How can Platform Ecosystems support Mission-Specific Innovation Systems?

Vladimir C.M. Sobota
TU Delft
v.c.m.sobota@tudelft.nl

Martijn Wiarda
TU Delft
M.J.Wiarda@tudelft.nl

Tom B.J. Coenen
University of Twente
t.b.j.coenen@utwente.nl

J. Roland Ortt
TU Delft
J.R.Ortt@tudelft.nl

Abstract

The recent uptake of transformative mission-oriented innovation policies introduces novel demands on innovation systems. Scholars suggest that platform ecosystems could help meet these new demands, but how this may be done remains unexplored and unspecified. This is problematic because policymakers already develop and deploy such resource-intensive platforms. To address this gap, this paper conceptualizes how platform ecosystems can be employed to support mission-specific innovation systems. We argue that platforms can cover a range of system functions, including the provision of problem/solution directionality, coordination of the transition, and market creation. We animate our conceptualization through an illustrative vignette of the NetZeroCities platform and provide urgent avenues for future research that would yield a better understanding of mission-oriented platform ecosystems.

Keywords: platform, ecosystem, mission-oriented innovation policy, mission, transformative innovation policy

1. Introduction

Mission-oriented innovation policies (MIPs) are gaining increased attention in Europe and beyond. These policies employ ambitious and time-bound objectives to induce socio-technical transformations in response to grand societal challenges (Ergas, 1987; Hekkert et al., 2020; Mazzucato, 2018). In contrast to conventional technology-focused 'accelerator' missions, 'transformative' or 'transformer' missions intend to gather and direct diverse actors toward a common objective (Janssen et al., 2021; Wittmann et al., 2021). Exemplary transformer missions include the Dutch ambition to achieve a 100% circular economy by 2050 (Dutch Ministry of Economic Affairs and Climate Policy, 2019) or the US Cancer Moonshot program to "eliminate cancer as we know it" (The White House, 2016).

Such MIPs impose new demands on the subjected innovation systems because these so-called *mission-specific innovation systems* (MSISs) require greater degrees of coordination and directionality to deal with the complexity, uncertainty, and contestation associated with societal challenges (Elzinga et al., 2023; Hekkert et al., 2020; Wanzenböck et al., 2020).

How policymakers can meet these new demands is an open question. Still recent research suggests that *platform ecosystems* could be a suitable tool to address societal challenges (e.g., Addo, 2022; Ritala, 2023) and support transformative missions (Elzinga et al., 2023; Reike et al., 2023; Wiarda et al., 2024). Platform ecosystems are generally understood as a set of independent yet interdependent heterogeneous actors contributing to a central value proposition commonly coordinated via a digital platform (Thomas & Autio, 2020). Interestingly, policymakers are already deploying such platform ecosystems as prominent mission governance tools (e.g., the European Commission's NetZeroCities platform), showing a demand for platform ecosystems as policy instruments.

Therefore, policy seems to be running ahead of theory because mission-oriented platforms have not yet been studied. It remains unclear how platform ecosystems support MSISs. Without this understanding, policymakers may miss out on the full potential that platform ecosystems offer in pursuing missions. This is especially problematic given the substantial resources allocated to these platforms despite our limited conceptual knowledge of their complementarity with MSISs. At the same time, this gap presents an opportunity for information systems research. Information systems scholars have a long history of studying how information technologies, in general, and platform ecosystems, in particular, contribute to organizing and disorganizing – two aspects relevant to MSISs.

In this conceptual paper, we address this gap and explore how platform ecosystems can promote the functions of MSISs. Put differently, we study how platform ecosystems support the central processes that determine how innovation systems pursue missions (Elzinga et al., 2023).

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We do so by first reviewing the fundamental principles underlying the concepts of MSISs (Section 2.1.) and platform ecosystems (Section 2.2.). We proceed by discussing conceptually how platforms could support each of these system functions (Section 3). In Section 4, we animate this potential of platform ecosystems by drawing from an illustrative vignette that substantiates our argumentation. Based on our conceptualization and vignette, we suggest several promising avenues for future research that would help us advance our understanding of mission-oriented platform ecosystems.

