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Research Paper

How product development partnerships support hybrid collaborations dealing with global health challenges

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ABSTRACT

Product Development Partnerships (PDPs) are organizations that target economically-deprived markets, aiming to develop a product by integrating contributions of diverse partners. They have gained importance in the global health arena by targeting and developing drugs for neglected tropical diseases. Their projects are difficult to manage given the multiplicity of roles, objectives and institutional logics of the partners that participate in the collaboration. We explore activities and strategies that platform PDPs – PDPs that orchestrate hybrid project networks – employ to stimulate collaboration between heterogeneous actors. Based on the analysis of two platform PDP projects targeting poverty-related diseases, we propose a framework outlining two innovation collaboration models. With this we support the better understanding of PDPs, which are gaining momentum to facilitate socio-technical transitions across the globe to tackle poverty-related diseases.
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1. Introduction

Poverty-related diseases constitute a global health challenge due to their high morbidity and mortality rates [1]. Diagnostic tools and drugs targeting poverty-related diseases are unappealing to develop for private companies as they account for a market population with low financial resources and are thus considered to be less profitable [2,3]. Public parties like academia and NGOs may aim to target these diseases, but lack the necessary resources to make the translational step from research to the market and patients [4]. There is a need for transforming socio-technical systems in such a way that medicinal innovations for poverty-related diseases are stimulated.

To meet this goal, push and pull mechanisms have been established, with the main goal of stimulating pharmaceutical companies and knowledge institutes to invest in R&D for poverty-related diseases. Push mechanisms include public R&D funding and tax credits, whereas pull mechanisms include extended market exclusivity, tax credits on sales of developed drugs and priority review vouchers [5–7]. In addition to these policy instruments, new organizational forms have emerged since the turn of the millennium, amongst which public-private partnerships (PPPs) dedicated to R&D for poverty-related diseases are prominent [6,8]).

This paper looks into a specific type of PPP that has gained momentum over the past two decades: Product Development Partnerships (PDPs). The challenge for PDPs as an organization is to bring public and private partners together, aimed at the discovery and development of, amongst others, pharmaceutical or diagnostic products [9,10]. It has been defined as a collaborative organizational innovation [11] covering "a partnership model prioritizing a need-based approach to research and development" [12][1]. PDPs can focus

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[1] Product Development Partnerships are a relatively new organizational form that lacks a clear definition in literature. The word 'partnership' might apply to the various projects they organize and in which multiple organizations participate. In practice however, scholars use the term to describe the organizations that continuously coordinate collaborative projects, potentially involving different partners per project.

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their research and development on one or multiple diseases [13]. In 2017, there existed around two dozen PDPs for neglected diseases [14]. Prominent examples include the Drugs for Neglected Diseases initiative (DNDi), the TB Alliance, and the Global Alliance for Vaccines and Immunization (GAVI). Disease areas in which PDPs are most active include malaria, HIV/AIDS and Tuberculosis [14]. PDPs exist in various forms, executing different kinds of activities. Some are led by established governmental, inter-governmental or not-for-profit organizations, focus on in-house development and specialize in the R&D process. Others are independent legal entities, controlling funds, taking decisions centrally and relying on external partners for R&D activities [6,10]. The latter kind has been described as 'virtual companies' or 'social capital venture funds'. PDPs also vary in focus, e.g. emphasizing R&D or enabling global access to pharmaceuticals through capacity building in endemic areas or technology transfer [6,10].

In this paper we focus specifically on PDPs as independent legal entities that act as orchestrators between institutionally-diverse partners. They aim to provide collaborative platforms pursuing goals based on independent scientific insight into unmet medical needs [15]. They "combine academic brain with pharmaceutical muscle" [16,17] by allocating funding to promising projects, coordinating partner activities and managing project portfolios. In theory, these what we call here platform PDPs should be well positioned to address poverty-related diseases, because 1) they have a global outreach and as such are able to connect pharmaceutical companies and clinical partners in several countries; 2) they have transformative missions, e.g. to deal with eradicating certain diseases; and 3) platform PDPs are able to facilitate collaborations across institutional boundaries, e.g. public and private parties [1,3,11].

Research has made clear that PDPs have achieved goals such as contributing to innovations for diagnosis and treatment of poverty-related diseases and introducing drugs to the market [10,12,18]. This paper specifically focuses on the challenge platform PDPs face of facilitating collaboration and convergence across different types of actors to reach such milestones. Previous research has attempted to define and describe different characteristics of PDPs, such as their aim, legal structure, funding structure, and organizational structure [1,10,14,19]. What is still lacking in current literature is research on *how* platform PDPs facilitate collaboration across different types of actors stemming from public, private, academic, non-profit, and philanthropic sectors. These actors have different institutional backgrounds and thus adhere to different institutional logics [20]. This translates to diverse organizational routines that influence the ease of collaboration between these actors [21]. We aim to answer the following question: *what activities and strategies do platform PDPs employ to stimulate collaboration between heterogeneous actors?*

To investigate activities and strategies, we build on concepts of two bodies of literature. First, platform PDPs can be regarded as *transition intermediaries*, i.e. "actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new collaborations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations" [22]. In this case, the dominant, unsustainable socio-technical configuration describes the drug development industry that, without interference, fails to allocate research and development efforts to poverty-related diseases. Platform PDPs contribute to a transition towards novel organizational forms and collaboration that help overcome this problem. We use literature that proposes activities that intermediaries can take on to align multiple organizational objectives and target 'wicked problems' [23], as change agents of institutions [24,25], and as actors that need to maintain a legitimized position in a heterogeneous context [26]. Second, platform PDPs engage in *hybrid organizing* when setting up their cross-sector collaborative partnership projects [27]. Hybrid organizations like PDPs and their projects represent novel combinations between existing organizational templates [28,29]. Organizing this requires certain strategies, which have been described in literature on hybrid organizing and that we apply to our cases.

