Master's Thesis – master Innovation Sciences:

"Innovation Policy for the 21st Century: an integrative literature review of 'mission-oriented' and 'transformative' innovation policy"

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"Social and technological trends and decisions occurring in the next decade or two could significantly influence the trajectory of the Earth System for tens to hundreds of thousands of years."

(Steffen et al, 2018)

Climate change needs 'immediate' action or the world could face economic damage of $1.7trn a year by 2025, experts warn

The economic damage may rise to about $30trn a year by 2075, according to estimates by 738 economists from around the world.

Amar Mehta
News reporter @Amarjournalist_

Tuesday 30 March 2021 19:22, UK

sky news

Spekulation mit CO_2-Zertifikaten

Wie Hedgefonds den Kohleausstieg befeuern

Der europäische Emissionshandel wird zunehmend zum Anlageobjekt für Banken, Hedgefonds und Spekulanten. Der CO_2-Preis steigt – und mit ihm die Chance auf einen früheren Kohleausstieg.

Von Stefan Schultz
29.03.2021, 20.33 Uhr

DER SPIEGEL

Kohlekraftwerk in Hohenhameln (Archivbild) Foto: Sean Gallup/ Getty Images

Tegenwind voor Nieuwe Economie, terwijl de oude de wind weer in de zeilen heeft

Peter de Waard 5 maart 2021, 19:59

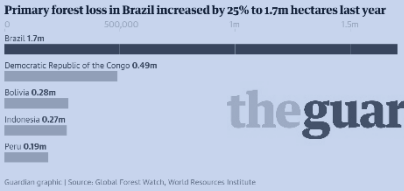
deVolkskrant

Shell-topman Ben van Beurden (rechts). Beeld EPA

Destruction of world's forests increased sharply in 2020

Calls for forests to be high on Cop26 agenda after loss of 42,000 sq km of tree cover in key tropical regions

▲ Smoke billows from a fire in the Amazon rainforest in Diapoque, Amapa state, Brazil, last October. Photograph: Nelson Almeida/AFP/Getty Images



Guardian graphic | Source: Global Forest Watch, World Resources Institute

theguardian

Neuer Hype um Ökostrom

Das sind die Gewinner des weltweiten Windkraft-Booms

Ob onshore oder offshore vor den Küsten Amerikas und Asiens: Windräder werden zum globalen Milliardengeschäft, auch wegen staatlicher Subventionen. Eine deutsch-spanische Firma könnte zum Weltmarktführer werden.

Von manager-magazin-Redakteurin **Angela Maier**
27.04.2021, 00.59 Uhr

DER SPIEGEL

ANALYSE

Fossiel rijden is in 2030 echt alleen nog voor dinosauriërs

deVolkskrant

(de Volkskrant, 2021b; Der Spiegel, 2021b, 2021a)(de Volkskrant, 2021b, 2021a; Der Spiegel, 2021a, 2021b; Guardian, 2021; Sky News, 2021)

Abstract

In response to grand societal challenges such as climate change and inclusive and smart economic growth, a new era of Science, Technology and Innovation (STI) policy has given rise to several 'challenge-led' topics and diverse expressions. This has resulted in a convoluted current state of the art and confusion among academics and policy makers in practice. This thesis conducts an integrative literature review of two of these emerging topics- 'Transformative Innovation Policy' (TIP) and 'Mission-Oriented Innovation Policy' (MIP).

To systematically study the respective properties of TIP and MIP, this study utilises insights from the Policy Sciences domain, engaging in a functional application of the Policy Cycle to investigate various aspects of the policy making process. This offers a novel and innovative approach to a systematic literature review which is operationalised to contribute a solid theoretical basis for advancing and applying the topics.

This thesis establishes what concepts of TIP and MIP are presented by the literature reflecting the current debate and how these concepts are similar or different, demonstrating to what extent, where and how the topics converge or diverge in their current understanding and further synthesising whether the topics conceptual understanding compete, complement or are neutral to one another.

Based on this analysis, the findings suggest several differences in the current TIP and MIP understanding, such as the topics' emphasis on certain actors (users, industry, government) in different phases of the policy process, governance modes (tentative, tilted) and the focus on demand-oriented and supply-oriented instruments. Furthermore, the synthesis also presents a case to potentially combine elements of their conceptual understanding, to align both top-down (supply-oriented) and bottom-up (demand-oriented) instruments, a framework to navigate the complex and contestable problem-solution space and a deeper understanding of reflexivity and learning. Finally, the study strongly acknowledges the need for further research to develop the topics' conceptual consistency with the purpose of navigating changes in socio-technical configurations towards socio-economic impact to address dynamic, heterogenous and 'wicked' grand societal challenges.

As a result, this study provides a more nuanced understanding of innovation policy for the 21st century disentangling the current debate on TIP and MIP to support attempts to develop a more refined understanding in-light-of the topics growing popularity among academics and policy makers.

Keywords: *transformative innovation policy; mission-oriented innovation policy; innovation policy; policy cycle; societal challenges*

Contents

1. Introduction

The stark acceleration of global environmental change (Steffen *et al.*, 2018) highlights the fact that the 21st century is becoming increasingly defined by the need to respond to major social, environmental and economic challenges. Often referred to as 'grand societal challenges', these include "environmental threats like climate change, as well as social demographic, health and wellbeing concerns, and the difficulties of generating sustainable and inclusive economic growth" (Mazzucato, 2018a, p803). Grand societal challenges are recognized as 'wicked problems' that are cross-sectoral (Mazzucato, Kattel and Ryan-Collins, 2020), complex, unpredictable, open ended or intractable (Head and Alford, 2015) and deeply rooted in societal structures (Wanzenböck *et al.*, 2020). To illustrate this, the societal challenge of achieving a 'stabilised Earth within 1.5degrees Celsius this century' as set out by the Paris Agreement Accord (2016), cannot be achieved without attention to the interconnectedness between industry, energy, food and mobility sectors, education and governance (UN, 2016). As a result, solutions need to span multiple domains (science, economy, education, environment, health) and dimensions (technological and institutional), potentially encompassing multiple levels (from local to global) and societal sectors (public, industry, civil society).

Navigating this problem-solution space (Wanzenböck *et al.*, 2020) is a key area for policy makers and approaches to tackling grand societal challenges through targeted Science, Technology and Innovation (STI) policies are becoming high on the agenda of many public agencies, in Europe and elsewhere (Robinson and Mazzucato, 2019). STI policy is a fusion of previous policy instruments carried out under different labels (science policy, research policy, technology policy) (Rothwell, 1982) and commonly considered not only to be about the generation of new ideas (the traditional focus of science and research policies) but about exploiting such ideas in practice (Edler and Fagerberg, 2017) (see Appendix 1 for illustrations on the evolution of innovation policy using Google NGrams). In recent years, the "'deepening' of innovation policy to incorporate an expanding set of instruments" (Uyarra, Ribeiro and Dale-Clough, 2019, p2366) coincides with what many call a 'normative turn' in innovation policy from economic to societal goals (Boon and Edler, 2018; Kattel and Mazzucato, 2018; Uyarra, Ribeiro and Dale-Clough, 2019).

As a result, we are now entering a new era of STI policy (Hekkert *et al.*, 2020), and the search for the next generation of innovation policies (Kuhlmann and Rip, 2018) has resulted in the emergence of a plethora of terms including 'challenge-led innovation' (Raven and Walrave, 2020) and 'challenge-driven policy' (Robinson and Mazzucato, 2019; Mazzucato, Kattel and Ryan-Collins, 2020) among Science, Technology and Innovation scholars, and 'grassroots innovation' (Smith, Fressoli and Thomas, 2014) and 'responsible research and innovation' (Stilgoe, Owen and Macnaghten, 2013) among Science & Technology Studies (STS). Two of the most influential developments that have emerged over the past decade are 'transformative innovation policy' (TIP) (Steward, 2012) and 'mission-oriented innovation policy' (MIP) (Mazzucato, 2016, 2018a, 2018b).

The term, 'transformative innovation policy' (TIP), has evolved across some spheres as the new paradigm to innovation policy thinking (Diercks, Larsen and Steward, 2019), and is presented as an evolution to the traditional linear based R&D innovation through basic research and the systems of innovation perspectives (Weber and Rohracher, 2012; Schot and Steinmueller, 2018b). At the same time, the term 'mission-oriented innovation policy' (MIP), originating from ambitious technology-oriented missions as demonstrated in the Apollo 11 man-on-the moon project, has evolved in meaning

and application in recent years to address broader and more persistent challenges towards societal challenge-oriented missions (Mowery, Nelson and Martin, 2010; Foray, Mowery and Nelson, 2012; Mazzucato, 2016), concerning the redefinition of governance structures, influencing the direction of innovation, and the shaping of markets (Mazzucato, 2016; Janssen *et al.*, 2020; Mazzucato, Kattel and Ryan-Collins, 2020). Examples of policy references to 'transformative' and 'mission-oriented' innovation policy include the aforementioned global Paris Agreement Accord target to prevent the increase in global average temperatures to well below 2 degrees Celsius before pre-industrial level (UN, 2016); the recent European mission for an improved soil health and food system (European Commission, 2020) and national goals such as those to develop a fully circular economy in the Netherlands by 2050 (Rijksoverheid, 2016).

However, while the increased reference to TIP and MIP within policy making assumes that the topics express internally consistent and coherent ideas; in reality, these topics are continuously being shaped and influenced by a range of rationales and actors, representing vibrant and rapidly evolving scientific concepts and inconsistent adoption of the topics in practice (Rathenau Instituut, 2020). At their core both TIP and MIP topics are directed towards complex, multi-dimensional and systemic societal challenges, reflect the changing role and legitimacy of policy intervention and require new and more decentralised governance modes (Wanzenböck, *et al.*, 2020). However, loose and interchangeable use of terms 'mission', 'transformation', 'transition' and 'innovation system' has resulted in a convoluted current state of the art and diverse expressions in contemporary innovation policy discourse. Indeed, while 'missions' is the new buzzword in policy departments, "both analysts and policy makers are struggling in their attempts to design and implement MIP" (Hekkert *et al.*, 2020, p.77), with 'transformative' change widely used as an aspirational term in both academia and practice, despite TIP still being a heavily contested discursive space (Diercks, Larsen and Steward, 2019).

The contestability in the topics' terms and meaning reflects natural patterns in the evolution of science, echoing Kuhnian thinking of scientific shifts as a mix of sociology, enthusiasm and scientific promise rather than as a logically determinate procedure (Kuhn and Hawkins, 1963). In short, STI studies are at a crossroad (Soete, 2019) and the emergent topics of TIP and MIP have not yet been institutionalised around a core set of ideas and concepts (Grillitsch, Hansen and Madsen, 2020). If STI policy is to contribute to the solutions for grand societal challenges, then the domain requires careful and systematic definition and assessment.

Scholars regularly seek to provide clarity to the definitions of concepts, relatedly in emergent fields such as the circular economy (Kirchherr, Reike and Hekkert, 2017), the knowledge economy (Brinkley, 2006) and the social economy (Restakis, 2006). However, while parts of the emergent TIP and MIP topics have been explored, there have been few attempts to systematically define and assess the topics to understand their current conceptual similarities and differences (Haddad *et al.*, 2019). Understanding these topics at the conceptual level, therefore, will help understand their applicability to supporting innovation activities and help allay potentially confusing overlap within academia and policy making that would be misleading and unproductive to the STI field. Furthermore, despite their growing popularity as policy topics (see Appendix 1 for illustrations on the evolution of innovation policy using Google NGrams); with a couple of exceptions (Kroll, 2019), STI scholars have consistently neglected the role of policy sciences in informing innovation policy discourse. Policy sciences is introduced herein for its functional value and its usefulness to offer insights to the innovation policy debate- helping take into account the value-based discourses in formulating a challenge, to capture the political dynamics in formulating policies or in framing the 'best' solutions for a particular problem (Hoppe, 2011).

This study therefore answers three main research questions:

I. What concepts of 'transformative' and 'mission-oriented' innovation policy are presented in the literature?
II. How are these concepts similar or different?
III. How do these concepts compete, complement, or present a neutral/underdeveloped understanding of one another?

This thesis conducts a systematic literature review to support the conceptual grounding of the TIP and MIP topics in academia and practice. The study first develops a literature-based understanding of key policy concepts according to the elements of the policy cycle which the author uses functionally and operationalises for analytical relevance to the study of innovation policy. The author then searches and collects academic literature making explicit reference to the topics before using the literature meta-data to derive an initial understanding of the theoretical foundations and the current debate. From the current debate, the author conducts an iterative literature review to collate concepts through axial coding process against the analytical framework. The concepts of the policy cycle are then used as a basis to analyse and discuss the TIP and MIP topics current understanding of key concepts of the policy making process, their similarities and differences, the strength (consistency) of their understanding and whether the topics conceptually diverge or converge. For the sake of providing clarity to two vibrant topics, the current conceptual understanding from TIP and MIP are synthesised to understand areas where the topics compete, are complementary or are neutral to one another (exhibiting neither competing nor complementary ideas) generating insights for further research and supporting a more nuanced TIP and MIP understanding within academia (Torraco, 2016). In short, this thesis is not an exhaustive study of all available literature on TIP and MIP, but an analysis on the current understanding presented by the TIP and MIP literature adopting explicit academic reference to the topics.

Academically, this study responds to scholarly calls recognising that STI policy is a domain in flux (Diercks, Larsen and Steward, 2019; Hekkert *et al.*, 2020), supporting STI scholars to leave their conceptual comfort zones behind to address in "complementary fashion some of the major societal policy challenges confronting innovation policy today" (Soete, 2019, p.849). It is important for scholars to achieve consensus because a topic with various understandings may ultimately collapse or remain in a deadlock due to permanent conceptual contention (Hirsch & Levin 1999, Bocken et al,. 2017, Blomsma & Brennan 2017 via Kirchherr, Reike & Hekkert, 2017). This thesis addresses this methodologically, conducting an integrative literature review on the emerging topics of TIP and MIP, disentangling their conceptual contributions through engaging in the broader policy sciences literature and delivering some stylised assessment on the similarities and differences as well as relative strengths and weaknesses of the presented ideas.

Despite efforts from think tanks and economic councils to disentangle the topics (AWTI, 2020; DEA, 2020; SERV, 2021) and the struggle from policy makers to translate a transformative innovation agenda to practice (Diercks, 2019) there remains a strong interest from governments towards ideas presented in the TIP and MIP topics (Rijksoverheid, 2019; UK Govt, 2021). The urgency for careful and considered conceptual understanding is exacerbated by the topics' growing popularity in practice, most recently by the European Commission (2020) who have established mission areas as part of its Horizon European programme towards cancer, climate adaptation, healthy oceans and waters, climate neutral and smart cities, and soil health and food (European Commission, 2020). This further highlights the need for steps towards clarifying the topics at an academic level.

In practice, today's innovation policy landscape is in something of a cognitive paralysis (Kattel and Mazzucato, 2018), with governments increasingly realizing the "wicked" nature of some of the most pressing problems they face while at the same time also realising that existing policy toolboxes (of design, coordination, and evaluation) are not enough to tackle these challenges (Kattel and Mazzucato, 2018). Coupled with the fact that "most of the recent societal problems have highly wicked tendencies and are 'immune to linear, rational or scientific methods of problem-solving'" (Newman and Head, 2017, p.414); effective understanding for the design and implementation of innovation policy towards societal challenges have never been more critical to ensure the long-term sustainability of the Earth Systems and socio-economic systems that are dependent on it.

2. Theoretical Framework

This section begins with a short background on the evolution to existing innovation policy rationales, before explaining the relevance of the policy cycle to help understand the process of government intervention in relation to socio-technical and socio-economic change.

2.1. Science, Technology & Innovation Policy Background

The 'framings' perspective offered by Schot and Steinmueller (2018b), provides a useful point of reference to chronologise the evolving rationales related to the field of innovation policy- which have, according to Grillitsch et al (2020), evolved gradually and are still relevant in today's contemporary innovation policy discussions (Fagerberg, 2018; Schot and Steinmueller, 2018b).

The first frame is identified as beginning with a Post-World War II institutionalisation of government support for science and R&D (Schot and Steinmueller, 2018b), introduced in the Bush report that recommended a single new agency, the National Research Foundation, be established to provide linear self-directed basic research (Lundvall and Borrás, 2009). The presumption here was that this would contribute to growth and private provision of new knowledge. The aim was to address market failures, defined as the inefficient allocation of resources within markets, that can occur if there are too few markets, non-competitive behaviour, or non-existence problems (Ledyard, 1987). This was a hugely successful approach to science and research policy predominantly used in the US and UK and among other things, stimulated the invention of computers, penicillin, and the nuclear bomb.

The second frame emerged in the 1980's globalising world and emphasises industry competitiveness for knowledge creation and commercialisation and based on the belief of differing national characteristics. Researchers from the Science Policy Research Unit defined the national systems of innovation (NIS) approach, as a set of institutions that (jointly and individually) contribute to the development and diffusion of new innovations (Metcalfe, 1995). This complex process, characterised by reciprocity and feedback mechanisms determines the success of innovations (Freeman, 1987, 1988, Lundvall, 1992; Nelson, 1993; Edquist, 1997; via Klein Woolthuis, Lankhuizen and Gilsing, 2005). As a result, policy focuses on building links, clusters and networks, stimulating learning between elements in the systems and enabling entrepreneurship (Schot and Steinmueller, 2018b). However, the emphasis on linkages between actors raised the challenges of infrastructural, institutional, network and capability failures of innovation systems resulting in lock-in to uncomplimentary cooperative relationships or technological trajectories that lead to an inability to respond to changing dynamics (Klein Woolthuis, Lankhuizen and Gilsing, 2005). Despite this, and because the NIS concept was simultaneously situated in both academic and policy worlds, the approach has been used widely in innovation policy across OECD, Scandinavia and Western European countries as it was a way for the European Commission to get away from linear-model type thinking (Smith, 2003).

The third frame, aimed at 'transformation change'- is linked to contemporary social and environmental challenges, such as those presented by the Sustainable Development Goals (UN, 2015). Weber and Rohracher (2012) argue that the market failure and system failure rationales that underpin current innovation policies should be complemented by policies aimed at transformation; evolving a new set of rationales exploring policies aimed at addressing the so-called 'transformation failures'- directionality, policy coordination, demand-articulation and reflexivity (Weber and Rohracher, 2012). This supported the emergence of 'challenge-led' innovation policy topics such as TIP and MIP under

investigation in this study. However, developing such innovation policies is a demanding task, requiring deep understanding of the innovation systems context and a long-term perspective that is subject to likely set-backs and failures (Edler and Fagerberg, 2017). Such policies may therefore become more contested politically than innovation policies have been hitherto, underlining the need for more reflexivity and capability in innovation policy-making at all levels (Edler and Fagerberg, 2017). The rapidly evolving and shaping of new rationales reflects the changing landscape of innovation policy to which current debates around the TIP and MIP topics are situated, with questions remaining to what extent the current TIP and MIP topics may or may not relate to the third frame and to each other. In other words, current innovation scholars are required to "address not just how to get there (which policies) but also fundamental issues of directionality (what future do we want), legitimacy (why do we want this future, who defines it), and responsibility (transformation by and for whom)" (Uyarra, Ribeiro and Dale-Clough, 2019, p2362).

2.2. Policy Sciences

Recognising the interplay between science policy and practice as a highly complex and contested area, this thesis draws inspiration from the field of policy sciences to capture the multiple levels, processes and dynamics involved in policy making.

The first approaches offered to understand how policies come about were the so-called conceptual models. The major models that can be found in the literature are (1) the institutional model, (2) the rational model, (3) the incremental model, (4) the group model, (5) the elite model, and (6) the process model. The main implication of these models is that they make different assumptions about the importance of the actors involved- institutions, politicians, bureaucrats, interest groups, and the public - and their rationality (Knill and Tosun, 2020). Furthermore, Knill and Tosun (2020) identify three features as the main characteristics of policy making. First, policy making occurs in presence of multiple constraints, e.g., shortage of time and resources, public opinion, and of course the constitution. Secondly, policy making involves the existence of various policy processes- governments are not unitary actors but consist of different departments that overlap and compete. Thirdly, these policy processes form an infinite cycle of decisions and policies (Knill and Tosun, 2020).

2.2.1. The Process Model: The Policy Cycle

Given these characteristics, it is convenient to conceive of policy making as a process model. Originally conceived by Lasswell, (1956) as a linear process and later evolved into a cyclical model by policy scientists, the policy cycle is a useful heuristic that breaks policy making down into different stages to illustrate how specific policies are actually made and implemented (Knill and Tosun, 2020). In short, each policy cycle begins with the identification of a societal problem and its placement on the policy agenda- '(1) agenda setting', then policy proposals are formulated- '(2) policy formulation', from which one will be adopted- '(3) policy adoption', then the adopted policy is taken to action- '(4) implementation', and finally, the impacts of the policy are evaluated- '(5) evaluation' (fig.1). This last stage leads straight back to the first, indicating that the policy cycle is continuous and unending (Knill and Tosun, 2020). The cyclical perspective emphasises feed-back (loop) processes between outputs and inputs of policy making, leading to the continual perpetuation of the policy process (Jann and Wegrich, 2007).

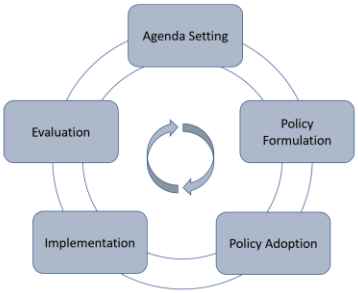


Fig.1: Policy Cycle based on Lasswell's Policy Making Process

The policy cycle was designed like a problem-solving model and accord with other prescriptive rational models of planning and decision-making developed in organisation theory and public administration (Jann and Wegrich, 2007). It has served as a basic template that allows authors to systematise and compare the diverse debates, approaches and models in the field and to assess the individual contribution of the respective approaches to the discipline (Jann and Wegrich, 2007). Indeed, the staggering complexity of the policy process means that we are to find some way of simplifying that situation to have any chance of understanding it (Sabatier, 2007).

However, despite criticisms of the policy cycle as an idealised view of policy making and its simplification of what is essentially a complex process (Jann and Wegrich, 2007; Cairney, 2012) the policy cycle has the potential to capture some of the fundamental features of current policy formulation, including the existence of numerous decision makers, the high degree of competition and contestability among sources of policy advice, and the substantial impact of previous policies on new efforts (Howard, 2005). While it is commonly used to follow specific policy instruments and objects through the policy process (to which it may be an oversimplification), for the purpose of assessing the conceptual contributions of TIP and MIP its simplicity can be considered a strength. In short, herein its usefulness lies in its explanatory power to capture a wide variety of processes a well as the complex and diverse concepts presented in TIP and MIP literature.

This study deviates from the policy cycle's more pragmatic and idealised use (in the context of iterative development, implementation and evaluation of one single policy instrument), and instead employs the policy cycle functionally to derive a comprehensive set of dimensions for studying the various ideas on which policy makers concerned with TIP or MIP would look for conceptual guidance. Since the number, nature, and interactions of actors change across the single stages, this theoretical disaggregation allows for deriving more clear-cut theoretical expectations (Knill and Tosun, 2020).

Recognising the limitation of the policy process as arguably more prescriptive and normative rather than descriptive and analytical (Jann and Wegrich, 2007), the study now describes the key characteristics relating to each of the stages and extracts the key concepts and terms (*in italics)* to operationalise the policy cycle to make it analytically relevant to the study of innovation policy.

2.2.1.1. Agenda-Setting

The first stage in policy making refers to the identification of a societal problem requiring the state to intervene. There are many societal problems, but only a small number will be given official attention by legislators and executives (Knill and Tosun, 2020). This phase is characterised by highly contentious debate of competing worldviews from actors.

Cobb et al. (1976) distinguish between three basic policy initiation models. 1. The *outside-initiative* model refers to a situation where citizen groups gain broad public support and get an issue onto the formal agenda. 2. The *mobilization* model describes a situation in which initiatives of governments

need to be placed on the public agenda for successful implementation. 3. In the *inside-initiation model*, influential groups with access to decision-makers present policy proposals, which are broadly supported by particular interest groups but only marginally by the public (Knill and Tosun, 2020). Further to this, 4. Howlett and Ramesh (2003) distinguish *consolidation* as a fourth type whereby state actors initiate an issue where public support is already high (e.g., such as in the unification of Germany) (Jann and Wegrich, 2007).

Key concepts: *Identification and Definition of Societal Problem | Policy Initiation | Policy Agenda | Source of Issue*

The factors determining whether an issue reaches the agenda may be cultural, political, social, economic, or ideological (cf. Schattschneider 1960; King 1973; Howlett et al. 2009 via Knill and Tosun, 2020). In addition, the raising of environmental issues onto the policy agenda by the media in the late 1980s combined with the publication and UN approval in 1987 of the Brundtland Report, put environmental policies onto the policy agendas of many governments (Beder, 2002).

Key concepts: *Cultural, Political, Social, Economic, Environmental and Ideological Contextual Factors*

In most cases, the policy agenda is set by four types of actors: (1) public officials, (2) bureaucrats, (3) mass media, and (4) interest groups (Gerston 2004 via Knill and Tosun, 2020). The confluence of a number of interacting factors and variables determines whether a policy issue becomes a major topic on the policy agenda, for example, interest from groups/relevant actors, material conditions such as the economic environment and the capacity of institutions (Jann and Wegrich, 2007).

Key concepts: *Actors | Agenda-Setting | Material Conditions | Institutional Capacity*

Kingdon (1995) defines agenda setting as 'three process streams flowing through the system—streams of problems, policies, and politics. Kingdon's notion of a 'policy window' is an important part of agenda setting theory and occurs when the opportunity arises to change policy direction (Beder, 2002). The policy window opens at a specific time for a specific policy when three usually separate and independent streams—the policy stream (solutions), the politics stream (public sentiments, change in governments, and the like), and the problem stream (problem perception)—intersect (Jann and Wegrich, 2007). Policy windows can be created by triggering or focussing events, such as accidents and disasters, as well as by changes in government and shifts in public opinion that offers opportunities to any group able to mobilise support for a particular set of policies (Beder, 2002).

Key concepts: *Policy Window | Timing | Directionality | Events | Shifts in Perception | Uncertainty*

Finally, McCombs & Shaw (1972) define a 'primary' level of agenda setting, when issues reach the public or policy agenda, and a 'secondary' level of agenda setting, which involves the assignment of attributes to issues that reach the agenda. The way issues are framed and problems defined shapes the understanding of what causes the problems and the relative merits of various solutions. Primary agenda setting is about '*what* to think about' (or *salience*) whilst secondary agenda setting has to do with '*how* to think about the issues' (or *framing*) (Beder, 2002).

Key concepts: *Salience | Framing*

2.2.1.2. Policy Formulation

The second stage in the policy cycle is characterised by a process of transforming expressed problems, proposals, and demands into government programs (Jann and Wegrich, 2007) and involves the

definition, discussion, acceptance, or rejection of feasible courses of action (policy options) for coping with policy problems (Knill and Tosun, 2020).

While executives adopt a leading role, interest groups, scientific experts and policy advisors can inform the design of policies (Stone, 2005; Knill and Tosun, 2012 via Knill and Tosun, 2020). Decision-making comprises not only information gathering and processing (analysis), but foremost consists of conflict resolution within and between public and private actors and government departments (interaction) (Jann and Wegrich, 2007).

Key concepts: *Multi-Level | Multi-Actor | Public-Private | Coordination | Decision-Making | Contestation*

As the historical-institutional approach in policy research has pointed out, countries have developed particular types of policy networks resulting from the interaction of the pre-existing state structure and the organisation of society at critical junctures in history (Lehmbruch 1991 via Fischer and Miller, 2007). Policy networks are sets of formal institutional and informal linkages between governmental and other actors structured around shared, if endlessly negotiated, beliefs and interests in public policy making and implementation (Rhodes, 2009).

Key concepts: *State Structures | Policy Networks | Linkages | Beliefs*

These differences are said to foster national styles of policy making in terms of preferred policy instruments and patterns of interaction between state and society (Richardson, Gustafsson, and Jordan 1982; Feick and Jann 1988 via Fischer and Miller, 2007). Policy options consisting of policy instruments have been classified into regulatory, financial, informational, and organizational policy tools (Jann and Wegrich, 2007).

Key concepts: *Policy Options | Instrumentation | Regulatory, Financial, Informational, and Organizational Tools*

Actors in the policy network are independent and policy emerges from the interactions between them (Rhodes, 2009). Actors such as think tanks and international organizations are regarded as catalysts fostering the exchange and transfer of policy ideas, solutions, and problem perceptions between governments and beyond (Stone 2004 via Fischer and Miller, 2007). Ultimately, policy formulation, at least in western democracies, proceeds as a complex social process, in which state actors play an important but not necessarily decisive role (Jann and Wegrich, 2007).

Key concepts: *Actors | Role of the State and Governance*

2.2.1.3. Policy Adoption

When it comes to the final adoption of a particular policy option, the formal institutions of the governmental system move into the centre (Jann and Wegrich, 2007). Which of the proposed policy options will be finally adopted depends on a number of factors, two of them should be highlighted:

First, the feasible set of policy options is reduced by basic substantial parameters. Some policies are excluded because of scarcity of resources—not only in terms of economic resources, but also because political support presents a critical resource in the policy-making process (Jann and Wegrich, 2007). Some are included or excluded on the basis of political party interests building majorities for their approval with consideration about values, party affiliation, constituency interests, public opinion, deference, and decision rules (Anderson 2003 via Knill and Tosun, 2020). Furthermore, party affiliation is a central predictor for the likelihood of a member of parliament to approve a policy draft weighing

up the costs/benefits of policy for their own constituency. Finally, considerations about the public opinion also affect policy choices as well as decision rules, values, and perception of deference (Knill and Tosun, 2020).

Key concepts: *Decision Making Heuristics and Biases | Boundaries/Parameters- Resource Availability, Political Preferences and Public Perception*

Second, the allocation of competencies between different actors (e.g., government) plays a crucial role in decision-making. For example, tax policy in Germany is one of the domains in which the federal government is not only dependent on the support of the Federal Parliament (Bundestag, which is most of the time assured in parliamentary systems), but also on the consent of the Federal Council (Bundesrat, the representation of the Länder governments) (Jann and Wegrich, 2007).

Key concepts*: Competencies of Government and Institutions*

In addition, the allocation of competencies between the actors involved in policy making affects the success, speed and nature of governmental policy making (cf. Lijphart 1999; Braun 2000 via Knill and Tosun, 2020). For example in the French presidential system, 'divided government' can impede policy adoption as there are generally insufficient incentives for political parties to cooperate and build policy making coalitions (Knill and Tosun, 2020).

Key concepts*: Cooperation, Collaboration and Coalition Opportunities*

2.2.1.4. Implementation

Implementation represents the conversion of policy options (new laws and programmes) into practice which since the 1980's has been considered one of *the* central focus areas of policy research that opens up of the 'black box' between policy formation and policy outcomes (Knill and Tosun, 2020).

An ideal process of policy implementation would include the following core elements (Jann and Wegrich, 2007):

- Specification of program details (i.e., how and by which agencies/organizations should the program be executed? How should the law/program be interpreted?);
- Allocation of resources (i.e., how are budgets distributed? Which personnel will execute the program? Which units of an organization will be in charge for the execution?);
- Decisions (i.e., how will decisions of single cases be carried out?).

Key concepts*: Clear Definition, Interpretation and Identification of Responsible Agents | Clear Allocation of Budgetary, Personnel and Organisational Resources | Clear Decision-Making Framework*

Implementation studies followed the hierarchical and chronological path of a particular policy and sought to assess how far the centrally defined goals and objectives are achieved when it comes to implementation (Jann and Wegrich, 2007). Various theoretical approaches were elaborated which Pülzl and Treib (2006) divide into three categories:

Top-down models primarily emphasize the ability of policy makers to produce clear policy objectives and control the implementation process (Knill and Tosun, 2020). However, different policy instruments are vulnerable to specific types of implementation problems, with regulatory policies being aligned with control problems and subsidies with windfall gains on the side of the target group (Mayntz 1979 via Jann and Wegrich, 2007). In addition, intra- and inter-organizational coordination problems and the interaction of field agencies with the target group ranked as the most prominent variables accounting for implementation failure (Jann and Wegrich, 2007). Another explanation

focused on the policy itself, acknowledging that unsuccessful policy implementation could not only be the result of bad implementation, but also bad policy design, based on wrong assumptions about cause-effect relationships (cf. Pressman and Wildavsky 1984 [1973]; Hogwood and Gunn 1984 via Fischer and Miller, 2007). This stage is critical as political and administrative action at the frontline are hardly ever perfectly controllable by objectives, programs, laws, and the like (cf. Hogwood and Gunn 1984 via Fischer and Miller, 2007). Therefore, policies and their intentions will very often be changed or even distorted; its execution delayed or even blocked altogether (Jann and Wegrich, 2007).

Key concepts*: Top-Down Models/Instruments and Tools | Implementation Problems- Design, Coordination, Control*

Empirical evidence, showing that implementation was not appropriately described as a hierarchical chain of action leading directly from a decision at the centre to the implementation in some field agency, provided the ground for a competing concept of implementation (Jann and Wegrich, 2007). Bottom-up models regard local bureaucrats as the central actors in policy delivery and view implementation as negotiation processes within networks (Knill and Tosun, 2020). Here, policy research is primarily interested in patterns of state-society interaction and has shifted its attention toward the institutional set-up of organizational fields in the wider society (e.g., the health, education, or science section) (Jann and Wegrich, 2007).

Key concepts*: Bottom-Up Models/Instruments and Tools | Implementation Problems- Uncertainty, Interactions*

Thirdly, hybrid models integrate elements of both previously mentioned models and other theoretical models (Jann and Wegrich, 2007).

