

TOWARDS A FRAMEWORK FOR IMPACT ASSESSMENT FOR MISSION-ORIENTED INNOVATION POLICIES. A FORMATIVE TOOLBOX APPROACH

FLORIAN WITTMANN, FLORIAN ROTH, MIRIAM HUFNAGL, RALF LINDNER AND MERVE YORULMAZ

DOI: 10.22163/fteval.2022.540

Mission-oriented policies (MOIP) have become important means to foster transformative change in many countries. Yet, approaches for assessing these policies' impacts are still in their infancy, not least due to the complexity of MOIP. To address this gap, we propose a toolbox approach that supports policy-makers during policy design and implementation, and allows for an identification of potential impacts by a theory-based approach. To disentangle the complexity of missions, we first conceptualize MOIPs as multiple translation processes from mission formulation and design to implementation. Each translation step shapes the policies' impacts. Based on this framework, we develop a set of specific analytical tools that are intended to support the process of bringing missions into realization, but also help to assess whether missions contribute to the postulated goals. These tools include a mapping of the socio-technical systems, a typology to explore the transformative ambition of missions, a process to develop impact pathways, an inventory of policy instruments to support the mission design, and indicators to measure mission progress along the developed pathways. Finally, we propose several analytical questions to explore the context for the development of potential impacts.

INTRODUCTION

In recent years, mission-oriented innovation policies (MOIP) aiming at transforming socio-technical systems have gained increasing attention in both academic debates (Larrue 2021; Mazzucato 2017; Robinson et al. 2019) and among policy-makers, as can be seen in numerous initiatives at different levels (German High-Tech Strategy, missions in Horizon Europe, etc.). The promise of catalyzing transformative change through coordinated cross-sectoral action, actor mobilization and a stronger directionality of science, technology and innovation (STI) policies, has gained momentum against the background of the challenges societies are facing. Ideally, MOIP apply a variety of policy instruments that *'span*

different stages of the innovation cycle, from research to demonstration and market deployment, mix supply-push and demand-pull instruments, and cut across various policy fields, sectors and disciplines' (Larrue 2021, p. 11).

With the growing number of MOIP initiatives, questions about the implementation and the ability to monitor and evaluate such approaches have come to the forefront (Dinges et al. 2020; Janssen et al. 2021; Larrue 2021; Weber et al. 2014). However, the analysis of impacts involves multiple conceptual challenges, including the multidimensionality and interaction of effects, the different analytical levels, the long time horizon associated with mission goals and the empirical diversity of missions to be found under the MOIP label (cf. e.g. Amanatidou et al. 2014; Arnold et al. 2018; Edler et al. 2012; Kuittinen et al. 2018; Magro et al. 2019; Weber et al. 2014; Wittmann et al. 2021a; Wittmann et al. 2021c). So far, there have been first attempts to evaluate and assess the impact of individual programs and strategies with mission-orientation from program or innovation systems perspectives (Bührer et al. 2020; Hekkert et al. 2020; Hüsing et al. 2017; Wesseling et al. 2020), as well as general frameworks for MOIP (Weber et al. 2014, p. 9) and transformative innovation policies in complex settings (Arnold et al. 2018; Ghosh et al. 2021; Grillitsch et al. 2019; Janssen 2016).

In this contribution, we propose a flexible and formative toolbox approach that enables evaluators to investigate the potential effects of missions, but at the same time supports policy-makers to formulate, design and implement MOIP successfully.¹ The toolbox draws on identified requirements for the evaluation and impact assessment of MOIP and transformative policies in general, offering a diverse set of analytical elements that can be employed selectively or in combination, depending on the specific conditions and contexts.

KEY REQUIREMENTS FOR ASSESSING THE IMPACT OF MOIP

In recent years, the debate around the challenges of impact assessment and evaluation of innovation policies has increasingly shifted to the requirements for assessing transformative innovation policies such as MOIP (Molas-Gallart et al. 2021; Wittmann et al. 2021c). Drawing on these insights, we postulate four key requirements to better understand MOIP and offer systemic guidance to the policy process.

1) A STRONG FORMATIVE PERSPECTIVE PROVIDING PRACTICAL GUIDANCE

The turn towards cross-cutting and transformative change has entailed calls for a formative perspective (Magro et al. 2019; Molas-Gallart et al. 2021). Imposing a long-term perspective and considerable requirements with regard to cooperation and coordination across different fields, actors, etc., a framework for impact assessment should effectively support policy actors during the implementation of this policy approach and provide the opportunity for feedback and learning. Thereby, it supports reflecting the experimental and dynamic character of missions. For this purpose, the emphasis is put on an approach that provides practical guidance making research insights on MOIP usable for implementation, as the practical realization of missions continues to be a considerable challenge for public actors colliding with established routines and institutional arrangements (Lindner et al. 2021). This also includes a shift towards an increased reliance on ex-ante elements to inform the process, as postulated by Weber and Polt (2014).

2) A COMPREHENSIVE AND INTEGRATED PERSPECTIVE GRASPING ALL PHASES OF MOIP

Closely related to the aforementioned point is an integration of the framework into the realization process of missions. Therefore, we need to take into consideration all phases of MOIP, including mission (policy) formulation, design and implementation. Previous research has demonstrated that the formulation process of mission goals can be considered as crucial for later success in implementation (Janssen et al. 2020; Lindner et al. 2021) as mission realization can be considered to consist of different linked phases (Wittmann et al. 2021b) that usually emerge in the context of existing policy traditions and fields (Larrue 2021). Therefore, we need to acknowledge the very specific complex negotiation processes at different levels that are associated with this approach. To capture this complexity, we draw on Kroll (2019) and the concept of translation processes for evaluation and its application to MOIP (Wittmann et al. 2021b) Applying this perspective, we conceptualize the process of carrying out missions as multiple interconnected translation processes at different levels that shape and constrain the ability of missions to realize impacts:

- **Mission formulation:** The translation process is necessary to narrow down the mission towards a specific goal. This process

is dependent on the specific context (Edler et al. 2020) and may lead to different interpretations on how to achieve these goals (Wittmann et al. 2021a). This decision at the strategic level has profound implications for the later stages as the legitimacy and urgency of missions affect the ability to mobilize actors and resources (cf. Janssen et al. 2020; Larrue 2021)

- **Mission design:** The second translation occurs at the stage of policy-makers designing the activities that are encompassed by a mission through a deliberate choice of inputs. To translate goals into specific measures and instruments it is necessary to combine different types and generations of policy instruments, which might lead to policy-layering but also include newly designed instruments.
- **Mission implementation:** The final translation relates to the step from mission design to mission implementation, focusing on administrations and funding agencies bringing instruments into realization. These implementation activities of actual instruments are the prerequisite for the unfolding of the intended effects of a mission in the long run.