Empirically, we investigated hybrid collaborations in two projects coordinated by two platform PDPs in the field of poverty-related diseases: a partnership aiming to find a treatment for pediatric schistosomiasis coordinated by the PDP Lygature and a partnership to find a treatment for malaria coordinated by the PDP Medicines for Malaria Venture (MMV). Lygature and MMV are salient examples of platform PDPs targeting system failures in economically-deprived contexts by building collaborative platforms. In both cases, pharmaceutical companies who have unique and necessary resources, lacked incentives to invest in poverty-related diseases given that profit prospects are limited. And in both cases, public organizations had targeted these diseases, but lacked resources to make the translational step from research and knowledge to the market on their own [4,30]. MMV was established in 1999 and is one the most prominent and well-known examples of PDPs for drug development [31]. Lygature was the result of a merger between two research-facilitating foundations in 2016 and is thus a relatively new player in the PDP field. From these case studies that differ in maturity but have the same aims, we distill strategies of PDPs dealing with hybrid collaborations, which led us to propose two innovation collaboration models. With this we aim to support better understanding of PDPs, which is important since PDPs are gaining momentum to facilitate socio-technical transitions across the globe to tackle poverty-related diseases.

2. Building on theories of intermediary and hybrid organizations

To gather insight into activities and strategies that platform PDPs employ to stimulate collaboration between heterogeneous actors, we borrow from literature on transition intermediary organizations and from hybrid organizations.

2.1. Transition intermediary activities

Transition intermediaries adopt entrepreneurial roles by approaching persistent problems in new manners and in doing so facilitate transitions of socio-technical systems [32]. In the case of poverty-related diseases, PDPs that provide platforms to facilitate collaboration act as transition intermediaries targeting neglected areas of research and development by seeking out partners that are fundamentally different in terms of their institutional background.

Typically, transition intermediaries engage in several activities, e.g. to enable cooperation between different types of actors, facilitate flows of knowledge, or contribute to articulating visions of future solutions, etc. [26]. Van Lente proposed three key sets of activities: 1) articulation of options and demand; 2) alignment of actors and possibilities; and 3) support of learning processes [33]. Howells advanced a more elaborate list of activities that intermediaries employ [34]:

i. Foresight and diagnostics
ii. Scanning and information processing
ii. Knowledge processing, generation and recombination
iv. Gatekeeping and brokering

v. Testing, validation and training
vi. Accreditation and standards
vii. Regulation and arbitration
vii. Protecting results
ix. Commercialization
x. Assessment and evaluation

We adopted the list as the empirical entry point to understand what platform PDPs that act as intermediaries do in their projects to align different actors and avoid conflicts along the way. These activities are focused on the operational dimension of collaboration, i.e. how projects should be set up. Platform PDPs may execute more, less or other activities than the ones mentioned here, but we use this framework as a starting point for analysis.

A second dimension of supporting collaboration between heterogeneous actors, next to the operational one, concerns the creation and maintenance of legitimacy. Involved actors need to be satisfied with the goals and operations of the project in order to collaborate. In other words, how are platform PDPs perceived by participating actors, and are the activities performed by the PDP regarded as acceptable?

In our case, we see that PDPs have a distinctive mission, e.g. to tackle a certain disease area, which aligns with the notion of transition intermediaries as directional agents [35]. Additional missions include providing project management and providing specialized support for partnerships [36]. This may become easier as their legitimacy grows based on previous positive output of projects they have coordinated. We expect that in the context of individual projects their role is neutral, though, similar to what has been theorized on intermediaries. Given the multiple backgrounds of the actors involved, intermediaries can only manage the project and maintain legitimacy with all parties involved, if their position is neutral, i.e. they do not exclusively adhere to the logic of one of their involved partners, and if they are impartial regarding the stakes in projects [26,37]. An intermediary should explicitly strive to safeguard the multiple interests that it attempts to align, while simultaneously safeguarding the project's overarching goal, without introducing any stakes of its own. Intermediaries should also maintain a degree of independence in project selection [25]. Moreover, studies emphasize that legitimacy can be raised by carefully thinking about which actors to include in a project. Attracting established organizations or being associated with them helps raising legitimacy [38]). Excluding actors from the partnership which may otherwise frustrate the process, has also been considered a key to the success of an intermediary [39]. Positioning in projects, as well as project and partner selection are careful activities that influence the perception or legitimacy of the project.

The operational and legitimacy dimensions of supporting collaboration between heterogeneous actors are studied by focusing on the activities of platform PDPs. From these activities strategies are distilled. To complement the types of activities advanced by transition intermediary studies, we now turn to the hybrid organizations literature.

2.2. Hybrid organizations and their strategies to deal with hybridity

Organizational forms provide order and structure to the way organizations shape and execute their activities, while simultaneously providing recognizable and trustworthy templates [40,41]. It is common to distinguish between commercial businesses, public organizations and civic organizations, which correspond to the private, public and non-profit sectors [40]. Over the past decades, we witnessed a surge in hybrid organizations that combine aspects of different organizational forms [42–44]. Platform PDPs are a salient example of organizations combining different organizational forms through involving various partners in their projects and facilitating collaboration among them.

Such hybrid organizing comes with challenges, as combining aspects of multiple organizational forms leads to internal and external tensions [42,45,46]. A way to theorize about such tensions is to understand hybrid organizations as combining multiple institutional logics in unprecedented ways [21]. Institutional logics have been defined as "the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" [20]; p. 804). Hybrid organizations combine multiple logics and they therefore need to employ strategies to deal with this hybridity [21]. Proposed two hybrid strategies based on hiring and socialization processes. We use these strategies as a starting point to explore the hybridity strategies applied by platform PDPs to facilitate hybrid collaboration.