For successful implementation, there must be an entity that is able to translate the policy objectives into an operational framework and that is accountable for its actions (Gerston 2004 via Knill and Tosun, 2020). The choice of policy instruments are perceived to be vulnerable to specific kinds of implementation problems (Mayntz 1979 via Knill and Tosun, 2020). If implementation relates to horizontal agency across and within government, the number of actors is low and implementation can be attained smoothly. In vertical implementation is concerned relating to a wider number of actors in sub-national levels the opposite occurs (Knill and Tosun, 2020).

Key concepts*: Accountability | Effective Leadership*

2.2.1.5. Evaluation

After a policy is passed by the legislature and implemented by the bureaucracy, it becomes a subject of evaluation. The main question at this stage is whether the output of the decision-making process—a given public policy—has attained the intended goals.

Evaluation is often a formal component of policy-making and is commonly carried out by experts who have some knowledge about the processes and objectives pertaining to the issue undergoing review (Knill and Tosun, 2020). Evaluation research forms a separate subdiscipline in the policy sciences that focuses on the intended results and unintended consequences of policies. It is not restricted to a particular stage in the policy cycle but to the whole policy making process and from different perspectives in terms of timing (ex. ante, ex post) (Jann and Wegrich, 2007).

Evaluation can be carried out in different ways. In this context, Munger (2000) differentiates between (1) purely formal evaluations (monitoring routine tasks), (2) client satisfaction evaluation (performance of primary functions), (3) outcome evaluation (satisfaction of a list of measurable

intended outcomes), (4) cost-benefit evaluation (comparison of costs and impacts of a policy), and (5) evaluation of long-term consequences (impact on the core societal problem, rather than symptoms alone) (Knill and Tosun, 2020).

Key concepts*: Evaluative Methods | Monitoring | Policy Performance | Intended and Unintended Outcomes | Short to Long-Term Impact*

The outcome of evaluation either determines a return back to the agenda-setting stage or termination of a policy. This feedback loop identifies new problems and sets in motion the policy-making process once again, creating an endless policy cycle. This turns policy evaluation into a powerful tool of the policy making process as it allows decision makers to draw lessons from each policy in operation and possesses the potential to reframe an issue once thought to be resolved by policy makers (Knill and Tosun, 2020).

Key concepts: *Feedback Loops/Reflexivity | Learning | Re-Framing*

The results of the evaluation procedure can also lead to the termination of a certain policy which occurs when a policy has either met its purpose or is dysfunctional (Knill and Tosun, 2020). Empirical findings show that, however, that once a policy is institutionalized within a government, it is hard to terminate it (Bardach 1976; Jann and Wegrich 2006 via Knill and Tosun, 2020).

Key concepts: *Termination | Policy Institutionalisation*

In practice, policy evaluation presents numerous challenges to the evaluators (cf. Knill and Tosun 2012 via Knill and Tosun, 2020). Interpretations of the effect of policy can be self-serving; assessing the difference between intended impacts and unintended impacts is highly challenging and establishing where one policy stops and another starts is also highly immeasurable (Knill and Tosun 2012 via Knill and Tosun, 2020).

Key concepts: *Impact Assessment and Measurement Challenges*

2.3. Theoretical Framework Summary

The stages presented by the policy cycle inform the generic dimensions and related concepts in the policy making process. This is used to collate and organise the concepts presented within the TIP and MIP literature.

Table 1 below collates these dimensions and concepts presented by the literature and are grouped as they are presented in the Theoretical Framework section 2.2.

Dimensions	Concepts
Agenda-Setting	Identification and Definition of Societal Problem | Policy Initiation | Policy Agenda | Source of Issue Actors | Agenda Setting | Material Conditions | Institutional Capacity Cultural, Political, Social, Economic, Environmental and Ideological Contextual Factors Policy Window | Timing | Directionality | Events | Shifts in Perception | Uncertainty Salience | Framing
Policy Formulation	Multi-Level | Multi-Actor | Public-Private | Coordination | Decision-Making | Contestation State Structure | Policy Networks | Linkages | Beliefs Policy Options | Instrumentation | Regulatory, Financial, Informational, and Organizational Tools Actors | Role of the State and Governance
Policy Adoption	Decision Making Heuristics and Biases Boundaries/Parameters- Resource Availability, Political Preferences and Public Perception Competencies of Government and Institutions Cooperation, Collaboration and Coalition Opportunities
Implementation	Top-Down Models/Instruments and Tools | Implementation Problems - Design, Coordination, Control Bottom-Up Models/Instruments and Tools | Implementation Problems- Uncertainty, Interactions

	Clear Definition, Interpretation and Identification of Responsible Agents | Clear Allocation of Budgetary, Personnel and Organisational Resources | Clear Decision-Making Framework Accountability | Effective Leadership
Evaluation	Evaluative Methods | Monitoring | Policy Performance | Intended and Unintended Outcomes | Short to Long-Term Impact Feedback Loops/Reflexivity | Learning | Re-Framing Termination | Policy Institutionalisation Impact Assessment and Measurement Challenges

Table 1: Table of dimensions, concepts from the Policy Cycle

Finally, the visualisation below (fig.2) highlights the various dimensions of policy making identified above. The grey-blue area represents the 'space' for study and the green (TIP) and orange (MIP) rings reflect the process of circulating through the literature to identify and extract concepts.

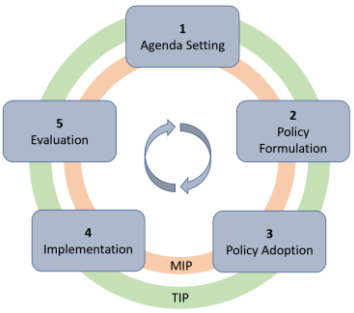


Fig.2: Conceptual framework; a Policy Cycle perspective for disentangling TIP and MIP.

The next section explains the methodology, source of literature, analysis approach and how the thesis operationalises these dimensions to identify concepts presented in the TIP and MIP literature.

3. Methodology

3.1. Integrative Literature Review

The integrative literature review is a distinctive form of research that generates new knowledge about the topic reviewed. Literature reviews can be written to (a) review, update, and critique the literature; (b) conduct meta-analysis of the literature; (c) review, critique, and synthesize the literature; (d) reconceptualize the topic reviewed in the literature; and (e) answer specific research questions about the topic reviewed in the literature (Torraco, 2016). This study reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new perspectives on the topic are generated (Torraco, 2016).

In line with related studies looking to conceptualise an emergent field such as Battilana's study on institutional entrepreneurship (2009) and Greenwood's study on institutional complexity (2011), this study conducts a "relatively broad review of [two] emerging topic[s] in need of initial synthesis" (Elsbach and van Knippenberg, 2020), resulting in a multi-level integrative review. This approach is in contrast with a relatively narrow review of a mature topic in need of re-conceptualisation, such as those offered by Magee & Galinsky on organisational hierarchy (2008) and Maitlis & Christianson's study on organisational psychology (2014) (Elsbach and van Knippenberg, 2020).

3.2. Approach

This study begins by conducting an initial understanding of the TIP and MIP topics through a basic assessment of the literature meta-data. Through the lens of the policy cycle, the author conducts an in-depth systematic review, critique and synthesis of the literature making explicit reference to TIP and MIP. The steps taken are summarised as follows:

i) definition of search term, search and filter of literature
ii) initial scan of topics' theoretical foundations and current debate,
iii) selection of 'core' literature for study,
iv) identification of concepts,
v) literature review of concepts
vi) synthesis

3.2.1. Definition of search terms, search boundaries and filter of literature

3.2.1.1. Publication Outlets (Population and Core)

In line with the research design, this study sources literature currently presented across peer-reviewed academic articles. This ensures academic reliability as all featured articles have been examined by people with credentials in the articles field of study before being published and is an indication of journal standards, quality of the research presented and the completeness of cited references (Clarivate Analytics, 2018). Table 2 below highlights the source for literature.

	Academic Articles	News Articles	Corporate White Papers	Blogs and Online Media
Suitable?	Yes	No	No	No
Reliable?	Yes	No	Yes	No
Accessible?	Yes	Yes	Yes	Not Easily
Retrievable?	Yes	Yes	Yes	Not Easily

**Table 2: Assessment of publication outlets.*

Web of Science (Thomson Reuters) is the largest repository for academic articles and is the database utilised to search for relevant, peer-reviewed articles. Search queries in Web of Science can mine several fields: title, abstract, keywords and keywords plus (expanded terms stemming from the records cited references or bibliography) for the occurrence of the search term (Clarivate Analytics, 2021). See table 3 for a summary of publication sources and their suitability (summary table 3).

Search Engine	Web of Science	Google Scholar	Scopus
Peer-Reviewed?	Yes	No	Yes
Citation No. Offered?	Yes	Yes	Yes
Downloadable Papers?	Yes	Yes	Yes
Analytics?	Yes	No	No
Working Papers?	No	Yes	No
Strength	Academic	Academic & Broad & Recent	Academic

**Table 3: Assessment of Publication Sources.*

3.2.1.2. Terms

Slight variances of language are used to represent both the 'transformative' and 'missions-oriented' innovation policy literature in databases, as is typical with the emergence of a topic. In contrast to the approach by Schulze et al (2016) who excluded articles based on title and abstract review, the author employed an approach similar to Bouncken et al (2015) who focussed literature selection on articles using specific terms (Bouncken *et al.*, 2015). Recognising the importance that search terms emerge from the literature rather than prescribe the search, the author obtained initial search terms from the leading research groups on the topics; TIPC- the Transformative Innovation Policy Consortium in the UK (TIPC, 2021) and MIPO- the Mission-Oriented Innovation Policy Observatory in the Netherlands (Utrecht University, 2021).

The author searched several combinations of "transformative" + "innovation" + "policy" and "mission" + "oriented" + "innovation" + "policy" in the Web of Science 'topic search' fields: title, abstract, keywords and keywords plus. The datasets using the terms "transformative" + "innovation policy" and "mission" + "innovation policy" were used for the 'population' literature. To capture the most relevant literature with explicit reference to the topics, the terms "transformative innovation policy" and "mission-oriented innovation policy" were used to represent the 'core' set of literature. This search reflects the literature explicitly connected to the current debate.

3.2.1.3. Time

A 20year time frame is applied ranging from 2001 to 2021 to source the relevant period of the topics' emergence. This is appropriate because integrative literature reviews are conducted on dynamic topics that experience rapid growth in the literature and that have not benefitted from a comprehensive review and update during an extended period (Torraco, 2016).

3.2.1.4. Size

The sample size was not predetermined, but rather guided by the search terms "transformative innovation policy" and "mission-oriented innovation policy" to arrive at the sample of literature herein titled the 'core'. The aim is to provide a sample of literature explicitly referencing the TIP and MIP topics so as to reflect on the current debate utilising the topics key terms. In line with the methodology, the results of the 'core' search term are filtered based on the criteria defined in section iii) Selection of 'core' articles (sample selection and distribution).

3.2.1.5. Domains

Recognising that societal and environmental challenges are 'wicked problems' with interdisciplinary features, this study conducts an interdisciplinary approach to research. The author does so by not restricting the considered literature to certain domains- namely social sciences, but by accepting literature with occurrences of the search terms across the domains of health, education and agriculture (to name a few) to uncover instances where the TIP and MIP topics have been tested and/or applied. This is categorised according to Web of Science's own, moderated, categorisation approach and titled 'Web of Science Categories'.

3.2.2. Initial Scan (Population and Core)

First, this study conducts an initial scan using the literature meta-data on i) publication year, ii) journal, iii) domain and iv) authors to yield some high-level comparative insights on the TIP and MIP topics. This reveals patterns of causal relationships across a body of research on a given topic (Hunter and Schmidt, 1990 via Torraco, 2016) to understand the current state of the art. This is conducted on the entire 'population' of results meeting the broader search term '"transformative" "innovation policy"' and '"mission" "innovation policy"' and the 'core' literature that references the search terms '"transformative innovation policy"' and '"mission-oriented innovation policy"'.

Secondly, the study conducts deeper analysis of the selected 'core' literature with explicit reference to the search terms '"transformative innovation policy"' and '"mission-oriented innovation policy"'. The literature meta-data will be exported from Web of Science containing citation and references data which is analysed to unpack the topics' i) theoretical foundations, and reflect on the literature presenting the ii) current debate. This will include an assessment of the key articles, citations, authors, research domains and provide an initial assessment of the relevance of the 'core' literature as well as initial comment on their similarities and differences.

3.2.3. Selection of 'core' literature (Core)

Identifying the 'space' for an impactful integrative review involves both justifying the review and identifying the boundary conditions of the review (Elsbach and van Knippenberg, 2020). Here, the author provides justifications and boundary conditions for literature selection.

The articles that capture the complete search term "transformative innovation policy" and "mission-oriented innovation policy" are considered as the 'core' literature for further study. Similarly to Schulze et als (2016) selection criteria for systematic review and Feola's (2015) study on 'transformation', the author filters and excludes articles: (Feola, 2015)

a) In which the topic of 'transformations' and 'missions' refers exclusively to 'old' technical missions such as putting a man on the moon or war and church missions
b) Where the need for 'transformations' and 'missions' represented a general background motivation of the study rather than the object of the study
c) Publications not in the English language
d) Not peer-reviewed and not available online

This process is conducted prior to any analysis on the 'core' literature resulting in a list of 'core' articles that capture the most explicit reference to the nascent TIP and MIP topics. A careful, comprehensive literature search is vital to the quality of the review because the literature constitutes the "data" for this type of research (Torraco, 2016).

3.2.4. Identification of Concepts (Core)

The integrative literature review approaches as presented by Torraco (2016) and Elsbach and van Knippenberg (2020) prescribes no analytical framework for which to identify and analyse literary concepts within a field. Torraco (2016) does however propose three forms of structure to the review, including conceptual or thematic structure. Here, Torraco (2016) suggests that most topics in the social sciences are composed of several key concepts wherein the main concepts of the topic provide a framework around which the review can be organized (Torraco, 2016). This study employs this approach to organise concepts from the TIP and MIP literature in a concept matrix using an Excel spreadsheet with the labels assigned to concepts of the policy cycle presented earlier in the x axis and topics in the y axis (see appendix 3 for example).

With reference to the dimensions and concepts presented earlier from the policy sciences field (1- Agenda-Setting, 2- Policy Formulation, 3- Policy Adoption, 4- Implementation, 5- Evaluation), the author employed an axial coding approach to make interconnections between concepts to develop categories that combine common patterns. This method is deemed fit for purpose as it utilises a coding approach that looks for thematic patterns in textual data. This is a valid and approved methodology for the identification of concepts and is introduced as an inductive, comparative methodology that provides systematic guidelines for gathering, synthesizing, analysing, and conceptualizing qualitative data for the purpose of theory construction (Charmaz, 2015). The coding process is conducted first for TIP and then for MIP literature through an iterative process.

The number of concepts were not predetermined and the concepts that were included in the analysis emerged from the literature. To support validity and reduce interpretive bias, the author employed several techniques suggested by Torraco (2016) to 1- read articles in full, 2- capture concepts, 3- group and organise concepts in an Excel table, 4- highlight key similar and common themes, 5- write up findings (Torraco, 2016). To clarify, the review is not meant as an extensive survey of all available literature on the topic, which is beyond the scope of this thesis but to reveal what key concepts of TIP and MIP in response to grand societal challenges are presented by the current literature that explicitly reference TIP and MIP and to systematically analyse them, so as to reflect on their relationship.

3.2.5. Analysis of Concepts (Core)

Critical analysis involves carefully examining the main ideas and arguments presented in the literature through a critical lens and deconstructing pieces of literature on the topic into their basic elements such as its social or environmental context and the main ideas or concepts (Torraco, 2016). Conducting the analysis across multiple levels as described supports integrating research findings into a relatively broad and multi-level model providing scholars with a detailed and rich framework from which to identify new research opportunities (Elsbach & Knippenberg, 2020).

3.2.5.1. Analytical Framework

Table 4 presents the analytical framework which operationalises the policy cycle and provides a structure to capture and analyse the wide variety of concepts presented across the TIP and MIP topics. Herein, the author reformulates the concepts presented in section 2.3 for consistent grouping and assigns a label to that group with an expression of that label as a question (indicator) to guide the author in the axial coding process. In support, the following definitions are offered:

Dimensions: The broad thematic categorisation following the stages of the Policy Cycle.

Concepts: Concepts that capture the key ideas of each stage of the Policy Cycle as presented in the theoretical framework (section 2.2).

Labels: The label aggregates these key ideas into a single term.

Indicators: The indicators are an expression of this label as a question, to guide the author in the analysis of the literature. These are descriptive, and based on asking how, who and what questions.

3.2.6. Synthesis

Critical analysis enables the literature review to build on the strengths and limitations of the literature to create a better understanding of the topic through synthesis (Torraco, 2016). Using the insights acquired from a careful and critical analysis of the literature, the author recasts, combines, reorganizes, and integrates concepts and perspectives on the topic to create new theoretical formulations and ways of thinking about the topic (Torraco, 2016).

The author stylises the TIP and MIP topics similarities and differences by synthesising findings to the following questions:

3.2.6.1. To what extent does the topic understand the concept?

Critical analysis lays the foundation for critique, which identifies the strengths of the literature as well as any deficiencies, omissions, inaccuracies, and other problematic aspects of the literature (Torraco, 2016). Based on the presented understanding, the author indicates whether the topics reflect a "Weak", "Medium" or "Strong" understanding against the understanding presented in the policy cycle. "Weak" does not necessarily mean negative, but rather that the topic is underdeveloped in this area, shows gaps, deficiencies or inconsistencies, whereas 'Strong' suggests there is significant understanding on this concept in the literature presenting consistent and extensive ideas.

3.2.6.2. Do the topics diverge or converge in their understanding of the concept?

On balance of the evidence presented by the literature review, the author determines whether the TIP and MIP topics current understanding converge, indicated by the arrows '→←' or diverge '←→'. The aim is to present the current understanding, recognising that the concepts are continually evolving through ongoing debate to which authors introduce different perspectives and the topics are yet to institutionalise around a core set of ideas.

3.2.6.3. Do these ideas present an understanding that competes, complements or are neutral/underdeveloped to one another?

Based on the approach offered by Torraco (2016) to identify major themes, tensions, and key constructs in a relatively young or emerging topic (Torraco, 2016), the author offers a synthesis of the literature through the assessment of the TIP and MIP topics current understanding. The ability to synthesise depends on the author's deep understanding of the topic and its literature (Torraco, 2016). This is assessed as either productive and supportive (complementary), unproductive (competing), are neither complementary nor competing to one another (neutral) or is underdeveloped on the understanding of the policy making process.

Dimensions	Concepts	Label	Indicators
Agenda-Setting	Policy Agenda	Policy Agenda	What is the topics focus of the policy agenda?
	Identification and Definition of Societal Problem | Policy Initiation | Source of Issue	Agenda Identification	How does topic source and identify potential policy issues for the agenda?
	Agenda Setting	Agenda Definition	How does the topic address the definition of policy issues for the agenda?
	Cultural, Political, Social, Economic, Environmental and Ideological Contextual Factors | Material Conditions	Contextual Factors	How does the topic consider the diverse contextual factors?
	Actors	Agents of Change	Who does the topic identify as responsible agents of change?
	Directionality	Directionality	How does the topic understand directionality?
	Events | Policy Window | Timing | Salience	Timing	How does the topic address urgency and time-based factors?
	Framing	Framing	How does the topic treat diversity in framing policy issues?
	Shifts in Perception | Uncertainty	Change	How does the topic recognise change and uncertainty in agenda setting?
Policy Formulation	Multi-Level | Multi-Actor | Actors	Actors	How does the topic address the multiplicity of levels and actors?
	Role of the State and Governance | State Structure	Governance	How does the topic perceive the role of governance?
	Public-Private | Coordination	Coordination	How does the topic understand coordination between actors?
	Decision-Making | Contestation	Contestation	How does the topic address contestation in the decision-making process?
	Policy Networks | Linkages | Beliefs	Networks and Linkages	How does the topic understand networks and linkages?
	Policy Options | Instrumentation | Regulatory, Financial, Informational, and Organisational Tools	Instrumentation and Tools	What policy options, instrumentation and tools does the topic present?
Policy Adoption	Boundaries/Parameters- Resource Availability, Political Preferences and Public Perception |	Boundaries & Parameters	What boundaries / parameters does the topic identify?
	Competencies of Government and Institutions | Institutional Capacity	Capabilities, Capacity & Competencies	How does the topic assess the capabilities, capacity and competencies of actors?
	Cooperation, Collaboration and Coalition Opportunities	Cooperation, Collaboration & Coalitions	How does the topic enable cooperation, collaboration and coalitions?
	Decision Making Heuristics and Biases	Decision Making Limitations	How does the topic understand limitations to decision making process?
Implementation	Top-Down Models/Instruments and Tools | Bottom-Up Models/Instruments and Tools	Top Down & Bottom Up	How does the topic understand top-down & bottom-up factors?
	Clear Definition, Interpretation and Identification of Responsible Agents | Clear Allocation of Budgetary, Personnel and Organisational Resources | Clear Decision-Making Framework	Design & Delivery	Does the topic offer a clear framework for policy implementation design and delivery?
	Accountability | Effective Leadership	Accountability	How does the topic enforce effective leadership?
	Implementation Problems - Design, Coordination, Control | Implementation Problems- Uncertainty, Interactions	Implementation Problems	What implementation problems does the topic identify?
Evaluation	Monitoring | Policy Performance	Monitoring & Performance	How does the topic address monitoring and performance during the policy process?
	Evaluative Methods | Short to Long-Term Impact | Intended and Unintended Outcomes | Re-Framing	Impact & Evaluation	How does the topic address impact and evaluation after the policy process?
	Feedback Loops/Reflexivity | Learning	Reflexivity	How does the topic enable space for reflexivity and feedback?
	Termination	Termination	How does the topic conclude/terminate policy process?
	Impact Assessment and Measurement Challenges | Policy Institutionalisation	Measurement Challenges	What measurement challenges does the topic present? And resolve?

**Table 4: Analytical framework for the study of TIP and MIP, showing dimensions, concepts, label and an expression of this label as a question.*

4. Results

The results begin by first explaining some key insights from the search followed by an initial scan utilising the literature meta-data ('population' and 'core' dataset). This is then followed by a deeper assessment of the theoretical foundations, positioning of the current debate and the systematic literature review (using the 'core' dataset).

4.1. Search Term Results

4.1.1. Population

The study first captures a set of articles using the search terms, '"transformative" "innovation policy"' (TIP) and '"mission" "innovation policy"' (MIP) and is used for the initial scan only as demonstrated in figure 3. This thesis refers to this set of articles as the 'population' as it provides a broader, yet relevant search term that captures a wider set of literature to produce a more reliable set of results.

The search query in Web of Science (conducted 22/2/21) mined the fields title, abstract, keywords and keywords plus and yielded 56 articles for TIP. In an additional step the author exported these results and mined the occurrence of common words in the 'Author Key Words' field to provide initial insights into the topics. The title 'primary' defines the top 3 occurring results while 'secondary' displays the next most popular terms. The results of this (with occurrences in brackets) for TIP are:

a. Primary: 'transform + (ative)' (20) + 'innovation' (44) + 'policy' (44)
   Secondary: 'system' (17) + 'change' (11) + 'transition' (9) + 'mission' (8)

The results of the search term for MIP yielded 55 articles and the same method is used to count the occurrence of common words from the 'Author Key Words' field. These are as follows:

b. Primary: 'mission' (25) + 'innovation' (45) + 'policy' (42)
   Secondary: 'system' (13) + 'transform + (ative)' (5), 'transition' (5) + 'technology' (5)

One can infer from these initial insights that there is evidence of several, related words. Most significantly, the word 'system' appears most frequently in both TIP and MIP, and the word 'transform+(ative)' and 'mission' appear in both results further evidencing their fluid use. The word 'transition' also appears in both sets of articles, but to a larger extent in the TIP meta-data than in MIP. Though the author is cautious to derive significant insights from this, it may indicate the presence of transitions studies influencing TIP to a larger extent than MIP.

4.1.2. Core

For the 'core' literature this study captures a set of articles using the narrower search terms, "transformative innovation policy" and "mission-oriented innovation policy" to reflect the clearest references to the current debate.

The result of the search yielded 11 articles for TIP and 14 articles for MIP. All articles are peer-reviewed (no. 1 in table 5) and were published in the past 20 years (no. 2 in table 5). According to Schulze et al (2016) and Feola's (2015) checklist (no 3 in table 5), all articles were written in English, though 1 article from both TIP and MIP were excluded on the basis that 'transformative' and 'mission' represented general background to the study rather than a specific focus or application (these articles are highlighted in red in Appendix 2). All articles featuring in the 'core' literature also featured in the

'population' dataset. Table 5 below shows the checklist, which is divided between TIP and MIP with the number of articles removed at each step (in parenthesis):

Criteria	Level	TIP	MIP
Start			
1	Peer-Reviewed?	11 (0)	14 (0)
2	Time: 2001-2021?	11 (0)	14 (0)
3	Checklist?	10 (1)	13 (1)
End		**10**	**13**

Table 5: Filter process for TIP and MIP articles

This 'core' sample of literature reflects the most relevant literary contributions based on our selection criteria (these articles are highlight in green in Appendix 2). The list of 23 articles do not present a complete and exhaustive set of literature on the topics, but – in line with the objectives of this study – merely the set of academic literary articles that have explicitly adopted the TIP and MIP term.

Figure 3 below, summarises the literature search and research approach which is common practice in integrative literature reviews (Bouncken *et al.*, 2015; Schulze *et al.*, 2016). The green arrows correspond to TIP and the orange arrows correspond to MIP. The dark black boxes define the literature used for the initial scan using the literature meta-data (left) and the literature review (right).

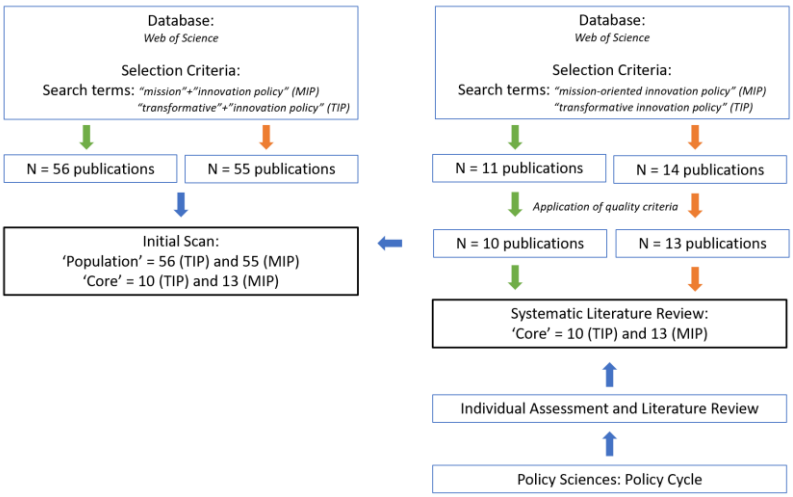


Fig.3: Literature search approach and results

Table 6 below demonstrates that the 'core' sample size (23 articles) is comparative to the average sample size used in other integrative literature reviews (16 articles). This suggests a reliable sample size has been achieved relative to number of authors and number of topics under assessment.

	No. of Articles	No. of Authors	Articles / Authors	No. of Topics	Source
Article 1	44	4	11	1	(Schulze *et al.*, 2016)
Article 2	82	4	~20	1	(Bouncken *et al.*, 2015)
Article 3	21	1	21	4	(Shuck, 2011)
TOTAL	147	9	-		
Average	**49**	**3**	**16**	**2**	
This Thesis	23	1	23	2	

Table 6: Comparison of number of articles used by similar literature reviews.

The next section presents and discusses an initial scan of the meta-data contained in the TIP and MIP literature for both the 'population' and the 'core' set of articles to derive generic themes and context.

4.2. Initial Scan (Population and Core)

Here, the study utilises the literature meta-data to provide generic themes and trends appearing in the wider 'population' of TIP and MIP literature and the 'core' literature which makes explicit reference to the TIP and MIP search term.

4.2.1. Publication Years

Population. TIP and MIP have emerged as topics for contemporary innovation policy thinking at remarkably similar times and degrees of intensity in terms of publication output as demonstrated by the graphs below (fig.4 and fig.5). In the past 10 years (from 2011 – 2021), there have been a total of 55 publications referencing "transformative" "innovation policy" and 55 publications referencing "mission" "innovation policy", representing 99% (TIP) and 100% (MIP) of publications in the entirety of the topics history with the only other article appearing in 1999 for TIP.

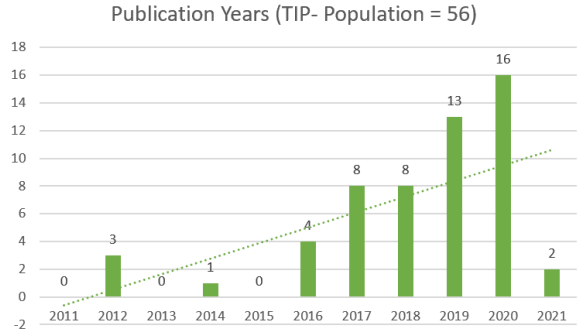


Fig.4. TIP Publication Years- Population 2011-2021

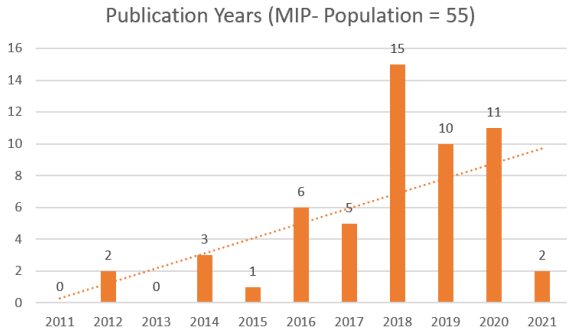


Fig.5. MIP Publication Years- Population 2011-2021

Core. In the 'core' literature (fig.6 and fig.7), one observes that the rate of publications explicitly referencing MIP appear somewhat more sporadic than the gradual emergence of TIP. Both however, appear for the first instance in 2012 and only again in 2018 suggesting that the key term referencing the topics may have only very recently found some consistency. This may call into query the repetition of papers in both 'core' sets but upon further investigation, this corresponds to 2 articles (Hekkert et al, 2020; van der Loos, Negro and Hekkert, 2020) appearing in both data sets to publishing year 2020.

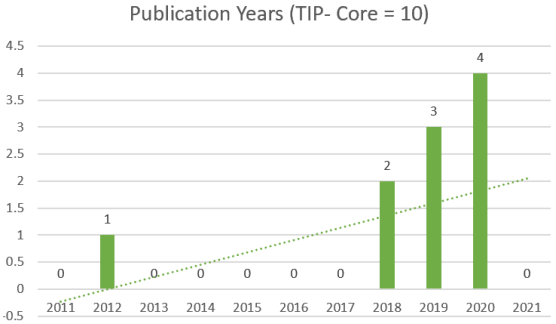


Fig.6. TIP Publication Years- Core (10)

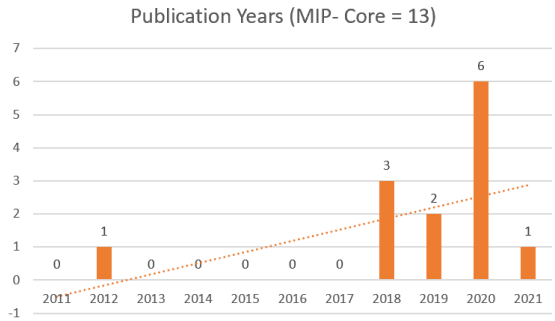


Fig.7. MIP Publication Years- Core (13)

4.2.2. Publication (Journal)

Population. The most frequent references to TIP and MIP occur across the Research Policy journal (corresponding to TIP = 23% of results; MIP = 9% of results), and Science and Public Policy (TIP = 9%; MIP = 5%). One can infer from this that from the journals presented below (fig.8 and fig.9), there is an active discussion in social sciences with non-sector specific journals corresponding to 43/111 (39%) of references to TIP and MIP. Journals of more applied/sectoral focus feature to a lesser extent, though are more prevalent and across broader research areas in MIP (Agriculture and Energy) than in TIP

(Climate). Indeed, the distribution across journals is wider within the MIP topic (36 different journals) compared with the TIP topic (31).

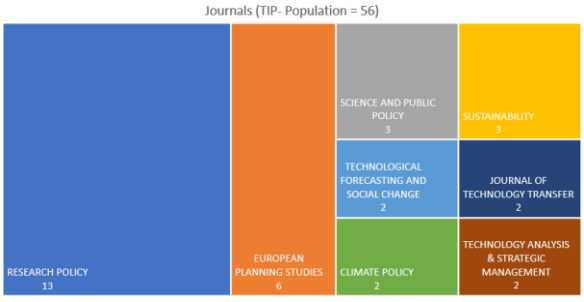


Fig.8. TIP- Population Journal Categorisation (Top 3)

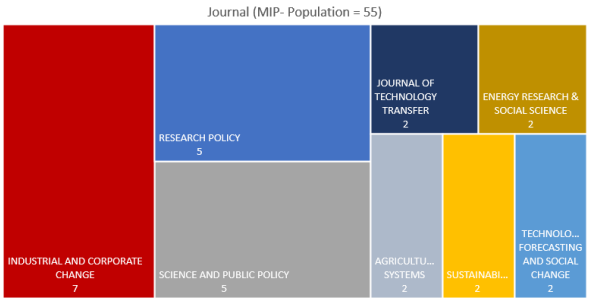


Fig.9. MIP- Population Journal Categorisation (Top 3)

Core. Despite Science and Public Policy journal featuring heavily in both TIP and MIP, this features to a lesser extent in the 'core' selection (fig.10 and fig.11). Rather, the journals, Research Policy (5), Industrial and Corporate Change (3) and European Planning Studies (2) were most strongly represented across TIP and MIP articles. When combining the 'core' journals with publication years, one observes that the journal focus appears more sectoral (Energy, Clean Technology, Food) in recent years (2020 and 2021) than in earlier years (2012, 2018 and 2019) for both TIP and MIP.