3) A THEORY-BASED AND PROCESS-ORIENTED APPROACH TO STUDY IMPACTS

One key complication of the analysis is the fact that missions require to take both the project- and systemic-level into consideration (Amanatidou et al. 2014; Weber et al. 2014). Theory-based evaluations are commonly considered as a useful tool for the evaluation of complex policies, as they are able to contrast actual developments with previously derived expectations (Arnold et al. 2018; Arnold 2019; Belcher et al. 2020; Bühner et al. 2019; Joly et al. 2015; Joly et al. 2017; Joly et al. 2019; Kalpazidou Schmidt et al. 2017a; Miedzinski et al. 2013; Molas-Gallart et al. 2021). This provides the opportunity for tracking the progress of missions even when effects are more systemic or are only expected to materialize in the long run and cannot be controlled by the mission owners (cf. Belcher et al. 2020). Moreover, this approach has proven to be appropriate for a context-sensitive perspective, accounting for the fact that dynamics may play out differently (Kalpazidou Schmidt et al. 2017b) depending on the topic, institutional context and existing policies (cf. Wittmann et al. 2021b). At the same time, missions build heavily on a different approach to policy-making being in contrast to established practices (Lindner et al. 2021), implying that an input-output perspective will not be sufficient to explore whether appropriate conditions/the existence of hindering factors for the materialization of effects are in place. Consequently, we propose to combine a theory-based approach with impact pathways and a process-oriented analysis of the translation processes (see above) that can be considered as a key bottleneck of such policies.

4) A FLEXIBLE AND MODULAR APPROACH

Given the considerable diversity of activities that can be observed in the context of MOIP (Griniece et al. 2018; e.g. Kuittinen et al. 2018; Larrue 2021; Polt et al. 2019; Wanzenböck et al. 2020; Wittmann et al. 2021a), a mission exhibits a highly specific profile with regard to the scope, the domain, and the way changes are to be achieved and the role of different types of instruments. In consequence, missions are highly di-

verse so that there is no blueprint how different areas (science, economy, society) will interact with each other and how important their role is relative to each other. For this reason, departing from the idea that missions in general aim for an overarching societal impact, a flexible and modular approach is indicated. Providing a set of stylized types of missions, ways of intervention etc., these can be applied to actual missions in order to develop a context-based framework for mission evaluation. Emphasizing the importance of a modular and flexible approach that fits the specific context also implies methodological openness and accounting for different ways of stakeholder involvement. In consequence, the framework does not aim to prescribe the use of a certain method, as the appropriateness may be conditional on the context and available resources.

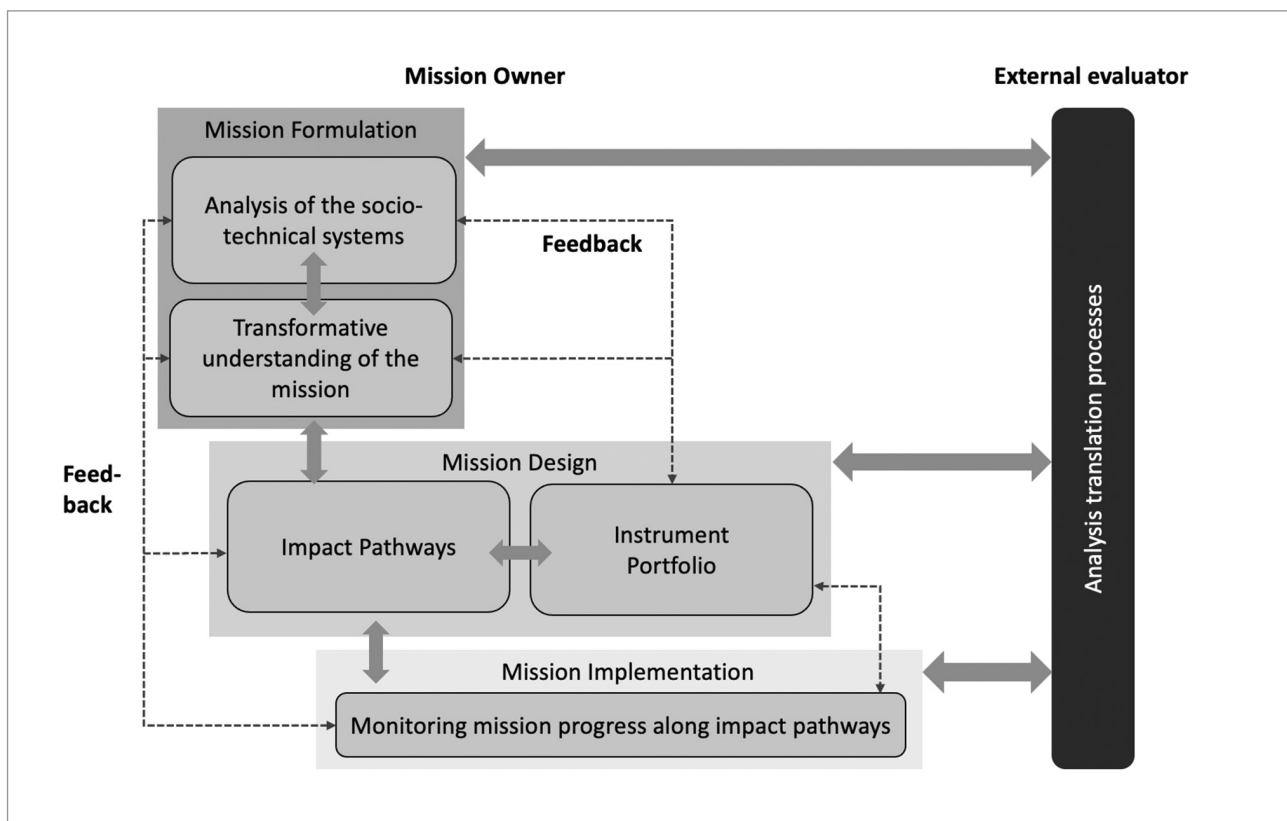
A TOOLBOX APPROACH FOR ASSESSING MISSION-ORIENTED POLICIES

We propose a modular approach that addresses the different levels of mission-oriented policies and thereby fulfills the aforementioned requirements. For this purpose, we introduce a total of six closely connected toolbox elements that can support the implementation process through creating awareness among stakeholders and provide learning

and feedback opportunities (see Figure 1). Five of these elements are directly linked to mission owners, i.e. those carrying out the missions. These elements may stimulate self-reflection processes among mission owners, provide guidance on decision-making and prepare the ground for a systematic impact assessment by putting the necessary features in place. These elements are complemented by a cross-cutting analysis of the translation processes of missions that constitute the key pillar for evaluation putting mission activities into context. The translation processes shape the realization of missions and provide the context for the manifestation of impacts. In sum, we consider the impact assessment as an integral part of a mission that needs to be closely aligned with the main elements of the mission from the very beginning.