The first strategy is coined 'apprenticeship' and entails "a tabula rasa hiring approach with a means-focused socialization approach" [21]; p. 1435). What is key to this approach is hiring personnel without much experience and preconceptions, as to ensure they can adopt a hybrid logic without having to deviate from a previously adopted organizational logic. The organization socializes new personnel in a means-focused manner implying that employees collectively strive for operational excellence. The strategy largely avoids the emergence of internal conflicts and tensions as all employees of the organization are trained in a similar way and setting. However, this strategy requires time and space for employees to learn [21].

The second strategy is coined 'integration', entailing "a mix-and-match hiring approach with an end-focused socialization approach" [21]; p. 1435). The integration approach focuses on organizations hiring experienced employees with different institutional backgrounds and expertise. Being carriers of different institutional logics, they are hired and motivated to support and strive towards shared hybrid organizational goals. The socialization process revolves around the focus on specific goals, and collectively working toward those goals. The pre-existing expertise of the employees enables such organizations to become operational fast, yet simultaneously increases the risk of personnel polarizing into subgroups with their own identities, reflecting the differing organizational logics based on their previous experience [21].

We use the two strategies to delve into the way PDPs deal with the creation of common identities versus the formation of subgroup identities. This balancing act is relevant to platform PDPs because their projects benefit from heterogeneous input by diverse partners, that often have not collaborated together previously, but do need common goals to be effective and legitimate.

3. Methodology

3.1. Design and case description

We study two PDPs that initiate and manage projects with the aim to find new treatments for particular poverty-related diseases by providing collaboration platforms. Our starting point was formed by the Lygature case. Lygature is a non-profit organization based in The Netherlands whose core business is to coordinate and facilitate public-private partnerships striving for new medical solutions [47]. Lygature was the result of a merger between Top Institute Pharma (which had a budget of 274 million euros) and the Center for Translational Molecular Medicine (which had a budget of 300 million euros) in 2015 [48]. They host 50 employees in 2020, and receive funding for their projects from various organizations, including the Dutch Ministry of Foreign Affairs, the Innovative

Medicine Initiative, the Bill and Melinda Gates Foundation and the Global Health Initiative Technology Fund. The organization has >20 active projects collaborating with >100 partners and focuses on five main portfolios: regulatory innovation, data infrastructure, flagship alliances, strategic asset sharing and global health. We focus on the global health portfolio for this paper. Within this portfolio one of the oldest projects is the Pediatric Praziquantel consortium, started in 2012 under Top Institute Pharma. Its objective is to develop a pediatric formulation of praziquantel, which is a drug to treat schistosomiasis. Schistosomiasis is a salient example of a poverty-related disease affecting more than 240 million people worldwide, notably in African countries [49,50]. By 2018, phase I and phase II clinical trials have been completed and the phase III development program, testing the drug on a larger set of patients, was announced in May 2018. If successful, the product is expected to be ready for launch in endemic countries by 2021 [51].

We see Lygature as a relatively new entrant in the field of platform PDPs – building on relevant experience and expertise of Top Institute Pharma and the Center for Translational Molecular Medicine – and therefore were interested in comparing Lygature to a more mature platform PDP: the Medicines for Malaria Venture (MMV). MMV is a not-for-profit public-private partnership, established in Switzerland in 1999, with the mission to discover, develop and provide antimalarial drugs. MMV has a broad portfolio of 46 active cases in various stages of the development [16]. It hosts a little over 100 employees. In 2019 it's expenditures amounted to 96.6 million USD [17], and they have received over half of their funds from the Bill and Melinda Gates Foundation. Since 1999 19 new malaria drug targets have been validated by the organization. Two drugs – Artesun® and Coartem® - have been distributed to endemic areas [52]. The project we studied is called DSM265 and has run since 2012. In 2020 it is in the development phase. DSM265 is a potential single-dose cure for plasmodium falciparum malaria, which would greatly ease the treatment of patients in endemic areas. The molecule kills drug-resistant malaria parasites in the blood and liver by targeting their ability to replicate [53]. DSM265 also shows promise to act as a chemo-preventive agent, which could be used not only to treat, but also to prevent malaria in patients. In 2016, a phase II clinical trial in Peru was successfully finished. The potential as a novel chemo-preventive agent of DSM265 is being investigated in Germany and USA in an ongoing study.

Both cases represent platform PDPs that actively coordinate and participate in projects in which actors from different institutional and geographical backgrounds engage in pharmaceutical R&D dedicated to poverty-related diseases. One author spent several months as an observing researcher at Lygature, thus being able to get a unique insight into the functioning of such a PDP. We selected MMV as a second case to compare the relatively young organization Lygature, with a well-established and older example in the PDP arena for drug development. In this way, we are able to reflect on the fact that PDP status and model can change over time and that newer PDPs might be inspired by older PDPs [12].

The two projects both include a heterogeneous and hybrid set of actors originating from multiple countries. The Pediatric Praziquantel consortium include two pharmaceutical companies (Merck KGaA and Astellas), an SME (Simcyp) and two public research institutes (Swiss TPH and Farmanguinhos). The DSM265 consortium consists of three public universities (UT Southwestern, University of Washington, Monash University) and two pharmaceutical companies (Abbvie and Takeda). These differences in institutional background and accompanying institutional logics constitute a gap between these actors who in other contexts are not likely to collaborate.