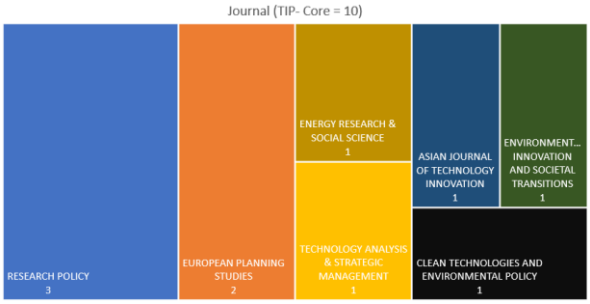


Fig.10. TIP- Core Journal Categorisation (ALL)

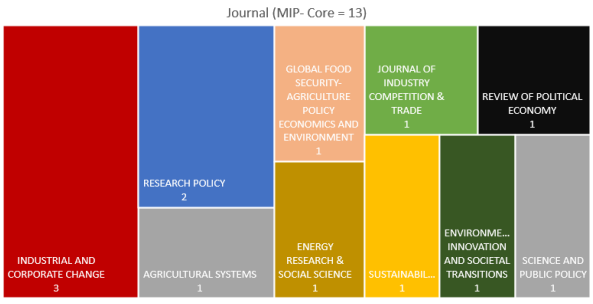


Fig.11. MIP- Core Journal Categorisation (ALL)

Lastly, it is interesting to observe that the MIP topic experiences a somewhat broader appeal (within Food and Agriculture, Energy and Environment) compared to the TIP topic which appears marginally narrower though with more specific reference to social sciences within a national and supra-national context (Asian Journal of Technological Innovation and European Planning).

4.2.3. Domain

Population. Considering the reach of these topics across domains for the whole population of articles (fig.16 and fig.17), there is a stronger emphasis in social science domains- management, business and economics; with these three domains alone representing 28% of TIP and 36% of MIP. Furthermore, Environmental Studies and Environmental Sciences are represented to a far greater extent in TIP than MIP.

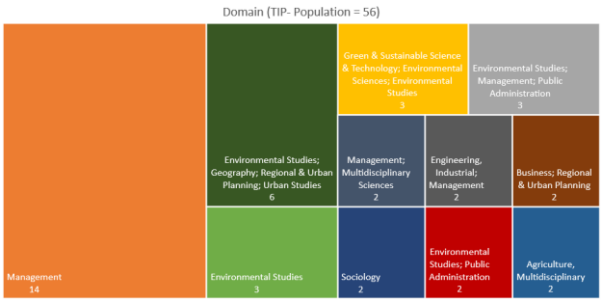


Fig.16: TIP- Population- Domain (Top 5)

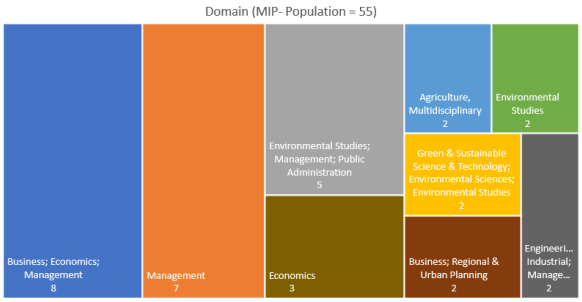


Fig.17: MIP- Population- Domain (Top 5)

Core. The 'core' selection of articles supports the previous assessment that the TIP and MIP topics appear to be divergent in their application. Since the topics' inception, TIP has received more recent reference to the domain of Environmental Studies and Urban Studies while MIP appears to receive more recent reference within Food Science & Technology and Agriculture (fig.18 and fig.19).

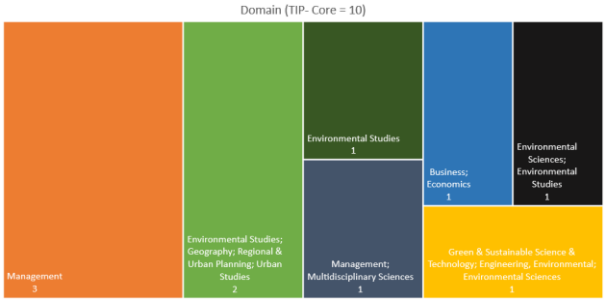


Fig.18: TIP- Core Domain (ALL)

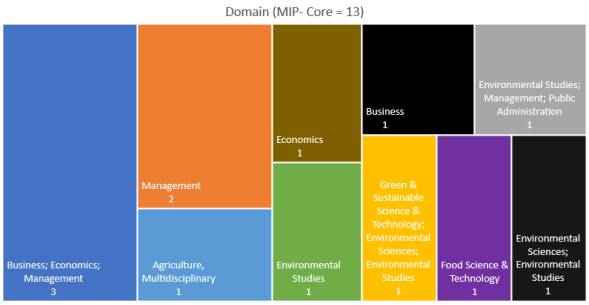


Fig.19: MIP- Core Domain (ALL)

4.2.4. Author

A network diagram, reflecting the authors (as nodes) and co-authors (lines), generates several useful relational insights to understand which authors are publishing on TIP and MIP.

Population. The network diagrams of the 'population' data (fig.20 and fig.21) reflect that 113 different authors for TIP versus a slightly broader range of 126 different authors for MIP. The diagrams reflect a highly fragmented network suggesting that the topics are clearly in their early stages. When co-publishing, authors generally engage in repeated collaborations as indicated by the van Est, Verbong and Girones triad (TIP) and the Hekkert, Wesseling, Negro and Janssen square (MIP). The most dominant author on the topics is Klerkx, L (4) for TIP and Mazzucato, M (8) for MIP who interestingly publish predominantly in differing fields, Agriculture (Klerkx, L) (TIP) and Business & Economics (Mazzucato, M) (MIP). Klerkx, L is featured strongly in both datasets which may reflect both TIP and MIP's wide reference already in other fields and its adoptive use specifically in the Agricultural domain.

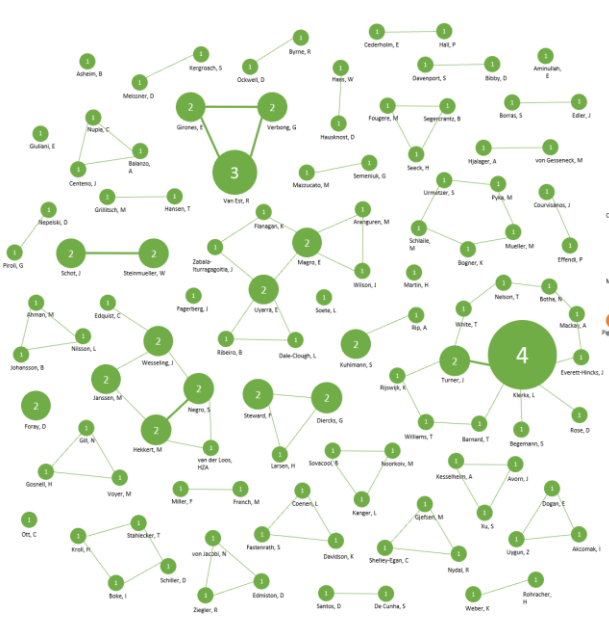


Fig.20: TIP- Population publications by Authors

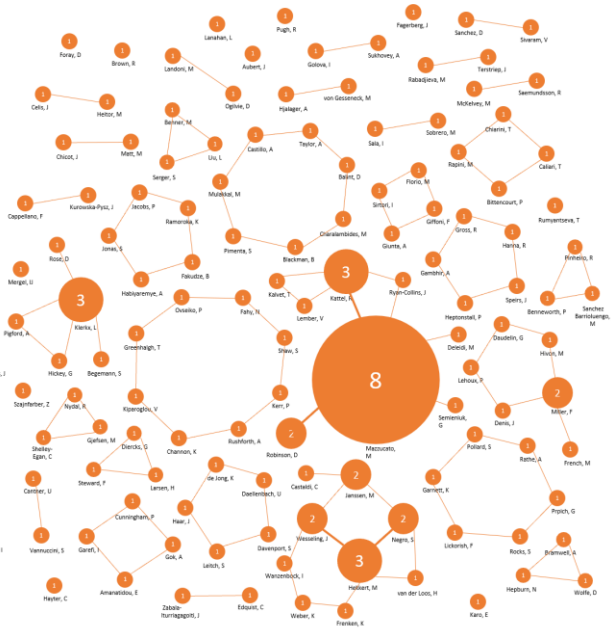


Fig.21: MIP- Population publication by Authors

The next section presents the results of further analysis into the theoretical foundations and the current debate from the 'core' literature.

4.3. Theoretical Foundations and Current Debate (Core)

4.3.1. Theoretical Foundations

Further assessment of the 'core' literature meta-data was conducted to generate a deeper understanding to recognise the key contributions, theoretical foundations and the connectedness of the current debate. Taking '3' references to articles as the starting point, this resulted in a set of '20' articles for MIP and '17' for TIP, herein referred to as the 'key contributions'.

Figures 22 and 23 below, show the evolution of the cited articles identified as the key contributions in date order across the x axis with the 'core' literature reflected in the legend. With reference to the key contributions title, TIP features several older articles contributing theoretical foundations that draw on influences of 'economic welfare' (Arrow, 1962), the 'allocation of resources' (Freeman, 1974) and 'interactive learning' (Lundvall, 1992). More recently, TIP articles draw on influences of 'new directions for innovation studies' (Schot and Steinmueller, 2018a), the 'failures framework' (Weber and Rohracher, 2012) and 'technological transitions as evolutionary reconfiguration processes' (Geels, 2002) which echoes earlier assertion of the influence of transitions literature to the TIP topic.

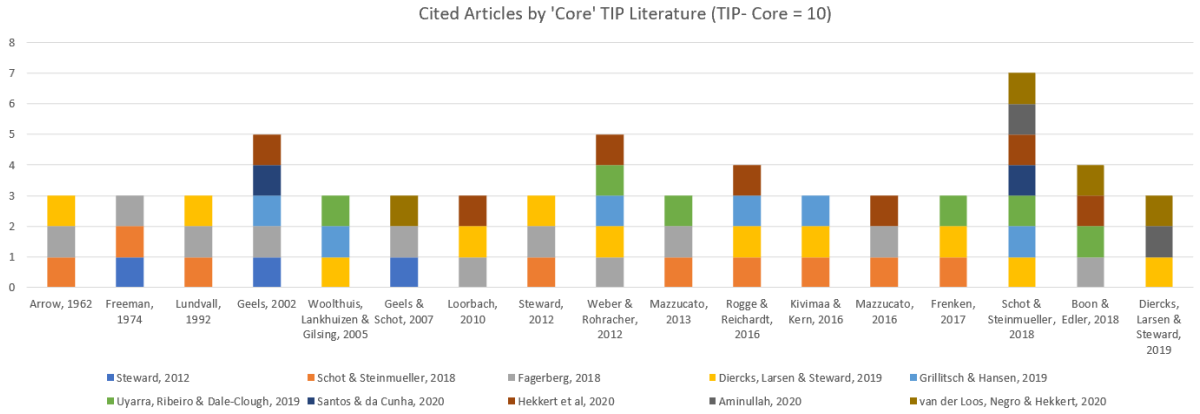


Fig.22: Cited Articles by 'Core' TIP Literature

Similarly for MIP, several older articles appear that draw influence from the 'evolutionary theory of economic change' (Nelson and Winter, 1982), the 'growth of industrial policy' (Johnson, 1982), and 'technology and global industry' (Ergas, 1987). More recently, the MIP topic appears to draw on influences of moving from 'market fixing to market creating' (Mazzucato, 2016), 'debunking the public vs private myth in risk and innovation' (Mazzucato, 2013) as well as Schot and Steinmueller's (2018a) article on 'new directions for innovation studies' and Boon and Edler's (2018) article 'making sense of new trends in innovation policy'.

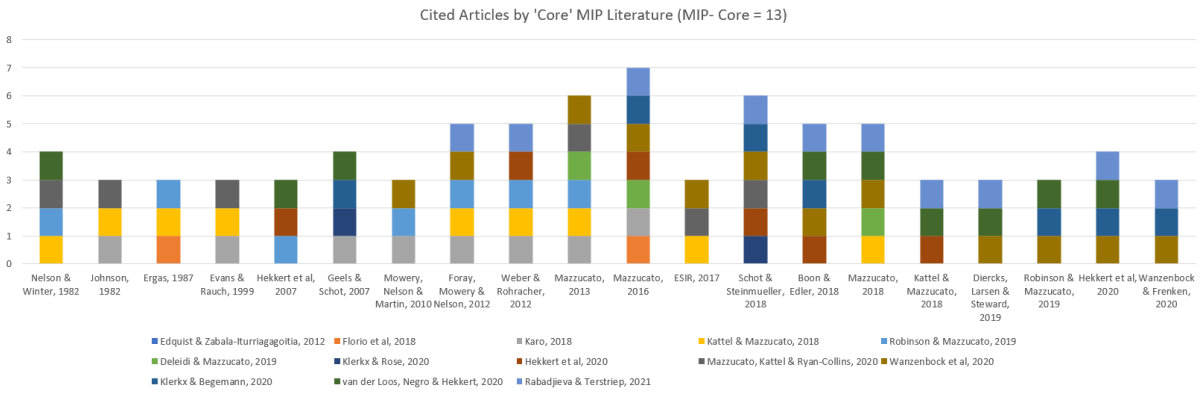


Fig.23: Cited Articles by 'Core' MIP Literature

Across both datasets, the articles of Schot and Steinmueller (2018a), Mazzucato (2016), Weber and Rohracher (2012) and Boon and Edler (2018) are highly cited by the TIP and MIP 'core' literature. This is similarly reflected in part by the occurrence of authors across the TIP and MIP 'core' dataset. As a result of a limitation in the dataset for reflecting the lead author only, figures 24 and 25 below reflects the top 10 authors cited as lead authors by the 'core' literature.

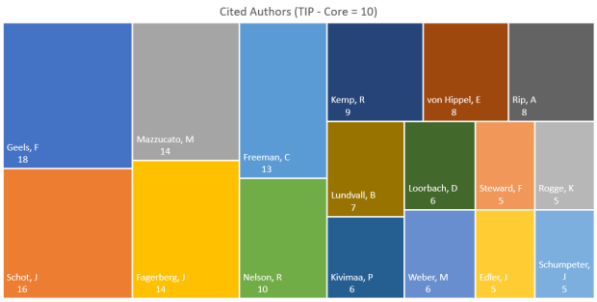


Fig.24: Top Cited Authors (TIP)

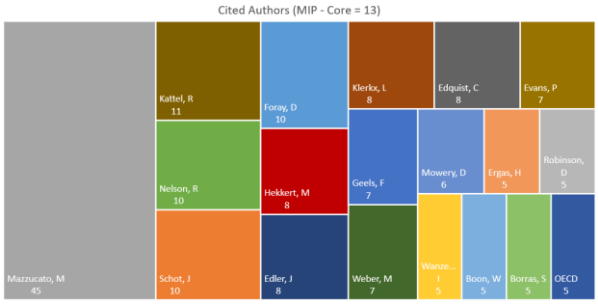


Fig.25: Top Cited Authors (MIP)

From the TIP dataset, one observes the influence of Geels, F (18), Schot, J (16), Mazzucato, M (14) and Fagerberg, J (14). From the MIP dataset, one observes the strong presence of Mazzucato, M (45), Kattel, R (11), Schot, J (10), Nelson, R (10) and Foray, D (10). Even without the presence of several Mazzucato, M articles in the 'core' dataset, the author would be the top cited author with 23 references. It is worth noting that Schot, J (26), Mazzucato, M (61), Nelson, R (20) and Freeman, C (17) appear highly influential to both datasets suggesting clear shared influences on the emergence of the TIP and MIP topics and potentially reflective of a shared knowledge base and similarities in their theoretical foundations.

The network diagrams below (fig.26 and fig.27) show the relationship between the most influential articles to the 'core' literature for TIP and MIP. The size of the nodes corresponds to the frequency the article has been cited by the 'core' literature, which the author takes '3' as the threshold. The links correspond to the frequency the key contribution is co-cited with another article from the knowledge base (fig.28 and fig.29).

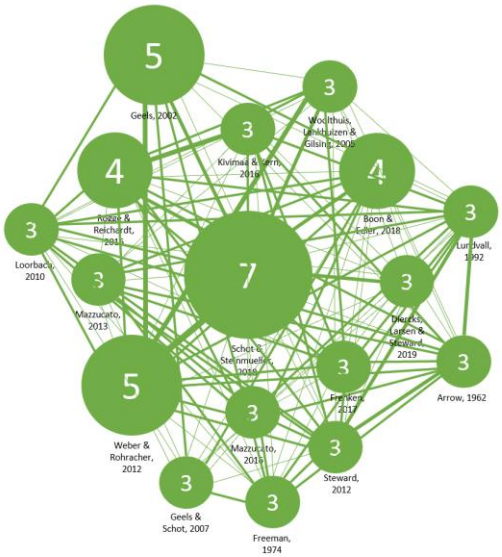


Fig.26: Network Diagram of TIP Key Contributions

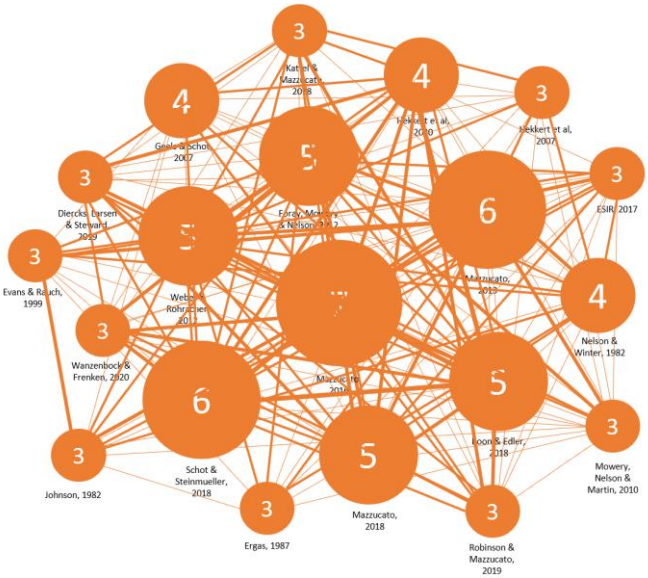


Fig.27: Network Diagram of MIP Key Contributions

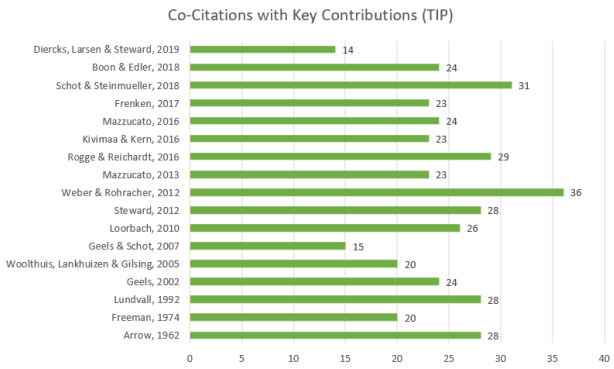


Fig.28: Total No. of Co-Citations of Key Contributions (TIP)

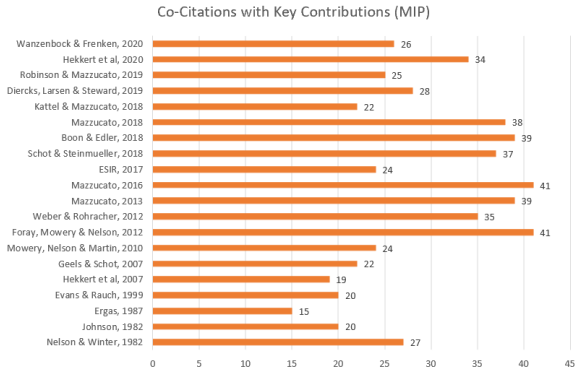


Fig.29: Total No. of Co-Citations of Key Contributions (MIP)

One can observe that while there are several prominent articles forming a relatively homogenous theoretical base to TIP and MIP (such as Weber and Rohracher, 2012; Schot and Steinmueller, 2018a and Mazzucato, 2016) there does not appear to be a clear dominance of a particular clique of articles or literature base. This is evident in TIP, where the articles of Geels (2002), Loorbach (2007) and Rogge and Reichardt (2016) heavily influenced by transitions literature appear as well connected as the articles of Steward (2012) and Frenken (2017) which are more influenced by science, technology and innovation studies. This is perhaps one indication of the emergent innovation policy topics crossing over academic boundaries and being influenced by a range of knowledge bases. In MIP, this pattern appears less obvious, though the evolutionary economics knowledge base of Nelson and Winters (1982) appears strongly and repeats again in the later article of Foray, Mowery and Nelson (2012). In addition, one observes that the knowledge base supporting MIP appears broader (average of 28.8) and corresponds to more recent publications (with an average of 2009), whilst the TIP knowledge base appears somewhat narrower (average of 24.5) corresponding to older publications (average of 2006).

For TIP, 13/17 key contributions correspond to journals, whilst 4/17 correspond to books. In MIP, 15/20 key contributions correspond to journals, whilst 4/20 are books and 1/20 is a report. From the 13 key contributions corresponding to journals, according to Web of Science (Clarivate Analytics, 2020), 8 (62%) are classified as originating from a theoretical foundation in Business & Economics while others originate from Political Science, Environmental Science and Multidisciplinary Sciences (TIP). For MIP, 10 articles (71%) have their theoretical foundations in Business & Economics while others originate from Sociology and Environmental Sciences and Ecology. 1 article classification was not available for MIP (Global Transitions). One can infer from this the similarities of the topics emerging from business and economics with a moderate preference within MIP of a theoretical foundation in economics (fig.30 and fig.31).

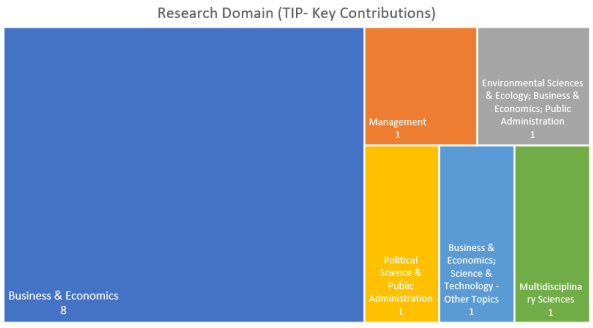


Fig.30: Theoretical Foundations Research Domain (TIP)

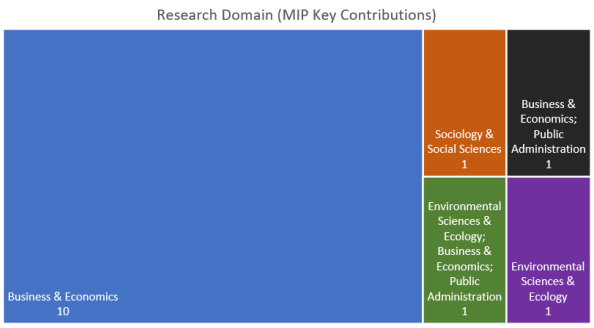


Fig.31: Theoretical Foundations Research Domain (MIP)

4.3.2. Current Debate

The articles contained in the current debate make explicit reference to the search terms "transformative innovation policy" and "mission-oriented innovation policy". From the 17 articles considered 'key contributions' for TIP, 2 are reflected in the TIP 'core' literature dataset. From the 20 articles considered 'key contributions' for MIP, 3 are reflected in the MIP 'core' literature dataset. From the total key contributions (37 articles), 7 are reflected as providing theoretical contributions to both TIP and MIP. Table 7 reflects how frequently these key contributions were cited in the 'core' literature:

	TIP Core (10 articles)	MIP Core (13 articles)	TOTAL
Geels and Schot (2007)	3	4	7
Weber and Rohracher (2012)	5	5	10
Mazzucato (2013)	3	6	9
Mazzucato (2016)	3	7	10
Schot and Steinmueller (2018a)	7	6	13
Boon and Edler (2018)	4	5	9
Diercks, Larsen and Steward (2019)	3	3	6

Table 7: Repeated key contribution articles across both TIP and MIP with frequency of references

One can observe that the Weber and Rohracher (2012) article appears to have been equally as influential to TIP as it has for MIP. Considering the earlier network diagram and graph reflecting co-citation, the Weber and Rohracher (2012) article was co-cited 36 times with key contributions within TIP and 35 times in MIP. Combining this with the volume of 'core' articles represented (TIP= 10 and MIP= 13), one can determine that Weber and Rohracher's (2012) article has been marginally more influential to the TIP literature relative to the MIP 'core' literature by frequency of citations.

By assessing the volume of references to the key contributions, the author assesses the connectedness (relevance) of the 'core' literature to the theoretical foundation (fig.32 and fig.33).

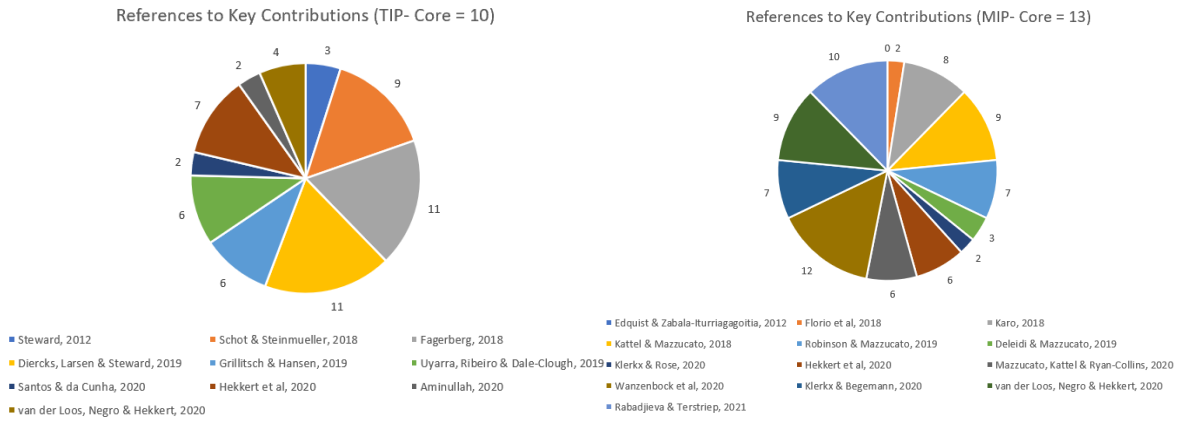


Fig.32: No. of Ref. to Key Contributions per Core Article (TIP) Fig.33: No. of Ref. to Key Contributions per Core Article (MIP)

Here the author observes that the 'core' literature from both datasets contains some strong articles that are well connected to the theoretical foundations. For TIP, this includes Fagerberg (2018), Diercks, Larsen and Steward (2019) and Schot and Steinmueller (2018b). Incidentally, these articles all reference Arrow (1962), Lundvall (1992) and Steward (2012) and draw influence across transitions literature and STI literature. The MIP articles most connected to the theoretical foundations are Wanzenbock et al (2020), Rabadjieva and Terstriep (2021), Kattel and Mazzucato (2018) and van der Loos, Negro and Hekkert (2020) with shared reference to Mazzucato (2016 and 2018). The captured TIP and MIP datasets also contain some weak reflections of the key contributions such as Aminullah (2020) and Santos and Da Cunha (2020) for TIP and Florio et al (2018) and Klerkx and Rose (2020) for MIP. The MIP article by Edquist and Zabala-Iturriagagoitia (2012) is the only article in either dataset

not to contain any reference to the key contributions presenting a somewhat obscure result to the capture of the term "mission-oriented innovation policy".

Figure 34 and 35 below show the emergence of the 'core' articles popularity through citations with TIP reflecting a far more sudden emergence than the gradual emergence of MIP. This appears largely based on two very highly cited articles, Schot and Steinmueller (2018b) for TIP which is evidence to have a strong connection to the key contributions, and Edquist and Zabala-Iturriagagoitia (2012) for MIP which picks up the search term despite this article having no connection to the key contributions. Incidentally, two of the three top cited MIP articles are very weak reflections of the key contributions which implies adoption of the term despite not being well connected to a similar literature base. In total, the TIP 'core' dataset has been cited 342 times with an average of 34.2 whilst the MIP 'core' dataset has been cited 302 times with an average of 23.2.

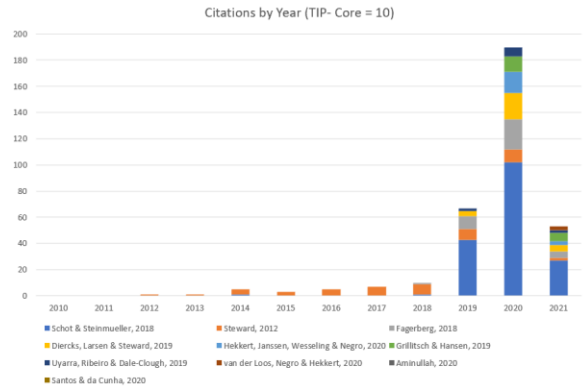


Fig.34: Total Citations by Year (TIP)

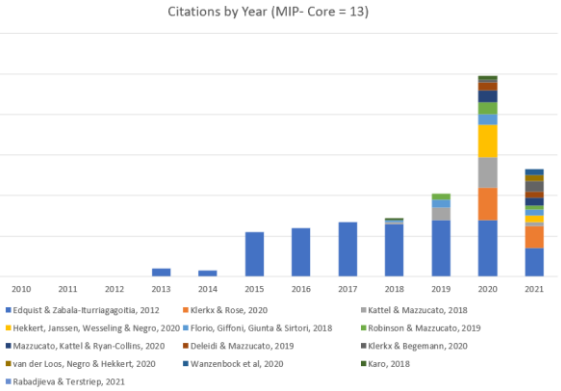


Fig.35: Total Citations by Year (MIP)

Notwithstanding the potential bias in citation analysis related to article age, the author also reflects the articles number of citations within the 'core' literature dataset (fig.36 and fig.37). For TIP, the articles by Schot and Steinmueller (2018b) and Diercks, Larsen and Steward (2019) remain influential whereas the articles by Grillitsch and Hansen (2019) and Uyarra, Ribeiro and Dale-Clough (2019) are two of 5 articles not cited at all by the 'core' literature. For MIP, the articles by Hekkert et al (2020), Kattel and Mazzucato (2019) and Robinson and Mazzucato (2019) are the most highly cited within the 'core' literature while the articles by Deleidi and Mazzucato (2019), Klerkx and Begemann (2020), van der Loos, Negro and Hekkert (2020) and Rabadjieva and Terstriep (2021) are not cited at all by the rest of the 'core' MIP literature. This further suggests that the 'core' literature reflects a diverse range of articles picking up the key search terms.

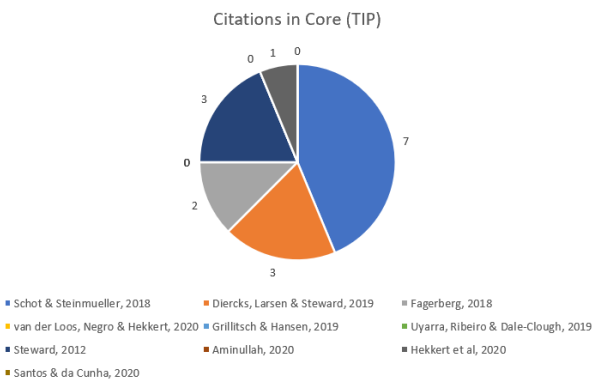


Fig.36: No. of Citations by 'Core' Literature (TIP)

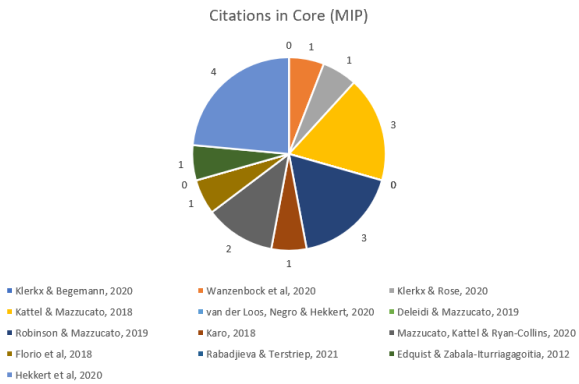


Fig.37: No. of Citations by 'Core' Literature (MIP)

Finally, the author assessed whether the 'core' articles were based on empirical study (through data, interviews, observational study) rather than theory or pure logic. From the 10 TIP articles, 3 derive insights from empirical study on the energy sector on clean technology initiatives (Denes_Santos and

da Cunha, 2020; van der Loos, Negro and Hekkert, 2020) and policy initiatives (Diercks, Larsen and Steward, 2019). From the 13 MIP articles, 6 articles can be considered empirical utilising data from policy instruments (Edquist and Zabala-Iturriagagoitia, 2012; Florio *et al.*, 2018), and case studies in cities (Rabadjieva and Terstriep, 2021), regions (Karo, 2018) and on space agencies NASA and ESA (Robinson and Mazzucato, 2019). This suggests a broader empirical base to MIP than to TIP.

4.3.3. Summary

In sum, investigating the topics meta-data to understand the theoretical foundations and the current debate identifies a relatively homogenous theoretical base and several prominent articles (Weber and Rohracher, 2012; Schot and Steinmueller, 2018a and Mazzucato, 2016). This is further emphasised by the repetition of several authors, Schot, J, Mazzucato, M, Nelson, R and Freeman, C who appear highly influential to both datasets and potentially reflective of a shared knowledge base and similarities in their theoretical foundations. Minor differences at this stage suggests a somewhat clearer clique of key contributions from transitions studies and science, technology and innovation studies in TIP while MIP appears to have no discernible patterns. This further indicates that the emergent innovation policy topics cross over academic boundaries and are yet to be embedded within a particular literature base.

The most representative measure of the 'core' articles connectedness to the key contributions, reflects that the datasets for both TIP and MIP contain articles with both a strong connection and weaker connection to the theoretical foundations. For TIP, the articles by Schot and Steinmueller (2018b), Diercks, Larsen and Steward (2019) and Fagerberg (2018) represent more relevant articles whereas the articles by Aminullah (2020) and Santos and Da Cunha (2020) appear less relevant. For MIP, the articles by Kattel and Mazzucato (2018), Robinson and Mazzucato (2019) and Hekkert et al (2020) represent more relevant articles than the articles of Edquist and Zabala-Iturriagagoitia (2012) and Deleidi and Mazzucao (2019).