As indicated by the feedback loops, we do not see the process as linear but as iterative, supporting learning effects by involved stakeholders between different elements. In practice, this implies that activities may temporally overlap, as e.g. the development of appropriate impact pathways and the identification of suitable instruments might affect each other. While emphasizing the importance of combining the different elements, the approach is not deterministic about methods and only describes the overall frame. Thereby, it acknowledges the potential existence of varying understandings, resources and priorities such as the extent to which missions aim for the integration of stakeholder involvement – a decision that is ultimately dependent on the mission owner.

Figure 1: Overview of the elements of the toolbox for assessing MOIP (own elaboration)



1) ANALYSIS OF THE SOCIO-TECHNICAL SYSTEM

A comprehensive picture of socio-technical systems can contribute to a better understanding of key societal challenges, but also of transformative policies that aim to alter the configuration of these systems. Socio-technical systems can be understood as the ‘articulated ensembles of social and technical elements which interact with each other in distinct ways, are distinguishable from their environment, have developed specific forms of collective knowledge production, knowledge utilization and innovation, and which are oriented towards specific purposes in society and economy’ (Borrás et al. 2014, p. 11). A detailed understanding of system complexities is needed to inform public (policy makers) as well as private actors (industry, consumer) about their role, responsibility and agency for systemic change.

A system mapping process presents an illustrative technique that serves a double purpose: a) as an analytical tool to (collaboratively) map out complex topical landscapes (looking back: capturing the status quo), b) as an explorative strategic tool to gather important topics, policies, actors, and system boundaries that need to be engaged before policy formulation starts (looking forward: depicting future needs). System mapping is a promising approach for better understanding complex challenges, but also to guide the development of solutions (Cavill et al. 2020; Matti et al. 2020). Employing this eagle’s perspective on complex socio-technical systems overcomes several shortcomings of classic tools of policy analyses, because it starts off with a clear delineation of the major topics and subtopics, providing the analytical basis for further investigation. Moreover, the association of key players with concrete policies or other measures can help to better understand the complex interdependencies between system elements.

Mapping the socio-technical system that is to be transformed may prove particularly useful in the process of mission formulation by the mission owners. At this stage of the mission process, it can enhance the mis-

sion owners’ understanding of key challenges, but also supports actors in clarifying the boundaries of the system a mission aims to transform. Creating awareness and consensus on these question can facilitate the discussion about the problem-solution space that characterizes MOIP (Wanzenböck et al. 2020). Moreover, grasping the overall complexity of socio-technical systems that relate to the challenges at stake provides a baseline for the subsequent assessment of translation processes.

2) EXPLORING THE TRANSFORMATIVE AMBITION

While assuming that all missions pursue a transformative agenda, there exist different understandings of how to achieve the desired changes. This is also reflected in the growing diversity of empirical missions and the academic attempts to conceptualize variations between missions (Polt et al. 2019; Wanzenböck et al. 2020; Wittmann et al. 2021a). Whereas some missions emphasize the role of technological/scientific innovation, others explicitly aim for behavioral changes as part of the transformative agenda. Exploring the transformative understanding of a mission can support the mission owners by pinpointing at requirements and consequences of these decisions and providing guidance for the process of mission design. At the same time, it prepares the ground for the ex-ante assessment of mission design, trying to understand whether activities in the mission context are compatible with the postulated goals. Whereas transformer missions are likely to require a more comprehensive instrument cross-cutting different fields, mission resembling an accelerator type will be sufficient with a narrower focus. In the following, we apply the typology developed by Wittmann et al. (2021a) that distinguishes between four types of missions characterized by specific challenges during implementation (see Table 1) that can serve as a point of reference for mission owners when deciding about the scope and character of their mission formulation.

Table 1: Different types of missions and key features (based on Wittmann et al. 2021a)

	Accelerator Mission		Transformer Missions	
	Type 1 (A1)	Type 2 (A2)	Type 1 (T1)	Type 2 (T2)
Motivation	Problem-solving	Solution-driven	Solution-driven	Problem-solving
Main logic of change	Scientific/ technological change	Bringing knowledge to application	Reconfiguration of sectoral logics	System transformation (incl. behavioral change)
Key stakeholders	Science	Science, Economy	Science, Economy, collective sectoral actors	Science, Economy, collective sectoral actors, civil society
Instrument mix	Mainly STI (distribution)	Mainly STI (distribution, systemic management)	Broad (distribution, regulation, information)	Broad (re-distribution, regulation, information)
Coordination requirements	Limited	Medium	High	Very high
Main challenges	Uncertainty, long-time horizons, shared understanding of problem, achieving critical mass for change	Ensuring appropriate framework conditions, overcoming existing bottlenecks, achieving critical mass for change	Dealing with path-dependencies/lock-ins, integration of sectoral policies, shift towards systemic change	Re-distribution/ compensating potential losers, involving society & different levels, shift towards systemic change

3) DEVELOPING IMPACT PATHWAYS

Based on the mission goals formulated, the next step is the design of the mission. A first key element in this regard is the development of appropriate impact pathways, describing how the mission goals are linked to the inputs provided by a mission (structured along the chain of Inputs-Outputs-Outcomes-Impacts (I-O-O-I)). The development of these pathways through the mission owners and ideally incorporating insights from the systems analysis and stakeholders prevents missions from ending up as a compilation of seemingly related policies and forms the foundation for tracking the progress of a mission and accounting for feedback loops. Thereby the derived impact pathways ensure a shared vision about how to translate mission goals into activities among mission owners and involved stakeholders, and ensures that evaluators have a starting point for their analysis by the description of a sound intervention logic. A key feature of the pathways is thereby the acknowledgement of a weakening control of mission owners over the potential outcomes and impacts (Belcher et al. 2020; Helman et al. 2020). Whereas immediate inputs like policy instruments/activities and their outputs can be shaped by the mission owner (sphere of control), their ability to influence out-

comes (sphere of influence) and impacts (sphere of interest) appears to be more limited, as mission activities interact with other elements of the socio-technical system.

The decomposition of complex missions in multiple impact pathways can help to structure the understanding of missions. In order to support this process, we propose a total of eleven stylized pathways that are considered as pivotal in mission realization and that draw on different theory-based strands of research such as transition studies, technological innovation systems (e.g. Ghosh et al. 2021; Wesseling et al. 2020), current work on crafting impact assessment concepts in the context of science and technology (Helman et al. 2020), and empirical insights of the research team of the scientific support action to the German High-Tech Strategy. In contrast to earlier discussions on the economic impact of science (e.g. Salter et al. 2001) and more recent discussions focusing on societal impacts (e.g. Muhonen et al. 2019), we assume that the societal impact of missions in many instances may be stimulated by science, but in others will also be conditional on a wider array of activities. Table 2 provides an overview of the proposed stylized pathways that can serve as a starting point for context-specific impact pathways and their potential relevance for different types of missions.