3.2. Data collection

We gathered data in documents, interviews, through observations, and surveys. We used documents like annual reports, website texts and articles written by or about MMV and Lygature. Annual reports and specific website pages provided valuable input for contextualizing and understanding the selected PDP projects, their goals, milestones and involved partners. Articles concerning MMV and Lygature increased our understanding of their nature and functioning.

We conducted semi-structured qualitative interviews with project leaders at the PDPs. Ten interviews, lasting approximately 60 min, were conducted both with employees at Lygature and at MMV. Six of these interviews were used to gather insights into the background and functioning of the platform PDPs in general, and four to investigate the respective projects specifically. The same interview protocol was used for both types of interviews (Appendix A in Supplementary Data). In these interviews we asked questions concerning strategies to cope with the institutional hybridity within the projects and operational and legitimacy-building activities of the PDP. The interviews were conducted face-to-face in case of the Lygature interviews and through teleconferences in case of the MMV interviews.

In the Lygature case the main author was an observing researcher at Lygature between September 2015 to June 2016. She attended staff meetings throughout this period and talked extensively to employees about their work for the organization and the functioning of the organization itself. She performed several informal interviews to understand the structure and activities of the PDP.

As the interviews and observations are conducted inside the PDPs we enriched and triangulated our data by surveying the 34 network partners of the two projects (Appendix B in Supplementary data). We used the survey to gather illustrative data on the characteristics and level of hybridity of the project partners (type of actor, aims, roles of individual participants), as well as on how they perceived the PDP's legitimacy and to what extent they indicated to place trust in them.

3.3. Operationalization

The explorative nature of our research is guided by using sensitizing concepts Bowen [54] derived from the activities and strategies introduced in Section 2. First, we explored the activities that the participants in the platform PDPs employed through document analysis, observations and qualitative interview questions. We took into account the operational dimension using Howell's [34] typology of intermediation roles (Table 1; questions 5–6 in Appendix A), and the legitimacy dimension (Appendix C; questions 12–17 in Supplementary Data). We explored strategies to deal with hybridity inductively through our interviews (questions 7–11 in Appendix A).

Second, we surveyed stakeholders working at the organizations that participate in the projects to contextualize the level of hybridity in the project and how the role of the PDP is perceived. The respondents were first asked about their background by categorizing themselves as representing university, (state-owned) research institute, private pharmaceutical company, NGO, SME or intermediary organization, and as either a public or private actor. Then the partners were asked about their opinion of the PDP and to what extent they placed trust in them and their activities. They were then asked to describe the overall goal of the project and their personal goal within the project. The latter was done to investigate if there was a clearly-defined shared goal and if personal goals differed highly or not, which would also indicate hybridity in the

Table 1
Operationalized activities based on Howell's [34] typology.

Howells' typology	Operationalized activities
1) Foresight and diagnostics a) Technology foresight and forecasting b) Articulation of needs and requirements	Continuously taking stock of necessary knowledge, technology(s) and resources (e.g. manpower, funding, materials) needed in project X at present time and in the future
2) Scanning and information processing a) Scanning and technology intelligence b) Scoping and filtering	Scanning the environment and (potential) partners or indirectly involved actors for relevant knowledge, technologies and resources (including funding) for project X
3) Knowledge processing, generation and recombination a) Combinatorial b) Generation and recombination	Formulating a specific project plan (e.g. a consortium agreement) by combining knowledge, technologies and resources from project partners (and potentially yourself) in a goal-oriented manner
4) Gatekeeping and brokering a) Matchmaking and brokering b) Contractual advice	Matchmaking and intermediating between (potential) partners involved in project X (potentially including contractual advice) to facilitate successful collaboration
5) Testing, validation and training a) Testing, diagnostics, analysis and inspection b) Prototyping and pilot facilities c) Scale-up d) Validation e) Training	Capacity building of (endemic) partners and validation/quality control of their activities in project X
6) Accreditation and standards	Setting of standards or certain requirements concerning project X's activities and accreditation
7) Regulation and arbitration a) Regulation b) Self-regulation c) Informal regulation and arbitration	Regulating (e.g. by setting codes of conduct) partner's activities formally and informally Arbitrating between the project network and external parties
8) Protecting the results a) Intellectual property (IP) rights advice b) IP management for clients	Protecting the results of project X through intellectual property management or through an advisory role concerning the matter
9) Commercialization a) Marketing, support and planning b) Sales network and selling c) Finding potential capital funding and organizing funding or offerings	Exploiting/distributing the outcome of project X by either 1) spreading new knowledge/technologies in the field of poverty-related diseases and/or 2) focusing on marketing strategies, analyses of (local endemic) stakeholders and the construction of potential local distribution networks
10) Assessment and evaluation a) Technology assessment b) Technology evaluation	Assessing and evaluating the project (at various decision points/stages)

sense of purposiveness within the project.

3.4. Data analysis

To gather insight into the activities of platform PDPs we collected affirming or negating statements in semi-structured interviews and observations applying the concepts introduced in Section 3.3 (Table 1 and Appendix C). We used these codes as a starting point to build a framework to understand the strategies they employ to deal with institutional hybridity in the PDP networks. We also used the interviews to ask the project leaders and participants directly about these strategies in an inductive manner. Conducted qualitative interviews were coded in open-source NVivo software. The coding process started directly after the interviews. We marked and labeled the relevant parts of the interview according to their content by means of these codes. We allowed for the development of new codes for emerging activities and strategies to accommodate arguments and perceptions not fitting the pre-determined codes. In the end, the coded operational and legitimacy activities are then perceived through the lens of the two hybrid collaboration strategies (cf. Section 2.2).