2. Theory

2.1. Mission-specific innovation systems

As discussed, using missions imposes new demands on innovation systems (Elzinga et al., 2023). Innovation systems were originally envisioned as systems of actors and factors that explain innovation in nations, regions, sectors, and technological domains (c.f., Breschi & Malerba, 1997; Cooke, 2001; Lundvall, 1992). Like these innovation system concepts, MSISs describe innovation as an interactive process consisting of structural and functional aspects. They represent the "network of agents and set of institutions that contribute to the development and diffusion of innovative solutions to define, pursue, and complete a societal mission" (Hekkert et al., 2020, p. 77).

The MSIS concept offers an analytical framework largely described through *system functions* to study how innovation systems contribute to missions. These system functions act as driving forces behind the system (Hekkert et al., 2007) and can be understood as "structure-building processes that explain the build-up and growth of the system rather than its output in terms of product and process innovation" (Bergek, 2019, p. 204). System functions were initially introduced to assess technological innovation systems (TIS) (Hekkert et al., 2007), but scholars have drawn on these to study the innovative performance of MSISs.

While TIS functions are still helpful, they have been criticized for not sufficiently explaining the system's ability to conduce transitions toward a mission or urgent goal (Elzinga et al., 2023; Hekkert et al., 2020). The TIS functions, as specified by Hekkert et al. (2007), assume that problems are well-understood and that solutions are known, but in the wicked context of societal challenges, stakeholders tend to disagree on the nature of problems and the appropriateness of solutions. MSISs, therefore, require greater degrees of coordination and directionality than conventional innovation systems, and as a result, Elzinga et al. (2023) proposed additional system functions: (1) providing

problem directionality, (2) providing solution directionality, and (3) coordinating the transition (Elzinga et al., 2023).

The validity and usefulness of these additional system functions are still debated (Coenen et al., 2023; Wesseling & Meijerhof, 2023). Nevertheless, we will build on these mission-specific system functions of Elzinga et al. (2023) as this approach most clearly distinguishes the directionality-oriented efforts that lay at the center of what characterizes missions. Let us now turn to the notion of platform ecosystems before we link it with MSISs. In section 3, we will introduce and explain the system functions in more detail and integrate the concepts of MSISs and platform ecosystems.

2.2. Platform ecosystems

New ways of using data, networks, and software that emerged as part of the digital revolution made it possible to spot and capitalize on complementarities across users, devices, and sectors (Gawer, 2021). As a result, individuals or organizations can connect with others almost frictionlessly. Innovation activities are no longer confined to organizations, and resources no longer need to reside within organizations to be exploited.

Platform ecosystems are a way of orchestrating interaction and collaboration (Jacobides et al., 2018), and they usually consist of two main components: a platform and an ecosystem. The two concepts of platform and ecosystem are distinct but often connected, as platforms are frequently used to underpin and orchestrate ecosystems. A platform is "a central agent at the nexus of a network of value creators" (Gawer, 2021, p. 4). Viewed as markets, platforms can be seen as intermediaries facilitating value exchange between actors (Hagiu & Wright, 2015). Therefore, a central characteristic is their intermediation between groups, commonly called 'sides.' Examples of these sides are the hosts and guests on the platform AirBnB. Third-party contributors, such as sellers, are commonly referred to as complementors because they complement the platform's functionality (Nalebuff & Brandenburger, 1997). Platforms are usually underpinned by digital technology infrastructures that allow participants to connect to and build on the platform ecosystem via boundary resources (Ghazawneh & Henfridsson, 2013).

An ecosystem consists of independent participants, meaning that they are not fully hierarchically controlled and interdependent and that their business operations depend on the existence of an overarching value proposition (Thomas & Autio, 2020). An ecosystem can thus be seen as a set of heterogeneous participants, often transcending industries (Autio, 2022), who collectively bring about an ecosystem value proposition (Thomas &

Autio, 2020). Ecosystems are bound together by non-generic complementarities (Jacobides et al., 2018), entailing that some investments by ecosystem participants are specific to one ecosystem and cannot be allocated elsewhere. For instance, apps developed for Apple's iOS operating system will not be readily compatible with Google's Android. As a result, some development efforts will be platform-specific and hence lost if the complementor leaves one platform for the other.