Table 2: Impact pathways and relation to different mission types (Own elaboration)

	A1	A2	T1	T2
P1: Research to solve problems through targeted research funding	X		X	X
P2: (Basic) Research to generate knowledge for better understanding of the problem	X			X
P3: Collective intelligence/promoting academic exchange to create new knowledge	X	X	X	X
P4: Modification of the research process for better/faster/more solid results	X	X	X	X
P5: Opportunities for new solutions/approaches through positive incentives		X	X	X
P6: Improving framework conditions to increase absorptive capacity		X	X	X
P7: Bringing knowledge & technological approaches to application through targeted support		X	X	X
P8: Creating markets for promising solutions as an impetus for system change			X	X
P9: Exnovation/destabilization of existing regimes to create space/opportunities for new solutions				X
P10: Raising awareness and changing public perceptions (as a prerequisite for change)				X
P11: Change practices, attitudes and behavior to support system changes				X

For example, Pathway P4 targets a modification of the way research is carried out to generate scientific knowledge at a systemic level. Driving motivations can be the aim to increase the quality/robustness of scientific results or better link research activities with societal needs. This may be achieved through the development of new or the adjustment of existing funding schemes, introduction of additional requirements, adjusted peer-review procedures, capacity building, promotion of approaches like citizen science or responsible research and innovation, etc. at the input level. These measures in turn may facilitate first a modified way of doing at the programme level (output) that over time spill-over into a different way of conducting research (outcome), which in turn are a prerequisite to the desired impacts.

4) DEFINITION AND INVENTORY OF INSTRUMENT MIX

Complex interventions such as MOIP require a comprehensive and well-designed mix of instruments, purposefully combining and aligning different instruments with each other. This also includes the deliberate design of new instruments addressing gaps and the realignment/re-orientation of existing policies. At the same time, missions entail the challenge of delineating the instrument mix, thus identifying those instruments that are supposed to contribute to the postulated goals and are under control of the mission owners, and specifying the way they contribute to the developed pathways. The establishment of an inventory of mission instruments, thereby making transparent the key features of

the instruments, supports the strategic orientation of the mission owners and forms the foundation for tracking mission progress along the impact pathways. This might be considered as a top-down approach to identify the instrument mix described by Ossenbrink et al. (2019).

5) TRACKING MISSION PROGRESS ALONG IMPACT PATHWAYS

Mission monitoring should from the beginning be thought of as a part of the implementation process, starting from the mission design towards expected impacts. Making use of the impact pathways, one can

derive a monitoring system that allows for an assessment whether the mission is on track or requires adjustment, for example through additional inputs or are re-adjustment of policy measures. In line with previous toolbox elements, the responsibility for this activity is closely associated with the mission owners, but also may involve stakeholders and external evaluators bringing in their expertise and capacity for the identification and collection of the relevant data.

Given the importance of contextual embedding of missions, we refrain from proposing a unified set of indicators as the scope and availability may vary considerably among mission. However, the stylized pathways can provide guidance for the development of appropriate indicators by indicating potentially relevant dimensions that may be worth further consideration

Table 3: Analytical dimensions for indicators (own elaboration)

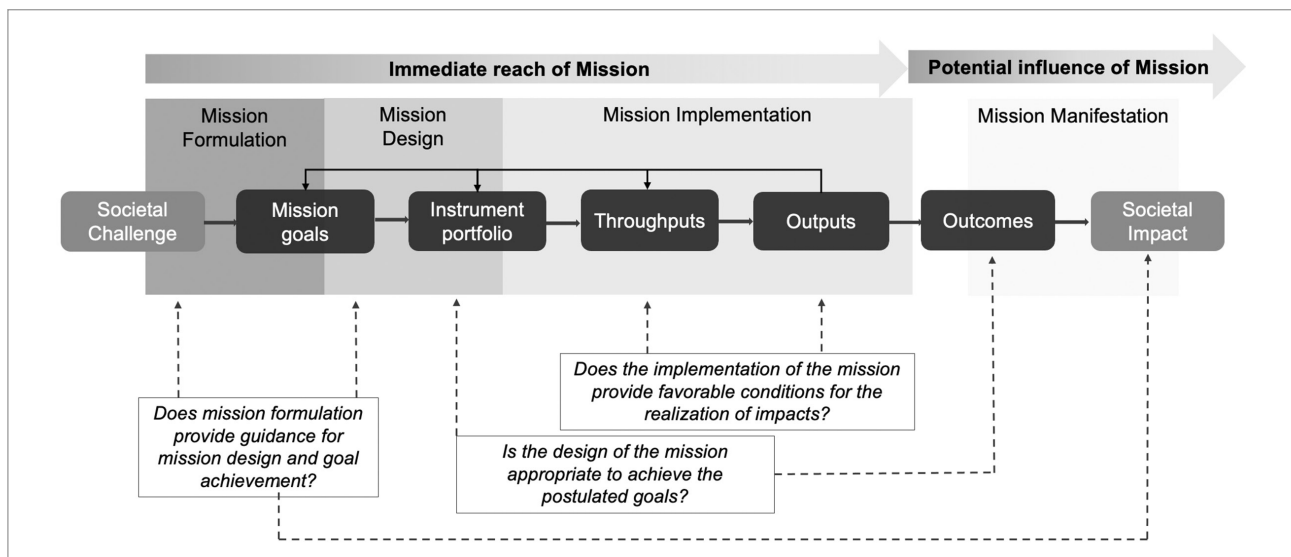
Input	Output	Outcome	Impact
Incentives/Measures to change established research processes <ul style="list-style-type: none"> Awareness raising instruments Modification of incentives structures (application procedures, requirements etc.) Dedicated support for key groups or approaches (e.g. citizen science) Self-declarations and self-commitments 	Modified way of doing research <ul style="list-style-type: none"> Number of projects in supported programmes Composition of advisory boards/ monitoring bodies Projects following certain principles/requirements (e.g. RRI) Funding schemes setting out specific principles/requirements 	Improved results <ul style="list-style-type: none"> Publication, citation, patenting patterns (of underrepresented groups) Career paths of researchers Patterns of co-publication, citation, diversity and multidisciplinarity Uptake in academic debates Research org. adjusting structures 	Improved knowledge generation <ul style="list-style-type: none"> Robust results through multi-perspectivity Embedding science into society More inclusive research

6) ANALYSIS OF TRANSLATION PROCESSES

In contrast to the aforementioned elements of the toolbox that directly interact with the mission owners, the analysis of translation processes explores to what extent favorable or hindering conditions for a materialization of effects were created at different stages. In this regard, it centers on the three guiding questions (see Figure 2 below). Each of these guiding questions encompasses several dimensions, each with a

set of more specific analytical questions. Together, the different questions provide for a combination of ex-ante, process- and output-oriented analytical elements. This complementary approach offers a holistic perspective on missions, reaching beyond individual contributions and pathways. Specifically, it is useful for pointing to supporting factors and potential bottlenecks that may hinder mission realization.