4. Findings

4.1. Lygature: Pediatric Praziquantel Consortium

4.1.1. Lygature's activities within the project

Lygature carried out activities in most of the ten types identified by Howells in the Pediatric Praziquantel Consortium (see Table 2). No additional activity categories were mentioned. Lygature is proactive in taking stock of necessary resources, scanning their environment for them and formulating a specific project plan (activities 1, 2 and 3). According to the project manager these agenda-setting and resource-mobilization activities help to set specific goals for diverse partners that join the hybrid collaboration and subsequently provide them with the necessary means to do so.

Subsequently, related to activities 4 and 5 regarding network building, they approach and involve partners that are (potentially) valuable to the project and facilitate contractual relationships between all parties involved. In this way they help to establish and formalize the responsibilities and rights of the partners. The project coordinator stated that they also broker between partners if need be, but take a facilitative rather than normative stance when it comes to this. They did not focus on setting standards or regulations around the project (activities 6 and 7). This was mainly because many regulations are already in place in the drug development industry. They did however mention to envision developing standards for effective public-private collaboration.

Finally, they employed the last three activities, indicating they are involved in protecting and exploiting the output of the project. The project's output was protected through the consortium agreement covering intellectual property rights and exploited through efficient communication strategies and by learning from local initiatives in endemic countries. Evaluation and assessment enabled Lygature to improve the functioning of the project (team) as well as develop as an enabler of public-private collaboration.

In addition to the operational activities, we observed several legitimacy-related activities that Lygature undertook. First, Lygature carefully selected project partners using criteria like resources and specific expertise of prospective partners. Actively attracting established organizations specifically to stimulate the legitimacy of the project has not been a strategy of Lygature. However, one employee mentioned that: "*larger established organizations often possess necessary resources and are thus naturally involved in the*

Table 2
Activities of lygature within the Pediatric Praziquantel Consortium.

Operationalized activities	Conclusion
1. Continuously taking stock of necessary knowledge, technology(s) and resources	**Yes**, with a focus on the transition from one drug development stage to the next
2. Scanning the environment	**Yes**, with a focus on the transition from one drug development stage to the next
3. Formulating a specific project plan	**Yes**
4. Matchmaking and brokering between (potential) partners	**Yes**, including contractual relationships between all partners involved, but brokering to an extent, i.e. more facilitative than normative
5. Capacity building of (endemic) partners	**No**, except strategically putting it on the agenda
6. Setting of standards	**No**, but may become normative in terms of collaboration standards
7. Regulating	**No**, except when it comes to gathering the proper documents that need to be sent to the funder
Arbitrating	**Yes**
8. Protecting results	**Yes**, through the consortium agreement, in collaboration with partners
9. Exploiting/distributing the outcome of project	**Yes**, through communication strategies and by learning from existing local initiatives
10. Assessing and evaluating the project	**Yes**, and they're increasingly becoming aware of their role in evaluating the process

partnerships." Another explained that partner selection relies on networking saying that: "*it's all about who you know. For us that has proven to be essential*." The main rationale behind selecting partners was then taking practical factors into account such as external funding priorities and necessary resources. Respondents indicated to maintain a neutral stance when it came to this. When potential partners meet these practical criteria, the existing network of the organization plays an important role.

Second, Lygature deliberately took a neutral position in the project network, clarifying their role of safeguarding the project's objectives and hybrid collaboration from the start. They describe themselves on their website as a neutral party safeguarding a solution-oriented approach [55] and even as a custodian of trust [36]. They are the main recipient of funding for the projects they coordinate, which requires a relationship based on trust and transparency with their partners. The project leader stated: "*I don't have the impression that there are partners who do not understand what Lygature's role is in the consortium or who think that Lygature doesn't know what it's doing*." Important in this was the role Lygature had in formulating a specific project plan, because this explicitly put on paper what their responsibilities and contributions would be, as well as those of all partners involved. This relationship of trust was underwritten by the partners of the project. In the survey we included four statements concerning the trust the partners confided in Lygature using a 5-point Likert scale, 1 being very little trust and 5 representing a high level of trust. Lygature's partners assigned an average score of 4.5 indicating a high level of trust. Third, the project leader explicitly invested in building trust on a personal level. At the start of the project, partners naturally explored who they were dealing with, but "*overall the personal ties were good and the service offered was well received*." Building networks with professional as well as personal ties is regarded as important, just like providing a proof of concept by delivering valuable work.

4.1.2. Strategies to handle hybridity within the project

Lygature had to cope with hybridity in their projects. The project manager commented on the institutional and organizational gap between the involved partners stating: "*the big companies involved […] are more acquainted with working on projects with timelines and deadlines. They have a much more rigid way of reaching decisions. SMEs, like Simcyp, are able to approve of things by return on email so to speak. Public partners, like Farmanguinhos and Swiss TPH, have less experience with that (…) they are much more research-focused*." He furthermore stated that "*each partner has their own way of doing things, which can cause friction*."

An example of friction emerged when the consortium was faced with a decision between two potential drug candidates that, unexpectedly, showed similar amounts of promise after the first rounds of pre-clinical trials. Some partners wanted to proceed with one of these candidates, while others wished to continue pre-clinical trials with both products. Moreover, the opinion of funders and the World Health Organization (WHO) was influential to the partnership. This led to a difficult decision-making process within the partnership where the Lygature team had an important role to play. They gathered information and opinions of all involved partners. The project leader stated they did not proceed to then present 'a right answer' but that their role was to present all information they gathered to the partners and facilitate decision making. In this way, Lygature crucially prevented inertia within the project. The project manager stated: "*we guided the process which eventually led to a conclusion that all partners could live with*."