While the debate on challenge-based innovation policies now seem to converge on two key topics with similarities in their theoretical foundations, the ideas of what they are and how they relate to each other are yet to fully mature. Utilising the 'core' dataset that captures the key term, the next section assesses, systematically and on a detailed level, the ideas floating around TIP and MIP.

4.4. Systematic review of the current TIP & MIP literature (Core)

The thesis first presents background to the topics before discussing and analysing in greater depth the concepts presented by explicit references to TIP and MIP according to the analytical framework. This identifies key similarities and differences, explaining how the topics have evolved where possible and their current understanding. The author highlights the key ideas in **bold**.

4.4.1. Background Concepts

4.4.1.1. Definition

Transformative change is presented as the third frame in the history of STI policy (Chataway *et al.*, 2017; Schot and Steinmueller, 2018a) and an evolution to Science & Technology (R&D) Policy of the 1940's-60's and the Innovation Systems (IS) approach since the 1980's (Lundvall and Borrás, 2009; Diercks, Larsen and Steward, 2019). Coined by Steward (2012) as "**Transformative Innovation Policy**" and extended in use by Schot and Steinmueller, (2018a; 2018b) and Diercks, Larsen and Steward, (2019), the TIP topic is presented as a **fundamental policy paradigm shift** from previous innovation policy framings (Steward, 2012; Schot and Steinmueller, 2018b; Diercks, Larsen and Steward, 2019; Hekkert *et al.*, 2020) and "seen as layered upon, but not fully replacing, the earlier policy paradigms

of science and technology policy and innovation systems policy" (Diercks, Larsen and Steward, 2019, p.890).

In comparison, termed by some as the "'new-mission' oriented approach" (Gassler, Polt and Rammer, 2007) or 'type 2 missions' (after 'type 1' missions of Science & Technology (R&D) policies of the 1940's, Robinson and Mazzucato, 2019), the term **"Mission-Oriented Innovation Policy"** originated from scholars exploring policies of public procurement for innovation (PPI) as a **demand-side instrument** to be exploited in the mitigation of grand challenges (Edquist and Zabala-Iturriagagoitia, 2012). Since then, the topic has been popularised by Mazzucato (Mazzucato, 2016, 2017) who is widely credited with leading the shift in perception away from technological feats of type 1 missions to 'wicked problems' and developing key MIP concepts of new market creation and directionality (Mazzucato, 2018a).

From this one can infer that TIP is considered a paradigm and MIP is considered an instrument.

4.4.1.2. Theoretical Foundation/Field

According to Steward (2012), the TIP topic reflects an interesting convergence between two theoretical strands of **science, technology and innovation** studies (Steward, 2012). One of these drew on **evolutionary economics** and addressed the role of innovation in long-term epochal transformations involving fundamental changes in economic and technological configurations. The other is **associational sociology** with a focus on explaining the emergence of innovation through attention to the creation and stabilisation of a heterogeneous network of actors (Steward, 2012). Since, however, the TIP topic has been firmly adopted by authors within the **sustainability transitions literature** (Schot and Steinmueller, 2018b; Fagerberg, 2018; Denes_Santos and da Cunha, 2020) which can trace its roots to the field of **science and technology studies** (Penna, 2021). Why the topic has shifted, what the implications are, what transformation and transitions can learn from this and whether this is even relevant continues to be debated (Hölscher, Wittmayer and Loorbach, 2018). One implication is that the **language (and tools) of transitions literature are widely embedded in the TIP literature**, referring to 'regimes' as a set of rules directing the behaviour of a set of actors in a single socio-technical system and 'transitions' as indicative of a shift or change in state from one set of rules and behaviours to another (Schot and Kanger, 2018).

According to Mazzucato et al (2020) MIP's theoretical foundation too emerges from **evolutionary economics** within the field of **science, technology and innovation** (Mazzucato, Kattel and Ryan-Collins, 2020; Penna, 2021). Similarly to TIP, it has been argued that MIP brings together elements of **innovation policy**, which traditionally aims to create **economic growth**; and **transition policy**, which principally aims to create change that is beneficial for **society** at large" (Alkemade, Hekkert and Negro, 2011; Schot and Steinmueller, 2018b; Rathenau Institute, 2020 via Klerkx and Begemann, 2020). Societal challenges have always been on the agenda of MIP, but these have shifted from being a spill-over effect of technological missions towards ambitious national defence and security in the past to forming a central priority in current MIP and focus on non-technological innovation towards grand societal challenges such as climate change and ageing societies (Kattel and Mazzucato, 2018).

From this one can infer that both MIP and TIP originated from STI but have been adopted and embellished by STS scholars to a lesser (MIP) or greater (TIP) extent.

4.4.1.3. Rationale/Approach

TIP literature consistently connects the TIP policy approach to addressing **socio-technical networks and configurations** in the **socio-technical regime** (Steward, 2012; Uyarra, Ribeiro and Dale-Clough,

2019; Denes_Santos and da Cunha, 2020) which fulfil **societal functions** (Geels, 2002 via Steward, 2012). To do so, attention should be directed to the explanation of 'a change from one sociotechnical configuration to another' (called **socio-technical transitions**), which relocates innovation away from one focal actor, such as a business enterprise to the **interactions** of a network of diverse actors. This dramatically shifts the perspective on innovation to one that is framed through **consumption or end use** and which embraces a heterogeneous mix of social and technological change (Geels, 2002 via Steward, 2012). Ultimately, it is recognised that the "transformation of **socio-technical systems** is needed in energy, mobility, food, water, healthcare, communication" which are considered the backbone systems of modern societies (Steward, 2012; Schot and Steinmueller, 2018b p.1562). In other words, managing the substantial negative consequences of the socio-technical system of modern economic growth to which they have contributed and of which they are a part is recognised as a key priority for TIP (Schot and Steinmueller, 2018b).

In contrast, instead of focusing on a single technological field or disciplines, MIP "**target a concrete problem/challenge**, often cross-disciplinary, with a large impact and a well-defined time frame" (Wittmann et al., 2020 via Klerkx and Begemann, 2020, p.2). Challenge led policies require confronting the **direction of growth** - growth that is for example more inclusive and sustainable (Mazzucato, Kattel and Ryan-Collins, 2020). To do so, MIP aims to identify and "articulate new missions that can **galvanise production, distribution, and consumption patterns** across various sectors" (Kattel and Mazzucato, 2018, p.787), enable a lead-and-learn approach to **create and shape markets** with a variety of policy instruments with **open-ended impact horizons**, and learning through wider **social engagement and coordination** (Kattel and Mazzucato, 2018). As a result, MIP is offered as a new **tool kit** to achieve challenge led growth (Mazzucato, Kattel and Ryan-Collins, 2020). Indeed, using clearly defined missions to elicit directed innovation (MIP) (Mazzucato, 2016; Kattel and Mazzucato, 2018), "may be regarded as a promising means to deploy transformative innovation policy" (Hekkert *et al*., 2020, p.77).

From this, one can again infer that the TIP rationale is presented more like a paradigm, while the MIP rationale is presented as a tool. TIP addresses specifically socio-technical system change (Schot and Steinmueller, 2018b) while MIP aims to influence socio-economic system change (Hekkert *et al*., 2020).

4.4.1.4. Level

TIP scholars suggest that addressing societal-functions through socio-technical configurations occurs in the meso-regime level of interactions (Steward, 2012; Fagerberg, 2018). A focus on a domain of '**meso-level networks of institutions and actors**' would enable a more appropriate analysis of innovation as a 'distributed process within a complex set of linkages' between diverse players (Steward, 2012). The array of regimes could be seen as 'sociotechnical configurations' that could be changed through policies and strategies which address the 'alignment' of actors including consumers and users (Steward, 2012). It was also suggested that insights into the dynamics of radical product and service innovation could be achieved through defining the meso-level as a '**nexus between production and consumption'** in order to directly investigate 'the **potential for demand and markets to emerge and to be shaped'**(Steward, 2012). Interestingly, this final point appears to have had a far greater impact on the MIP topic than TIP, as the propensity for innovation policy to create and shape markets has been utilised as a key concept in MIP (see Mazzucato, 2018a).

MIP scholars recognise that grand societal challenges concern the socio-economic system as a whole, which often implies large-scale transformations with **multiple actors and elements** (Kuhlmann and

Rip, 2015; Geels, 2004 via Robinson and Mazzucato, 2019). Understanding the role of new actors required to confront missions that are socio-economic and not just technical, requires MIP with an '**innovation ecosystems'** viewpoint (Robinson and Mazzucato, 2019). While some embed MIP within the system of innovation (IS) approach (Edquist and Zabala-Iturriagagoitia, 2012; Robinson and Mazzucato, 2019; Klerkx and Begemann, 2020; Klerkx and Rose, 2020) which by definition emphasise networks, linkages and interactions between actors, recent research by Hekkert et al (2020), introduced specific **"Mission-Oriented Innovation Systems"** as a dedicated framework to connect specifically to the meso level network of actors and to help facilitate interaction and knowledge transfer (Hekkert *et al*., 2020). There are similar efforts to contextualise TIP within an innovation systems approach (Grillitsch and Hansen, 2019) which have been central to providing a nuanced understanding of regional policies for (new) industry development (Grillitsch and Hansen, 2019), supporting earlier suggestions of TIP not as fully replacing previous innovation policy framings but as layered upon (Schot and Steinmueller, 2018b; Diercks, Larsen and Steward, 2019). This is more closely aligned with Steward's (2012) original suggestion that innovations required for sustainability are **'systemic'** in nature, meaning that singular technological innovations need to be embedded in innovative systems for them to have a significant impact and the **'situatedness' of sociotechnical regimes at the meso-level** linked specific innovations with the wider system (Steward, 2012).

One can infer therefore that both TIP and MIP acknowledge the similar need to address meso level network of interactions and recognise the systemic, not singular nature of innovations and 'situatedness' in innovation systems.

4.4.2. Agenda Setting

4.4.2.1. Policy Agenda- What is the topics focus of the policy agenda? (Policy Agenda)

It is critical to recognise that after 30 years of almost uncontested hegemony of a predominantly economic policy agenda, a shift towards a broader societal policy agenda can be noticed within innovation policy since the mid-2000s, spurred on by the advent of societal challenges such as climate change, resource scarcity and ageing societies (Kallerud et al, 2013, via Diercks, Larsen and Steward, 2019).

Diercks et al, (2019), provide a framework in the TIP literature for distinguishing between innovation policy as having an **economic or societal policy agenda** (Diercks, Larsen and Steward, 2019). An economic agenda has the underlying assumption that innovation will lead to more competitive economies, allowing for more consumption, growth and jobs, whereas a societal policy agenda has shifted from being motivated by national prestige or strategic priorities such as defence programmes, aviation or nuclear energy in the past to more recently being expressed through the need to address societal challenges such as climate change, growing inequality, demographic change or resource scarcity (Diercks, Larsen and Steward, 2019; Grillitsch and Hansen, 2019).

Within this framework, the literature presents a clear focus of the TIP topic on addressing issues on the **societal policy agenda** and is further expressed in other literature as meeting social needs, environmental goals and issues of sustainable and inclusive societies (Schot and Steinmueller, 2018b; Grillitsch and Hansen, 2019; Diercks, Larsen and Steward, 2019). MIP on the other hand, must "not only optimize the innovation system to improve **economic competitiveness and growth**, but also induce strategic directionality and guide processes of transformative change towards desired **societal objectives"** (Daimer et al., 2012; Weber and Rohracher, 2012; Schlaile et al., 2017 via Diercks, Larsen and Steward, 2019, p.884; Karo, 2018; Kattel and Mazzucato, 2018; Hekkert *et al.*, 2020).

Despite being more heavily influenced by transitions studies in the pursuit for societal objectives, Diercks et al (2019) arrive at an important outcome of this work which appears to recognise the convergence of innovation policy to capture both economic and societal issues for the agenda. While an economic policy agenda only informs economic or industrial policy, a societal policy agenda also informs other policy domains, such as environment, energy, health or agriculture (Diercks, Larsen and Steward, 2019). One needs to acknowledge that "innovations can have negative outcomes and may even exacerbate societal challenges, rather than contribute to tackling them" (Diercks, Larsen and Steward, 2019, p.882). A societal policy agenda acknowledges this more nuanced understanding of innovation, taking both positive and negative outcomes into account and implying the need for both **creative and destructive polices** (Kivimaa and Kern, 2016 via Diercks, Larsen and Steward, 2019).

One can infer therefore that while the historical agendas of TIP lie with addressing societal challenges and for MIP lie with addressing economic challenges, and it may be argued that these beliefs may persist, the current understanding presents their convergence on the objective for addressing societal challenges and desiring societal impact.

4.4.2.2. Agenda Identification and Definition- How does topic source and identify potential policy issues for the agenda?; How does the topic address the definition of policy issues for the agenda? (Identification and Definition of Societal Problem | Policy Initiation | Source of Issue | Agenda Setting)

Identifying and defining the innovation policy agenda was for many years based on fixing market failures (information asymmetries, knowledge spill over, externalisation of costs, over-exploitation of commons) associated with the R&D approach (Arrow, 1962). Both TIP and MIP are **critical of the neo-classical** approaches for underestimating the potential of actors (including policy makers) at different levels to cooperate constructively in the solution of collective challenges (Ostrom, 2010 via Fagerberg, 2018; Mazzucato, Kattel and Ryan-Collins, 2020). Later, after the introduction of the IS approach, the purpose shifted to fixing systemic failures (infrastructure, institutional, interaction and capabilities) associated with network externalities (Klein Woolthuis, Lankhuizen and Gilsing, 2005). In short, most mainstream approaches to innovation policy have been built on the assumptions of "rational" processes of policy making – where policies are designed and implemented through impersonal and impartial processes of discovering specific "failures" in existing markets/systems that provide commonly acceptable and analytically replicable "rationales" for government interventions (Karo, 2018). While the **failures framework** has become a widely accepted rationale for government intervention it should be used to identify, at most, problems- rather than as a guide for identifying areas with the potential highest "social profit" (Nelson, 1959 via Kattel and Mazzucato, 2018). More recently, the failures framework was extended in the influential work by Weber & Rohracher (2012) to cover **transformation failures** (directionality, policy coordination, demand-articulation, reflexivity) (Weber and Rohracher, 2012) associated with negative externalities. Whilst the rationale for a failures approach to fully and reliably inform innovation policy agendas is still up for debate, it has nevertheless informed a significant body of literature across both TIP (Schot and Steinmueller, 2018b; Grillitsch and Hansen, 2019) and MIP (Mazzucato, Kattel and Ryan-Collins, 2020; Wanzenböck, *et al.*, 2020) that have utilised the failures framework either to inform issues for the agenda or to inform the design of innovation policy.

Schot & Steinmueller (2018) suggest that policies for TIP begin with the recognition of transformation failures with the idea to establish corridors of acceptable development pathways (Weber and Rohracher, 2012; Schot and Steinmueller, 2018b). In addition, they propose **foresight activities** and **technology assessment groups** as 'pro-active' methods to anticipate collateral effects and consequences of TIP. The "aim of **anticipation** is to identify areas for experimentation and, in doing so, to examine the consequences that may follow in terms of energy and materials use, the jobs likely

to be created, and the effects on the environment of the introduction and use of new physical artefacts or information processes" (Schot and Steinmueller, 2018b, p.1564). The need to address transformation failures identified by Weber & Rohracher (2012) is recognised in regional level innovation policy towards transformative change which employed **smart specialisation**. Although smart specialisation was employed "focussing on firm-led regional branching- it somewhat overlooked the influence of strategic or deliberate state action on the conditions for path creation and development" (Feldman & Lowe, 2018 via Uyarra, Ribeiro and Dale-Clough, 2019, p.2363).

In contrast, MIP policies utilise transformation failures not in the recognition of defining problems for the agenda but for informing the design and delivery of missions. In support of this and placing societal challenges as of central importance in navigating the problem-solution space, Wanzenbock et al, (2020) developed a framework which reflects the **contestation, complexity and uncertainty** inherent in the processual nature of agenda setting (Wanzenböck, *et al.*, 2020). Wanzenbock et al's, (2020), **problem-solution framework (PSF) for MIP** addresses head-on the degree of 'wickedness' involved in particular societal challenges as well as the process of identifying solutions for that challenge. The framework avoids a one-size-fits-all approach for MIP, taken-for-granted problem definitions or too strong an emphasis on technological innovation (Wanzenböck, *et al.,* 2020). In addition, it avoids marginalising opposing voices or discarding complex trade-offs, for instance, between economic goals and societal goals, or when pre-defining problems or solutions in a narrow sense (top-down) versus leaving it open for identification based on plurality (bottom-up) (Wanzenböck, *et al.,* 2020). In this way, MIP aims at advancing **problem–solution constellations** which become sufficiently stable to serve as **common frame and direction**, also by providing guidance to conventional market- or system-based innovation policies, to support the **development, diffusion and embedding** of technological, and/or institutional innovations (Wanzenböck, *et al.,* 2020). Incidentally, this connects with an earlier call from Steward (2012), an early contributor of TIP, who recognised the change in policy landscape from a focus on climate change as a scientific 'problem' to a new interest in innovation 'solutions' for a transition to sustainability (Steward, 2012).

In addition to this, Mazzucato et al's (2020) **'ROAR' framework**, presents an alternative approach to supporting the agenda-setting and formulation process. ROAR involves strategic thinking about the desired direction of travel (Routes), the structure and capacity of public sector (Organisations), the way in which policy is (Assessed) and the incentive structure for both private and public sectors (Risks and Rewards) (Mazzucato, Kattel and Ryan-Collins, 2020).

MIP literature further presents that the agenda may arise from a **supply-push** (e.g. by policy, science, or business), or rather from a **demand-pull** (raised by social movements and worried citizens and consumers) or a combination of these forces (Klerkx and Begemann, 2020). They may "arise **'pro-actively'** in view of **horizon scanning** and **scenario building** exercises of future food systems" (CSIROFutures, 2017; De Wilde, 2016; Hebinck et al., 2018; Manners et al., 2020; Rutter, 2012; van der Weele et al., 2019; WorldBank, 2019 via Klerkx and Begemann, 2020), or rather "**'reactively'** when sectors or countries are faced with intractable problems such as intensifying droughts" (Klerkx and Begemann, 2020, p.3). In addition, the same authors argue that food systems transformation also implies "deconstruction of existing systems or **'exnovation'**, by for example **phasing out** research investments in a non-sustainable technology or practice" (David and Gross, 2019; Kivimaa and Kern, 2016; Krüger and Pellicer-Sifres, 2020 via Klerkx and Begemann, 2020, p.3). Beyond questioning environmental sustainability of production systems and supply chain set-up, exnovation may also include questioning prevalent economic paradigms (e.g. neoliberal capitalism, economic growth) (Feola, 2020; Ghisellini et al., 2016; Mier et al., 2018; Giuliani, 2018 via Klerkx and Begemann, 2020).

This requires **scrutinizing prevalent policy frames, goals, and policy instruments** (Candel and Biesbroek, 2016; Galli et al., 2020; Janssen et al., 2020 via Klerkx and Begemann, 2020).

In summary, TIP and MIP similarly recognise the influence of the failure's framework on agenda setting but differ on their ideas. TIP offers smart specialisation and specific reference to 'pro-active' methods to identify issues for the agenda, while MIP offers a stronger understanding through the PSF and ROAR frameworks to support the contestation, complexity and uncertainty involved in agenda-setting.

4.4.2.3. Contextual Factors- How does the topic consider the diverse contextual factors? (Cultural, Political, Social, Economic, Environmental and Ideological Contextual Factors | Material Conditions)

TIP literature to some extent recognises that a society led plan based on TIP could address the challenge of meeting **public expectations** of material prosperity (Steward, 2012) recognising that a number of complementary factors need to be in place, not only in the form of an **appropriate infrastructure**, but also with respect to the **economic, organizational and institutional set up** of society (Freeman and Perez, 1988 via Fagerberg, 2018). Denes Santos and da Cunha (2020) in their study of the PV sector for energy in Brazil argue that research in this area involves understanding the socio-technical context in which a certain technology is installed. This, in turn, comprises not only the development of knowledge and prototypes, but also the mobilization of resources, the creation of social networks, the **formation of new markets,** and the **regulatory frameworks** (Denes_Santos and da Cunha, 2020).

However, short of acknowledging the importance of contextual factors, TIP literature offers little in the form of frameworks and models to formally consider these in an innovation policy process. The development of a MIP requires a focus not only on thinking about what types of missions to set, but also on the local context of politics and governance (Karo, 2018). Local context is recognised by Wanzenbock & Frenken, (2018) who suggested that "despite labels of "grand" and "global"-challenges are contextual and do not present themselves as the same for every region or nation, as underlying problems affect places in different ways and to different extents" (Wanzenböck & Frenken, 2018 via Uyarra, Ribeiro and Dale-Clough, 2019, p.2363). These factors are taken into more formal consideration in the form of competing worldviews of actors in the **problem-solution process framework** (Wanzenböck, *et al.,* 2020). This would address calls from TIP scholars to contextualise challenges at the local level by making them more operational and concrete in ways that relate to the public (Uyarra, Ribeiro and Dale-Clough, 2019).

One can infer that while both acknowledge, to some extent, the importance of understanding contextual factors, the problem-solution framework from MIP explicitly adopts competing views and a deeper understanding of contextual conditions pervasive to addressing societal challenges.

4.4.2.4. Agents of Change- Who does the topic identify as responsible agents of change? (Actors)

In TIP literature, Steward (2012) presents the agents of change as **institutions and organisations** who deal with key systems, while regional players enable the participation of the diversity of actors involved in system innovation, defined as, **universities, business enterprises, community groups, public institutions**, and **research/technology organisations** (Steward, 2012). While many studies have shown that incumbent organisation are ill-prepared to engage in new markets and often actively resist transitions, in some instances, such as offshore wind, they also actively engage in setting the policy agenda and help foster diffusion (van der Loos, Negro and Hekkert, 2020). **Legitimacy from incumbent industries** can therefore act as a catalyst for change under the right institutional conditions (van der Loos, Negro and Hekkert, 2020).

Innovation policy has traditionally been understood as actions/interventions by public organizations that influence innovation processes, i.e. the development and diffusion of innovations (Edquist, 2011). This would place governments and the public sector as key agents of change in the innovation policy process. This rationale appears to be applied consistently in MIP literature, which positions **public sector and government actors** as having a central role to policy design and implementation (Karo, 2018), specifically in the case of initiating public procurement instruments as innovation policies when governments are also considered key users of innovation (Florio *et al.*, 2018). Such policies give an explicit **catalytic role to governments and public organizations** for providing the basis for private investments, including their ability to make bold demand-side policies to change consumption and investment behaviour (Florio *et al.*, 2018).

One can infer that TIP considers the key agents of change as the industry and system actors, whereas MIP considers the key agents of change as the state/government. The extent to which the state/government play a centralised or decentralised role continues to be debated though this appears to depend on the phase of the policy process, types of instruments and industry conditions.

4.4.2.5. Directionality- How does the topic understand directionality? (Directionality)

Innovation always represents a certain directionality and is reflected in literature not only a key feature of innovation policy in general but specifically for TIP and MIP who legitimately argue that while existing directions of innovation policy have led to high levels of wealth and welfare in a number of countries, it has also left many people in the developing world behind leading to increasing resource intensity, carbon lock-in, and severe ecological degradation (Schot and Steinmueller, 2018b). This suggests that purposive and directional innovation is missing in current mainstream innovation policy (Weber and Rohracher, 2012).

Setting direction was a feature highlighted by Fagerberg (2018) who attests that the long-run goal of transforming the economy to sustainability has become broadly accepted giving policy makers a **golden opportunity** to provide a firmer direction for society's collective innovation journey (Fagerberg, 2018). Fagerberg, (2018), further suggests that a **vision** (or common perception) for society's long run development may function as a soft coordination device for the many actors, including policy makers at different levels, that need **to align their actions** if the transition is going to succeed. The suggestion is that with more refined directionality, firms can then **mobilise talent, resources and knowledge**, and the **targets can be set, monitored and assessed** to understand to what degree society's performance is in line with the long run goals (Fagerberg, 2018).

While aspirational, Fagerberg (2018) suggests that if this is going to work as intended (and avoid being victim to, say, shifting parliamentary majorities and changes of government), it is essential that policy makers avoid the temptation to develop such a vision behind closed doors, and instead **engage in a broad, open and transparent dialogue with stakeholders at different levels of society**. Similarly, in practice, Grillitsch and Hansen (2019) recognise that orientation for industry development is needed which requires establishing a **shared vision** for regional industry development and a specification of a focus on particular green industries (Grillitsch and Hansen, 2019). In this case, directionality is particularly important where policies should also create room for green industries by destabilizing competing dirty industries, e.g., by initiating control policies or withdrawing support (Kivimaa & Kern, 2016 via Grillitsch and Hansen, 2019).

One response to this offered by TIP (Uyarra, Ribeiro and Dale-Clough, 2019), is the theory of responsible research and innovation (**RRI**) which could support to address directionality. Directionality is understood as the normative process of shaping innovation pathways in order to contribute to

specific societal goals, through its concern with promoting institutional responsiveness (Stilgoe, Owen and Macnaghten, 2013); 'modulating' innovation at the 'mid-stream' by shaping decision-making at the level of scientific and technological development (a process that takes place after funding and policy decisions, but before regulation) (Fisher, Mahajan, & Mitcham, 2006); and aligning innovation with societal needs (Ribeiro et al., 2018 via Uyarra, Ribeiro and Dale-Clough, 2019). By focussing on 'desirable' societal benefits and arguing for a broad mix of legitimate actors to influence policy making and innovation processes, RRI taps into the issue of directionality and brings up the question of what kinds of **public values** are being fostered by innovation. To this, "RRI is both an engine and a 'product' of innovation policies developed in the context of transitions and societal challenge-orientation" (Uyarra, Ribeiro and Dale-Clough, 2019, p.2365). In practice, a RRI agenda was used as a cross-cutting theme in the EU's R&D program "Horizon 2020," when the EU attempted to tackle what has been called "orientation failure" inherent to its innovation policies (Daimer et al., 2012 via Kattel and Mazzucato, p.789). These efforts, however, also show that "most countries have in fact already agreed in which direction innovation policy efforts should be steered and what is missing is **innovation road-mapping** to get there" (Fagerberg, 2018 via Kattel and Mazzucato, 2018, p.789). The value of directionality was highlighted in the case of offshore wind energy pathways in the Netherlands (van der Loos, Negro and Hekkert, 2020). The Dutch Roadmaps to 2023 and 2030 implemented a strong institutional focus on cost reduction and market uptake, laying out strong and consistent policy visions and providing much needed confidence in the market (van der Loos, Negro and Hekkert, 2020). These roadmaps are directly tailored towards increasing the diffusion of offshore wind while driving costs down through incremental and process innovation (van der Loos, Negro and Hekkert, 2020). Under these conditions, clear directionality through public and private guidance focussed and targeted rapid cost reduction and technological diffusion, however, at the expense of potentially breakthrough technologies (van der Loos, Negro and Hekkert, 2020).

Similarly, as a market-shaping public investment and policy framework that aims to **shift the direction of innovation system(s)** the MIP literature offers potential mission type **visions** conducive to orienting transformative change (Kattel and Mazzucato, 2018). Any industrial strategy should "not only seek to improve the conditions under which firms invest, but also aim to stimulate demand and increase business expectations about where future growth opportunities might lie" (Mazzucato, Kattel and Ryan-Collins, 2020, p.433). The **market-shaping policies** aim to "crowd in" private and third sector experimentation and innovation (Mazzucato, Kattel and Ryan-Collins, 2020). Indeed, MIP could be productive "if the missions are formulated in an open-ended way that encourages experimentation and diversity" (Schot and Steinmueller, 2018b, p.1564). In practice, Deleidi and Mazzucato (2019) investigated the theoretical underpinnings of austerity measures which were implemented after the 2007 financial crisis in order to stimulate investment and foster GDP growth. Results suggest how targeted public expenditure towards strategic sectors and the promotion of innovation and mission-oriented policies, generated the largest effect in terms of output, investment and labour productivity growth (Deleidi and Mazzucato, 2019).

One can infer that both TIP and MIP offer similar understanding on the importance of directionality. Ideas presented in TIP of RRI and road-mapping can support directionality as does clear vision setting and market shaping aims in MIP. Differences between past and present approaches between open-ended and targeted directionality as well as undefined and defined objectives appear either underdeveloped or dependent on the industry, sector and policy instruments.

4.4.2.6. Timing- How does the topic address urgency and time-based factors? (Events | Policy Window | Timing | Salience)

Both TIP and MIP authors recognise an urgency and opportunity in implementing transformative change (Schot and Steinmueller, 2018b) and argue that the conventional pattern of incremental innovation is insufficient to meet challenges (Steward, 2012).

TIP scholars promote a shift to 'radical innovation' in all elements of the configuration and the importance of shifts in 'technological regime' as part of a change in 'technoeconomic paradigm' (Steward, 2012; Schot and Steinmueller, 2018b). However, while there is a need for radical innovation to altering socio-technical systems, one of the **most salient features of radical innovation is that it takes time**, often **several decades** if not more (Fagerberg, 2018). Acknowledging this, TIP scholars have since argued the importance of 'incremental innovation', recognising for example, that the ongoing technological revolution in renewable energy in combination with other changes (e.g., the continuing ICT revolution), may provide humanity with the means needed to escape its current dependence on burning fossil fuels (Uyarra, Ribeiro and Dale-Clough, 2019). Embracing this opportunity will require a lot of innovation and experimentation in areas such as energy storage and distribution, energy use (including savings), electrification of transport and so on, as well as in business models, in the organization and activities of the public sector, and in ways of life more generally (Uyarra, Ribeiro and Dale-Clough, 2019). Furthermore, energy research has shown that while previous energy transitions have taken several decades if not more to unfold (Wilson, 2012; Smil, 2016), change may occur much faster when advantages for **end-users are sufficiently large** (Grubler, 2012; Pearson and Foxon, 2012) and/or there are **proactive policies** in place (Sovacool, 2016 via Fagerberg, 2018). This echoes Steward's (2012) assertion that innovation embracing novelty which is non-technological in nature, such as **business models and services** will be of primary importance (Steward, 2012) and could be used as an approach to address the short-medium term TIP goals.

Similarly, MIP literature understands that diffusion of new ideas and technologies, for example in the case of precision agricultural technologies, is not always quick (Eastwood et al., 2017; Griffin et al., 2017 via Klerkx and Rose, 2020), and generally large-scale transformations of sectors takes **more than a decade or even several decades** (Elzen et al., 2012 via Klerkx and Begemann, 2020). A combined radical and incremental innovation agenda was also recognised in the case of offshore wind, where innovation focused mostly on process innovation and incremental improvements combined with radical, high-variation product innovation largely only began after **15–20 years** of diffusion and market formation (van der Loos, Negro and Hekkert, 2020).

One may argue that this presents a paradoxical situation that innovations may only be diffused after a lengthy period whereby the majority of current societal and environmental challenges are looking for solutions within a far shorter time frame of 10-20 years. However, industries (and policy makers) are not addressing societal challenges from a standing start and that a critical consideration is in addressing contextual industry and sector conditions.

It appears that both TIP and MIP scholars are consistent in the importance of addressing windows of opportunity and their understanding of an agenda for both radical and incremental innovation while accepting of the time to market and diffusion. The challenge of achieving short-term impact within a window of opportunity appear to be left to instruments and system configurations.

4.4.2.7. Framing- How does the topic treat diversity in framing policy issues? (Framing)

TIP necessitates engagement in science and technology politics not just policy (Schot and Steinmueller, 2018b) since "socio-technical systems will be defended by policy makers, users, industry and civil

society groups who benefit from their current shape and hold worldviews and values which would not require systematic change" (Schot and Steinmueller, 2018b, p.1563). Steward (2012) offers a clear idea that TIP should frame goals in terms of societal outcomes rather than technical inputs (Steward, 2012). Schot & Steinmueller (2018b) further develop this to present the concept of **anticipatory deliberation** which aims to "sustain a process of collective search and learning rather than a short-term assessment based on narrow criteria and yes/no type decision making" (Schot and Steinmueller, 2018b, p.1564). The rationale is that assumptions and values are co-produced in these processes, are emergent in character and are further shaped and consolidated in the process of system change (Schot and Steinmueller, 2018b). This echoes the field of RRI, presented earlier, as engaging a **public deliberative process** to inform anticipatory governance. These processes enable participants to creatively and empathetically envision complex socio-technical futures (Lehoux, Miller and Williams-Jones, 2020). Applying the principles of RRI prompts the questions of "**how and by whom 'public value' is being defined; how 'societal challenges' are being framed; what kinds of solutions are proposed and by whom**, and **what is the rationale behind choosing certain innovations to address these challenges over others"** (Uyarra, Ribeiro and Dale-Clough, 2019, p.2369).

This approach presents a competing frame to the earlier presented PSF framework by Wanzenbock et al (2020) which considers diverse framings inherent to the agenda-setting process. Within MIP, sometimes a mission may involve a truly novel focus, and sometimes it is a 're-framing' or 'rebranding' of ongoing efforts (Janssen et al., 2020 via Klerkx and Begemann, 2020). Ultimately, until we articulate **inclusive visions of the future**, it is difficult to start to anticipate what the impacts of the transition will be, and how they can be made more responsible (Klerkx and Rose, 2020).

One can infer therefore that both TIP and MIP strongly consider diverse framings in the agenda-setting process, but differ in their approach between RRI (TIP) and the PSF (MIP).

4.4.2.8. Change- How does the topic recognise change and uncertainty in agenda setting? (Shifts in Perception | Uncertainty)

TIP literature implicitly recognises that assumptions and values are "co-produced in these processes, are emergent in character and are further shaped and consolidated in the process of system change" (Schot and Steinmueller, 2018b, p.1564). The MIP problem-solution framework presented earlier by Wanzenbock et al, (2020) explicitly considers change an inherent concept of this problem-solution process and reveals different routes a MIP approach may take "-intentionally or non-intentionally- in dealing with the changing patterns of uncertainty, contestation, and complexity" (Wanzenböck, J. Wesseling, *et al.*, 2020, p.484).