Figure 2: Overview of impact assessment concept and guiding questions (own elaboration)



The first analytical question explores whether mission formulation provides sufficient guidance for mission design and possible implementation. This can be considered as an ex-ante element for assessing legitimacy and urgency of missions. Whereas the analysis of goals primarily draws on key strategic documents, the study of mobilization and legitimacy issues may bring together a diverse set of sources, including

insights from system analysis, mission typology (see above), expert opinions, participatory observation, and public opinion data. The key analytical dimensions relate to the scope of the mission, definition and operationalization of goals, the relationship between the goals, the legitimacy and ambition of goals, and the mobilization of stakeholders.

Table 4: Analytical questions for mission formulation

<p><u>MISSION GOAL</u></p> <p>Scope of mission</p> <ul style="list-style-type: none"> • Does the mission formulate a clear vision/desirable state to be achieved? • Is the mission explicit in the areas it strives for change/solutions? Does the mission explicitly exclude topics or policy fields? Does the mission contain a justification for its priorities? • Are mission goals connected to a specific technology? Is the geographical scope of the mission clearly defined? <p>Definition of goals</p> <ul style="list-style-type: none"> • Does the mission have explicitly formulated goals? • Does the mission include quantitative indicators corresponding to the mission goals? Are mission goals measured on nominal, ordinal, interval or relational scales? Does the mission define a clear baseline/ measurement of the status quo for the intended changes? Does the mission specify data types or sources to be used for measuring goal achievement? • Do mission goals explicitly define complex constructs linked to goal (e.g. quality of life)? Are mission goals defined in terms of international comparisons or rankings? • Is a clear time horizon defined for the achievement of mission goals? Does the mission include interim goals or milestones? Do the goals include flexible elements, e.g. if/when context conditions change throughout the mission? Is there a defined process for the adjustment of goals throughout the mission? <p>Relationship between goals</p> <ul style="list-style-type: none"> • Does the mission define more than one goal? Is the prioritization of goals clearly defined? • Does the mission define if/how one mission goal contributes to other goals? Are postulated goals coherent/non-contradictory or is there a possible tension between goals? <p><u>LEGITIMACY, URGENCY, AND PROCESS OF FORMULATION</u></p> <p>Legitimacy of goals</p> <ul style="list-style-type: none"> • Does the mission refer to a specific societal problem it seeks to address? • To what extent is there a societal consensus about the importance of the underlying problem? Is there a societal consensus on the urgency of the problem? Do the problems the mission aims to address rank high on the political agenda? <p>Level of ambition</p> <ul style="list-style-type: none"> • Are the mission goals realistic? Are the goals also realistic if context conditions change? Is the realization of mission goals linked to best-case expectations? 	<ul style="list-style-type: none"> • Does the mission aim for transformative change? Do goals go beyond existing trends or push for radical change? Do mission goals appear ambitious compared to similar missions in other countries? <p>Embedding in political & administrative context</p> <ul style="list-style-type: none"> • Is a single mission owner or group of mission owners clearly defined? Can the main mission owner(s) credibly claim capacity/mandate for change (through activities or bringing together relevant actors)? Is the initiator of the mission also responsible for managing the mission? • Are all relevant political actors and administrative units involved in the mission formulation process? How intense is the collaboration during the mission formulation process? How much attention and support does the mission receive at higher political levels? • Does the mission refer to existing policies or are there overlapping/duplicating structures at the national level? Does the mission describe how to create synergies based on existing policies? Is it clear what the added value of the mission is, compared to existing policies? • Does the mission explicitly refer to goals of international strategies? Do the mission goals appear to be in line with international strategies (SDGs, etc.)? Are mission goals aligned with initiatives of supra-national organizations (e.g. EU)? <p>Legitimacy and stakeholder mobilization</p> <ul style="list-style-type: none"> • Are relevant stakeholders (actively) involved in the mission formulation process? Which stakeholders are involved in the process of mission formulation? How are stakeholders identified and selected? Are key stakeholders missing? What are drivers for stakeholders to participate? Are stakeholders incentivized to participate in the mission formulation process? • Did mission owners reach a mutual understanding of mission goals? Does the involvement of stakeholders include the development of a shared vision? Do stakeholders (formally) commit to the goals formulated? • Are topical expertise, insights from foresight, or perspectives of stakeholders integrated into the process of mission formulation? • Is the strategic process of mission formulation designed and equipped with sufficient resources (personnel, financial, temporal)? How does the formulation process deal with possible resistance from key actors/veto players?
--	--

The second main question focuses on the ex-ante assessment of the mission design, exploring whether the design of the mission is in line with the expected goals. Essentially, it assesses to what extent the impact pathways and the instrument mix are aligned with the postulated mission goals. At this stage, the analysis mainly draws upon programme documents, expert assessments, insights from the system mapping, participatory observation, and stakeholder perspectives. The analytical

questions cover the development of impact pathways, their fit with postulated goals, as well as their consistency and coherence. Further, the questions address the fit between pathways and the instrument mix, as well as the specific character and leverage of policy instruments. Finally, they ask for the process that led to the development of the instrument mix, the coordination of the instruments and the mission's governance structures.

