance style. This poses an additional challenge for transformative policy regarding the role of the government during implementation—whether there is a need for strong leadership to execute and guide the process towards the desired direction.

Therefore, implementation challenges can be determined as follows:

- Failure to consider the constraints of the political system (political resistance) and the cultural context in which the policy is applied.
- Risk of conflicting interests and power struggles.
- The necessity to include different actors to foster institutional change sought at transformation, i.e., institutional entrepreneurship.
- Lack of coordination between ministries and applying agencies can lead to a mismatch between strategic goals and operational implementation of policies.

- **Monitoring and Evaluation:** They indicate the oversight and evaluation of policy outcomes. This involves offering information about the observed policy outcomes and assessing the value of those outcomes (evaluation). The latter involves evaluating the correctness of the policy decision, the appropriateness of its implementation, and its fulfillment of the intended effect. Given the longevity and uncertainty related to transformative innovation, this is a prerequisite for a dynamic and flexible policy approach, where feedback is employed to make adjustments throughout the policy process. However, this encompasses additional difficulties in attributing policy impacts and can complicate pre-assessment due to the high level of experimentation, risk, and uncertainty (Haddad et al., 2022, p. 24-27).

- **Policy Learning:** The final phase in the cycle of transformative innovation policy is policy learning, leading to the reframing of problems and solutions, the continuation, modification, or termination of certain policies. In principle, this can be considered as the beginning of a new cycle. However, despite the significance of feedback, it often does not materialize. In contexts characterized by high levels of uncertainty, all feedback and learning are necessarily partial. Although learning, in general, may be a common goal for all stakeholders, policy learning typically is not, implying that it can be challenging to get stakeholders to take responsibility for learning regarding policy-making (Haddad et al., 2022, p. 28).

Conclusion

In response to modern societal challenges, innovation policies in recent years have adopted new directions, shifting from the predominant focus on technological, organizational, and market innovations to a "third framework" that also considers

ongoing environmental and social challenges and the need for sustainable transformations and transformative change in the context of a comprehensive global agenda to fulfill the Sustainable Development Goals (2030). While this agenda offers an opportunity for policy-making for change, transformative innovation policy can play a significant role in driving these transformative processes and building the necessary capacities and preparedness to achieve them. Thus, the 2030 Agenda and transformative innovation policy are mutually intertwined and must evolve together within an interdisciplinary knowledge base, contributing to the sustainability transition literature, science and technology studies, governance studies, and development studies in general.

While transformative innovation policy is expected to play a crucial role in any process of sustainability transition, it is increasingly apparent that transformation is also a result of policy processes. There are cognitive, conceptual, political, and practical challenges and constraints that impede the transformation of the transformative innovation approach into a political practice for managing sustainability-based transformation in public policy. There is still a lack of an analytical framework and empirical evidence to better understand this issue. In the context of research and policy, the "innovation community" and the "sustainability community" remain largely separate worlds, despite efforts to create consistent analytical frameworks and integrated implementation approaches. Few studies have tried to link a comprehensive sustainability approach to innovation, such as the approach taken by the Sustainable Development Agenda. Few countries have consciously attempted to link innovation and the 2030 Agenda in the context of public policy.

Adopting transformative innovation policy as an integrated approach to managing sustainability-based transformation necessitates addressing the organizational and institutional aspects of innovation, at the sectoral and system levels, as well as integrating innovation policy and implementation within an expanded and deepened institutional and political context. This means that innovation policy should be part of a policy mix for transitions across various policy areas, encompassing the whole government and transforming the "entire society" towards economic, social, and environmental sustainability.

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