One can infer that both TIP and MIP accept change in the innovation process, though the PSF framework (MIP) appears to take this into more formal consideration than RRI (TIP).

4.4.3. Policy Formulation

4.4.3.1. Actors- How does the topic address the multiplicity of levels and actors? (Multi-Level | Multi-Actor | Actors)

Frequently described as the **collective innovation journey** (Fagerberg, 2018), TIP authors place significant importance on a **'wide partnership'** of actors (Steward, 2012) which come from 'not only the **business sector**, but also **public authorities** at national, regional and local level, **civil society organisations**, **trade unions and consumers'** (Steward, 2012). Similarly in MIP literature, the collective innovation journey towards a sustainable economic system crucially depends on the active participation of numerous actors in **different sectors**, **levels of the society** and **parts of the globe** (Mowery, Nelson and Martin, 2010 via Fagerberg, 2018; Bonvillian and Weiss, 2015 via Karo, 2018). Specifically, in their **ROAR framework**, Mazzucato et al's, (2020) agree that public value is collectively

generated by **a range of stakeholders**, including the **private sector**, the **state and civil society** (Mazzucato, Kattel and Ryan-Collins, 2020). MIP adds that both empirical knowledge and innovation theory strongly indicate that interactive learning between organizations operating on the demand/pull side as well as the supply/push side is extremely important for innovations to emerge. Despite the relevance of demand-side organizations (and **individual consumers**), they have for long been neglected in innovation studies and innovation policy (Edquist and Zabala-Iturriagagoitia, 2012). Despite this, TIP has applied a greater emphasis on the role of **consumers and users** in literature than MIP. **Users** are highly knowledgeable and resourceful, and their active participation is a vital ingredient in successful innovation (von Hippel, 2005) and play a crucial innovative role – not just one of articulating a demand to be supplied by firm innovation (Oudshoorn and Pinch, 2003; Schot et al., 2016 via Schot and Steinmueller, 2018b).

While users and consumers are considered important actors, recent MIP authors look specifically at the interaction between multiple actors in **public and private sectors** suggesting that a need to **rethink the role** and the way governments, public agencies, and private agents act in the economy to be successful (Mazzucato, 2016, 2017 via Florio *et al*, 2018). Focussing on science-based institutions, universities and businesses is thinking more in line with the reality recognised by the earliest TIP contribution who suggests that in spite of this new 'transformative' territory being revealed, the main actors remain the science-based institutions, university or business, and the main model of innovation continues to reflect this (Steward, 2012). Therefore, it is recognised by both TIP and MIP that **mobilizing** the private business sector in transformative innovation will be essential for the outcome (Fagerberg 2018).

Most modern challenges require the participation of different actors, from global and local users and producers to infrastructure owners and regulators, in the diffusion of new innovations (Bonvillian and Weiss, 2015 via Karo, 2018). One can infer therefore that both TIP and MIP consider a wide variety of public, private, sector, industry and consumer actors though differ on the emphasis of users or the states participation in the innovation process which may have significant implications.

4.4.3.2. Governance- How does the topic perceive the role of governance? (Role of the State and Governance | State Structure)

The role of governance and the governance model is recognised as a key feature to delivering on TIP and MIP towards societal challenges and it is increasingly being questioned whether the state, which has traditionally led such mission-oriented research in the past, will be able and willing again to take up this role (Schot and Steinmueller, 2018b). Some argue that as a result, the transition to sustainability not only requires innovations in the economy – but also **innovations in governance** (Edler and Fagerberg, 2017 via Fagerberg, 2018).

Following on from the earlier call for **new types of innovation actors and new types of knowledge** (Steward, 2012), TIP scholars recognise that **new institutional arrangements** and **governance structures** are important to cut across governments, markets, and civil society (Schot and Steinmueller, 2018b). Governance of transformative innovation should be recognized as **a political process** which should provide room for appraising and negotiating the development of a diverse set of pathways as well as making choices for specific ones (Schot and Steinmueller, 2018b). Schot & Steinmueller (2018b) present **tentative governance** as an approach which is **provisional, revisable, dynamic** and **open** and includes **experimentation, learning, reflexivity**, and **reversibility** (Schot and Steinmueller, 2018b). Governance is 'tentative' when public and private interventions are designed as a **dynamic process** that is prudent and preliminary rather than assertive and persistent. Tentative governance "typically aims at creating spaces for probing and learning instead of stipulating definitive

targets" (Kuhlmann, Stegmaier and Konrad, 2019, p.1091). In practice, the case of offshore wind in the Netherlands shows how strong government support for radical product innovation at low-technology readiness levels through research institutes and incubators led to the provision of low-cost lab space and support for start-ups and university spin- offs (van der Loos, Negro and Hekkert, 2020). As societies shift from technology specific endeavours towards addressing complex grand societal challenges necessitating a higher degree of coordination on an increasingly reduced timeline, it is likely that system architects – usually **governments – will seek to leverage existing industries and related technologies to enact change** (van der Loos, Negro and Hekkert, 2020). In the case of the PV sector in Brazil, effective governance and government led initiatives can generate economic, behavioural, and cultural impacts (Denes_Santos and da Cunha, 2020).

MIP authors echo the sentiments that government and public policy and the associated organizational forms can be as dynamic and explorative as the policies themselves (Kattel and Mazzucato, 2018). Criticising the neo-classical approach and recognising that future innovations are by definition clouded in uncertainty, Mazzucato, (2017) and Kattel & Mazzucato (2018) suggest a **role for government to actively shape and create markets and systems**, not just fix them; and **for creating wealth**, not just redistributing it (Mazzucato, 2017; Kattel and Mazzucato, 2018). Rather than de-risking, and levelling the playing field, creating and shaping markets helps **tilt the playing field** in the **direction** of the desired goals which increase the expectations of business around future growth opportunities, thus driving private investment (Kattel and Mazzucato, 2018). The author interprets this to be less open than tentative governance but less pre-determined than missions of old. Critically, policies are not administered by a centralized decision-making authority in a vertical structure (such as in 'old mission-oriented science and technology policy'); but are administered by public agencies engaged in **decentralized and dynamic innovation systems** that **include bottom-up** innovation and variation beyond the control of central administrations (Robinson and Mazzucato, 2019). As a result, by adopting MIP, policy makers – within innovation departments and beyond – become intrinsically motivated to better understand and **steer changes in socio-economic systems** (Hekkert *et al*., 2020). Setting the direction for innovation by defining targets at the outset might not be sufficient as it impedes actors to learn, in a reflexive manner, how to deal with the wickedness involved in addressing societal issues, and how to converge in both the problem dimensions and the solution dimensions (Wanzenböck, *et al.*, 2020). Positioning within an innovation systems context allows for **both direction setting and self-organisation** of MIP in practice (Klerkx and Begemann, 2020) which is strengthened by the work of Hekkert et al, (2020) who present the **mission-oriented innovation system (MIS)** concept as a structure to support mission formulation. The MIS approach could be considered as complementary to TIP as it supports a **relational-type governance structure** to channel information, facilitate the acquisition of technical know-how, provide access to scarce resources, and reduce the uncertainty and risks associated with complex projects, thus enabling suppliers to enhance their performance and increase their development activities (Florio *et al*, 2018).

Ultimately, governing wicked problems comes with a **trade-off.** (Daviter, 2017 via Wanzenböck, *et al.,* 2020). Wanzenbock et al (2020) explain that while a 'taming strategy' may facilitate governability through prioritising one way of problem-solving and excluding competing perspectives; it comes at a high cost of problem reflexivity. If problem identification is "based on specific epistemic knowledge of a certain group of experts, then it may allow faster agreement and action" (Wanzenböck *et al*, 2020, p.477). On the other hand, "the stifling of conflicts and competing perspectives in the policy process might not only reduce the quality but in the end also provoke resistance against the mission and its implementation" (Wanzenböck, *et al.,* 2020, p.477). This echoes Kuhlmann et al's (2019) suggestion that inherent contingency of emerging science & technology requires rather tentative approaches to

governance, though often in combination with more definitive modes of governance, with the exact mixture involving a **balancing act** (Kuhlmann, Stegmaier and Konrad, 2019).

One observes strong understanding from both TIP and MIP in the importance of governance though present differing approaches; tentative (open) for TIP and tilted (directed) for MIP. Ultimately, governance requires a trade-off and the exact mixture of the mode of governance is a balancing act.

4.4.3.3. Coordination- How does the topic understand coordination between actors? (Public-Private | Coordination)

The higher stakes associated with the transition to sustainability make the need for effective policy coordination even more acute and an important (albeit demanding) part of innovation policy (Fagerberg, 2018). Both TIP and MIP suggest a need for a **higher degree of coordination** amongst and within industrial sectors, political actors and knowledge institutes than conventional, science-oriented agendas (Kattel and Mazzucato, 2018; van der Loos, Negro and Hekkert, 2020). Coordination should be, by the very nature of public policies, "the paramount task for government organizations, yet because the results of the coordination processes (policy outcomes) can easily be contested, coordination itself becomes of secondary importance" (Kattel and Mazzucato, 2018, p.790).

TIP scholars argue that since transformative change is about transforming many systems through socio-technical configurations, it is crucially important to address the **horizontal coordination with other cross-cutting policies**, including tax policy, economic policy, social policy, and with **policies from various domains** and specific **sectors** such as healthcare, transport, energy, food and agriculture (Schot and Steinmueller, 2018b). Empirical evidence also suggests the importance of coordination between policies targeting multiple industries, from transportation and vehicle manufacturing to fuel cells and biogas (Carvalho et al, 2012 via Grillitsch and Hansen, 2019).

TIP scholars propose that the focus should be on **emerging and open-ended coordination** in a process of working together towards transformative change and **involving public and private finance and new ways** to share and appropriate the gains in knowledge from these activities (Schot and Steinmueller, 2018b). So called **'Innovation Councils'** aim to strengthen the coordination, inclusiveness and, ultimately, the effectiveness of innovation policy governance and have been introduced to a variety of countries (Serger, Wise and Arnold, 2015 via Fagerberg, 2018). While these offer analysis, evaluations and recommendations they offer little in the way of decisions, plans and guidelines for future policy (Serger, Wise and Arnold, 2015). Work on policy mixes for green industry development highlights the **importance of alignment between policies** targeting diverse aspects, from knowledge development to market access and availability of finance (Binz et al., 2017; Rogge & Reichardt, 2016 via Grillitsch and Hansen, 2019), but also the role of coordination in terms of the policy strategy, which may vary significantly (see Imbert, Ladu, Morone, & Quitzow, 2017 via Grillitsch and Hansen, 2019).

MIP authors generalise the success of policies of 'old' in mobilising a wide variety of technological and innovation efforts under a single challenge, however recognise that 'new' grand challenges and resulting 21st-century missions can only be solved through **dynamic public-private partnerships** and developing **dynamic capabilities in the public sector** (Kattel and Mazzucato, 2018). It is argued that clear vision statements set by the public sector enable the private sector to mobilise resources supporting in overcoming the endemic policy coordination failures (Ergas, 1987 via Kattel and Mazzucato, 2018). While ambitious, the reality is that "effective coordination and alignment between research and innovation policy and sectoral/thematic policies, multi-level coordination between European-level research and local implementation, and the orchestration with private and third sector stakeholders pose serious challenges for the governance of missions" (Wanzenböck and Frenken, 2020 via Wanzenbock *et al*., 2020, p486).

Finally, TIP scholars suggest that **supra-national structures** may ensure global coordination through "constructing a new relationship between the state, the market, and civil society, that foster new forms of pro-active and entrepreneurial state action on national and city levels, as well as new networks between the state, business, civil society" (Schot and Steinmueller, 2018b, p.1565). This may be addressed in some way through vision setting concepts of MIP as demonstrated at the European level (Mazzucato, 2018b).

Both TIP and MIP recognise the complexity and importance of addressing coordination in the policy formulation process. The topics differ in their role as vision setting and developing dynamic capabilities for public-private partnerships (MIP) and providing structure and alignment through 'Innovation Councils' (TIP).

4.4.3.4. Contestation- How does the topic address contestation in the decision-making process? (Decision-Making | Contestation)

Policy making is ultimately shaped by **political contest** in which rival coalitions with alternative paradigmatic solutions fight for control over policy (Hall, 1993 via Diercks, Larsen and Steward, 2019). Similarly, both TIP and MIP **face continuing trade-offs** among the interests and visions of different groups (Klerkx and Rose, 2020; Schot and Steinmueller, 2018b).

TIP does not assume consensus but rather that "the underlying innovation thrives on the need to identify and **work with diversity, dissension and conflicting worldviews**, recognizing the contributions which can be made by a **large variety of actors**, and bringing out into the open the politics involved in any innovation process" (Schot and Steinmueller, 2018b, p.1564). A key rationale to supporting TIP is that innovation scholars have started to question whether established innovation systems policy designs are adequate to cope with the contestation, non-linearity and bifurcations of societal challenges (Kuhlmann and Rip, 2018; Schot and Steinmueller, 2018b).

In MIP, recent work by Wanzenbock et al, (2020), places **contestation as a central tenet in the PSF** framework. Based on reoccurring aspects in the scientific discussion and typologies of wicked problems as 1) contested, 2) complex, and 3) uncertain; Wanzenbock et al (2020) develop the framework to help navigate through divergent framings and values resulting from multiple-stakeholders involved through the problem-solution space (Wanzenböck, *et al.*, 2020).

Indeed, **embracing contestation** seems a necessary condition to the policy process, with convergence in both problems and solutions helping to build legitimacy towards certain directions. In Brazil, the PV technology under study is now seen as an opportunity for the industry, and no longer as a threat, and is beginning to gain **legitimacy** with important actors in the system, leading to a process of change in the current consolidated mental model (Denes_Santos and da Cunha, 2020). Ultimately, reaching out to stakeholders (including the broader public) and engaging them in the **collective innovation journey** towards a sustainable economic system may not only be more democratic but also more effective (Fagerberg, 2018).

In sum, MIP offers a more explicit treatment of contestation in the policy making process however TIP, recognising that contestation is an issue, offers more implied understanding of dealing with contestation in the policy making process through RRI.

4.4.3.5. Networks and Linkages- How does the topic understand networks and linkages? (Policy Networks | Linkages | Beliefs)

The importance of strong networks and linkages are expressed by both TIP and MIP authors, who recognise that global industries are becoming more connected and interlinked, as epitomized by the idea of Industry 4.0 (Karo, 2018; Robinson and Mazzucato, 2019). At the same time, industrialized

nations are also seeking to connect industrial transformations with grand societal challenges (Robinson and Mazzucato, 2019). This suggests **new forms of partnerships** (Robinson and Mazzucato, 2019), **engagements and networks** between public, private and third sector actors (Schot and Steinmueller, 2018b) that embrace **all actors and all regions** in the innovation cycle (Steward, 2012).

Instead of the recommendation to build systems of innovation of various kinds, TIP scholars argue to experiment and transform the **existing set of relationships**, and for example focus on **local and transnational** instead of national linkages (Schot and Steinmueller, 2018b). TIP emphasises the need to "build networks of knowledge among **producer and user** organisations, stimulating the alignment and coordination of these organisations with the aim of producing technological change, and facilitating entrepreneurship in the service of the goals of growth, employment and international competitiveness" (Schot and Steinmueller, 2018b, p.1563). In practice, the importance of such linkages vary according to the type of regions (Grillitsch and Hansen, 2019). One outcome is that policies focusing on establishing **extra-regional linkages** are of significant importance in peripheral regions in order to provide access to capabilities and technologies as well as to build on directionality exercised by actors operating at the national or global scale (Grillitsch and Hansen, 2019).

When embedding MIP within an innovation systems perspective, the understanding of networks and linkages becomes clearer. Interactions between technologies and systems may be **'passive'** via competitive dynamics through global markets or **'active'** through processes of active collaboration, competition or co-opetition between innovators (Planko et al., 2019 via Klerkx and Rose, 2020). These co-evolutionary dynamics take place in the self-organising interaction between multiple actors, and are affected by economic, biophysical and social forces which are not under the control of one actor (Ekboir, 2003; Kash and Rycroft, 2002; Klerkx et al., 2010 via Klerkx and Rose, 2020).

One can infer that both TIP and MIP have been embedded within an innovation systems perspective which supports their understanding of the types, strengths and direction of linkages required between actors towards transformative change. However, in the case of MIP one can observe the development of a dedicated innovation system (MIS; Hekkert *et al.*, 2020) which differs to the TIP approach of embedding in existing innovation systems (Schot and Steinmueller, 2018b).

4.4.3.6. Instrumentation and Tools- What policy options, instrumentation and tools does the topic present? (Policy Options | Instrumentation | Regulatory, Financial, Informational, and Organizational Tools)

While it is easy to argue that innovation must play an important role in the transition towards sustainability, it is much more challenging to provide good models for how policy may help in mobilizing innovation for this purpose (Mowery, Nelson and Martin, 2010). Steward, (2012) presented the issue that while climate change policy has embraced the new transitions discourse; with regard to the domain of innovation policy and evidence of new approaches, they remain confusingly intertwined with old models. Instead, a framework for transformative innovation should **tackle the complex systemic nature of the underlying problem** as it is **deeply embedded in current economic and social arrangements** (Steward, 2012).

In response to the call for **more demand-oriented instruments than purely supply-oriented instruments** (Steward, 2012; Fagerberg, 2018), **public procurement for innovation (PPI)** has become increasingly widespread amongst policy makers and governments around the world as an instrument that may be used to drive innovation (Edler and Georghiou, 2007). Citing its relevance to be exploited in the mitigation of grand challenges, PPI is recognised across both TIP (Uyarra, Ribeiro and Dale-Clough, 2019; Grillitsch and Hansen, 2019) and MIP literatures (Edquist and Zabala-Iturriagagoitia, 2012; Florio *et al.*, 2018; Robinson and Mazzucato, 2019) and in general, is meant to stimulate

innovation by shaping the demand environment and the economic landscape in which suppliers operate (Uyarra and Flanagan, 2010). PPI is thus likely to lead to radical innovations and lay the foundations for new markets, particularly in areas where market interest is suboptimal owing to high risk and uncertainty (Lember et al., 2015; Mazzucato, 2016 via Florio *et al*., 2018).

Addressing a "whole" grand challenge by a single instrument is normally impossible (Edquist and Zabala-Iturriagagoitia, 2012) and bottom-up processes may be context-specific and suit only a few Western systems, if at all (Angel & Rock, 2009 via Karo, 2018). Successful innovation therefore depends on the ability to access and combine a number of different factors, such as knowledge, skills, finance, institutions and demand which has led to a call from authors for a **holistic policy making** approach that takes into account not only a few but all factors influencing innovation (Coenen et al., 2015; Frenken, 2017 via Uyarra, Ribeiro and Dale-Clough, 2019; Fagerberg, 2018). Overall there seems to be a growing consensus that modern "boundary spanning" societal challenges (Arundel et al., 2011; Hicks, 2016; Ulnicane, 2016 via Karo, 2018) and "socio-technical transitions" towards more sustainable techno-economic environments (Geels and Schot, 2007; Markard et al., 2012 via Karo, 2018), possibly delivered by MIP, may require policy and governance approaches that **balance between the top-down direction giving role of the state and the maintenance of spaces for more bottom-up experimental search** (Karo, 2018).

In sum, both TIP and MIP recognise the opportunity to utilise PPI as a demand-side instrument and recognise the need for a holistic policy making approach and a broad mix of policy instruments. However, the emphasis on experimentation (demand-oriented instruments) is considered to a greater extent in TIP literature than MIP (both supply and demand-oriented instruments).

4.4.4. Policy Adoption

4.4.4.1. Boundaries & Parameters- What boundaries / parameters does the topic identify? (Boundaries/Parameters- Resource Availability, Political Preferences and Public Perception)

Boundaries and parameters to policies are typically presented geographically at the national and regional level for both TIP (Schot and Steinmueller, 2018b; Uyarra, Ribeiro and Dale-Clough, 2019; Grillitsch and Hansen, 2019) and MIP (Karo, 2018; Robinson and Mazzucato, 2019). Steward (2012) suggested that innovative experimentation is often more feasible at regional rather than at national or international levels because the scale is manageable, yet significant resources can be leveraged (Steward, 2012).

Grillitsch & Hansen, (2019), present TIP within a **regional innovation systems (RIS)** approach considering development of regional typologies based on "(1) key actors and governance (Asheim & Isaksen, 2002; Cooke, 1998 via Grillitsch and Hansen, 2019); (2) the strengths in radical versus incremental innovations (Cooke, 2004 via Grillitsch and Hansen, 2019); and (3) RIS failures" (Isaksen, 2001; Tödtling & Trippl, 2005 via Grillitsch and Hansen, 2019 p.2164). This typology differentiates in three types of regions: peripheral regions, specialized regions, and metropolitan regions with specific challenges and opportunities for regional development. These types of **regions are distinct** in terms of the regional support system for innovation and entrepreneurship, the exploitation of knowledge, infrastructures, networks and linkages, access to capital etc (Grillitsch and Hansen, 2019). In the case of green energy development, authors argue that the rise of new paths is, to a high degree, place-specific due to regional actor constellations, natural resources that can be exploited for renewable energy, and existing infrastructure (Grillitsch and Hansen, 2019). The main challenge often does not lie in importing the technology but in shaping the conditions for their implementation, which requires the coordination and mobilization of distributed actors (Späth & Rohracher, 2010 via Grillitsch and Hansen, 2019). Uyarra et al, (2019) suggest **RRI** can be used as a basis to develop more spatially

sensitive and responsive approaches to implementing innovation policy at a regional level. Of particular concern to the RRI agenda is "how to ensure innovation is aligned with societal needs and responds to pressing societal challenges" (Uyarra, Ribeiro and Dale-Clough, 2019, p.2360).

Given the contested nature of problem identification, the contextual nature of problem-solving and the variety of institutional settings, MIP is best implemented at the subnational level of regions and cities (Rabadjieva and Terstriep, 2021). Europe's multi-level governance system is highly suitable for MIP, as it allows Member States and regions to experiment within larger EU-wide missions. This rationale justifies the inception of a dedicated **mission-oriented innovation system (MIS)** approach (Hekkert *et al*., 2020), which has been applied in the case of the agricultural sector in the Netherlands and offers some complementarity to understanding the diversity of regional conditions.

Presented as a sector specific **mission-oriented agricultural innovation system (MAIS)** (Klerkx and Begemann, 2020), authors justify its use in that many proposed food systems transformation concepts transcend national, sectoral and technological boundaries (Klerkx and Begemann, 2020). They are developed in many countries simultaneously and are connected to supra-national or even global transformative policy narratives and flows of technologies and capital (Wanzenböck and Frenken, 2020 via Klerkx and Begemann, 2020). Missions may 'travel' geographically and a MAIS may have a different pace of development in different countries due to differences in state governance, and between cultural and regulatory contexts that may determine consumer attitude (Bekker et al., 2017; Gupta et al., 2013 via Klerkx and Begemann, 2020). However, given the geographical fluidity of a MAIS, the system complexity and degree of self-organization, the analytical boundaries of a MAIS are not easy to establish (Klerkx and Begemann, 2020).

In sum, the boundary and parameters to TIP and MIP are predominantly recognised as geographical and sectoral in nature. However, while TIP presents RRI, MIP authors present MIS to support innovation activities to understand and overcome conceptual and geographical boundaries.

4.4.4.2. Capabilities/Capacity & Competencies- How does the topic assess the capabilities, capacity and competencies of actors? (Competencies of Government and Institutions | Institutional Capacity)

TIP require **new capabilities** which include: understanding of systemic (not singular) innovation, 'learning by doing' – sociotechnical experiments, framing goals in terms of societal outcomes rather than technical inputs, promoting 'bottom–up' innovation to complement the 'top–down', new **interdisciplinary boundary spanning competences** and policy measures for communities of practice (Steward, 2012). In addition, for innovation to come to (full) fruition, a number of complementary factors need to be in place, not only in the form of an **appropriate infrastructure** (although that may be essential) in which the "**public sector should focus on enhancing capabilities** and ensuring that as many actors as possible are able to participate productively in the economy" (Feldman et al., 2016; Iam-marino et al., 2018 via Uyarra, Ribeiro and Dale-Clough, 2019, p.2362), but also with respect to the **economic, organizational and institutional** set up of society (Fagerberg, 2018).

Nevertheless, since such factors take time to develop, a mismatch between the requirements of an emerging technological revolution and the existing socio-economic framework is likely, and this may significantly slow down the diffusion of the new technological revolution (Fagerberg, 2018). This may hamper its potential beneficial effects as the capacity of a country to undertake appropriate changes may be of vital importance for its ability to exploit the potential offered by an emerging technological revolution (Fagerberg, 2018). According to Schot and Steinmueller (2018b), "when the goals set for of socio-technical systems reflect a range of social and environmental needs and more inclusive ideas about social welfare, bridging between what is possible and what is desirable will also require

individuals with capabilities for bridging social and scientific and technological domains (Schot and Steinmueller, 2018b, p.1564). This implies a "re-orientation of education policy and, ultimately, a pedagogy that is consistent with the desired transition to more sustainable outcomes" (Schot and Steinmueller, 2018b, p.1564). In addition, **firms and entrepreneurs may have capabilities** which tend to compensate for a lack of local knowledge spill-overs with national or international networks (Grillitsch & Nilsson, 2015 via Grillitsch and Hansen, 2019). This was evidenced in the case of the Dutch offshore wind industry, where despite the perceived need for new capabilities, **leveraging existing skills and assets** helped to populate and establish the new offshore industry (van der Loos, Negro and Hekkert, 2020). Capabilities can be regional and based on the existence of sophisticated **users with core competencies** as in the case of integrating the fuel cell technology into new applications in metropolitan regions (Tanner, 2014 via Grillitsch and Hansen, 2019). Additionally, authors have extended the involvement of **users** in a wide range of capacities (Schot and Steinmueller, 2018b), as "**user-producers** (users-entrepreneurs)" who actively come up with new solutions, "**users-legitimators"** who provide new visions and expectations helping shape investment decisions and policy changes, "**user intermediaries"** who broker contacts between producers and larger groups of users, "**user-citizens"** who lobby for wider system reform and "**user-consumers"** who develop new life-styles, preferences and practices (Ornetzeder and Rohracher, 2006; Schot et al., 2016 via Schot and Steinmueller, 2018b, p.1564).

For MIP, the "translation" of needs/problems/challenges into functional requirements requires highly developed **competences** on the part of the (procuring) organization, and the suppliers to "translate" the functional requirements into technical specifications which assumed that both "translations" together determine the future technological and product trajectories of the innovations (Edquist and Zabala-Iturriagagoitia, 2012). The functional specifications must constitute solutions to the challenges, but at the same time they must be achievable given the state of the art at the time (Edquist and Zabala-Iturriagagoitia, 2012). This presents a more endogenous understanding of competencies and capabilities in the policy making process that were later extended to require new thinking in ways that public organizations design, implement, and evaluate (innovation) policies (Kattel and Mazzucato, 2018). In the same way that the private sector requires dynamic capabilities (Teece, 2016), Kattel and Mazzucato (2018) and Mazzucato et al, (2020) highlight that **dynamic capabilities** are needed in the **public sector** to deliver MIP. The term 'dynamic' refers to the shifting character of the environment; such as "certain strategic responses are required when time-to-market and timing is critical, the pace of innovation accelerating, and the nature of future competition and markets difficult to determine" (Kattel and Mazzucato, 2018, p.795). The term 'capabilities' emphasizes "the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organizational skills, resources, and functional competencies toward changing environment" (Kattel and Mazzucato, 2018, p.795). A key concern should be to establish skills/resources, capabilities, and structures (**administrative capabilities**) that can increase the chances that a public organisation will be effective, both at learning and at establishing symbiotic partnerships with the private sector, and ultimately succeed in implementing mission-oriented and transformative policies (Mazzucato, Kattel and Ryan-Collins, 2020). Mazzucato et al, (2020), suggest the adoption of a **portfolio approach** for public investments to support public-private partnerships (Mazzucato, Kattel and Ryan-Collins, 2020), arguing that in such an approach, the success of a few projects can cover the losses from many projects, and the public organisation in question also learns from its loss-making investments (Mazzucato, 2013 via Mazzucato, Kattel and Ryan-Collins, 2020).

In sum, TIP and MIP differ on their emphasis of competencies and capabilities commensurate with their understanding of the key actors in the policy process. MIP strongly considers the development

of dynamic capabilities (characterised as endogenous) while TIP considers the role of firms, entrepreneurs and users (characterised as exogenous) in the innovation policy process. TIP considerations of the economic, organisational and institutional set up of society are arguably addressed by the PSF framework of MIP previously presented.

4.4.4.3. Cooperation, Collaboration & Coalitions- How does the topic enable cooperation, collaboration and coalitions? (Cooperation, Collaboration and Coalition Opportunities)

The agendas of conventional innovation policies, which are science oriented, are typically executed through national ministries or innovation agencies (Braun, 1993 via Diercks, Larsen and Steward, 2019). However, the scope and scale of societal challenges imply a more global outlook, **demanding boundary-spanning collaborations** across diverse disciplines, organisations and countries (Steward, 2008; Cagnin et al., 2012; Smith, 2017 via Diercks, Larsen and Steward, 2019).

TIP authors recognise the value of **forming networks and coalitions** involving multiple actors (civil society, regulatory agencies, producers, financing institutions and consumers) since new technologies and innovation bring about changes in the structural, organisation and cultural aspects of the sector (Denes_Santos and da Cunha, 2020). In addition, research highlights how partnerships between cleantech firms specialized in green technologies, and producers of traditional, non-environmentally conscious products are important for **firm-level** diversification into new cleantech products (Hansen, 2014 via Grillitsch and Hansen, 2019). Furthermore, value may be added through **meaningful relations** or 'conversations' (Uyarra, Ribeiro and Dale-Clough, 2019) with suppliers, users, citizens, etc. This requires "replacing a 'one-size-fits-all' perspective with one that 'assesses any potential provider according to their capacity to create value', which in turn demands greater leadership, capacity to listen to and work with citizens/local groups, and the ability to innovate" (Kelly & Muers, 2002 via Uyarra, Ribeiro and Dale-Clough, 2019, p.2367). TIP practices should therefore seek active contributions and find ways to **assist users in constructing new demands, user environments and markets** (Schot and Steinmueller, 2018b).

MIP argues extensively on the creation on public-private partnerships and new markets, arguing that collaborations may emerge from an emphasis on the state's ability to take risks (Mazzucato, Kattel and Ryan-Collins, 2020). These may be further enabled by previous concepts on vision setting and directionality to enable private sector mobilisation around missions and forming new networks and collaborations, thus enabling suppliers to enhance their performance and increase their development activities (Florio *et al.*, 2018).

In sum, both TIP and MIP aim to support meaningful relations at the public-private level though the MIP concept to promote the state as a risk taker may foster stronger conditions for the formation of coalitions.

4.4.4.4. Decision-Making Limitation- How does the topic understand limitations to decision making process? (Decision Making Heuristics and Biases)

Policy makers have the most direct influence, power and responsibility for their constituencies, however, policy makers have previously been found to emphasize policies aimed at building innovation systems and correcting structural innovation systems failures, while policies addressing transformative innovation challenges are few and far between (Kivimaa & Kern, 2016 via Grillitsch and Hansen, 2019).

With such high emphasis on the state/government actors, decision making limitations and biases are exacerbated in MIP. One response offered is through the emphasis on developing **dynamic**

capabilities (Kattel and Mazzucato, 2018). Similarly, it is implied that the **PSF framework** embed possible limitations and biases of actors in the decision-making process through explicit attention to the wickedness of challenges at both the problem and solution side (Wanzenbock, *et al,* 2020).

This is similar to what TIP aims to establish as 'corridors of acceptable development pathways' (Weber & Rohracher, 2012 via Schot and Steinmueller, 2018b). As Schot and Steinmueller (2018b) explain, these pathways "nurture opportunities for various groups to challenge dominant views embedded in the current socio-technical systems, yet, at some point in the process, there will be a need to close down exploration and focus on certain options" (Schot and Steinmueller, 2018b, p.1562). In this negotiation process, visions of various groups do not have to be fully congruent, but stakeholders need to "recognize **sufficient commonly attractive elements** they can relate to in order to move forward" (Grin et al., 2010 via Schot and Steinmueller, 2018b, p.1562).

In sum, both TIP and MIP recognise the importance of decision making but MIP offers an explicit approach through dynamic capabilities and the problem-solution framework.

4.4.5. Implementation

4.4.5.1. Top-Down & Bottom-Up- How does the topic understand top-down & bottom-up factors? (Top-Down Models/Instruments and Tools | Bottom-Up Models/Instruments and Tools)

Because of the broad range of concepts presented here, the author has broken this down further into the following subsections: understanding of the innovation process, bottom-up and top-down, policy mix and innovation model.

4.4.5.1.1. Understanding of the Innovation Process

Diercks et al, (2019) provide a useful framework for assessing a narrow vs broad understanding of the innovation process which can be expressed by considering: (1) which actors are actively involved in the innovation process; (2) what types of activities are contributing to innovation (supply v demand); (3) the different modes of innovation, i.e. the different modes of learning and forms of knowledge as emerging from STI or from STI + doing, using and interacting (Diercks, Larsen and Steward, 2019).