Table 5: Analytical questions for mission design

<p><u>IMPACT PATHWAYS</u></p> <p>Process of pathway development</p> <ul style="list-style-type: none"> • Do mission documents (or later provided documents) describe the links between instruments and goals? • Who lead the process of impact pathway development? To what extent is the development of impact pathways supported by stakeholders or external expertise? What resources are available for the development process? <p>Fit between pathways & postulated goals</p> <ul style="list-style-type: none"> • Are all mission goals addressed by pathways? • What approach do pathways suggest for achieving the postulated goals? Do goals match with underlying understanding for transformative change? <p>Consistency of pathways</p> <ul style="list-style-type: none"> • Which obstacles need to be overcome to successfully realize the pathways? • Are pathways appropriate to achieve the desired goals? • Do pathways aim at second order effects/ cascading effects? • Coherence of pathways • Do several impact pathways relate to a shared goal? • Are there any contradictions/tensions or conflicts arising between pathways? <p><u>INSTRUMENT MIX</u></p> <p>Fit between pathways & instruments</p> <ul style="list-style-type: none"> • Are all impact pathways addressed with instruments/activities? Are pathways highly dependent on one or few dedicated instruments? • How specific is the alignment of instruments with pathways? <p>Character of instruments</p> <ul style="list-style-type: none"> • What are the main characteristics of the instrument mix applied in the mission (combination of regulation, distribution/incentives, information)? • Are relevant target groups addressed by the instruments? • Does the policy instrument mix for individual pathways show gaps or only addresses parts of them? • Do the mission instruments focus on research output and scientific knowledge production? Do the mission instruments focus on fostering transfer (research to application) and/or adjustment of regulatory frameworks? Do the mission instruments focus on reconfiguring an existing system (e.g. by facilitation of new solutions; building new networks)? Do the mission instruments aim at behavioral change? Do the mission instruments focus on exnovation/regime destabilization/ phase out? Are there compensation mechanisms or incentives for potential losers/actors resisting the anticipated changes? 	<ul style="list-style-type: none"> • Does the policy instrument mix fit the corresponding pathway? Does the instrument mix provide room for experimentation (policy experiments, etc.)? Are there any plans for institutionalizing successful instruments (e.g. pilot projects)? <p>Leverage of instruments</p> <ul style="list-style-type: none"> • What leverage do these instruments possess in the socio-technical system (size, scope, centrality)? • To what extent does the instrument create synergies with other policies in the field (beyond the mission)? Can the suggested instruments plausibly contribute to a change? <p>Instrument development & actors' commitment</p> <ul style="list-style-type: none"> • Which actors are mobilized to participate in the mission? • Does the mission mobilize the relevant key stakeholders in the field? • Which actors are involved in developing the instrument mix? How are instruments identified and selected for the mission? How was the process implemented? • Who is responsible for instruments of the mission? Were all ministries/public actors active in the field involved in this process? What share of resources is provided by non-public actors? • Is there a formal commitment of actors to provide resources? How precisely is this defined? Are there incentives for stakeholders to contribute to the mission? To what extent is their contribution formalized? • Is there a dedicated mission budget? • Does the commitment include the necessity to adjust/modify existing instruments/activities? • How is their implementation coordinated between different actors? • Are the instruments designed specifically for the purpose of the mission or how are existing measures aligned? How were new instruments developed? What resources were available for mission design? <p>Coordination of instrument mix & governance structure</p> <ul style="list-style-type: none"> • What kinds of coordination arrangements are created for the mission? What are their competencies? Who is member of them? How regularly are those planned to convene? • How is the implementation of instruments coordinated between different actors? • Are there any pre-defined approaches for mission monitoring, evaluation and learning? How are these to be achieved?
--	---

The final group of analytical question deals with the implementation of mission instruments, which represents a central prerequisite for the materialization of impacts in the long run. Examining the implementation of selected instruments and the mission allows to better understand whether favorable conditions exist for the realization of impacts. For this purpose, both the (interim/ex-post) program evaluation of selected (key) instruments as well as the general mission management require an in-depth analysis. Important sources to unravel the implementation

of missions are interviews with representatives of administration, stakeholders and experts, as well as participatory observations and document analyses. The key analytical dimensions cover the characteristics of key policies, their effectiveness and potential unintended consequences. Further, they relate to the coordination of the policy mix, as well as the robustness and responsiveness at the implementation stage. Finally, the analytical questions aim at spill-over effects, the quality of monitoring structures and the degree of transparency of mission implementation.

Table 6: Analytical questions for mission implementation

<p><u>TRANSLATION PROCESSES</u></p> <p>Characteristics of key policies</p> <ul style="list-style-type: none"> • What are key policy instruments of the mission that are crucial for the success of the mission? To which pathways do they contribute? • Was the instrument implemented on time? Did the financial volume of the instrument change? Did the policy instruments experience changes in thematic priorities, application regulations etc.? • Was the programme evaluated? <p>Effectiveness</p> <ul style="list-style-type: none"> • Did the implemented policy instruments have their intended effects? • Are the instruments implemented in line with the described goals? Was the implementation achieved at reasonable efforts/costs? • Is there evidence of potential policy-delivery failures? <p>Unintended consequences</p> <ul style="list-style-type: none"> • Did the instrument lead to unintended and undesirable side-effects or secondary effects? • Did the instruments lead to unintended but desirable side-effects or secondary effects? • To what extent did learning take place during the implementation process? <p><u>MISSION MANAGEMENT</u></p> <p>Coordination activities</p> <ul style="list-style-type: none"> • What are their competencies and routines (members, main tasks, budget)? Were there additional coordinative bodies created after mission initiation? How regularly do governing/steering bodies of the missions meet? • Are stakeholders involved in mission governance, e.g. by creation of an advisory board? How are they involved and what are their competencies? <p>Robustness of implementation</p> <ul style="list-style-type: none"> • Were the policy instruments implemented as planned? • Which policy instruments were terminated or delayed? <p>Flexibility</p> <ul style="list-style-type: none"> • Were policy instruments adjusted? For which reasons? • Were there any developments/events that would have made a modification of the impact pathways necessary? • Were instruments able to adapt to exogenous shocks, changing contexts etc.? How fast were instruments adapted? Were adaptive measures 	<ul style="list-style-type: none"> • successful in overcoming obstacles? Is there a regular/scheduled review of the instrument mix and appropriateness of the pathways? <p>Responsiveness</p> <ul style="list-style-type: none"> • How is strategic intelligence (e.g., foresight, evaluations of individual instruments) exchanged within the mission? • When obstacles or challenges occurred during mission implementation, were the governing/steering bodies able to find and agree on suitable instruments? • How is the mission progress communicated within the authorities/administration? • What resources and capacities are available for the coordination of the mission? <p>Spill-over effects and mobilization</p> <ul style="list-style-type: none"> • Does the mission mobilize additional activities/spill-overs for actors that are not part of the mission? • Does the implementation of the mission contribute to a changing understanding of the underlying problem and its possible solutions for the involved actors and the general public? <p>Monitoring structures</p> <ul style="list-style-type: none"> • Is there a defined process for assessing the progress of the policy instruments of the mission? How regularly is the progress of the instruments assessed? • Are there defined standards for the reports on instrument progress? • Is there a clear responsibility to manage the monitoring process? Is there a sufficient budget foreseen for monitoring and evaluation? <p>Transparency</p> <ul style="list-style-type: none"> • Is the progress of the mission/individual regularly discussed at the level of political decision-makers? Is the progress of the instruments part of the mission regularly discussed with stakeholders? • Are reports on instrument progress regularly communicated to the general public? Is there a unified communication strategy/shared label/website/etc. or does each partner communicate independently? • How can the outreach of mission activities be assessed? <p>Feedback & learning</p> <ul style="list-style-type: none"> • Does the monitoring feed into the adjustment of instruments? • Are there processes for collecting experiences/good practices made during mission implementation? Are there structures for institutional knowledge management? • Is there a process to inform and improve future policies?
---	--

DISCUSSION AND CONCLUSION

Our contribution aims not only at proposing a closed framework for impact assessment, but is rather an invitation to all stakeholders interested in empowering the MOIP approach as a means for transformative change. Therefore, we highlight what we consider to be the most important requirements for impact assessment, namely reflecting and acknowledging the need for strong formative, comprehensive and yet integrated perspectives to provide practical guidance to actors involved, and the willingness to follow a theory-based and process-oriented approach to study impacts at the same time. Our flexible and modular toolbox approach pays tribute to these preconditions. It takes the translation processes as a key reference point for analyzing missions, with each translation step accompanied by a set of corresponding questions to guide the assessment. These questions are complemented by additional tools for analysis and assessment. We regard it as important that these tools are developed by or in close cooperation with those implementing the missions and, ideally, with those who are affected by the mission policies. This way, the concept can not only provide for the assessment of missions from the outside, but also support policy-makers, mission owners and stakeholders throughout the mission process.