Typically, a central actor owns the platform and orchestrates the ecosystem via relational governance and technological arrangements (e.g., rules). Actors do not need to fulfill singular roles - roles can change, and several roles can be fulfilled simultaneously (Dedehayir et al., 2018). In summary, a platform ecosystem often consists of an enabling technology (often a digital platform), an ecosystem (independent yet interdependent actors such as complementors and users), and an orchestrator (usually the platform owner).

After expounding MSISs and platform ecosystems, we will compare them in key dimensions.

2.3. Mission-specific innovation systems and platform ecosystems

MSISs and platform ecosystems exhibit key commonalities and differences (see Table 1). Most prominently, the concepts have historically been developed in different scientific communities. The concept of platform ecosystems (as invoked in this study) originates from management science and information systems, while the MSISs emerged from innovation policy and transition studies. As systemic ways of looking at innovation and actors, both have been developed and applied in relation to contexts with interdependencies between actors that cannot be explained based on traditional economic analysis of supply and demand.

Table 1. Comparison of platform ecosystems and mission-specific innovation systems

	Platform ecosystem	Mission-specific innovation system
(Disciplinary) perspective	Management science (market, company)	Innovation policy, transition studies (policymaker)
Definition	A set of independent yet interdependent heterogeneous actors contributing to a central value proposition, commonly coordinated via a digital platform (Thomas & Autio, 2020)	"The network of agents and set of institutions that influence the development and diffusion of innovative technological and social solutions and the transformation of existing production and consumption systems with the aim to complete a societal mission" (Elzinga et al., 2023, p. 2)
Structure	Networked	
Typical actors	Platform orchestrator, users, complementors	Policymakers, incumbents, start-ups, research institutes, civil society, intermediaries
Actor relations	Independent, yet interdependent	
Typical actor governing	Platform orchestrator	Policymaker
Governance style	Orchestrating function	

Partly driven by diverging origins, the two domains typically consider different actors. At its very core, platform ecosystems consist of users, complementors, the ecosystem, and the platform ecosystem orchestrator. MSISs consider a wider set of actors, including policymakers, incumbents, entrepreneurs, various intermediaries, research institutes, and civil society. Both streams see actors as independent yet interdependent entities, transgressing traditional organizational borders and control. Although the governing actor differs - platform ecosystems are typically governed by the platform orchestrator and MSISs by policymakers or governmental institutes -

both are characterized by an orchestrating governance style rather than command and control.

3. Platforms supporting mission-specific innovation systems

In what follows, we will discuss the mission-specific system functions (so-called 'programming functions') and conventional system functions (so-called 'performance functions') used to understand and govern an MSIS. These functions are (1) providing problem directionality, (2) providing solution

directionality, (3) coordinating the transition, (4) knowledge development, (5) knowledge diffusion, (6) entrepreneurial experimentation, (7) market creation, (8) resource mobilization, and (9) creating legitimacy. We deductively explore how platform ecosystems can support these system functions (functions, henceforth). For example, a government can bring various actors together via a platform to discuss and (over time) converge views on the problem and solution directions (two of the programming functions we will further describe in the next section).

It is important to note that not all mission-oriented platform ecosystems will support the same functions, support these equally, or support these knowingly. In addition, some platforms can be an integral and/or dedicated part of an MSIS, while others may partly fall outside of it. Hence, the extent and ways in which platform ecosystems can support functions will vary in practice.

3.1. Programming functions

A major task for mission governance is converging views on societal challenges and solutions deemed necessary to address the respective challenges (Wanzenböck et al., 2020). Through this directionality, missions may mobilize and coordinate actors because they create a shared understanding across different communities of what problems to target and what solutions to promote (Janssen et al., 2023). One way policymakers can stimulate such a shared understanding is to identify, compare, and bridge different views to mitigate contestation, promote mutual learning, and make compromises needed to drive collective action (Wiarda et al., 2023). Efforts that help align such views are categorized under the functions of problem directionality (function 1) and solution directionality (2), respectively.