First, in its extreme form, a narrow understanding portrays innovation as the "commercialization of science" with an active role for academia and industry. Government is there either to support these actors directly or to create the right framework for them to thrive. The role of society is limited to one that passively conforms to the new inventions and innovations coming from science and industry (Joly et al., 2010 via Diercks, Larsen and Steward, 2019). Diercks et al, (2019) suggest that a narrow supply-side focus on innovation without considering necessary behavioural changes in established habits and lifestyles is insufficient to deal with the nature and complexity of contemporary societal challenges (Diercks, Larsen and Steward, 2019). Diercks et al, (2019) suggest 'old' MIP presents a narrow understanding of the innovation process, meaning that they largely view innovation as the "commercialization of science", with academia and industry as leading actors, a strong focus on R&D for new technologies informed by a linear model of innovation, and the need to address market failures. In the end, scientific breakthroughs are intended to lead to radical changes in technology, such as the transition to energy-efficient light bulbs, solar and wind energy, or electric vehicles (Geels et al., 2015 via Diercks, Larsen and Steward, 2019).

Secondly, a broad understanding implies that the innovation process should acknowledge a wider variety of actors, moving away from a singular focus on the "triple helix" of universities, industry and government (Etzkowitz and Leydesdorff, 2000), and taking on the direct engagement of a diversity of "social partners" (Steward, 2012). A wider understanding of innovation implies an open and

networked view of the process, which pays more attention to the rich diversity of "broader" non-technical innovation modes such as social innovation (Mulgan, 2012), institutional innovation (Hargrave and Van De Ven, 2006) open innovation (Chesbrough, 2003), and user-led innovation (von Hippel, 2005) which Schot and Steinmueller, (2018b) added to by also including grassroots innovation with communities and civil society as essential for success in innovation policy (Smith and Seyfang, 2013 via Schot and Steinmueller, 2018b).

The **TIP** topic can be positioned within this second understanding and following a **"broad"** innovation process (Steward, 2012; Diercks, Larsen and Steward, 2019). The **MIP** topic is less easy to position according to this framework. Despite for many years being considered "narrow", continued efforts to reframe MIP argues that the topic has evolved to understand the innovation process as not only **"narrow"** but also **"broad"** (Robinson and Mazzucato, 2019; Mzzucato, Kattel and Ryan-Collins, 2020).

4.4.5.1.2. Bottom-Up (Demand-Pull) & Top-Down (Supply-Push)

The understanding of the innovation process has a significant implication on the understanding of the use of bottom-up or top-down factors which the author understands as influenced by past or current understanding. Authors present the TIP rationale as predominantly about promoting **bottom-up** innovation (Steward, 2012; Penna, 2021) that can be achieved through processes of **experimentation**, **learning**, **networking**, and **participation** (Chataway et al. 2017 via Denes_Santos and da Cunha, 2020) and by enabling **'learning by doing'** through sociotechnical experimentation (Steward, 2012). However, Steward (2012) originally suggests **demand-pull** from citizens and consumers as well as **supply push** innovations from universities and business are equally important (Steward, 2012). More recent authors share the view that a **holistic** perspective on innovation is required, focusing **not only on supply but also demand factors**, (Edler and Georghiou, 2007; Edler and Fagerberg, 2017; Kemp, 2011 via Fagerberg, 2018; Diercks, Larsen and Steward, 2019).

MIP scholars argue more recently about the relevance of **demand-side organizations** (and **individual consumers**), which have long been neglected in innovation studies and innovation policy (Edquist and Zabala-Iturriagagoitia, 2012). The **interactive learning** between organizations operating on the **demand-pull** side as well as the **supply-push** side is extremely important for innovations to emerge (Edquist and Zabala-Iturriagagoitia, 2012). In the case of European Space sector, authors suggest that **demand-side** policies focussing on **experimentation** should be harmonized with sector specific **supply-side** policies to seek **alignments (and misalignments)**, which require more active engagement with other sectors and perhaps the pursuit of demand articulation forums (Robinson and Mazzucato, 2019). In sum, the MIP approach to industrial policy is not about **'top down'** planning by an overbearing state; it is about providing a direction for growth comprising of a strategic portfolio of innovation projects or **'coupled innovations'** (technological, social, institutional innovation) (Klerkx and Begemann, 2020), increasing business expectations about future growth areas and catalysing activity that otherwise would not happen (Mazzucato and Perez, 2015 via Mazzucato, Kattel and Ryan-Collins, 2020).

In sum, TIP and MIP converge on the need to combine bottom-up (demand pull) and top-down (supply push) processes though present diverse expressions that are historically focussed on top-down (MIP) and bottom-up (TIP).

4.4.5.1.3. Policy Mix

Industrial policies have always been composed of both a horizontal and a vertical element. While horizontal policies are more focused on the background conditions necessary for innovation correcting

for different types of market and system failures, such as the need to fund infrastructure and the creation of intermediary organizations between science and industry; vertical policies are more directional and "active", focusing on directing change in sectors like transport, health or energy, or technologies often through missions that require the active creation and shaping of markets (Robinson and Mazzucato, 2019).

TIP suggests that a societal policy agenda supports innovation that is cross-cutting and recognises that policy coordination failure refers to a lack of horizontal policy coordination across domains (Schot and Steinmueller, 2018b).

While acknowledging that certain sectors might be more suited for sector-specific vertical strategies, 'grand challenges' are cross-sectoral by nature, and hence, we cannot simply apply vertical approaches to such challenges (Mazzucato, Kattel and Ryan-Collins, 2020). In contrast, MIP scholars offer a clearer proposition for a **dynamic mix of vertical and horizontal policies** to focus on achieving bottom-up experimentation, where new sources of value and growth are explored and catalysed by new forms of public–private partnerships (Robinson and Mazzucato, 2019; Mazzucato, Kattel and Ryan-Collins, 2020). Vertical and horizontal interventions should be linked to a mission, which can then invite private sector interactions based on these missions, through specific projects, and through instruments, such as prizes, that reward success on key metrics (Robinson and Mazzucato, 2019).

Relatedly, the complexity resulting from directionality, high urgency and a specified time path in combination with different sets of interrelated technological and institutional/behavioural solutions is likely to require a broad mix of policy instruments, governance and coordination mechanisms (Hekkert *et al*., 2020). MIP differs in its understanding to offer both vertical and horizontal policies.

4.4.5.1.4. Innovation Model

TIP scholars have widely adopted **Strategic Niche Management** from the sustainability transitions literature (Kemp, Schot and Hoogma, 1998; Schot and Geels, 2008) to support 'bottom-up' concepts of experimentation (Schot and Steinmueller, 2018; Fagerberg, 2018). This enables actors to accept uncertainty and failure as part of the learning process, focus on articulating new shared expectations and visions, build new networks, and shape new markets (called niches) (Schot and Steinmueller, 2018b). Niches are seen as temporary spaces for actors working together on a variety of concrete pathways, including policy actors as well as other business, civil society, users and private funders (Steward, 2012; Schot and Steinmueller, 2018b). The creation of a niche market turned out to be essential for developing innovation (e.g, increasing performance and reducing costs through learning and economies of scale) so that it would eventually get broader acceptance (Fagerberg, 2018). The approach has been criticized for being overly technocratic and for paying too little attention to democratic processes (Hendriks, 2009; Schmitz, 2015 via Fagerberg, 2018), while in practice transition management in the Netherlands proved vulnerable to capture by incumbent interests from the established oil and gas industry (Smith and Kern, 2009 via Fagerberg, 2018). In 2011, following the formation of a new and more conservative government, the 'transition action plan' program was formally terminated illustrating that while strategic niche management may be an effective model, it requires effective and long-term political buy-in (Fagerberg, 2018).

An alternative approach, offered by MIP scholars, is the **Mission-oriented Innovation System (MIS)** framework defined as "the network of agents and set of institutions that contribute to the development and diffusion of innovative solutions with the aim to define, pursue and complete a societal mission" (Hekkert *et al*., 2020, p.77). In its essence, the MIS is another type of innovation system, such as the national, regional, sectoral and technological equivalents. However, it differs from

the latter in how the system boundaries are delineated, how interactions in this system come about (e.g. demand pull versus supply-push) and what it ultimately produces (e.g. new technological and behavioural solutions) (Hekkert *et al*., 2020). Depending on which problem is prioritized and how the associated mission is formulated, actors from different public and private domains (including various sectors) might be involved in promoting and experimenting with innovations that have the potential to contribute to the collectively shared goal. In an ideal case, a MIS is likely to be characterized by constant urgency and directionality through ambitious targets, continuous monitoring and assessment of milestones (Hekkert *et al*., 2020).

One can infer that TIP and MIP converge on the importance of frameworks but offer competing models for understanding and supporting the implementation of innovation policy.

4.4.5.2. Design and Delivery- Does the topic offer a clear framework for policy implementation design and delivery? (Clear Definition, Interpretation and Identification of Responsible Agents | Clear Allocation of Budgetary, Personnel and Organisational Resources | Clear Decision-Making Framework)

In the context of sustainability transitions, implementation and diffusion are essential (Mowery, Nelson and Martin, 2010). Weber and Rohracher's failures frameworks (2012) include a series of socially relevant and political elements including the design of collective priorities (i.e. societal challenges); the public acceptance of innovation; the dynamics between multiple innovation policy actors; and the high levels of uncertainty, ambiguity and ignorance inherent to innovation and social change (Weber and Rohracher, 2012). According to Schlaile (2017), "these elements emphasise the need for a normative lens for investigating and guiding innovation policy, with more explicit and integrative research on directionality, legitimacy, responsibility, and their interrelations necessary" (Schlaile, 2017 via Uyarra, Ribeiro and Dale-Clough, 2019, p.2362).

For TIP, it is vital that the autonomy of government is retained through appropriate policy design. Rodrik (2014) suggests **that a design emphasising clear goals/targets that are enforceable, transparent, and accountable** may go a long way in doing so (Rodrik, 2014 via Fagerberg, 2018). Uyarra et al (2019) offer more pragmatic advice to design and delivery of TIP, suggesting that "using public procurement as an instrument requires a bolder normative framework for the analysis of innovation policy in the context of societal 'grand challenges' and must **a) have a focus on creating public value**; **b) investigate how societal problems are framed**; and **c) assess the capabilities of different societal groups to engage in transformational change"** (Uyarra, Ribeiro and Dale-Clough, 2019, p.2361).

For MIP, the policies tackling grand challenges should be broad enough to **engage the public**, **enable concrete missions**, **attract cross-sectoral investment**, and remain **focussed enough** to involve industry and achieve measurable success (Mazzucato, Kattel and Ryan-Collins, 2020). The design and implementation of effective MIP depends on how different countries manage to achieve complementarity between effective ways of **legitimizing policies** (which is often an issue out of the hands of innovation policymakers), and ways of **implementing policies**, (which is a "choice" innovation policy makers are more likely to be able to make), within the broader politico-economic, politico-administrative, and techno-economic contexts (Karo and Kattel, 2018).

One can infer that both TP and MIP recognise the similar priority for creating public value, though the design and delivery of innovation policy depends on the responsible agents which differ between TIP and MIP and in practice will ultimately require a trade-off and be based on contextual and situational conditions.

4.4.5.3. Accountability- How does the topic enforce effective leadership? (Accountability | Effective Leadership)

Both TIP and MIP recognise the challenges of industry alignment and reinforcing mechanisms (Schot and Steinmueller, 2018b; Denes_Santos and da Cunha, 2020), resistance to change from incumbent networks and vested interests (Schot and Steinmueller, 2018b; Mazzucato, Kattel and Ryan-Collins, 2020), cognitive lock-in and values (Schot and Steinmueller, 2018b; Denes_Santos and da Cunha, 2020) and regulatory, cognitive and normative collective rules embedded in prevailing socio-technical systems (Schot and Steinmueller, 2018b). These industry, users and civil society actors instead believe that they can cope with challenges ahead within existing frameworks (Schot and Steinmueller, 2018b).

Similar to the agents of change identified earlier, TIP implicitly recognises the role of government whereas MIP explicitly aims to support and develop the role of government to drive the innovation policy process. More so, scholars recognise that "a market co-creating role requires the state to have **capabilities** for leadership and engagement because missions can all too quickly become either just fashionable labels on 'business-as-usual' practices or too rigid top-down planning exercises" (Mazzucato, Kattel and Ryan-Collins, 2020, p.429). Therefore, capabilities to "engage with a wide set of social actors, to **show leadership through bold vision,** are vital in times with high 'democratic deficit' in many developed countries" (Mazzucato, Kattel and Ryan-Collins, 2020, p.429). Of course, **democracy** is no guarantee that societal missions—such as climate change—will be adopted globally as the current administrations in the USA and Brazil clearly demonstrate (Mazzucato, Kattel and Ryan-Collins, 2020).

One can infer that both TIP and MIP are aware of the challenges of resistance, lock-in and capture but MIP differs in the understanding that bold leadership, dynamic capabilities and vision may play in ensuring governments are accountable for supporting the policy process and overcoming challenges.

4.4.5.4. Implementation Problems- What implementation problems does the topic identify? (Implementation Problems - Design, Coordination, Control | Implementation Problems- Uncertainty, Interactions)

In addition to the challenges of resistance, lock-in and capture previously mentioned, innovation policies may be among the most difficult to directly legitimize since policy issues and challenges are often too complex to engage nonexperts in policy design (to achieve **input legitimacy**), implementation phases (to achieve **throughput legitimacy**), and difficulty proving outcomes and effectiveness of policies (**output legitimacy**) (Edler et al., 2016 via Karo, 2018).

While both TIP and MIP continue to respond to legitimacy challenges of innovation policy, TIP argue that despite a new range of policy initiatives that increasingly recognise innovation in terms of socially situated practices, policy advice remains dominated by economics (the market) and psychology (the individual) (Steward, 2012). While the **prevailing economic approaches** to sustainable innovation policy still prove a barrier to shifting to a more systemic approach, with a focus on singular technologies as opposed to systemic (Steward, 2012), it is, as yet, unclear how TIP approaches of experimentation can generate transformative change, beyond the pilot and/or the niche development which may follow from it (Schot and Steinmueller, 2018b).

For TIP, strategic niche management require very capable policy makers (or managers) and stringent procedures to avoid the many traps that such a project easily may fall into (Fagerberg, 2018). These include e.g., **aborting the project too early**; **premature lock-in** to a specific technological trajectory (before the pros and cons of various alternatives have been properly explored); or **capture by special interests** (within the private business sector for example) (Fagerberg, 2018). The author suggests that it could be argued that these challenges may also apply to MIS and for MIP.

While transformative change needs a whole of government approach; "such an approach is prone to red tape issues, huge transaction costs and capture by incumbents who are thriving on the dominant socio-technical systems" (Schot and Steinmueller, 2018b, p.1563). In practice, as in the case of offshore wind energy in the Netherlands, van der Loos et al, (2020) suggest that while a rapidly formed dominant design and quick diffusion are critical to ensuring countries meet their climate pledges, it may risk early lock-in if there is no room for experimentation, impeding breakthrough which may potentially lead to a suboptimal design (van der Loos, Negro and Hekkert, 2020). To overcome this, governments should ensure sufficient attention to variety and experimentation in innovation systems while maintaining a focus on rapid diffusion (van der Loos, Negro and Hekkert, 2020).

Similarly in MIP- governments can and do become captured by particular interest groups which limit their ability to both establish missions and follow through on them (Mazzucato, Kattel and Ryan-Collins, 2020). The challenges of climate change and inequality are obvious examples. Government subsidies continue to favour vested interests (for example fossil fuel energy firms) whilst taxation policy favours labour saving (increasing unemployment or underemployment) over resource saving (supporting decarbonisation), despite governments signing up to Treaties committing themselves to different policy directions (Mazzucato, Kattel and Ryan-Collins, 2020).

Choosing top-down governance systems and politicized change agents remote from the actual policy implementation, organizations and capabilities is a more debatable and questionable choice (Karo, 2018). Without **supportive state structures** focusing on long-term implementation of the new missions and policy innovations emerging under the umbrellas of these missions, it might easily be that the new ideas of super smart or intelligent societies striving toward ever greener economies remain short-term buzzwords resulting in spectacular policy failures (or just government waste) and subsequent de-legitimization of the role of the state in innovation (Karo, 2018).

One can infer that both TIP and MIP have similar, significant uncertainties and implementation challenges to overcome, both related directly to their own approaches and others resulting from established policies and industrialisation. Similarly, both TIP and MIP are also subject to challenges around the etymological meanings of 'transformation' and 'mission'. MIP differs in challenges of governance whereas TIP presents challenges around control and impact of experimentation.

4.4.6. Evaluation

4.4.6.1. Monitoring & Performance- How does the topic address monitoring and performance during the policy process (Monitoring | Policy Performance)

Although there is significant attention from TIP scholars afforded to perceived impact and policy evaluation tools *after* policy implementation, very little understanding is presented by scholars as to monitoring and performance of TIP *during* the policy process. Only Schot and Steinmueller, (2018b) indicate to the need reflect on social and environmental needs and that the search process has to be guided by improvements in anticipation of collateral effects and consequences (Schot and Steinmueller, 2018b). Schot and Steinmueller, (2018b), do however acknowledge that "it is only through actual practice that experience and **deep learning** are generated, and that the advantages and disadvantages of a particular innovation pathway can be identified and remedied by revision or by choosing a different development pathway" (Schot and Steinmueller, 2018b, p.1564).

Traditional public policies often rely on static approaches to assessment such as cost-benefit analysis (Robinson and Mazzucato, 2019), however, for transformative change, more dynamic measures are needed in order to measure the socio-economic impact. In the case of the space sector, such measures should be focused on the entire innovation chain, with **spill-overs being the focus upstream** and

formation of high-growth innovative companies downstream. If missions are to be combined with horizontal policies, then the **growth of the companies might also be measured in terms of the value of the products and services** they produce. In this way, societal challenges can help steer the metrics so that public funds produce public value (Robinson and Mazzucato, 2019). It is also argued that policies aiming to actively create and shape markets require **indicators that assess and measure the performance** of a policy **along that particular transformational objective** (Mazzucato, Kattel and Ryan-Collins, 2020).

While monitoring and performance is important, MIP differs to TIP in offering several useful indicators for measuring and understanding the performance of innovation policy which are likely related to its emphasis on more defined goals and a narrower understanding of the innovation process.

4.4.6.2. Impact & Evaluation- How does the topic address impact and evaluation after the policy process? (Evaluative Methods | Short to Long-Term Impact | Intended and Unintended Outcomes | Re-Framing)

As discussed, TIP aims to influence socio-technical system change (Schot and Steinmueller, 2018b; Penna, 2021) effective in the societal end-use function such as mobility, shelter, hygiene or communication (Steward, 2012). Though, what matters for achieving real progress with respect to the transition to sustainability is a policy's impact, not its label (Fagerberg, 2018).

Examples of the outcomes reported through **public procurement** of the Social Value Act in the UK, included the "increase of public contracts to **facilitate local training** and **apprenticeships**; the **inclusion of environmental considerations**; **support for local businesses**, **charities and social enterprises**; **support to people with disabilities**; help to **tackle homelessness**, and **reduction of food waste**" (Uyarra, Ribeiro and Dale-Clough, 2019, p.2368). What the case of public procurement policy shows is "that focussing on local needs and defining those needs in processes that are as bottom-up as possible is one of the ways of creating **public value"** (Uyarra, Ribeiro and Dale-Clough, 2019, p.2371) as well as providing more certainties around measurement and evaluation. In the case of the Procel programs for energy technology in Brazil - promoting the efficient use of electric energy and energy efficiency in public lighting, it can be said that the impacts were **economic, behavioural, and cultural**, since most of the actors involved in the socio-technical system, including final consumers, became aware of the innovation and many made their purchasing decisions based on following the guidelines of the programs (Denes_Santos and da Cunha, 2020).

Lastly, the impacts of the offshore wind case in the Netherlands are harder to identify since the sector capitalized on the knowledge previously garnered from R&D policies to quickly roll-out the new technology and rapidly form a dominant design (van der Loos, Negro and Hekkert, 2020). Arguably, these **impacts resulted from the innovation system and previous policies focussing on science and technology initiated 20-30 years ago** when onshore wind turbines went through a heavy product innovation phase in the 1970s-1980s, allowing for the quick marinization of existing technology (van der Loos, Negro and Hekkert, 2020).

From a MIP perspective, proper evaluation of public investments and their results requires **new methods, metrics and indicators** (Mazzucato, 2015 via Florio *et al.*, 2018). Equally important are "evaluation capabilities that do not rely only on market failure-based approaches (e.g., cost-benefit analysis) but can integrate **user research**, **social experiments**, and **system-level reflection"** (see also Rip, 2006; Lindner et al., 2016 via Kattel and Mazzucato, 2018, p.797). With reference to innovation systems, there is considerable evidence that these exhibit increasing returns or an 'S-curve'-type effect, where shifting incentives across multiple sectors may be more likely to achieve such increasing returns (Mazzucato 2017 via Mazzucato, Kattel and Ryan-Collins, 2020). To test this, one can compare

MAIS development between countries, in terms of what missions are espoused by a country, the stage of development of missions and whether technologies and practices have reached certain stages of readiness to go to scale (Herrero et al., 2020; Sartas et al., 2020 via Klerkx and Begemann, 2020). How this conflicts with system of innovation failures (Weber and Rohracher, 2012) and whether and how this logic will hold for MIS empirically is unknown.

Creating public value is similarly recognised by MIP literature. Public value in this conception builds on the idea of markets as embedded in society and on a public purpose-focused service approach in the public administration and strategic design literatures and practice (Mazzucato, Kattel and Ryan-Collins, 2020). Public purpose(s) would include **cultural enrichment,** a more even **distribution of wealth and income**, **ecological sustainability**, **affordable shelter and health care** and the **creation of good quality jobs** (Mazzucato, Kattel and Ryan-Collins, 2020).

One can infer that where literature suggests that specific instruments are used one can more easily evaluate impact such as in the case of PPI. Both TIP and MIP offer a several, similar suggestions for impact and evaluation based on public value.

4.4.6.3. Reflexivity- How does the topic enable space for reflexivity and feedback? (Feedback Loops/Reflexivity | Learning)

Reflexivity according to Weber & Rohracher (2012) refers to the capacity to monitor, anticipate and involve all actors in the self-governance process of transformative change (Weber and Rohracher, 2012). The focus on learning suggests that reflexivity is a strong (Grillitsch, Hansen and Madsen, 2020) concept in the TIP literature, though has weaker reference in MIP literature.

TIP authors suggest a direct attention to the need for coherence and consistency between policy levels and fields, while at the same time allowing for modification and transformation of policy approaches based on learning and previous experiences (Grillitsch *et al.*, 2019; Rogge & Reichardt, 2016; Weber & Rohracher, 2012 via Grillitsch and Hansen, 2019). Addressing the policy learning and coordination challenge is **central for complex, uncertain and long-term processes**, and particularly relevant when there is a weak support system for innovation (Grillitsch and Hansen, 2019).

One approach is offered by Schot and Steinmueller, (2018b) who propose that reflexivity is embedded in the tentative governance model connected to **deep learning (or second-order learning).** Addressing reflexivity should stimulate "the ability to look from a distance (this could be an imagined future; or a set of social and environmental challenges) at one's own deeply embedded routines which drive collective behaviours and socio-technical change towards optimisation instead of transformative change" and assumes that actors critically assess their own preferences and experiment with alternatives (Schot and Steinmueller, 2018b, p.1563). Deep learning "**occurs collectively and enables changes in cognitive frames and assumptions** and is akin to second-order learning" which happens when "actors question their underlying assumptions, for example about mobility and energy consumption" (Schot and Geels, 2008 via Schot and Steinmueller, 2018b, p.1563 and p.1564).

In MIP, those that formulate and are tasked to enact MIPs should proactively contemplate how these missions are realized, through what types of technologies and social innovation, anticipating the consequences of those missions and **continuously reflect** on how these missions evolve (Klerkx and Rose, 2020). Furthermore, learning is enabled through the development of dynamic capabilities.

In sum, learning and reflexivity should be embedded throughout the policy process rather than as a feature of evaluation. While both TIP and MIP acknowledge the importance of learning, explicit recognition in TIP literature through the concept of deep learning in relation to tentative governance

offers a stronger understanding than implicitly in the MIP literature through the concepts of MIS and dynamic capabilities.

4.4.6.4. Termination- How does the topic conclude/terminate policy process? (Termination)

Based on the literature, neither TIP nor MIP literature demonstrated reference to understanding how to terminate policies.

4.4.6.5. Measurement Challenges- What measurement challenges does the topic present? And resolve? (Impact Assessment and Measurement Challenges | Policy Institutionalisation)

Not only is innovation inherently open-ended, non-linear, and rife with uncertainty, innovations also challenge existing institutional frameworks and values and challenge the idea of value that should be measured (Schumpeter, 1942). This applies to both TIP and MIP. For TIP, while ambitious, transition processes are dynamic and present aspects of complexity that make it impossible to draw prescriptive and long-term results (Denes_Santos and da Cunha, 2020). Similarly, "while 'old' technological missions such as 'putting a man on the moon' had obvious end points which made evaluation easier, modern **grand challenges are more long term** with less easy to define end points" (Mazzucato, Kattel and Ryan-Collins, 2020,p.431). Furthermore for TIP and MIP, the embedding within innovation systems (either embedded or dedicated) presents unknown challenges on dealing with system of innovation failures (Weber and Rohracher, 2012) requiring further empirical assessment.

Lastly, Mazzucato et al, (2020) argue that theoretical and practical approaches to **policy evaluation should be considerably enriched and diversified** in order to create the capacities needed to deliver challenge-driven policies (Mazzucato, Kattel and Ryan-Collins, 2020).

In the next section the study presents a synthesis of the systematic literature review, summarising the key concepts offered by the current debate reflecting the TIP and MIP literature, their similarities and differences and the nature of the ideas to compete, complement or be neutral to one another.

5. Discussion

The discussion section first presents the similarities and differences between TIP and MIP, then discusses where and how the topics compete, complement or are neutral to one another before finally presenting a clear synthesis of TIP and MIP.

5.1. Synthesis of Literature Review: Similarities and Differences

Here, the study answers the questions, what concepts of 'transformative' and 'mission-oriented' innovation policy are presented in the literature? And how are these concepts similar or different?

The author synthesise new knowledge by weaving together ideas from the literature into a synthesis model (Torraco, 2016). Table 8 below shows a synthesis of the literature review with the key ideas presented in the TIP and MIP literature on the concepts of the policy cycle. This synthesis also presents the conceptual analysis of the topics' similarities and differences, incorporating whether the topics present a 'weak', 'medium' or 'strong' understanding, and whether the topics currently 'diverge' (◄——►) or 'converge' (——► ◄——) on their understanding. To clarify, 'weak' does not necessarily mean negative, but rather that the topic is underdeveloped in this area, shows gaps, deficiencies or inconsistencies, whereas 'strong' suggests there is significant understanding on this concept in the literature presenting consistent and extensive ideas.

TIP	Diverge / Converge	MIP
Overview		
Definition: Paradigm (3rd Frame)	◄——►	Definition: Tool
Theoretical Foundation: STI	——► ◄——	Theoretical Foundation: STI
Theoretical Field: STS Strong Influence	◄——►	Theoretical Field: STS Weak Influence
Socio-Technical System Change	◄——►	Socio-Economic System Change
Meso Level Interactions Focus	——► ◄——	Meso Level Interactions Focus
'Situatedness' in IS	——► ◄——	'Situatedness' in IS
Agenda Setting		
Policy Agenda: (Strong: Societal (Economic))	——► ◄——	Policy Agenda: (Strong: Economic (Societal))
Agenda Identification & Def (Strong: Failures)	——► ◄——	Agenda Identification & Def (Strong: Failures)
Agenda Identification & Def (Medium- Foresight & Anticipation)	◄——►	Agenda Identification & Def (Strong- PSF & ROAR)
Contextual Consideration (Weak)	——► ◄——	Contextual Consideration (Strong- PSF)
Agents of Change: (Strong: Key Actors (Industry))	◄——►	Agents of Change: (Strong: Key Actors (State/Gov))
Directionality (Strong- RRI & Road Mapping)	——► ◄——	Directionality (Strong- Vision & Market Creation)
Directionality: (Med: Open-Ended (Un-Defined))	◄——►	Directionality: (Med: Targeted & Open-Ended (Defined))
Time: (Strong: Windows of Opportunity)	——► ◄——	Time: (Strong: Windows of Opportunity)
Time Agenda:	——► ◄——	Time Agenda:

(Strong: Radical & Incremental Innovation)	(Strong: Radical & Incremental Innovation)
Framing: (Strong- RRI)	Framing: (Strong- PSF)
Change Consideration (Medium: Implicit- RRI)	Change Consideration (Strong: Explicit- PSF)

Formulation

Capture of Actors (Strong- Broad)	Capture of Actors (Strong- Broad)
Key Actors: (Strong: Users)	Key Actors: (Strong: State)
Governance: (Strong- Tentative (Open- Un-Defined))	Governance: (Strong- Tilted (Directed- Defined))
Coordination: (Strong- Experimentation)	Coordination: (Strong- Public-Private)
Coordination: (Medium: Structuring- Innovation Councils)	Coordination: (Strong: Enabling- Dynamic Capabilities)
Contestation: (Medium- RRI Implied)	Contestation (Strong- PSF Explicit)
Networks & Linkages: (Strong)	Networks & Linkages: (Strong)
Networks & Linkages: (Medium- Embedded- IS)	Networks & Linkages: (Strong- Dedicated- MIS)
Instruments & Tools: (Medium- PPI, Holistic & Broad)	Instruments & Tools: (Medium- PPI, Holistic & Broad)
Instruments & Tools: (Medium: Demand Oriented)	Instruments & Tools: (Weak: Supply + Demand Oriented)

Adoption

Boundaries & Parameters: (Strong- Regional & Sectoral)	Boundaries & Parameters: (Strong- Regional & Sectoral)
Boundaries & Parameters: (Strong- RRI & RIS)	Boundaries & Parameters: (Strong- MIS)
Capabilities/Capacity & Comp.: (Strong- Exogenous (Inst, Firms, Users))	Capabilities/Capacity & Comp.: (Strong- Endogenous (Public Sector))
Cooperation, Collab. & Coalitions: (Medium)	Cooperation, Collab. & Coalitions: (Medium: State as Risk Taker)
Decision-Making (Weak)	Decision-Making (Strong- Dynamic Capabilities & PSF)

Implementation

Understanding of Innovation Process (Strong- Broad)	Understanding of Innovation Process (Strong- Narrow (& Broad)
(Strong) Bottom-Up (Demand Pull) (Weak) Top-Down (Supply Push)	Top-Down (Supply Push) (Strong) Bottom-Up (Demand Pull) (Weak)
Policy Mix (Weak- Horizontal)	Policy Mix (Strong- Vertical & Horizontal)
Innovation Model (Medium- SNM)	Innovation Model (Medium- MIS)
Design & Delivery: (Medium- Public Value)	Design & Delivery: (Medium- Public Value)
Design & Delivery: Who, What, How (Medium)	Design & Delivery: Who, What, How (Medium)
Accountability & Leadership: (Weak)	Accountability & Leadership: (Medium- Govt. Vision & Democracy)

Implementation Problems (Strong- Capture, Lock-In, Resistance)		Implementation Problems (Strong- Capture, Lock-In, Resistance)
Evaluation		
Measuring & Performance: (Weak)		Measuring & Performance: (Medium: Indicators- Spill-Overs & Firms)
Impact & Evaluation: (Medium- PPI, Public Value)		Impact & Evaluation: (Medium- PPI, Public Value)
Reflexivity (Strong- Explicit- Deep Learning)		Reflexivity (Weak- Implicit- Dynamic Capabilities)
Termination (Weak)	Underdeveloped	Termination (Weak)
Measurement Challenges (Medium- IS & Long-Term Uncertainties)		Measurement Challenges (Medium- IS & Long-Term Uncertainties)

Table 8. Summary of systematic literature review and conceptual comparison

One can infer that there is a striking number of concepts on where the TIP and MIP literature present similarities in their understanding of concepts pertinent to the policy cycle. For example, in the acknowledgment of contestation in the agenda-setting process, the desire for holistic and broad instruments and the ambitions to achieve public-value. However, while some of these areas are similar, TIP and MIP present some different ideas, for example, the offering of RRI (TIP) in dealing with contestation in the agenda setting process against the offering of PSF by the MIP literature.

In contrast, there are also several areas where TIP and MIP differ in their understanding, such as in addressing the limitations of decision-making and the emphasis placed on the role of certain actors (users/industry v government) in the policy process. In the former, the MIP understanding can be considered somewhat complementary to TIP however in the latter, differing understanding on the role of key actors may have significant implications on the design and delivery and types of implementation problems encountered for both topics.

The similarities and differences presented in table 8, highlight interesting opportunities and challenges for the topics of TIP and MIP and posits the question, where can the topics learn from one another? And where do their current understandings and ideas potentially conflict?

5.2. Synthesis of Literature Review: Compete, Complement or Neutral

Here, the author addresses the question, how do these concepts compete and complement or present a neutral understanding of one another? The study presents this section as a discussion based on the analysis contained in appendix 4 (see appendix 4 for compete, complement, neutral table).

Agenda: Societal (TIP) & Economic (MIP)

TIP and MIP converge on the idea that societal challenges are a key driver to innovation policy though their historical differences may prove to be *complementary* in the policy making process where one or the other are deficient in their understanding. A strong societal agenda includes economic issues as well an environmental and social issues.

Level: Socio-Technical (TIP) & Socio-Economic (MIP) System Change

TIP and MIP are consistent in their approach to address meso-level interactions and recognise the bridge between micro level initiatives and macro-level system impact. TIP offers a stronger micro-level understanding though the socio-technical change perspective while MIP offers a stronger macro-level

understanding for socio-economic change. In this area, the topics offer some conceptual *complementarity* to one another.

Frameworks: RRI (TIP) or PSF & ROAR (MIP)?

PSF and ROAR (MIP) offer some strengths to the agenda-setting, policy formulation and adoption process through their understanding of contextual considerations, recognising contestation in the problem-solution framework (PSF) and continuous acknowledgement of change. However, TIP also presents a strong understand through RRI in recognising diverse framings and contestation in the agenda setting process highlighting several key areas for further research.

Innovation Systems: Embedded & RIS (TIP) or Dedicated & MIS (MIP)?