There are, however, multiple caveats associated with the framework. Embedding the framework into mission implementation and emphasizing the role of formative elements impose high requirements on the involved mission owners. On the one hand, it requires an open administrative culture, willing to actively incorporate stakeholders and seeking close exchange with evaluators that are in charge of the analysis of the translation process. Whereas research has increasingly emphasized the importance of formative evaluation (Magro et al. 2019; Molas-Gallart et al. 2021), there might exist considerable tensions with established working routines and administrative cultures - thus the question whether public actors are willing and institutionally prepared to embrace these principles. On the other hand, the framework is based on the active involvement of different actors and intense reflection processes, entailing significant capacity requirements. The first five toolbox elements aim at making many of the often implicit decision-making processes explicit, thereby supporting the implementation processes. While not providing a blueprint, the tool box elements underline that MOIP does not come at zero costs, but are a highly demanding approach (cf. Lindner et al. 2021).

LITERATURE

Amanatidou, E.; Cunningham, P.; Gök, A.; Garefi, I. (2014): Using Evaluation Research as a Means for Policy Analysis in a 'New' Mission-Oriented Policy Context. In: *Minerva*, 52 (4), pp. 419–438.

Arnold, E. (2019): *Evaluating Complex Innovation and Transition Programmes (CITPs)*. Manchester.

Arnold, E.; Aström, T.; Glass, C.; Scalzi, M. de (2018): *How should we evaluate complex programmes for innovation and socio-technical transitions?* Brighton: technopolis group.

Belcher, B. M.; Davel, R.; Claus, R. (2020): A refined method for theory-based evaluation of the societal impacts of research. In: *MethodsX*, 7, p. 100788.

Borrás, S.; Edler, J. (Eds.) (2014): *The Governance of Socio-Technical Systems. Explaining Change*. Cheltenham: Edward Elgar Publishing.

Bührer, S.; Reidl, S.; Schmidt, E. K.; Palmen, R.; Striebing, C.; Groo, D. (2019): Evaluation Framework for Promoting Gender Quality in Research and Innovation: How does gender equality influence research and innovation outcomes and what implicants can be derived for suitable evaluation approaches. In: *Fteval - Journal for Research and Technology Policy Evaluation*, (49), pp. 140–145.

Bührer, S.; Walz, R.; Seus, S.; Astor, M.; Stehnen, T.; Malik, F. (2020): Evaluation der BMBF-Rahmenprogramme Forschung für die Nachhaltigkeit FONA 1 (2005-2009) & Forschung für Nachhaltige Entwicklungen FONA 2 (2010-2014). Abschlussbericht. Studie/Gutachten im Auftrag des Bundesministeriums für Bildung und Forschung (BMBF). Karlsruhe, Berlin: Fraunhofer ISI in Zusammenarbeit mit Prognos.

Cavill, N.; Richardson, D.; Faghy, M.; Bussell, C.; Rutter, H. (2020): Using system mapping to help plan and implement city-wide action to promote physical activity. In: *Journal of public health research*, 9 (3).

Edler, J.; Berger, M.; Dinges, M.; Gök, A. (2012): The practice of evaluation in innovation policy in Europe.

Edler, J.; Salas Gironés, E. (2020): How do framing and ideas influence the design of missions? A comparative analysis between Germany, the Netherlands, & the United Kingdom. EU-SPRI virtual session on Shaping System Transitions - Insights from practice. 5th of June 2020.

Ghosh, B.; Kivimaa, P.; Ramirez, M.; Schot, J.; Torrens, J. (2021): Transformative outcomes: assessing and reorienting experimentation with transformative innovation policy. In: *Science and Public Policy*.

Grillitsch, M.; Hansen, T.; Coenen, L.; Miörner, J.; Moodysson, J. (2019): Innovation policy for system-wide transformation: The case of strategic innovation programmes (SIPs) in Sweden. In: *Research Policy*, 48 (4), pp. 1048–1061.

Griniece, E.; Sorokins, J. (2018): Analysis Report. Responses to the call for feedback on "Mission-Oriented Research and Innovation in the European Union" by Mariana Mazzucato. European Commission - Directorate-General for Research and Innovation.

Hekkert, M. P.; Janssen, M. J.; Wesseling, J. H.; Negro, S. O. (2020): Mission-oriented innovation systems. In: *Environmental Innovation and Societal Transitions*, 34, pp. 76–79.

Helman, A.; Barberis, M.; Vignetti, S.; Catalano, J.; Griniece, E.; Kroll, H.; Zenker, A.; Martin, C. (2020): Deliverable 5.1. Validated IA Model. Research Infrastructure imPact Assessment paTHwayS.

Hüsing, B.; Kulicke, M.; Wydra, S.; Stahlecker, T.; Aichinger, H.; Meyer, N. (2017): *Evaluation der „Nationalen Forschungsstrategie*

BioÖkonomie 2030". Wirksamkeit der Initiativen des BMBF - Erfolg der geförderten Vorhaben - Empfehlungen zur strategischen Weiterentwicklung. Abschlussbericht. Karlsruhe.

Janssen, M. J. (2016): What bangs for the bucks? Assessing the design and impact of transformative policy. Center for International Development at Harvard University.

Janssen, M. J.; Torrens, J.; Wesseling, J.; Wanzenböck, I.; Patterson, J. (2020): Position paper. 'Mission-oriented innovation policy observatory'. Utrecht: Copernicus Institute of Sustainable Development, Utrecht University.

Joly, P.-B.; Gaunand, A.; Colinet, L.; Larédo, P.; Lemarié, S.; Matt, M. (2015): ASIRPA: A comprehensive theory-based approach to assessing the societal impacts of a research organization. In: *Research Evaluation*, 24, pp. 440–453.

Joly, P.-B.; Matt, M. (2017): Towards a new generation of research impact assessment approaches. In: *The Journal of Technology Transfer*, 1 (4).

Joly, P.-B.; Matt, M.; Robinson, D. K. R. (2019): Research Impact Assessment. From ex post to real-time assessment. Wien: fteval - Platform for Research and Technology Policy Evaluation.

Kalpazidou Schmidt, E.; Bühner, S.; Schraudner, M.; Reidl, S.; Müller, J.; Palmen, R.; Haase, S.; Graversen, E. K.; Holzinger, F.; Striebing, C.; Groó, D.; Klein, S.; Rigler, D.; Høg Utoft, E. (2017a): Conceptual Evaluation Framework for Promoting Gender Equality in Research and Innovation. Toolbox I - A synthesis report. EFFORTI - Deliverable 3.3.