The individual stakes of members seemed to converge throughout the project as it was mentioned that "*the second board meeting was completely different from the first one. During the first one all partners were cautious and exploring their own and the other partners' interests, during the second meeting all partners were already more aligned*." Recognizing the different stakes remained a subtle process for Lygature, which involved "*listening and communicating well with all partners, and getting a good feel for what's going on and intervening if that should be required*." This highlights the focus and importance of the PDP in creating close interorganizational and personal ties between the involved partners while balancing the multitude of stakes involved in the context of a shared goal. Frequent communication, in personal and group meetings, was described as important activities leading to building shared goals and horizons.

The descriptions of the overall goal of the project provided by the survey respondents deviated only little, which indicates that it was clearly defined and well understood by the involved partners. Individual interests that were described mostly had a personal functional focus:

> "To provide clinical research support and expertise" (Clinical expert of a large company)
>
> "Challenging project in view of science and people with different cultures" (Unit head of a SME)
>
> "Successful completion of trials, on time, in budget, to speed up access to the children" (Clinical team member of a public research institute)

These quotes show that partners have personal goals as part of the overarching project objective. This indicates that those involved were not fully tied by their organizational backgrounds within the realm of the project, as they considered to be contributing to a

single shared goal. The project manager stated that "*even though sometimes partners use the rhetoric of their parent organization, stemming from personal stakes, most of the time it is the project team against the rest of the world.*" Facilitating this shared project identity was a way in which Lygature could improve collaboration between the diverse partners, which was underwritten by other interviewed employees at Lygature.

When one employee was asked if he felt that partners were willing to be flexible in diverging from their regular routines and practices he responded: "*Everyone wants to be flexible, but they are not always able to, because they have to report back to their own organization's superiors and are dependent on their judgement as well (…) we all think this project is great, but in the end it also costs money and time investment so we often discuss together what proper ways are to approach the internal stakeholders.*" He thus emphasized that the representatives of certain organizations that were personally involved in the project usually wanted to be flexible to work towards the project's main goals, but that they had to justify their actions and investments to their own internal stakeholders, e.g. their superiors. He furthermore stated that this holds specifically true for more hierarchical organizations but that "*once I have somewhat detached the partners [from their own institutional background] they all identify themselves as members of the project that sometimes have to fall back on their parent organization.*" Lygature therefore also provided advice as to how to communicate the project within their own 'home organization'.

The project manager also said that he felt that all partners were willing to think outside the box and that "*some partners are doing things they would not normally do.*" This, he explained, also stemmed from a shared sense of responsibility toward the project and its goals, which is a result of the shared vision and goal that Lygature promoted and the consortium partners have adopted.

The most important strategies to handle hybridity amongst project partners were then to focus on building effective networks by creating close interorganizational and personal ties between all members of the project through contractual relationships and frequent communication and creating a sense of shared identity by detaching them from their institutional background within the realm of the project.

4.2. MMV: DSM265

4.2.1. MMV's activities within the project

Table 3 lists MMV's activities as mentioned in the interviews. The interview respondents did not mention any additional activities. Notably, regarding the first three activities related to initiating and formulating a project, MMV engaged only moderately in taking stock of necessary knowledge and technology and scanning the environment. MMV seemed to scan the environment for lacking resources within the project, but they only started doing this after the project was introduced to them by an academic partner. The organization was not proactive in scanning the environment for potential partners – rather these partners approached them. The only exception was the search for a 'pharma partner' who would be able to take over the project in the future, by this safeguarding the project's sustainability.

In terms of constructing networks (activities 4 and 5), MMV perceived itself as a matchmaker between individual actors and aimed to include specific partners, such as actors from endemic areas. The PDP did not act as a matchmaker between the partners involved within the project and also did not engage in brokering activities. MMV aimed for functional division of tasks within the project and not so much for collaboration, i.e. different partners having distinct and defined tasks, and avoiding contractual relationships between the partners. MMV was not active in the setting of standards and regulations (activities 6 and 7), which was, like in our first case, mostly due to the high levels of regulation already present in the drug discovery and development industry. The PDP was, however, active in protecting and exploiting the output of the project, as well as evaluating it, thus much like Lygature aiming for optimizing the output of the hybrid collaboration (activities 8, 9 and 10).

MMV employs four types of legitimacy-related activities aimed at facilitating hybrid collaboration. First, MMV relies on specific project plans to communicate *"who is going to get what and who is going to do what"* in order to pursue legitimacy of its own contribution and those of the involved partners. Second, the importance of building a network differed, as MMV attracted rather than actively recruited most of its partners. Attracting rather than recruiting partners might be easier for MMV to do because they focus on malaria only, and over the years have profiled and positioned themselves in that field as a central platform and go-to organization for malaria R&D. Third, and related to this they focused more on the selection of specific projects than on selecting and recruiting partners. MMV can independently select the projects it takes on or (partially) funds. The project manager did not mention any major organizational stakes MMV had within the project context aside from the overall project goal, saying: "*I'm entirely committed to the success of this project. And one should never lose sight of the near future so obviously you do your networking activities, this is the modern way of working these days right.*" This networking, however, did not necessarily manifest itself as active partner selection strategies, but is indicative of the fact that good relationship management and successful project outcomes are beneficial for MMV in the long run as it increases their visibility and legitimacy. MMV publishes calls which are the main tool for project selection.

Table 3
MMV's activities in the DSM265 project.