Problem and solution directionality are central to platform ecosystems in several ways (Addo, 2022). When platform ecosystem emerge, the central value proposition to be co-created may transgress what future participants can currently imagine. Platform leaders must emphasize the potential gains and contributions vis-a-vis the platform ecosystem, for instance, by portraying the potential value gained through participation (Ansari et al., 2016). The orchestrator creates directionality by nurturing a platform ecosystem identity – a mutual understanding of "who we are" and "what we do" (Navis & Glynn, 2010, p. 479). Like the development of missions, the platform orchestrator crafts a value proposition around which ecosystem participants gather (Dattee et al., 2018), persuades ecosystem participants and external actors of the ecosystem's viability, and affirms ecosystem participants of the agreed-upon value proposition to be co-created (Thomas & Autio, 2020). Around such value propositions, platform ecosystems can align problem understandings (i.e., problem directionality) and solution propositions (i.e., solution directionality) (Thomas & Autio, 2020). Directionality can also be provided by defining platform ecosystem roles (Dedehayir et al., 2018) – designed blueprints of orchestrated interactions and value distribution to be enacted by participants. Roles render individual contractual agreements between participants unnecessary (Jacobides et al., 2018). Platform ecosystems offer a model of contributing to and engaging with the ecosystem to fulfill the central value proposition. In summary, platform ecosystems thus offer an identity, value proposition, and blueprint that can direct actors toward certain problems and solutions relevant to missions.

While directionality is deemed important for the success of missions, it is not sufficient. Missions require coordination (function 3) that strongly determines how an innovation system can act upon directionality (Elzinga et al., 2023). Platforms have been described as potent coordinating tools (Addo, 2022) because they bring together a wide variety of societal actors around transition issues (Kok & Klerkx, 2023). Such coordination relies on rules, incentives, and nudges for the desired contribution quality, quantity, or type (Claussen et al., 2013). For instance, platform ecosystems may offer valuable resources such as information on user preferences, development kits, application programming interfaces (APIs) (Ghazawneh & Henfridsson, 2013), and performance feedback such as awards or rankings (Rietveld et al., 2019). Structures that determine actor roles and interactions, too, provide coordination because they influence how power and responsibility in networks are shared (Patterson et al., 2017). This may require re-negotiation to overcome legitimization issues (Lindgren et al., 2015). Together, these features make platform ecosystems suitable orchestration tools to help steer actor contributions in a desired direction.

3.2. Performance functions

As discussed, the performance functions studied in an MSIS analysis largely stem from the widely adopted literature on TISs (c.f., Bergek, 2019).

Knowledge development (function 4) deals with activities such as knowledge programs, co-production, and cross-disciplinary collaborations (c.f., Andersson et al., 2017). Many contributions in the platform literature have studied the role of platforms in learning (e.g., Ravi et al., 2021). Platform ecosystems may provide new knowledge by aggregating insights, for example, about

the quality of certain products and services (e.g., google reviews, Yelp, Tripadvisor, etc.; Parker et al., 2016). Similarly, transition studies have discussed the role of platform ecosystems in challenge-led knowledge development. For instance, in citizen science, platforms commonly provide the infrastructure and interface for citizens to contribute crucial insights regarding environmental problems (Sauermann et al., 2020). Perhaps a more common example includes using platforms like Scopus as input for research (e.g., medical sciences).

The diffusion of this knowledge is allocated to the knowledge diffusion (function 5). This draws attention to interaction for knowledge exchange, such as stakeholder meetings, public consultations, and conferences. Platform ecosystems can help because they can facilitate data distribution with private and public organizations to stimulate their innovative performance (Addo, 2022). Platforms like Scopus, Overton, GitHub, and Nexus Uni exemplify how knowledge in the form of academic articles, policy documents, and news articles is stored and shared. Platforms also played a central role in many educational systems, especially during the COVID-19 pandemic. Platforms furthermore help facilitate online meetings (e.g., workshops and conferences) and can diffuse knowledge through tools and resources (Ghazawneh & Henfridsson, 2013).

Moreover, activities such as experiments, pilot projects, market introductions, and novel business models of entrepreneurs are clustered in entrepreneurial experimentation (function 6). The participatory architecture of many platform ecosystems can support such activities by providing structures promoting distributed experimentation by drawing on external participants' capabilities via openness, learning-by-doing, and iteration (Addo, 2022). Together, these characteristics enable generativity, a system's ability to bring about unprompted change (Zittrain, 2006). Ubuntu's operating system exemplifies generativity by harnessing an international developer community's collective creativity and collaboration. Platform ecosystems also enable users to experiment. Users know their specific use context and needs best (von Hippel, 2006), and co-creating novel technologies and offerings can help meet their needs (Baldwin & von Hippel, 2011). Intermediary technologies such as platforms can help users create novel combinations of existing products or services for specific use cases (Harvey et al., 2020).