While TIP and MIP share an understanding for the 'situatedness' of policy in innovation systems for proximity to networks, linkages and broad capture of actors, they offer somewhat different perspectives on the approach for an embedded IS (TIP) or a dedicated IS (MIP). This has a direct influence on the perceived boundaries and parameters to innovation policy, which are presented as regional or sectoral (TIP & MIP), though the flexibility offered by MIS (MIP) may offer a route out of this impasse.

Governance: Tentative & Open (TIP) &/or Tilted & Open/Targeted (MIP)?

The vision setting and market creating approach from MIP may prove *complementary* to an agenda where clear direction is needed, solutions are more easily defined and where leadership is democratic. However, the TIP approach for a more open agenda where solutions are undefined may prove beneficial where reflexivity and deeper learning is needed. This suggests that TIP & MIP approaches to governance may *compete* though this may ultimately depend on the industries, actors and problem/solution configurations suggesting an area for further research.

Key Actors: Broad (TIP & MIP) & Industry (TIP) & Government (MIP)

The diverging governance approach is further reflected in the emphasis on the state/government (MIP) as the key agents of change against users/consumers and industry actors (TIP). Both acknowledge a strong understanding of the value for a broad network of actors in the policy making process but differ to what extent these actors shape, design and implement policy. Whether TIP and MIP *compete, complement* or *neutral* depends on the phase of the policy making process, for example, a state will have a key role when deciding the policy mix whereas users/consumer and industry actors will likely have a stronger role in implementation.

Coordination: Innovation Councils (TIP) & Dynamic Capabilities (MIP)

The emphasis on coordination depends on the key actors, though a greater emphasis on experimentation presented in TIP may be mutually beneficial with a MIP focus on public-private sector interactions. The TIP approach for Innovation Councils supporting the structure of coordination activities can be *complementary* to the MIP idea to develop dynamic capabilities in government which may also support adaptation to changing contextual factors.

Capabilities: Industry, Firms & Users (TIP) & State/Gov (MIP)

In line with their different understanding of the role of industry or the state in the agenda setting and formulation process, TIP and MIP have diverging though *complementary* ideas on the need to foster capabilities, capacity and competencies within industry, firms and users (TIP) and the state/government (MIP) in the adoption of policy.

Directionality: Targeted & Open-Ended (MIP & TIP)

TIP and MIP are similar in acknowledging that directionality leads to necessary actions, knowledge development, decision-making and legitimacy. However, when directionality is too specific it can lead to premature lock-in. Directionality of TIP is not lost, but rather more explicit and defined in MIP. A dual open-ended (undefined) and targeted (defined) policy agenda, which accounts for 'guided exploration' suggest that MIP may offer a *complementary* approach to TIP- particularly in instances where strong vision, market creation and the state as a risk taker (MIP) are required. However, the implications of a dual open-ended and targeted policy agenda may significantly handicap the strength and rationales of other MIP concepts.

Implementation: Supply & Demand Oriented, Top Down & Bottom Up (MIP)

Both TIP and MIP strive for creating public-value and recognise the inherent problems associated with implementation. However, wider understanding presented in MIP to accommodate both narrow and broad innovation process, include holistic top-down (supply) and bottom-up (demand) instruments and vertical and horizontal policy mix could offer more flexibility. TIP here supports through a stronger understanding of demand-oriented instruments and promoting a stronger bottom-up rationale.

Evaluation: Reflexivity & Deep Learning (TIP) & Measurement Indicators (MIP)

Because MIP promotes a stronger directionality and more defined outcomes, the MIP approach offers stronger understanding of measurement and performance indicators compared to the exploration involved in a TIP approach. TIP offers strong and explicit insights on deep learning and reflexivity which could be complementary to a MIP approach depending on the governance and innovation model and instruments employed. While TIP & MIP *compete* in their approach to seeking defined vs undefined outcomes, a combined open and targeted approach may support both a reflexive and measurable policy process though it is recognised that this trade-off is a balancing act.

Underdeveloped: Termination

Termination of policies reflects an underdeveloped area of understanding by both TIP and MIP and is an area for further research.

5.3. Synthesis Discussion

One can infer from this synthesis that the current debate literature presents several stronger and more consistent areas of conceptual understanding that reflect a potentially mutually beneficial relationship. For example, the earlier similarity recognised in the need for directional policy is determined to be mutually complementary based on road-mapping as conducive to vision-setting and market creation supportive of the TIP rationale. However, within directionality, a key difference between an open-ended and targeted approach despite recent MIP efforts towards more open-ended directionality may suggest an area for further academic development. A stronger example of a mutually beneficially approach is in the difference of supporting coordination activities through the inception of innovation councils (TIP) and enabling these activities through dynamic capabilities (MIP).

There are also several areas where the MIP topic may be more one-way complementary towards TIP. For example, referring to the earlier similarity in the recognition of contestation to the agenda-setting process. While the ideas presented of RRI (TIP) and PSF (MIP) in understanding contestation may be problematic and compete on the surface, deeper conceptual analysis suggests that more explicit treatment of contestation throughout the problem-solution space of agenda-setting and formulation in PSF may prevail and support the TIP understanding.

On the other hand, there are also several areas where the TIP topic may complement MIP. For example, the deeper understanding of demand-oriented instrumentation and tools in TIP would support a MIP topic that demonstrates more recent ambitions for demand-oriented tools alongside a traditionally supply oriented focus. Incidentally, while MIP demonstrates a weaker understanding here, it is in fact recognised by both TIP and MIP that alignment between supply and demand-oriented tools should be high on the innovation policy agenda.

There are also several areas that compete in understanding between TIP and MIP which may be unproductive to the topics. For instance, with reference to the earlier example highlighting differences in the emphasis placed on certain actors between users/industry (TIP) or state/government (MIP) in the policy process. The emphasis on different groups appears to have notable implications and is embedded in the rationale of the topics. However, this can be caveated on the understanding that the emphasis on certain actors differs at different stages of the policy process and critically, also depends on contextual conditions and issues on the policy agenda. This represents a priority area for further research.

Several areas are presented with the same understanding, ideas and shared emphasis for example, on the situatedness of policy in innovation systems, the importance of strong networks and linkages and design and delivery towards creating public value. This shared understanding could form the basis to exploring more the contestable ideas between TIP and MIP.

Finally, there are several areas that the author interprets as being underdeveloped and represent areas for further research. For example, delineating the who, what and how of design and delivery for both TIP and MIP and the related challenge of overcoming implementation challenges that are both generic to the policy environment and specific to the policy approach.

The synthesis below (fig.38), rearranges the key concepts according to the topics to present across-dimensions and integrates existing ideas with new ideas to create a new formulation of the topics (Torraco, 2005).

TIP Concepts Summary	Concepts (Both)	MIP Concepts Summary
Paradigm	STI	Tool
STS Influence	Meso Level	Socio-Economic System Change
Socio-Technical System Change	Situatedness in IS	Economic Policy Agenda
Societal Policy Agenda	Addressing Failures	PSF & ROAR (Agenda Ident)
RRI & Road-mapping (Directionality)	Responding to Windows of Opportunity	PSF (Contextual Cons.)
Governance (Tentative)	Regional & Sectoral	Vision Setting & Market Creation (Directionality)
Experimentation (Coordination)	Networks & Linkages	PSF (Change Cons.)
Instrumentation & Tools (Demand-Oriented)	Holistic & Broad Instruments and Tools	Governance (Tilted)
Capabilities (Exogenous)	Design and Delivery for Public Value	Public-Private (Coordination)
Bottom-Up (Demand-Pull)	Radical and Incremental Innovation	PSF (Contestation)
Reflexivity & Deep Leaning	Implementation Problems (Existing)	MIS (Networks & Links)
	Impact and Evaluation	Instrumentation & Tools (Supply + Demand Oriented)
		Capabilities (Endogenous)
		Coalitions (State as Risk Taker)
		Dynamic Capabilities & PSF (Decision Making)
		Narrow & Broad
		Top-Down (Supply Push)
		Vertical & Horizontal (Policy Mix)
		Govt. Vision & Democracy (Accountability & Leadership)
		Measurement Indicators

Key Questions / Further Research
RIS / MIS (Boundaries)
Industry / State/Govt (Key Agents)
Users / State (Key Actors)
Open-Ended & Targeted? (Directionality)
RRI / PSF (Framing)
SNM / MIS (Innovation Model)
Design & Delivery (Who, What, How)
Implementation Problems (New)
Termination
Measurement Challenges

Fig 38: Synthesis of conceptual contributions of TIP and MIP demonstrating key knowledge areas and further research.

5.4. Discussion Summary, Limitations and Further Research

By looking at innovation policy through the analytical lens of policy sciences, this study conceives and operationalises an analytical framework based on the policy cycle to critically review the contributions of TIP and MIP for the first time. In the preceding chapter, this study presents some high-level insights using the literature meta-data to understand the topics key contributions and positioning of the literature representing the current debate. Following this, the author analyses and discusses in considerable depth the conceptual contributions from the body of literature that makes explicit reference to the TIP and MIP topics, identifying where they reflect a strong (more consistent) or weak (inconsistent) understanding of the policy making process, where and how they appear to converge or diverge in their current understanding and further assessed whether they offer ideas that compete or complement one another.

The initial scan (sections 4.2 and 4.3) identified similarities in the topics' theoretical foundations with the presence of several influential articles and the fluidity to which authors publish across the topics suggesting a somewhat shared knowledge base. This is reflected to some extent in the subsequent literature review (section 4.4), which recognised similarities such as the need to address market and system failures (as ideas presented within Weber and Rohracher, 2012) and the emphasis of engaging in a broad network of actors to facilitate interactions (consistent with innovation systems thinking). Another finding that was echoed in the literature review of the current debate were the differences between the topics' literature base, with articles from transitions studies forming a stronger base within TIP than in MIP.

Furthermore, the initial scan identified how the current debate contains a broad mix of articles that present both a clear and strong connection to the theoretical foundation as well as articles presenting a weak connection to the theoretical foundation. The capture of articles to the 'core' that present a loose connection to the TIP and MIP topics highlights the current situation on the one hand but on the other hand emphasises the current risk to the topics' conceptual institutionalisation. Unwanted misinterpretation of the topics conceptual contributions may confound existing challenges around the topics' usefulness in academia and practice. This is critical as a consistent understanding of the topics will help to facilitate interaction between academics, and to transfer this knowledge to policy makers and other strategic actors (Hekkert *et al*., 2020).

Notwithstanding the limitations to the generalisability of the 'core' literature and the topics short history in which have evolved from specific origins in specific directions, the study's stylised synthesis shows for the first time that current conceptual understanding presented of the TIP and MIP topics have potential to be combined to support the policy making process. This includes an emphasis on a societal policy agenda and the use of holistic and broad instruments through flexible governance modes. This aims to capture the technical, economic and social complexities of contemporary societal challenges, and that possible solutions must also include social, institutional, behavioural and technological change in an interrelated way as well as "changing skills, infrastructures, industry structures, products, regulations, user preferences and cultural predilections" (Schot and Steinmueller, 2018, p1562; Diercks, Larsen and Steward, 2019).

The author acknowledges several limitations to the study. While a narrow search term generated specific and valid articles, this excluded looser references to TIP and MIP. Despite this, the author believes the method to capture a broad range of concepts meant that the study was able to some extent include key contributions from the papers outside the narrow search term. These were captured if consistently presented and had strong representation in the literature, such as the paper

of Mowery, Nelson and Martin (2010) and Weber and Rohracher (2012). The second limitation is that coding reliability and interpretative bias is exacerbated when being conducted by a single coder. To mitigate this, this study introduced several intuitive steps based on the suggestions by Torraco (2016) to ensure valid interpretations of the literature, including reading articles, extracting relevant concepts, assessment against an analytical framework and selecting. To further ensure concept validity and operationalisations, the author has provided an example of the coding (see appendix 3). Furthermore, the process to allow the insights or perspectives offered to arise from the review, rather than guide the review (Elsbach and van Knippenberg, 2020), helps minimise biases and bounded rationality.

While there are several interesting complementarities presented by the TIP and MIP literature, further research is required to support continued development of the TIP and MIP topics towards more consistent conceptual understanding. First this study highlights closer and deeper attention to some key competing ideas between TIP and MIP such as the capabilities and flexibility of governance to design both open-ended and targeted policies, delineating who, what and how policy is designed and delivered and the challenges of overcoming implementation problems that are both generic to the policy environment and specific to the policy approach. Second, the author recommends continued academic critique of innovation policy with respect to policy sciences. Lastly, the simultaneous developments in the parallel field of transitions management (which has to some extent shaped both TIP and MIP) and the associated field of transition policy presents an interesting and very relevant field for further comparative study. Continued academic development to refine the TIP and MIP topics conceptual contributions for consistency will support the robustness and usefulness of the topics in practice.

6. Conclusion

This study conducts a systematic integrative literature review of two emerging topics circulating among academia and policy makers: 'Transformative Innovation Policy' (TIP) and 'Mission-Oriented Innovation Policy' (MIP).

First the study develops an understanding of the theoretical foundations and the current debate, drawing insights from the topics' key contributions and the connectedness of the literature to the knowledge base. To this, the study infers that TIP and MIP present similarities in their theoretical foundations reflected by the strong presence of several key articles (Schot and Steinmueller, 2018a; Weber and Rohracher, 2012; Mazzucato, 2016), and the appearance of several authors to both datasets (Schot, J, Mazzucato, M, Nelson, R and Freeman, C). To this, the topics also present some differences such as the presence of different theoretical strands such as a stronger transitions studies focus within TIP than science, technology and innovation studies to MIP. Both datasets for the current debate contain articles that are more or less relevant to the topics and connected to key contributions.

Then, the study utilised insights from the policy sciences domain to operationalise the policy cycle to capture, analyse and critically review the diverse concepts presented by TIP and MIP literature. This drew useful insights that clarifies the current understanding of the current debate and established what concepts of TIP and MIP are presented, how these concepts are similar or different and understood to what extent, where and how they converge or diverge in their understanding of the policy making process. This analysis infers several similarities of the current debate making explicit reference to TIP and MIP, including addressing a societal agenda, recognising the importance of wide framing and contestation from a broad set of actors, and the importance of strong networks, linkages and embeddedness within innovation systems during the policy process. More significantly, this analysis highlighted differences of TIP as an innovation policy paradigm with a stronger focus on reflexivity and bottom-up (demand-side) instruments while MIP is presented as a tool/instrument in itself with a stronger understanding on the role of government and a deeper understanding on the complexity and contestability of the policy making process. Other notable key differences include the emphasis on certain actors (users/industry v government) in different phases of the policy process and governance modes (tentative v tilted).

Lastly, this study presented a stylised synthesis on where the TIP and MIP topics conceptual understanding compete, complement or are neutral or underdeveloped. Key concepts presented by the current debate such as a shared societal agenda (incorporating economic, social and other), aligning both top-down (supply-oriented) and bottom-up (demand-oriented) approaches, a framework to navigate the problem-solution space and a deeper understanding of reflexivity and learning demonstrate areas where TIP and MIP may complement one another to navigate changes in socio-technical configurations towards socio-economic impact. Areas where the current debate appears to compete or is underdeveloped requiring further research include the capabilities and flexibility of governance to design both open-ended (undefined) and targeted (defined) policies, the emphasis on the role of users and government throughout the policy process (design and delivery) and greater understanding on the termination process of policies.

While this study enables both academics and policy makers to better understand the topics for further study, debate and use, this thesis does not provide an exhaustive review of all the literature on the topics and is therefore limited in its generalisability as a comprehensive analysis of all available

literature on the TIP and MIP topics. Acknowledging that the topics continue to evolve and are in many areas yet to present a clear and consistent understanding based on the current debate, untangling the conceptual similarities and differences provides a deeper understanding of the TIP and MIP debate making explicit reference to the topics in academia. This serves to support growing reference in practice of the topics and the emerging need to provide conceptual clarity.

To close, this study provides a more nuanced understanding of innovation policy for the 21st century disentangling the current debate on TIP and MIP to support the topics' understanding among academics, policy makers and governments in utilising innovation policy to address grand societal challenges.

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Wanzenböck, I., Wesseling, J. H., *et al.* (2020) 'A framework for mission-oriented innovation policy: Alternative pathways through the problem-solution space', *Science and Public Policy*. doi: 10.1093/scipol/scaa027.

Wanzenböck, I. and Frenken, K. (2020) 'The subsidiarity principle in innovation policy for societal challenges', *Global Transitions*. doi: 10.1016/j.glt.2020.02.002.

Weber, K. M. and Rohracher, H. (2012) 'Legitimizing research, technology and innovation policies for

transformative change', *Research Policy*. doi: 10.1016/j.respol.2011.10.015.

8. Appendices

8.1. Appendix 1: Evolution of Policy: From All Policy to STI Policy

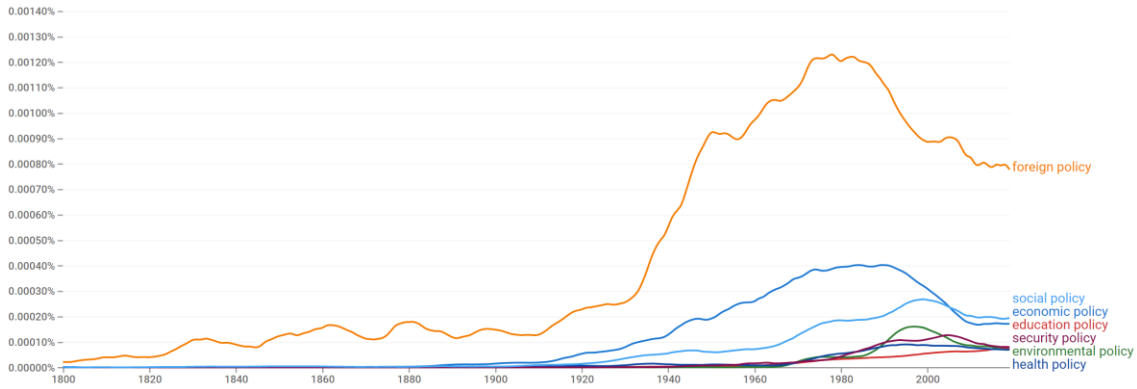
How active are the respective policy fields and where does the innovation policy discussion rank in relation to these?

To answer this, this study utilises the Google Ngram Viewer. The Google Ngram Viewer is an online search engine that charts the frequencies of any set of search strings using a yearly count of n-grams found in sources (books, magazines and newspapers) printed between 1500 and 2019 in Google's text corpora (Google, 2021). In October 2019, Google celebrated 15 years of Google Books and estimated the number of scanned books at more than 40 million titles (Google, 2019). When you enter phrases into the Google Books Ngram Viewer, it displays a graph showing how those phrases have occurred in a corpus of selected sources in a selected language over the selected years (Google Ngrams, 2021).

This study selected book and white paper publications in English between 1800 and 2019, to conduct a search on the policy areas as defined by the European Commission (European Commission, 2021; search conducted 1/2/21). The policy areas provide a relevant search term which then returned corresponding publications. An example can be found here, "health policy" - Google Search. The graphs present the quantitative data of occurrences of the search term. The y-axis of the graph shows the Ngram trend showing what % of a phrase is represented. In order to arrive at a reliable sample, the author checked the first page of all results to ensure that the terms use was consistent with the study focus and captured relevant literature.

In this section the author interprets these graphs to recognise and compare the high-level trends in policy areas, narrowing in scope from all policy areas (primary, secondary, tertiary) to STI policy topics to innovation policy topics.

A1.1. Policy Areas (Primary)

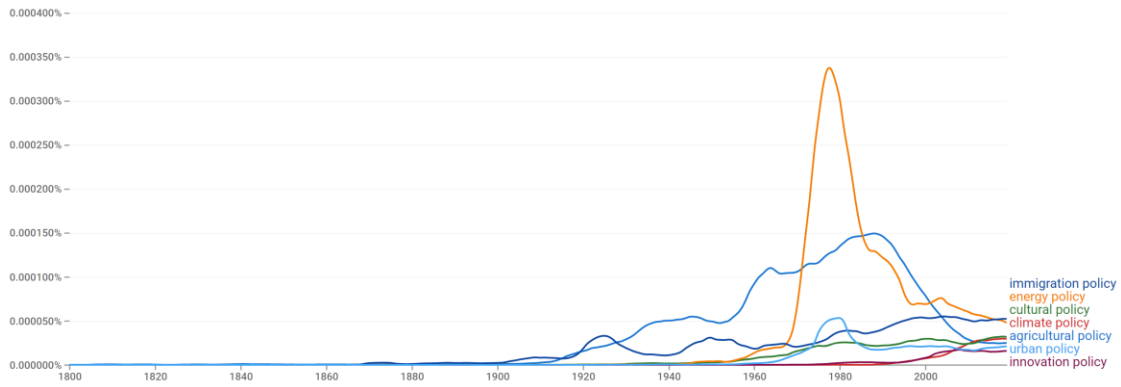


Economic Policy | Education Policy | Environmental Policy | Foreign Policy | Health Policy | Security Policy | Social Policy

'Foreign policy' has always and continues to dominate policy discourse and focuses on how countries work with each other economically, politically, socially and militarily. 'Social policy' and 'economic

policy' also feature highly and reflect that policy making is country specific and closely aligned with political and national characteristics. From the top 7 areas, only 'education policy' appears to be increasing in output, 'foreign policy' publications appear on the decline and one observes steady output in the areas of 'social policy', 'economic policy', 'security policy', 'environmental policy' and 'health policy'.

A1.2. Policy Areas (Secondary)



Agricultural Policy | Climate Policy | Cultural Policy | Energy Policy | Immigration Policy |Innovation Policy | Urban Policy

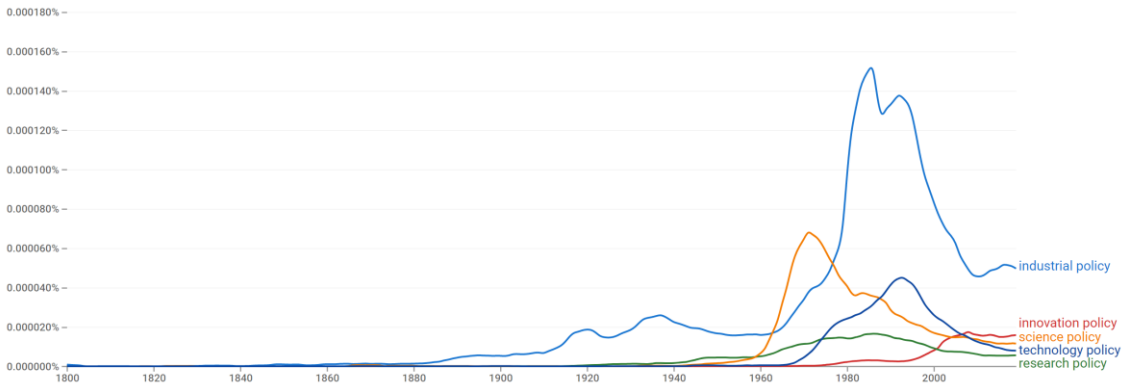
'Energy policy' reflected a significant peak in the late 1970's likely relating to the passing of several Energy Policy bills to acts in the US. Recently 'immigration policy' has been high on the political agenda in Europe and the UK possibly relating to the British exit from the European Union and the US with immigration as a key policy area for the Trump administration. 'Innovation policy' features in this level which the author will explore in more depth in the next section.

A1.3. Policy Areas (Tertiary)

Consumer Protection Policy | Employment Policy | Fisheries Policy | International Development Policy | Political Policy | Space Policy | Sport Policy | Tourism Policy | Transport Policy

The third level of policy areas are more niche in character, with a focus on 'space policy', 'sport policy' and 'fisheries policy'.

A1.4. Science, Technology and Innovation Policy (STI)

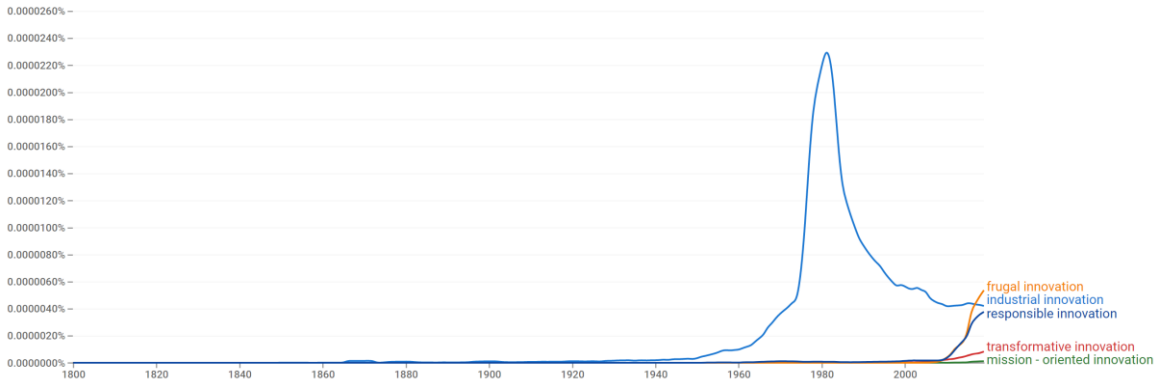


Industrial Policy | Innovation Policy | Research Policy | Science Policy | Technology Policy

Research and Innovation is presented by the European Commission as a distinctive policy area (European Commission, 2021). In addition to 'research policy', the author place 'science policy' and 'technology policy' recognising that 'innovation policy' is a fusion of previous policies/policy instruments carried out under different labels (science policy, research policy, technology policy, etc (Rothwell, 1982). These areas loosely relate to the activities of generating and commercialising new knowledge as presented by neo-Schumpeterian economics (Hanusch and Pyka, 2007). Innovation policy is not primarily about the generation of new ideas (the traditional focus of science and research policies) but about exploiting such ideas in practice (Edler and Fagerberg, 2017).

One can clearly observe three key 'peaks' of literary output, starting with 'science policy' followed by 'industrial policy' and 'technology policy'. The author interprets these peaks as loosely following the theoretical evolution of STI over the decades. One could interpret this as what started as science policy (R&D, market failure approach to innovation policy) evolved into technology policy (through the innovation systems approach to innovation policy) with a growing place for 'innovation policy' as a distinctive area. Indeed, these three phases in the evolution of innovation policy have been recognised in various studies (Schot and Steinmueller, 2018b; Edler and Fagerberg, 2017; Grillitsch et al, 2020).

A1.5. Innovation Policy



Demand-Oriented Innovation | Frugal Innovation

Mission-Oriented Innovation | Responsible Innovation | Transformative Innovation

The field of 'innovation policy' was dominated by 'industrial innovation' citing industrial dynamics as a key feature up until recently when the topics of 'frugal innovation' (Bhatti et al, 2012) and 'responsible innovation' (von Schomberg, 2011), emerged most strongly, indicating a clear trend and shift of innovation policy with purely economic goals to acknowledging wider, societal goals. Indeed, scholars have recognised that with this shift, the role of innovation policy genuinely changes in a mission-oriented context (Wanzenböck, *et al.*, 2020). Finally, to a lesser extent, the topics of 'transformative innovation' and 'mission-oriented innovation' appear with 'demand-oriented innovation' (Edler, 2010) also receiving emerging attention over the past 10-20 years.

A1.6. Transformative Innovation Policy & Mission-Oriented Innovation Policy

*Note: various combinations of 'policy', 'innovation' and 'innovation policy' yielded either obscure results or were unrecognised as were the complete terms 'transformative innovation policy' and 'mission oriented innovation policy'.

Transformative Innovation | Transformative Policy
Mission-Oriented Innovation | Mission-Oriented Policy

The final Ngram this study presents is that which attempts to present the literary output of TIP and MIP based on books contained in the Google Books database. The author herein excluded the complete terms as these were not recognised but instead present a combination of 'innovation' and 'policy' for both the topics.

The results suggest that after a period of simultaneous development, which were largely dominated by the 'policy' term, the 'innovation' term rapidly evolved around the year 2000 (TIP) and 2010 (MIP) overtaking the 'policy' terms. The graph shows that the 'transformative innovation' and 'transformative policy' terms have emerged most strongly which supports that assertion that the shift to a transformative innovation perspective is emphasised as a more than incremental change in the innovation policy domain (Diercks, Larsen and Steward, 2019).

8.2. Appendix 2.1.: Transformative Innovation Policy Literature (Population Lit = All, Core Lit = Green, Excluded Lit from Core = Red)

Authors	Article Title	Source Title	Cited Reference Cou	Publication Year	WoS Categories	Research Areas
Urmetzer, S; Schlaile, MP; Bogner, KB; Mu	Exploring the Dedicated Knowledge Base of a Transformation towards a Sustainable Bioecc	SUSTAINABILITY	208	2018	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Environmental Sciences & Ecology
Turner, JA; Klerkx, L; White, T; Nelson, T; I	Unpacking systemic innovation capacity as strategic ambidexterity: How projects dynamica	LAND USE POLICY	140	2017	Environmental Studies	Environmental Sciences & Ecology
Kelrkx, L; Begemann, S	Supporting food systems transformation: The what, why, who, where and how of mission-or	AGRICULTURAL SYSTEMS	132	2020	Agriculture, Multidisciplinary	Agriculture
Schot, J; Steinmueller, WE	Three frames for innovation policy: R&D, systems of innovation and transformative change	RESEARCH POLICY	131	2018	Management	Business & Economics
Diercks, G; Larsen, H; Steward, F	Transformative innovation policy: Addressing variety in an emerging policy paradigm	RESEARCH POLICY	122	2019	Management	Business & Economics
Klerkx, L; Rose, D	Dealing with the game-changing technologies of Agriculture 4.0: How do we manage divers	GLOBAL FOOD SECURITY-AGRICULTU	118	2020	Food Science & Technology	Food Science & Technology
Kanger, L; Sovacool, BK; Noorkoiv, M	Six policy intervention points for sustainability transitions: A conceptual framework and a s	RESEARCH POLICY	115	2020	Management	Business & Economics
Gosnell, H; Gill, N; Voyer, M	Transformational adaptation on the farm: Processes of change and persistence in transitior	GLOBAL ENVIRONMENTAL CHANGE-H	112	2019	Environmental Sciences; Environmenta	Environmental Sciences & Ecology; Geography
Fagerberg, J	Mobilizing innovation for sustainability transitions: A comment on transformative innovatio	RESEARCH POLICY	106	2018	Management	Business & Economics
Diercks, G	Lost in translation: How legacy limits the OECD in promoting new policy mixes for sustaina	RESEARCH POLICY	100	2019	Management	Business & Economics
van der Loos, HZA; Negro, SO; Hekkert, M	Low-carbon lock-in? Exploring transformative innovation policy and offshore wind energy pa	ENERGY RESEARCH & SOCIAL SCIENCI	96	2020	Environmental Studies	Environmental Sciences & Ecology
Mazzucato, M; Semieniuk, G	Public financing of innovation: new questions	OXFORD REVIEW OF ECONOMIC POLI	95	2017	Economics	Business & Economics
Uyarra, E; Zabala-Iturriagagoitia, JM; Flan	Public procurement, innovation and industrial policy: Rationales, roles, capabilities and imp	RESEARCH POLICY	92	2020	Management	Business & Economics
Grillitsch, M; Hansen, T	Green industry development in different types of regions	EUROPEAN PLANNING STUDIES	87	2019	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Girones, ES; van Est, R; Verbong, G	Transforming mobility: The Dutch smart mobility policy as an example of a transformative S	SCIENCE AND PUBLIC POLICY	85	2019	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Girones, ES; van Est, R; Verbong, G	The role of policy entrepreneurs in defining directions of innovation policy: A case study of	TECHNOLOGICAL FORECASTING AND	84	2020	Business; Regional & Urban Planning	Business & Economics; Public Administration
Miller, FA; French, M	Organizing the entrepreneurial hospital: Hybridizing the logics of healthcare and innovation	RESEARCH POLICY	82	2016	Management	Business & Economics
Martin, H	The scope of regional innovation policy to realize transformative change - a case study of t	EUROPEAN PLANNING STUDIES	81	2020	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Turner, JA; Klerkx, L; Rijswijk, K; Williams,	Systemic problems affecting co-innovation in the New Zealand Agricultural Innovation Syste	NJAS-WAGENINGEN JOURNAL OF LIFE	81	2016	Agriculture, Multidisciplinary	Agriculture
Hjalager, AM; von Gesseneck, MJ	Capacity-, system- and mission-oriented innovation policies in tourism - characteristics, me	JOURNAL OF POLICY RESEARCH IN TC	80	2020	Hospitality, Leisure, Sport & Tourism	Social Sciences - Other Topics
Hausknost, D; Haas, W	The Politics of Selection: Towards a Transformative Model of Environmental Innovation	SUSTAINABILITY	80	2019	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Environmental Sciences & Ecology
Dogan, EO; Uygun, Z; Akcomak, IS	Can science diplomacy address the global climate change challenge?	ENVIRONMENTAL POLICY AND GOVEI	78	2021	Environmental Studies	Environmental Sciences & Ecology
Weber, KM; Rohracher, H	Legitimizing research, technology and innovation policies for transformative change Combi	RESEARCH POLICY	78	2012	Management	Business & Economics
Meissner, D; Kergroach, S	Innovation policy mix: mapping and measurement	JOURNAL OF TECHNOLOGY TRANSFEI	77	2021	Engineering, Industrial; Management	Engineering; Business & Economics
Davenport, S; Bibby, D	Rethinking a national innovation system: The small country as 'SME'	TECHNOLOGY ANALYSIS & STRATEGIC	77	1999	Management; Multidisciplinary Science	Business & Economics; Science & Technology - Other Topics
Uyarra, E; Ribeiro, B; Dale-Clough, L	Exploring the normative turn in regional innovation policy: responsibility and the quest for p	EUROPEAN PLANNING STUDIES	75	2019	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Janssen, MJ	What bangs for your buck? Assessing the design and impact of Dutch transformative policy	TECHNOLOGICAL FORECASTING AND	73	2019	Business; Regional & Urban Planning	Business & Economics; Public Administration
Nepelski, D; Piroli, G	Organizational diversity and innovation potential of EU-funded research projects	JOURNAL OF TECHNOLOGY TRANSFEI	68	2018	Engineering, Industrial; Management	Engineering; Business & Economics
Balanzo, A; Nupia, CM; Centeno, JP	INTRODUCTION TO THE SPECIAL ISSUE: SCIENTIFIC KNOWLEDGE, HETEROGENEOUS KNOW	OPERA-COLOMBIA	67	2020	Public Administration	Public Administration
Ott, C	Enabling Transformative Research: Lessons from the Eastern and Southern Africa Partnersh	CHALLENGES IN SUSTAINABILITY	66	2017	Green & Sustainable Science & Techno	Science & Technology - Other Topics
Soete, L	Science, technology and innovation studies at a crossroad: SPRU as case study	RESEARCH POLICY	65	2019	Management	Business & Economics
Fougere, M; Segercrantz, B; Seeck, H	A critical reading of the European Union's social innovation policy discourse: (Re)legitimizir	ORGANIZATION	64	2017	Management	Business & Economics
Aranguren, MJ; Magro, E; Wilson, JR	Regional competitiveness policy evaluation as a transformative process: From theory to pra	ENVIRONMENT AND PLANNING C-POI	62	2017	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration
Shelley-Egan, C; Gjefsen, MD; Nydal, R	Consolidating RRI and Open Science: understanding the potential for transformative change	LIFE SCIENCES SOCIETY AND POLICY	56	2020	Ethics; History & Philosophy Of Science	Social Sciences - Other Topics; History & Philosophy of Science; Biomedical Social Sciences
Steward, F	Transformative innovation policy to meet the challenge of climate change: sociotechnical n	TECHNOLOGY ANALYSIS & STRATEGIC	54	2012	Management; Multidisciplinary Science	Business & Economics; Science & Technology - Other Topics
Borras, S; Edler, J	The roles of the state in the governance of socio-technical systems' transformation	RESEARCH POLICY	52	2020	Management	Business & Economics
Giuliani, E	Regulating global capitalism amid rampant corporate wrongdoing-Reply to Three frames fo	RESEARCH POLICY	51	2018	Management	Business & Economics
von Jacobi, N; Edmiston, D; Ziegler, R	Tackling Marginalisation through Social Innovation? Examining the EU Social Innovation Pol	JOURNAL OF HUMAN DEVELOPMENT	51	2017	Development Studies	Development Studies
Aminullah, E	STI policy and R&D governance for the attainment of SDGs: envisioning the Indonesia's futu	ASIAN JOURNAL OF TECHNOLOGY INI	48	2020	Business; Economics	Business & Economics
Ahman, M; Nilsson, LJ; Johansson, B	Global climate policy and deep decarbonization of energy-intensive industries	CLIMATE POLICY	48	2017	Environmental Studies; Public Administ	Environmental Sciences & Ecology; Public Administration
Effendi, P; Courvisanos, J	Political aspects of innovation: Examining renewable energy in Australia	RENEWABLE ENERGY	48	2012	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Energy & Fuels
Wesseling, JH; Edquist, C	Public procurement for innovation to help meet societal challenges: a review and case stud	SCIENCE AND PUBLIC POLICY	47	2018	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Ockwell, D; Byrne, R	Improving technology transfer through national systems of innovation: climate relevant inn	CLIMATE POLICY	45	2016	Environmental Studies; Public Administ	Environmental Sciences & Ecology; Public Administration
Cederholm, EA; Hall, P	Performing ambiguous policy: How innovation events simultaneously perform change and c	SOCIOLOGICAL REVIEW	43	2020	Sociology	Sociology
Kuhlmann, S; Rip, A	Next-Generation Innovation Policy and Grand Challenges	SCIENCE AND PUBLIC POLICY	43	2018	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Asheim, BT	Smart specialisation, innovation policy and regional innovation systems: what about new pa	INNOVATION-THE EUROPEAN JOURNA	42	2019	Sociology	Sociology
Kesselheim, AS; Xu, S; Avorn, J	Clinicians' Contributions to the Development of Coronary Artery Stents: A Qualitative Study	PLOS ONE	38	2014	Multidisciplinary Sciences	Science & Technology - Other Topics
Fastenrath, S; Coenen, L; Davidson, K	Urban Resilience in Action: the Resilient Melbourne Strategy as Transformative Urban Inno	SUSTAINABILITY	35	2019	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Environmental Sciences & Ecology
van Est, R	Responsible Innovation as a source of inspiration for Technology Assessment, and vice ver	JOURNAL OF RESPONSIBLE INNOVATI	31	2017	Ethics; History & Philosophy Of Science	Social Sciences - Other Topics; History & Philosophy of Science; Business & Economics; Social Issues
Kroll, H; Boke, I; Schiller, D; Stahlecker, T	Bringing owls to Athens? The transformative potential of RIS3 for innovation policy in Germ	EUROPEAN PLANNING STUDIES	27	2016	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Hekkert, MP; Janssen, MJ; Wesseling, JH;	Mission-oriented innovation systems	ENVIRONMENTAL INNOVATION AND S	25	2020	Environmental Sciences; Environmenta	Environmental Sciences & Ecology
Foray, D	In response to 'Six critical questions about smart spezialisation'	EUROPEAN PLANNING STUDIES	21	2019	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Santos, DD; da Cunha, SK	Transformative innovation policy for solar energy: particularities of a developing country	CLEAN TECHNOLOGIES AND ENVIRON	19	2020	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Engineering; Environmental Sciences & Ecology
Kuhlmann, S	Introduction to discussion paper on 'Three Frames for Innovation Policy: R&D, Systems of In	RESEARCH POLICY	11	2018	Management	Business & Economics
Schot, J; Steinmueller, WE	Transformative change: What role for science, technology and innovation policy? An introdu	RESEARCH POLICY	10	2019	Management	Business & Economics
Foray, D	Six additional replies - one more chorus of the S3 ballad	EUROPEAN PLANNING STUDIES	9	2020	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies

8.3. Appendix 2.2.: Mission-Oriented Innovation Policy Literature (Population Lit = All, Core Lit = Green, Excluded Lit from Core = Red)

Authors	Article Title	Source Title	Cited Reference Cou	Publication Year	WoS Categories	Research Areas
Landoni, M; Ogilvie, D	Convergence of innovation policies in the European aerospace industry (1960-2000)	TECHNOLOGICAL FORECASTING AND	138	2019	Business; Regional & Urban Planning	Business & Economics; Public Administration
Klerkx, L; Begemann, S	Supporting food systems transformation: The what, why, who, where and how of mission-or	AGRICULTURAL SYSTEMS	132	2020	Agriculture, Multidisciplinary	Agriculture
Gross, R; Hanna, R; Gambhir, A; Heptonst	How long does innovation and commercialisation in the energy sectors take? Historical cas	ENERGY POLICY	126	2018	Economics; Energy & Fuels; Environme	Business & Economics; Energy & Fuels; Environmental Sciences & Ecology
Diercks, G; Larsen, H; Steward, F	Transformative innovation policy: Addressing variety in an emerging policy paradigm	RESEARCH POLICY	122	2019	Management	Business & Economics
Wanzenbock, I; Wesseling, JH; Frenken, K	A framework for mission-oriented innovation policy: Alternative pathways through the probl	SCIENCE AND PUBLIC POLICY	121	2020	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Klerkx, L; Rose, D	Dealing with the game-changing technologies of Agriculture 4.0: How do we manage divers	GLOBAL FOOD SECURITY-AGRICULTU	118	2020	Food Science & Technology	Food Science & Technology
Kattel, R; Mazzucato, M	Mission-oriented innovation policy and dynamic capabilities in the public sector	INDUSTRIAL AND CORPORATE CHANC	107	2018	Business; Economics; Management	Business & Economics
Fagerberg, J	Mobilizing innovation for sustainability transitions: A comment on transformative innovatio	RESEARCH POLICY	106	2018	Management	Business & Economics
Mulakkal, MC; Castillo, AC; Taylor, AC; Bl	Advancing mechanical recycling of multilayer plastics through finite element modelling and	RESOURCES CONSERVATION AND REC	102	2021	Engineering, Environmental; Environme	Engineering; Environmental Sciences & Ecology
Janssen, MJ; Castaldi, C	Services, innovation, capabilities, and policy: Toward a synthesis and beyond	SCIENCE AND PUBLIC POLICY	101	2018	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Hayter, CS	A trajectory of early-stage spinoff success: the role of knowledge intermediaries within an	SMALL BUSINESS ECONOMICS	98	2016	Business; Economics; Management	Business & Economics
van der Loos, HZA; Negro, SO; Hekkert, M	Low-carbon lock-in? Exploring transformative innovation policy and offshore wind energy pi	ENERGY RESEARCH & SOCIAL SCIENCI	96	2020	Environmental Studies	Environmental Sciences & Ecology
Mazzucato, M; Semieniuk, G	Public financing of innovation: new questions	OXFORD REVIEW OF ECONOMIC POLI	95	2017	Economics	Business & Economics
Pigford, AAE; Hickey, GM; Klerkx, L	Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems a	AGRICULTURAL SYSTEMS	94	2018	Agriculture, Multidisciplinary	Agriculture
Rapini, MS; Chiarini, T; Bittencourt, P; Cal	The intensity of private funding and the results of university? Firm interactions: the case of	INNOVATION & MANAGEMENT REVIE	93	2019	Management	Business & Economics
Sala, I; Sobrero, M	Games of policy and practice: multi-level dynamics and the role of universities in knowledg	JOURNAL OF TECHNOLOGY TRANSFEI	90	2020	Engineering, Industrial; Management	Engineering; Business & Economics
Deleidi, M; Mazzucato, M	Putting Austerity to Bed: Technical Progress, Aggregate Demand and the Supermultiplier	REVIEW OF POLITICAL ECONOMY	83	2019	Economics	Business & Economics
Miller, FA; French, M	Organizing the entrepreneurial hospital: Hybridizing the logics of healthcare and innovation	RESEARCH POLICY	82	2016	Management	Business & Economics
Brown, R	Mission-oriented or mission adrift? A critical examination of mission-oriented innovation pc	EUROPEAN PLANNING STUDIES	80	2020	Environmental Studies; Geography; Re	Environmental Sciences & Ecology; Geography; Public Administration; Urban Studies
Robinson, DKR; Mazzucato, M	The evolution of mission-oriented policies: Exploring changing market creating policies in t	RESEARCH POLICY	80	2019	Management	Business & Economics
Hjalager, AM; von Gesseneck, MJ	Capacity-, system- and mission-oriented innovation policies in tourism - characteristics, me	JOURNAL OF POLICY RESEARCH IN TC	80	2020	Hospitality, Leisure, Sport & Tourism	Social Sciences - Other Topics
Karo, E	Mission-oriented innovation policies and bureaucracies in East Asia	INDUSTRIAL AND CORPORATE CHANC	78	2018	Business; Economics; Management	Business & Economics
Lanahan, L	Multilevel public funding for small business innovation: a review of US state SBIR match pr	JOURNAL OF TECHNOLOGY TRANSFEI	76	2016	Engineering, Industrial; Management	Engineering; Business & Economics
McKelvey, M; Saemundsson, RJ	An evolutionary model of innovation policy: conceptualizing the growth of knowledge in inn	INDUSTRIAL AND CORPORATE CHANC	75	2018	Business; Economics; Management	Business & Economics
Pugh, R	Universities and economic development in lagging regions: triple helix' policy in Wales	REGIONAL STUDIES	75	2017	Economics; Environmental Studies; Ge	Business & Economics; Environmental Sciences & Ecology; Geography; Public Administration
Lember, V; Kattel, R; Kalvet, T	Quo vadis public procurement of innovation?	INNOVATION-THE EUROPEAN JOURN/	74	2015	Sociology	Sociology
Mazzucato, M; Kattel, R; Ryan-Collins, J	Challenge-Driven Innovation Policy: Towards a New Policy Toolkit	JOURNAL OF INDUSTRY COMPETITIOI	71	2020	Business	Business & Economics
Greenhalgh, T; Ovseiko, PV; Fahy, N; Shav	Maximising value from a United Kingdom Biomedical Research Centre: study protocol	HEALTH RESEARCH POLICY AND SYST	71	2017	Health Policy & Services	Health Care Sciences & Services
Bramwell, A; Hepburn, N; Wolfe, DA	Growing entrepreneurial ecosystems Public intermediaries, policy learning, and regional in	JOURNAL OF ENTREPRENEURSHIP AN	67	2019	Economics	Business & Economics
Florio, M; Giffoni, F; Giunta, A; Sirtori, E	Big science, learning, and innovation: evidence from CERN procurement	INDUSTRIAL AND CORPORATE CHANC	67	2018	Business; Economics; Management	Business & Economics
Mazzucato, M; Robinson, DKR	Co-creating and directing Innovation Ecosystems? NASA's changing approach to public-priv	TECHNOLOGICAL FORECASTING AND	65	2018	Business; Regional & Urban Planning	Business & Economics; Public Administration
Rabadjieva, M; Terstriep, J	Ambition Meets Reality: Mission-Oriented Innovation Policy as a Driver for Participative Go	SUSTAINABILITY	63	2021	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Environmental Sciences & Ecology
Chicot, J; Matt, M	Public procurement of innovation: a review of rationales, designs, and contributions to gran	SCIENCE AND PUBLIC POLICY	62	2018	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Cantner, U; Vannuccini, S	Elements of a Schumpeterian catalytic research and innovation policy	INDUSTRIAL AND CORPORATE CHANC	61	2018	Business; Economics; Management	Business & Economics
Mazzucato, M	From market fixing to market-creating: a new framework for innovation policy	INDUSTRY AND INNOVATION	58	2016	Economics; Management	Business & Economics
Shelley-Egan, C; Gjefsen, MD; Nydal, R	Consolidating RRI and Open Science: understanding the potential for transformative changi	LIFE SCIENCES SOCIETY AND POLICY	56	2020	Ethics; History & Philosophy Of Scienc	Social Sciences - Other Topics; History & Philosophy of Science; Biomedical Social Sciences
Cappellano, F; Kurowska-Pysz, J	The Mission-Oriented Approach for (Cross-Border) Regional Development	SUSTAINABILITY	55	2020	Green & Sustainable Science & Techno	Science & Technology - Other Topics; Environmental Sciences & Ecology
Benner, M; Liu, L; Serger, SS	Head in the clouds and feet on the ground: Research priority setting in China	SCIENCE AND PUBLIC POLICY	52	2012	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Garnett, K; Lickorish, FA; Rocks, SA; Prpich	Integrating horizon scanning and strategic risk prioritisation using a weight of evidence fra	SCIENCE OF THE TOTAL ENVIRONMEI	51	2016	Environmental Sciences	Environmental Sciences & Ecology
Jacobs, PT; Habiyaremye, A; Fakudze, B; F	Producing Knowledge to Raise Rural Living Standards: How Universities Connect with Reso	EUROPEAN JOURNAL OF DEVELOPME	48	2019	Development Studies	Development Studies
Mazzucato, M	Mission-oriented innovation policies: challenges and opportunities	INDUSTRIAL AND CORPORATE CHANC	48	2018	Business; Economics; Management	Business & Economics
de Jong, K; Daellenbach, U; Davenport, S;	Giving Science Innovation Systems a 'Nudge'	TECHNOLOGY INNOVATION MANAGE	45	2019	Management	Business & Economics
Mergel, I	Open innovation in the public sector: drivers and barriers for the adoption of Challenge.gov	PUBLIC MANAGEMENT REVIEW	43	2018	Management; Public Administration	Business & Economics; Public Administration
Edquist, C; Zabala-Iturriagagoitia, JM	Public Procurement for Innovation as mission-oriented innovation policy	RESEARCH POLICY	43	2012	Management	Business & Economics
Foray, D	Smart specialization strategies as a case of mission-oriented policy-a case study on the em	INDUSTRIAL AND CORPORATE CHANC	40	2018	Business; Economics; Management	Business & Economics
Amanatidou, E; Cunningham, P; Gok, A; G	Using Evaluation Research as a Means for Policy Analysis in a 'New' Mission-Oriented Poli	MINERVA	36	2014	Education & Educational Research; His	Education & Educational Research; History & Philosophy of Science; Social Sciences - Other Topics
Benneworth, P; Pinheiro, R; Sanchez-Barri	One size does not fit all! New perspectives on the university in the social knowledge econo	SCIENCE AND PUBLIC POLICY	34	2016	Environmental Studies; Management; I	Environmental Sciences & Ecology; Business & Economics; Public Administration
Celis, JE; Heitor, M	Towards a mission-oriented approach to cancer in Europe: an unmet need in cancer researc	MOLECULAR ONCOLOGY	30	2019	Oncology	Oncology
Lehoux, P; Daudelin, G; Hivon, M; Miller, I	How do values shape technology design? An exploration of what makes the pursuit of healt	SOCIOLOGY OF HEALTH & ILLNESS	27	2014	Public, Environmental & Occupational	Public, Environmental & Occupational Health; Biomedical Social Sciences; Sociology
Szajnfarber, Z	Space science innovation: How mission sequencing interacts with technology policy	SPACE POLICY	26	2014	International Relations; Social Sciences	International Relations; Social Sciences - Other Topics
Hekkert, MP; Janssen, MJ; Wesseling, JH;	Mission-oriented innovation systems	ENVIRONMENTAL INNOVATION AND S	25	2020	Environmental Sciences; Environmenta	Environmental Sciences & Ecology
Golova, IM; Sukhovey, AF	Differentiation of Innovative Development Strategies Considering Specific Characteristics o	EKONOMIKA REGIONA-ECONOMY OF	25	2019	Area Studies	Area Studies
Sanchez, DL; Sivaram, V	Saving innovative climate and energy research: Four recommendations for Mission Innovati	ENERGY RESEARCH & SOCIAL SCIENCI	21	2017	Environmental Studies	Environmental Sciences & Ecology
Aubert, JE	Rwanda's innovation challenges and policies - lessons for Africa	JOURNAL OF INTELLECTUAL CAPITAL	15	2018	Business; Management	Business & Economics
Rumyantseva, TB	THE US GOVERNMENT POLICY AIMED AT THE DEVELOPMENT OF THE INDUSTRIAL AND TE	TOMSK STATE UNIVERSITY JOURNAL	10	2017	Multidisciplinary Sciences	Science & Technology - Other Topics

8.4. Appendix 3.1: Identification of Concepts

This appendix shows some examples of how the author identified concepts, illustrated using an article from TIP (Steward, 2012) and one from MIP (Mazzucato, 2016).

Dimensions	Concepts	Labels	Indicators	TIP	MIP
Agenda-Setting	Policy Agenda Identification and Definition of Societal Problem | Policy Initiation | Source of Issue Agenda Setting Cultural, Political, Social, Economic, Environmental and Ideological Contextual Factors | Material Conditions Actors Directionality Events | Policy Window | Timing | Salience Framing Shifts in Perception | Uncertainty	Policy Agenda Agenda Identification Agenda Definition Contextual Factors Agents of Change Directionality Timing Framing Change	What is the topics focus of the policy agenda? How does topic source and identify potential policy issues for the agenda? How does the topic address the definition of policy issues for the agenda? How does the topic consider the diverse contextual factors? Who does the topic identify as responsible agents of change? How does the topic understand directionality? How does the topic address urgency and time-based factors? How does the topic treat diversity in framing policy issues? How does the topic recognise change and uncertainty in agenda setting?	"demand-side considerations" and the role of "social change" in addition to "technological change" "new consumption /end use led reframing"	"policy as setting the direction of change"
Policy Formulation	Multi-Level | Multi-Actor | Actors Role of the State and Governance | State Structure Public-Private | Coordination Decision-Making | Contestation Policy Networks | Linkages | Beliefs Policy Options | Instrumentation | Regulatory, Financial, Informational, and Organizational Tools	Actors Governance Coordination Contestation Networks and Linkages Instrumentation and Tools	How does the topic address the multiplicity of levels and actors? How does the topic perceive the role of governance? How does the topic understand coordination between actors? How does the topic address contestation in the decision-making process? How does the topic understand networks and linkages? What policy options, instrumentation and tools does the topic present?	"innovation as a process of interactions situated in 'meso-level' social networks" "needs new types of innovation actors", "knowledge", "capabilities" and "novel social arrangements"	"array of stakeholders" "public-private partnerships" "market shaping and creating" "vertical policies"
Policy Adoption	Boundaries/Parameters- Resource Availability, Political Preferences and Public Perception Competencies of Government and Institutions | Institutional Capacity Cooperation, Collaboration and Coalition Opportunities Decision Making Heuristics and Biases	Boundaries & Parameters Capabilities/Capacity & Competencies Cooperation, Collaboration & Coalitions Decision Making Limitations	What boundaries / parameters does the topic identify? How does the topic assess the capabilities, capacity and competencies of actors? How does the topic enable cooperation, collaboration and coalitions? How does the topic understand limitations to decision making process?	(Empty)	(Empty)
Implementation	Top-Down Models/Instruments and Tools | Bottom-Up Models/Instruments and Tools Clear Definition, Interpretation and Identification of Responsible Agents | Clear Allocation of Budgetary, Personnel and Organisational Resources | Clear Decision-Making Framework Accountability | Effective Leadership Implementation Problems - Design, Coordination, Control | Implementation Problems- Uncertainty, Interactions	Top Down & Bottom Up Design & Delivery Accountability Implementation Problems	How does the topic understand top-down & bottom-up factors? Does the topic offer a clear framework for policy implementation design and delivery? How does the topic enforce effective leadership? What implementation problems does the topic identify?	"matching demand-pull with supply-push" "learning by doing" "experimentation"	"provide directions of change around which bottom-up solutions can then experiment" "public sector [as] vision, risk taking and investment [function]" "welcome the underlying uncertainty and discovery process"
Evaluation	Monitoring | Policy Performance Evaluative Methods | Short to Long-Term Impact | Intended and Unintended Outcomes | Re-Framing Feedback Loops/Reflexivity | Learning Termination Impact Assessment and Measurement Challenges | Policy Institutionalisation	Monitoring & Performance Impact & Evaluation Reflexivity Termination Measurement Challenges	How does the topic address monitoring and performance during the policy process? How does the topic address impact and evaluation after the policy process? How does the topic enable space for reflexivity and feedback? How does the topic conclude/terminate policy process? What measurement challenges does the topic present? And resolve?	(Empty)	"evaluation" through "dynamics metrics" not static
				Steward, F, 2012.	Mazzucato, M, 2016.

8.5. Appendix 3.2: Excel Example

This appendix shows a snapshot from the Excel document used to capture and formulate key ideas from the TIP and MIP literature.

The author first read the text to understand its angle and position, before relevant textual concepts presented in the analytical framework were extracted and then placed against the appropriate label within an Excel document. After the iterative process has been conducted for all literature on the topic, the author read all extracted segments in a label and highlighted the most common and strongest examples in green.

Overview					
	Frame	3	(Chataway, 2017; Schot & Steinmueller, 2018)	3.1	
	Topic	**Transformation**		**Missions**	
	Policy Paradigm				
		transformative innovation polic	(Diercks et al, 2019)		
				'new' mission-oriented approac	(Gassler et al, 2007)
				type 2	(Robinson & Mazzucato, 2019)
	Introduced	2012 -	(Weber & Rohracher, 2012) / (Steward, F, 2012)		
Agenda-Setting					
	Policy Agenda	societal functions of consumpti	(Steward, 2012)	economic growth	(Florio et al, 2018)
		social & environmental	(Schot & Steinmueller, 2018)	economic growth --> societal (	(Karo, 2018)
		meeting social needs and addres	(Schot & Steinmueller, 2018)	economic and societal but not	(Karo, 2018)
		involves deliberating and explori	(Schot & Steinmueller, 2018)	innovation policies and bureau	(Karo, 2018)
		societal. The emerging literature	(Grillitsch & Hansen, 2019)	In 1995, Japan adopted the S&T	(Karo, 2018)
		TIP encourages a deeper set of	(Schot & Steinmueller, 2018)	The mid-2000s saw a shift towa	(Karo, 2018)
		Diercks et al provide a framewo	(Diercks et al, 2019)	economic growth that is ... Cou	(Kattel & Mazzucato, 2018)
		Kallerud et al. (2013) argue that,	(Diercks et al, 2019)	Next to governments, academi	(Kattel & Mazzucato, 2018)
		transformative innovation polic	(Diercks et al, 2019)	broadly defined grand challeng	(Robinson & Mazzucato, 2019)
		societal (& economic). With reg	(Diercks et al, 2019)	grand societal challenges conce	(Robinson & Mazzucato, 2019)
		disinguishing past innovation po	(Hekkert et al, 2020)	one of the key drivers (in space	(Robinson & Mazzucato, 2019)
		We propose that a unique in- sti	(van der Loos et al, 2020)	To summarize, a number of pre	(Robinson & Mazzucato, 2019)
				The mission is defined in terms	(Robinson & Mazzucato, 2019)
				inclusive and challenge led grov	(Robinson & Mazzucato, 2019)
				The agricultural sector is currer	(Klerckx & Rose, 2020)
				social mo- mentum for change	(Klerckx & Begemann, 2020)
				Janssen et al. (2020) have indic	(Janssen et al, 2020)
				societal	(Hekkert et al, 2020)
				Taking 'directionality' as a start	(Schot & Steinmueller, 2018 via Rabadjieva, 2021)
				Challenges may be wicked in di	(Wanzenbock et al, 2020)
	Agenda Identification	policies for transformative chan	(Weber & Rohracher, 2012 via Schot & Steinmuelle	Mis- sions may arise from a sup	(Klercks & Begemann, 2020)
		TIP aims to establish what Webe	(Weber & Rohracher, 2012 via Schot & Steinmuelle	Perhaps paradoxically, food sys	(Klercks & Begemann, 2020)
		anticipation of collateral effects	(Schot & Steinmueller, 2018)	By disregarding the 'degree of v	(Wanzenbock et al, 2020)
		Transformative in- novation pol	(Schot & Steinmueller, 2018)	(framework)) ..On this basis, we	(Wanzenbock et al, 2020)
		Evolutionary approaches to regi	(Uyarra et al, 2019)		
	Agenda Definition	The array of regimes could be se	(Steward, 2012)	The mission is defined in terms	(Soete and Arundel, 1993)
		'challenge led' as global challeng	(Steward, 2012)	The "Innovation 25," a vision d	(Karo, 2018)
		Transformative not incremental	(Steward, 2012)	Broad challenges with a comple	(Robinson & Mazzucato, 2019)
		Climate change, reduction of eq	(Schot & Steinmueller, 2018)	Agri innovation systems and inr	(Robinson & Mazzucato, 2019)
		Challenges such as ageing societ	(Uyarra et al, 2019)	It is also important to contemp	(Klercks & Begemann, 2020)
		Established companies played a	(van der Loos et al, 2020)	As yet, the literature on MIP ha	(Wanzenbock et al, 2020)
				We will argue that societal chal	(Wanzenbock et al, 2020)
				Reoccurring aspects in the scie	(Wanzenbock et al, 2020)
				Disregarding the normative ele	(Wanzenbock et al, 2020)
				At the problem side, a non-trivi	(Wanzenbock et al, 2020)
				By contextualizing societal chal	(Wanzenbock et al, 2020)
	Contextual Factors	policy response has been to see	(Steward, 2012)	context of risky, uncertain, inno	(Florio et al, 2018)
		according to Freeman and Perez	(Freeman & Perez, 1988 via Fagerberg, 2018)	East Asian economies that still	(Karo, 2018)
		Transformative innovation polic	(Uyarra et al, 2019)	The development of mission-or	(Karo, 2018)
		conclude by emphasizing that gr	(Grillitsch & Hansen, 2019)	The Fourth S&T Basic Plan (Gov	(Karo, 2018)
		Authors use the socio-technical	(Denes Santos & De Cunha, 2020)	Growth.. This has to be achieve	(Robinson & Mazzucato, 2019)
				Agri innovation systems and inr	(Klerckx & Rose, 2020)
				(contained in framework)..	(Wanzenbock et al, 2020)

8.6. Appendix 4: Compete, Complement, Neutral Table

A new model or framework for the topics posit new relationships and perspectives and also yields new questions or an agenda for further research (Torraco, 2016). The table below assesses whether the conceptual understanding, presented in the topics of TIP and MIP, can help to support and reinforce their understanding (complement '*arrows*'), present a competing understanding (compete ' ✖'), presents neither a complementary nor competing understanding ('**Neutral**') or cannot be determined based on current understanding requiring further research (' ? '). The author highlights in **bold** the stronger understanding and reflects whether this relationship is one directional (one-way arrows) or multi-directional (two-way arrows).

TIP	Complementary / Compete / Neutral / Neutral / Underdeveloped / Unknown	MIP
Overview		
Definition: Paradigm (3rd Frame)	⟷	**Definition: Tool**
Theoretical Foundation: STI	Neutral	Theoretical Foundation: STI
Theoretical Field: STS		Theoretical Field: STS
Strong Influence	→	Weak Influence
Socio-Technical System	⟷	**Socio-Economic System**
Change		**Change**
Meso Level Interactions Focus	Neutral	Meso Level Interactions Focus
'Situatedness' in IS	Neutral	'Situatedness' in IS
Agenda Setting		
Policy Agenda:	⟷	**Policy Agenda:**
(Strong: Societal (Economic))		**(Strong: Economic (Societal))**
Agenda Identification & Def	Neutral	Agenda Identification & Def
(Strong- Failures)		(Strong- Failures)
Agenda Identification & Def	←	**Agenda Identification & Def**
(Medium- Foresight & Anticipation)		**(Strong- PSF & ROAR)**
Contextual Consideration	←	**Contextual Consideration**
(Weak)		**(Strong- PSF)**
Agents of Change:	✖	Agents of Change:
(Strong: Key Actors (Industry))		(Strong: Key Actors (State/Gov))
Directionality	⟷	**Directionality**
(Strong- RRI & Road Mapping)		**(Strong- Vision & Market Creation)**
Directionality:	?	Directionality:
(Strong: Open-Ended)		(Strong: Targeted & Open-Ended)
Time:	Neutral	Time:
(Strong: Windows of Opportunity)		(Strong: Windows of Opportunity)
Time Agenda:	Neutral	Time Agenda:
(Strong: Radical & Incremental Innovation)		(Strong: Radical & Incremental Innovation)
Framing:	✖	Framing:
(Strong- RRI)		(Strong- PSF)
Change Consideration	←	**Change Consideration**
(Medium: Implicit- RRI)		**(Strong: Explicit- PSF)**
Formulation		
Capture of Actors	Neutral	Capture of Actors
(Strong- Broad)		(Strong- Broad)
Key Actors:	?	Key Actors:
(Strong: Users)		(Strong: State)
Governance:	⟷	**Governance:**
(Strong- Tentative (Open- Undefined))		**(Strong- Tilted (Directed- Defined))**
Coordination:	⟷	**Coordination:**
(Strong- Experimentation)		**(Medium- Public-Private)**
Coordination:	⟷	**Coordination:**
(Medium: Structuring Innovation Councils)		**(Strong: Enabling Dynamic Capabilities)**
Contestation:	←	**Contestation**
(Medium- RRI Implied)		**(Strong- PSF Explicit)**

Networks & Linkages: (Strong)	Neutral	Networks & Linkages: (Strong)
Networks & Linkages: (Medium- Embedded- IS)	←	**Networks & Linkages: (Strong- Dedicated- MIS)**
Instruments & Tools: (Medium- PPI, Holistic & Broad)	Neutral	Instruments & Tools: (Medium- PPI, Holistic & Broad)
Instruments & Tools: (Medium- Demand Oriented)	→	Instruments & Tools: (Weak- Supply + Demand Oriented)

Adoption

Boundaries & Parameters: (Strong- Regional & Sectoral)	Neutral	Boundaries & Parameters: (Strong- Regional & Sectoral)
Boundaries & Parameters: (Strong- RRI & RIS)	✖	Boundaries & Parameters: (Strong- MIS)
Capabilities/Capacity & Comp.: (Strong- Exogenous (Inst, Firms, Users))	→ ←	**Capabilities/Capacity & Comp.: (Strong- Endogenous (Public Sector))**
Cooperation, Collab. & Coalitions: (Medium)	←	**Cooperation, Collab. & Coalitions: (Medium: State as Risk Taker)**
Decision-Making (Weak)	←	**Decision-Making (Strong- Dynamic Capabilities & PSF)**

Implementation

Understanding of Innovation Process (Medium- Broad)	←	**Understanding of Innovation Process (Medium- Narrow & Broad)**
(Strong) Bottom-Up (Demand Pull) (Weak) Top-Down (Supply Push)	→ ←	**Top-Down (Supply Push) (Strong) Bottom-Up (Demand Pull) (Weak)**
Policy Mix (Weak- Horizontal)	←	**Policy Mix (Medium- Vertical & Horizontal)**
Innovation Model (Medium- SNM)	✖	Innovation Model (Medium- MIS)
Design & Delivery: (Medium- Public Value)	Neutral	Design & Delivery: (Medium- Public Value)
Design & Delivery: Who, What, How (Weak)	?	Design & Delivery: Who, What, How (Medium)
Accountability & Leadership: (Weak)	←	**Accountability & Leadership: (Medium- Govt. Vision & Democracy)**
Implementation Problems (Strong- Capture, Lock-In, Resistance)	Neutral	Implementation Problems (Strong- Capture, Lock-In, Resistance)
Implementation Problems: (Control and Unknown Experimentation)	?	Implementation Problems: (Governance System & Coordination)

Evaluation

Measuring & Performance: (Weak)	←	**Measuring & Performance: (Medium: Indicators- Spill-Overs & Firms)**
Impact & Evaluation: (Strong- PPI, Public Value)	Neutral	Impact & Evaluation: (Strong- PPI, Public Value)
Reflexivity (Strong- Explicit- Deep Learning)	→	Reflexivity (Weak- Implicit- Dynamic Capabilities)
Termination (Weak)	?	Termination (Weak)
Measurement Challenges (Medium- IS & Long-Term Uncertainties)	?	Measurement Challenges (Medium- IS & Long-Term Uncertainties)

Synthesis across TIP and MIP showing competing, complementary, neutral and underdeveloped ideas.