Operationalized activities	Conclusion
1. Continuously taking stock of necessary knowledge, technology(s) and resources	**Moderately**, building on an existing network stemming from the academic source that introduced the project to MMV
2. Scanning the environment	**Moderately**, mostly for funding and searching for a "true" pharma partner
3. Formulating a specific project plan	**Yes**, but only in collaboration with partners individually
4. Matchmaking and brokering between (potential) partners	**No**, because of functional divisions, and the lack of contractual relationships between the partners
5. Capacity building of (endemic) partners	**Yes**
6. Setting of standards	**No**, only following existing standards
7. Regulating	**No**
Arbitrating	**Yes**
8. Protecting the results	**Yes**
9. Exploiting/distributing the outcome	**Yes**, capacity building in other projects
10. Assessing and evaluating	**Yes**

When selecting a project, several partners are usually a given with additional partners being sought if necessary. Fourth, they relied on a proof of concept through the visibility of their previous successful projects. The project manager expressed confidence in the trust partners place in MMV, stating: "*we get positive feedback, I see their enthusiasm and commitment, and I see their ongoing involvement in new projects. So they trust the mission of MMV.*" This trust was also underwritten by MMV's project partners, who assigned an average score of 5.0 on a 5-point Likert scale concerning four statements on the trust they place in MMV, where 1 indicated a very low level of trust, and 5 a very high level.

4.2.2. Strategies to handle hybridity within the project

MMV had to cope with hybrid actors in their projects. The interviewed project manager characterized facilitating the collaboration in the project as follows: "*as a project director of a cross-functional team of that composition, with various parties, virtual teams, across the globe (…) it's conducting a big orchestra of all kinds of different styles of cultural music.*" The project manager further stated: "*when I took over the project (…) I interviewed each individual on the team for at least an hour to understand where they come from, who they are, what is their aspiration, what is their environment and what is their personal goal to the project, and out of this I made my synthesis.*" He stressed that even though partners were different in some aspects, the combination of their expertise and their knowledge was necessary to reach the final project goal.

When partners were asked to describe the main goal of the project, they seemed to agree on developing a single dose treatment of malaria. Thus, the shared goal of the project was well understood by all involved parties. When it came to the individual or organizational goals, they again were aligned to the overall project goal:

> "Interested in using my skills to help MMV meet their goal." (Non-clinical team member of a large company)

> "To decrease the infant mortality due to malaria in the world; find treatment to reduce malaria resistance - humanitarian cause." (Project manager of a large company)

> "Development of new therapies for the treatment of malaria, with an emphasis on treatments for Africa." (Biology advisor development team of a university partner)

The project manager confirmed the convergence on the project goal, at the same time underlining differences in the way partners approach the project stating that "*the goals are the same. But the way to get there … they have different approaches yes, between academic sophistication and industrial pragmatism.*" This underlines differences in institutional backgrounds, requiring the PDP to find an appropriate way to align them. The project manager chose to deal with streamlining information flows by maintaining functional division of work to ensure efficiency, at the same time introducing regular communication. The interviewee commented: "*every two weeks I have a team meeting with the entire team, where we do an update of everything that is going on in the project, so really, the butcher gets to know from the hair-dresser that he is cutting hair and so on, which is not his business but he gets informed. And I do that because I want everyone to have a minimum of level of knowledge.*"

In terms of streamlining the institutional backgrounds of the project partners, the project manager emphasized communication skills: "*you have to have a good sense of emotional intelligence. You have to have a situational management style and I guess you have to have a good level of common sense. So that when a professor of toxicology proposes you a probably meaningful but super complex study, and the pragmatic pharma guy says,* "this is useless because this doesn't take us anywhere"*, we have to find a common ground, not turning down the creative idea of the professor and at the same time telling the pharma guy, hey you are being too blunt, give this a chance.*"

Mediating between partners in this sense and aiding them in finding common ground signaled the effort of the PDP to consolidate the partly conflicting logics of the involved partners. And these efforts seemed to pay off, as one MMV employee stated: "*The more they grow into the project the more they become a family member of it. And they speak the same language.*"

However, the project manager explained that mediating and brokering between project partners has a limit as "*the partners have very specific roles*", "*they do collaborate, but they don't have mutual contractual agreements. So [they] exchange data, but the contract is only between MMV and the respective parties.*" The project manager mentioned that the inherent heterogeneity of the involved partners remained important. He said: "*I don't want to create clones that after a couple of years all have the same style. So the individual style and the individual cultural component and the individual historical background are important because it provides a team dynamic with so many different colors. And it's up to me to make the right painting out of it.*" Heterogeneous networks within projects seem to be valued.

One of the most important strategies to deal with institutional hybridity and support collaboration within the project was to create a shared sense of commitment and belonging. However, MMV relied on heterogeneity within the project networks and on functional division during operations while sufficiently updating the partners of each other's activities. The focus was therefore more on constructing bilateral contractual relationships and less on network building.

5. Analysis of creating hybrid collaboration in PDP projects

Our data showed that Lygature, being a relatively new entrant as a platform PDP, executes activities linked to most of Howell's ten intermediation activities [34]. They scan their environment for partners and resources and shape projects with a specific focus – but these foci vary between projects in terms of targeting multiple disease areas – and congruent timeline. Subsequently, they are pro-active in involving partners and building a network of supporters of their vision. The fact that they started as a PDP platform in 2016 in their current form and under their current name may have played an important role in this. Being a new player in the field, it was necessary for Lygature to actively build a network within which they are now able to find partners for their various projects. Additionally, they broker between partners when this is necessary for the progress of the project. They then employ a PDP model that entails the active establishment of temporary partnerships through ad-hoc partner coalitions that focus on a specific challenge or disease. These temporary partnerships are to a great extent project-based. Thus, focusing on specific projects embedded in a broad portfolio, proposing finite timelines and proactively involving partners are activities that platform PDPs, especially newer players in the field, can employ to initiate goal-oriented partnerships and collaboration of hybrid partners.