In addition, creating new markets to diffuse innovations is classified under market creation (function 7). Platform ecosystems offer spaces for online market creation (e.g., Eckhardt et al., 2018; Nambisan & Baron, 2021) through aggregation (Anderson, 2004) or re-intermediation (Parker et al., 2016). Exemplary market platforms include the App Store, TripAdvisor, Steam, and Google Play. A few studies on MIPs have already illustrated how platforms create markets where consumers and sellers interact, for instance, in the context of circularity missions (Elzinga et al., 2023; Reike et al., 2023).

Resource mobilization (function 8) refers to the efforts that (re-)allocate and withdraw financial, human, infrastructural, and material resources in favor of solutions. Platform ecosystems can likewise play an important role here because of their ability to bring together actors (e.g., complementors) that each provide certain resources (e.g., investments, goods, information). These resources are subsequently channeled toward ecosystem participants. Crowdfunding platforms, for instance, demonstrate how resources are mobilized to support certain businesses or innovations (Testa et al., 2019; Wehnert & Beckmann, 2023). Although empirical evidence of mission-oriented platforms is slim, Reike et al. (2023) discuss how platforms have channeled material resources (i.e., clothes) to support circularity missions. Similarly, transition studies at large have reported how some platforms mobilize funding and knowledge to accelerate sustainable innovations (Häußler, 2019; Troise et al., 2021).

Finally, legitimation (function 9) refers to activities that benefit the ways and extent to which problems and solutions are perceived as valid, effective, or desirable. Activities within this function include lobbying, evidence, championing, and local anchoring (Bergek, 2019). Reike et al. (2023) argue that the emergence of a platform ecosystem linked to a mission's solutions can provide legitimation. We speculate that this is especially the case once platforms have large user bases (i.e., input legitimacy) and when their identity and value proposition align with societal values (i.e., moral legitimacy; Mena & Palazzo, 2012; Suchman, 1995).

Thomas and Ritala (2022) suggest that ecosystem participants together drive the emergence of ecosystem legitimacy. Platform leaders can contribute to legitimation by convincing participants of the value to be co-created (Gawer & Phillips, 2013; Thomas & Autio, 2020). Users and complementors can provide legitimation through their mere act of participating, signaling the viability of the platform ecosystem (Thomas & Ritala, 2022). Without complementors, the value proposition cannot be achieved, and the presence of users can signal the value proposition's viability. A platform ecosystem's legitimacy can hence reflect on a mission, provided that the platform ecosystem is recognized as mission-oriented.

Studies operationalizing MSIS functions generally assume that an appropriate presence and interaction of these functions indicates a healthy innovation system,

effectively contributing to mission attainment (Elzinga et al., 2023; Wesseling & Meijerhof, 2023). We have delineated several ways platforms can support such functions. Let us now look at how this may materialize in practice.

4. The NetZeroCities platform: an illustrative vignette

In the following, we draw on the NetZeroCities platform as an illustrative vignette to showcase how policymakers currently use platforms to support missions. This illustration does not serve as a robust empirical analysis but is meant to substantiate our conceptualization of how platforms may support functions, as discussed above.

The European Commission (EC) recently launched the EU Mission '100 Climate Neutral and Smart Cities by 2030', also known as the 'Cities Mission' (European Commission, 2023c). The mission targets several causes underlying climate change such as greenhouse gas emissions and the energy consumption of cities. The EC expects that achieving this mission will roughly cost 96 billion Euros (European Commission, 2023a, p. 31) and hopes it will contribute to the European Green Deal by reducing CO2 emissions. The EC recognizes that this will require the multi-level involvement of various European actors, particularly those in cities. One of the core strategies to support the Cities Mission is the instigation of the platform ecosystem NetZeroCities. The platform's interface is web-based, like other innovation platforms. The EC states that it will use this platform ecosystem to co-create the formal commitments – called Climate City Contract – of participating cities like Rome, Amsterdam, and Munich with local actors (e.g., citizens) to reap broad support (function 9).