Kalpazidou Schmidt, E.; Cacace, M. (2017b): Addressing gender inequality in science: the multifaceted challenge of assessing impact. In: *Research Evaluation*, 26 (2), pp. 102–114.

Kroll, H. (2019): How to evaluate innovation strategies with a transformative ambition?: A proposal for a structured, process-based approach. In: *Science and Public Policy*, 46 (5), pp. 635–647.

Kuittinen, H.; Skov Kristensen, F.; Pelkonen, A.; Lehenkari, J.; Goetheer, A.; van der Zee, F.; Arrilucea, E.; Unger, M.; Türk, A.; Polt, W.; Fisher, R.; Domini, A.; Chicot, J.; Terziev, N.; Vincze, M.; Taranic, I.; Lykogianni, E.; Misojcic, M. (2018): Mission-oriented research and innovation. Assessing the impact of a mission-oriented research and innovation approach: Final report. Luxembourg: European Commission - Directorate-General for Research and Innovation.

Larrue, P. (2021): The design and implementation of mission-oriented innovation policies. A new systemic policy approach to address societal challenges. Paris: OECD.

Lindner, R.; Edler, J.; Hufnagl, M.; Kimpeler, S.; Kroll, H.; Roth, F.; Wittmann, F.; Yorulmaz, M. (2021): Missionsorientierte Innovationspolitik. Von der Ambition zur erfolgreichen Umsetzung. Karlsruhe: Fraunhofer Institut für System- und Innovationsforschung ISI.

Magro, E.; Wilson, J. R. (2019): Policy-mix evaluation: Governance challenges from new place-based innovation policies. In: *Research Policy*, 48 (10), p. 103612.

Matti, C.; Corvillo, J.; Lalinde, I. (2020): Challenge-led System Mapping. A knowledge management approach.

Mazzucato, M. (2017): Mission-Oriented Innovation Policy. Challenges and opportunities. London: RSA Action and Research Center.

Miedzinski, M.; Allinson, R.; Arnold, E.; Cassingena Harper, J.; Doranova, A.; Giljum, S.; Griniece, E.; Kubeczko, K.; Mahieu, B.; Markandya, A.; Peter, V.; Ploeg, M.; Stasiakowska, A.; van der Veen, G. (2013): Assessing environmental impacts of Research and Innovation Policy. Study for the European Commission, Directorate-General for Research and Innovation. Brussels: technopolis group.

Molas-Gallart, J.; Boni, A.; Giachi, S.; Schot, J. (2021): A formative approach to the evaluation of Transformative Innovation Policies. In: *Research Evaluation*, Online before print.

Muhonen, R.; Benneworth, P.; Olmos-Peñuela, J. (2019): From productive interactions to impact pathways: Understanding the key dimensions in developing SSH research societal impact. In: *Research Evaluation*, 14 (1).

Ossenbrink, J.; Finnsson, S.; Bening, C. R.; Hoffmann, V. H. (2019): Delineating policy mixes: Contrasting top-down and bottom-up approaches to the case of energy-storage policy in California. In: *Research Policy*, 48 (10).

Polt, W.; Weber, M.; Biegelbauer, P.; Unger, M. (2019): Matching type of mission and governance in mission-oriented R&I policy: conceptual improvement and guidance for policy. Eu-SPRI Conference. Rome, 06.06.2020. Available at https://www.researchgate.net/publication/334277744_Matching_type_of_mission_and_governance_in_mission-oriented_RI_policy, accessed 25.09.2019.

Robinson, D. K.; Mazzucato, M. (2019): The evolution of mission-oriented policies: Exploring changing market creating policies in the US and European space sector. In: *Research Policy*, 48 (4), pp. 936–948.

Salter, A. J.; Martin, B. R. (2001): The economic benefits of publicly funded basic research: a critical review. In: *Research Policy*, 30 (3), pp. 509–532.

Wanzenböck, I.; Wesseling, J. H.; Frenken, K.; Hekkert, M. P.; Weber, K. M. (2020): A framework for mission-oriented innovation policy: Alternative pathways through the problem–solution space. In: *Science and Public Policy*, 47 (4), pp. 474–489.

Weber, M.; Polt, M. (2014): Assessing mission-orientated R&D programs: combining foresight and evaluation. In: *fteval - Journal for Research and Technology Policy Evaluation*, (39), pp. 5–10.

Wesseling, J.; Meijerhof, N. (2020): Development and application of a Mission-oriented Innovation Systems (MIS) approach.

Wittmann, F.; Hufnagl, M.; Lindner, R.; Roth, F.; Edler, J. (2021a): Governing varieties of mission-oriented innovation policies: A new typology. In: *Science and Public Policy*, 48 (5), pp. 727–738.

Wittmann, F.; Hufnagl, M.; Roth, F.; Yorulmaz, M.; Lindner, R. (2021b): From mission definition to implementation: Conceptualizing mission-oriented policies as a multi-stage translation process. Karlsruhe: Fraunhofer Institut für System- und Innovationsforschung ISI.

Wittmann, F.; Yorulmaz, M.; Hufnagl, M. (2021c): Impact Assessment of Mission-Oriented Policies. Challenges and overview of selected existing approaches. Project deliverable. Karlsruhe: Fraunhofer Institut für System- und Innovationsforschung ISI.

AUTHORS

FLORIAN WITTMANN

Fraunhofer Institute for Systems and Innovation Research
Breslauer Str. 48, 76139 Karlsruhe, Germany
E: florian.wittmann@isi.fraunhofer.de
<https://orcid.org/0000-0002-9890-6091>

FLORIAN ROTH

Fraunhofer Institute for Systems and Innovation Research
Breslauer Str. 48, 76139 Karlsruhe, Germany
E: florian.roth@isi.fraunhofer.de
<https://orcid.org/0000-0002-5287-6448>

MIRIAM HUFNAGL

Fraunhofer Institute for Systems and Innovation Research
Breslauer Str. 48, 76139 Karlsruhe, Germany
E: miriam.hufnagl@desy.de
<https://orcid.org/0000-0003-0106-6653>

Deutsches Elektronen-Synchrotron DESY, Hamburg
Notkestraße 85, 22607 Hamburg, Germany

RALF LINDNER

Fraunhofer Institute for Systems and Innovation Research
Breslauer Str. 48, 76139 Karlsruhe, Germany
E: ralf.lindner@isi.fraunhofer.de
<https://orcid.org/0000-0002-6927-8866>

MERVE YORULMAZ

Fraunhofer Institute for Systems and Innovation Research
Breslauer Str. 48, 76139 Karlsruhe, Germany
E: merve.yorulmaz@isi.fraunhofer.de
<https://orcid.org/0000-0001-7810-4860>

KEYWORDS: mission-oriented innovation policy, impact assessment; impact pathways; formative evaluation