NetZeroCities aims to address climate change (function 1) and encourages efforts directed toward the decarbonization and climate neutrality of European cities (function 2). It is a "one-stop-shop Platform" (European Commission, 2023b) that "will be accessible to all cities, aggregating new and existing tools, resources and expertise" (LGI Sustainable Innovation, 2023). The orchestrator of this platform ecosystem organizes several sensemaking workshops, conferences, and forums to coordinate the mission (function 3). It additionally helps the experimental pilots of cities (function 6) to support their learning-by-doing (function 4). Moreover, it contains a knowledge repository and a 'twinning program' to promote knowledge exchange between cities (function 5). It additionally provides a 'finance guidance tool' to help cities find the appropriate financial resources for their projects (function 8). That said, NetZeroCities does not specify

how and if it supports market creation through the platform (function 7). Overall, these statements suggest that NetZeroCities could play an important role in supporting various functions of the innovation system that pertains to the Cities Mission.

5. Discussion: towards mission-oriented platforms

In this article, we have explored how platform ecosystems can support the functions of an MSIS. For example, platforms can help align, connect, and facilitate collaboration among stakeholders and, as such, support the coordination of the transition. We have also argued that such platform ecosystems may support functions in various ways, to various extents, and with or without intent. In addition, platforms can be an integral or partial element of an MSIS. Our conceptualization has been primarily deductive in nature, and empirical evidence would help support or reject some of the potential relationships we propose. This conceptual paper, therefore, opens new directions for future research, particularly about efforts that examine the *de facto* effects of platform ecosystems on the functions of MSISs.

Firstly, we speculate that platform ecosystems provide the greatest support for the functions of coordination (function 3), market creation (function 7), and resource mobilization (function 8). Future research could examine the role of platform ecosystems in supporting such functions more in-depth to yield a better understanding of a platform's contribution to missions. Our scope is limited to the functionalities introduced by Elzinga et al. (2023). However, we recognize that the validity and usefulness of these mission-specific functions are still a topic of debate (Coenen et al., 2023; Wesseling & Meijerhof, 2023). Other studies could expand our analysis to other potentially valid functions.

Secondly, our analysis has considered platform ecosystems in general, but we speculate that specific platform typologies (e.g., Cennamo, 2021) probably have distinct contributions to particular functions. For instance, we see a primary role of information platforms in the functions of knowledge development (function 4) and knowledge diffusion (function 5). Market platforms probably focus more chiefly on entrepreneurial experimentation (function 6) and market creation (function 7). Innovation platforms, however, are likely linked strongest to the functions of solution directionality (function 2), knowledge development (function 4), and entrepreneurial experimentation (function 5). Future research could specifically look at the interoperability and synergies between different types of platform ecosystems (Mosterd et al., 2021) in supporting missions.

Further, we have built our argument primarily on centralized platform ecosystems. Future research could address under which conditions decentralized platform ecosystems (for instance, relying on blockchain technology) are more suitable to support missions. This aligns well with the ongoing debate on centralized and decentralized missions (c.f., Bauwens et al., 2020; Kirchherr et al., 2023).

Thirdly, we expect that platforms can play a significant role in addressing the programming functions providing problem and solution directionality (functions 1 and 2), and coordinating the transition (function 3, Elzinga et al., 2023). At the same time, addressing these functions comes with new challenges, as MSISs comprise a broader set of actors that platforms typically coordinate – actors that would not seek to interact on their own. This contrasts with typical platform contexts, where transaction costs are reduced between parties seeking to interact independently. Consequently, there is a need for empirical research on the extent to which principles of platform ecosystem orchestration from IS and management research apply in these contexts.

Fourthly, we have primarily discussed how platform ecosystems can support the innovation side of MSISs (Elzinga et al., 2023). It would also be insightful to understand better how platform ecosystems support the destabilization side of such systems (Kivimaa & Kern, 2016). So far, the disorganizing properties of technology in general (Ratner & Plotnikof, 2022) and platform ecosystems in specific have been largely unaddressed. Platforms could constrain unsustainable markets or exclude regime players.

In contrast, such potential destabilization mechanisms could also impede efforts towards missions. We wonder if and what type of counterproductive tensions arise between platform ecosystems and functions. We expect platform ecosystems could reinforce incumbent markets and thus impede the competitiveness of niche innovations (Pelzer et al., 2019), for instance, by harnessing network effects. Platform ecosystems can also be used to diffuse misinformation, echo biases, and strengthen power imbalances, all of which could work counter-productive to achieving mission goals.

Fifthly, while some platform ecosystems may, at face value, align with a mission, this does not always hold true in practice. For instance, second-hand market platforms like Vinted may reduce waste streams by enabling clothing reuse, but whether such platforms contribute to circularity missions remains to be seen. Buyers may be inclined to buy more clothes because of the low prices associated with second-hand clothing, and sellers may use their additional income to consume products or services that they would otherwise not have

consumed, potentially negating or even countering the effect of circularity platforms (Jevons, 1856). Attempts to estimate the societal effects of platform ecosystems have been few (for an exception, see Fremstad, 2017).

Sixthly, we would like to raise additional caution on the potential role of platform ecosystems. Several studies have already reported unexpected and undesirable impacts of platform ecosystems (e.g., Mosaad et al., 2023). For example, in some cases, sharing economy platforms have led to employment disadvantages, discrimination, social inequality, and privacy issues (Mosaad et al., 2023). Clearly, platforms can create new problems. Therefore, future research should consider the 'dark sides' of platform ecosystems. Responsible platform instigation and governance likely require inclusive, reflexive, and anticipatory practices that align platform genesis with societal values and worldviews (Stilgoe et al., 2013).

Lastly, platform ecosystems rarely emerge in their final form (Dattee et al., 2018), and their genesis is a messy process that necessitates multi-sided conversation and iteration between the orchestrator and ecosystem participants. Hence, employing platform ecosystems as a tool comes with uncertainties concerning the eventual design and functionalities of the final tool. Further, the participants who join platform ecosystems in early phases (early adopters) typically do not reflect the diverse interests of society at large. This is a challenge because platform ecosystems that engage with a broader set of participants are often deemed more legitimate and may expect greater support and adoption. We therefore advocate future research that studies how platforms can be 'best' instigated in the context of missions.

6. Concluding remarks

In this conceptual paper, we explored how platform ecosystems can support the functions of MSISs – that is, how they can promote the key processes that explain the ability of innovation systems to pursue and complete a societal mission. Based on the literature on mission-oriented innovation policy, transitions, and platform ecosystems, we have explored how platform ecosystems could do so. Additionally, we used a vignette to animate our conceptualization and illustrate how European policymakers already use the NetZeroCities platform as a tool to coordinate the so-called 'Cities Mission.' While the vignette is not a robust case study, it points to the broader relevance of platform ecosystems concerning MSISs.

We conclude that platforms may support functions in numerous ways, to several extents, and with or without their intent. These platforms can be a dedicated or overlapping part of an MSIS. We have also

speculated that platform ecosystems may be most helpful in promoting the functions of coordination (function 3), market creation (function 7), and resource mobilization (function 8). Platform ecosystems can provide problem and solution directionality through the developed identity, roles, and value proposition. The associated structures, rules, and incentives subsequently act as coordinating mechanisms that partly determine how actors react and interact concerning a mission.

In addition, platforms can enable and facilitate the development and diffusion of knowledge by providing (raw) data, aggregated insights through built-in analyses, sharing records such as news articles, and offering infrastructures for collaborations. We also discuss how platform ecosystems may provide spaces in which sellers, users, and consumers can interact, for instance, with the intention of experimentation or market creation. Platform ecosystems, furthermore, represent mechanisms to collect and allocate resources (e.g., financial, material, or human capital) while legitimizing particular problem definitions and solution pathways – all of which could help mission efforts.

Consequently, this conceptual paper opens a novel debate on platform ecosystems in MSISs. We have suggested various important avenues for future research. For example, we advocate research that could empirically validate or reject our conceptualization and help understand how platform ecosystems support/hinder the innovation and destabilizing side of MSIS functions. Destabilization could occur by restricting certain markets, mitigating entrepreneurial experimentation, or moderating the power and access of actors. If platform orchestrators indeed possess such abilities, then this inherently raises new normative questions about whether such actions are desirable and effective in the first place.

To conclude, this conceptual paper explored how platform ecosystems can support the functions of MSISs. Further research is needed to understand better how one can govern such platform ecosystems to pursue and complete societal missions effectively.

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