MMV employs a different PDP model, when we look at their activities, which may be partially related to their relative maturity in the field. They are less active in scanning their environment for resources and partners, matchmaking and brokering. They rely on networks of academic partners that approach them with project plans, rather than that they have to solicit partners within a project. MMV's established and mature position manifests itself through their modest role in constructing networks. They allocate the agency to form networks to their partners and thus attract rather

than pro-actively involve partners. Their less proactive networking approach might be a result from the fact that MMV has established itself as a stable center of partnerships, functioning as a permanent platform for R&D targeting one specific disease. They accommodate projects with finite timelines on their platform. As an intermediary, MMV does not mainly focus on active matchmaking or brokering, yet they remain a crucial central point within hybrid networks and are evidently valued by their partners. In addition to their established position, which may be related to their maturity as a platform PDP, MMV has a narrow focus in terms of targeting just one disease. Focusing solely on malaria eradication, they are more easily recognized as a 'go-to' organization, or even an obligatory passage point, for any research and projects related to this disease. In addition to this, malaria is a widely recognized and therewith legitimate concern with an *ex ante* agreement on drugs as a solution, underwritten by its status as a high priority disease area as posited by the WHO [56]. This decreases the need for MMV to focus on building legitimacy and a shared identity. Instead, MMV can apply a professional stance towards collaboration relying mostly on bilateral contractual relationships rather than personal ones and focusing on the selection of projects instead of partners.

While the two projects we investigated were coordinated quite differently by the PDPs in question, and the maturity and focus of both PDPs themselves differed as well, both have led to tangible results in terms of successful clinical trials. Both PDPs have thus garnered success with their different set of activities in the projects under study in terms of positive project output.

Next to the operational activities, we investigated activities aimed at legitimacy creation. Lygature indicated that project plans, effective relationship management with their partners in the shape of building strong networks, remaining neutral in project and partner selection, and a proof of concept by recognized project outputs contributed to the project's legitimacy. The construction of their networks is closely related to their ability to strengthen collaboration, since they can only effectively build interorganizational and personal ties if they are capable of understanding and communicating with their diverse partners and creating a shared identity for them within the realm of the project. Successful projects served as validation and contributed to the growth of their legitimacy. They stressed this more than MMV, seeing as Lygature manages a portfolio of diverse projects, thus enhancing the range of their possible partners and their subsequent need to be perceived as a legitimate project by a wide array of actors.

Building on insights into their operational and legitimacy activities to support collaboration between heterogeneous actors, we looked into platform PDP strategies to deal with institutional hybridity in their projects. We found that both Lygature and MMV focused on creating a shared identity for all partners involved, while, likely partially related to their level of maturity, Lygature simultaneously focused on building close interorganizational and personal ties and MMV focused on benefitting from heterogeneity through functional divisions within projects. We were interested to see to what extent these two different, yet successful strategies can be compared with the strategies posited by Battilana and Dorado [21] on hybrid organizations more generally. As discussed in Section 2.2, they identified a strategy of *apprenticeship* and a strategy of *integration* regarding hiring and socialization processes. Evidently, these approaches entail the hiring of employees. In our cases it is more about recruiting organizations to join and making sure these partners collaborate.

Lygature actively targeted and recruited partners to join the PDP project. The nature of the network Lygature built was heterogeneous and involved partners that each contributed their own expertise. This network-building strategy resembled a mix-and-match hiring approach, albeit at the level of organizations, not individual employees. Lygature furthermore invested heavily in the construction of strong interorganizational, contractual and personal ties between them and their partners, as well between the partners amongst themselves, to create an environment of effective collaboration and learning. This resembled a means-focused socialization strategy similar to the one described by Battilana and Dorado [21] under the apprenticeship strategy. In the context of PDPs facilitating hybrid collaboration, we can formulate one strategy as: *actively recruit partners and invest in interorganizational and personal ties to stimulate collaborative learning, in line with a means-focused socialization approach.*

MMV attracted partners that approached them with a desire to join a PDP project. As such, they did not seem to focus on network building as much. The nature of the network that developed, however, was heterogeneous and involved partners who each contributed their own expertise. This again resembled a mix-and-match hiring approach, yet achieved in a different manner. In terms of socialization strategy, MMV indicated not to focus on brokering activities, as all partners had their own expertise and therewith function or purpose within the project. Additionally, the partners only had contractual relations with MMV bilaterally and not with each other. This pragmatic approach resembled an end-focused socialization strategy where all involved partners focus on reaching a specific goal, rather than learning together supported by a common identity. MMV did focus on creating a shared identity and sense of belonging to the project, but also did not want to get involved much in creating or facilitating relationships amongst their partners. We can formulate a second strategy for platform PDPs as: *attract partners and rely on functional divisions within projects, in line with an end-focused socialization approach.*

Lygature and MMV thus employed different strategies to create collaboration in hybrid projects. It is important to take into account that both cases differ in the broadness of their focus. The more specific focus of MMV, and their well-established track record in the drug development for malaria arena, explains why they were able to attract rather than pursue relevant partners, which in turn influenced the extent of their need to apply means-end socialization approaches. The type of problem (in terms of e.g. scope and complexity) a PDP targets then influences which strategy it applies, and experience and legitimacy of the organization might also be of influence. Being a younger player in the field and having a broader focus, such as the one Lygature works with targeting various poverty-related diseases in different projects, may posit a challenge in attracting partners and proving their worth, but also provides possibilities to create sustainable, effective networks that collectively became conducive for a PDP logic that is applicable to a wide array of projects targeting the broader healthcare arena. A broad scope of projects and complex goals that Lygature targets may then constitute more uncertainty with regards to the shape and specific goals of PDP projects, which in turn may increase the need for a means-end socialization approach in order for the PDP and the partners to learn and shape their projects together effectively. PDPs targeting a clearly-defined and delineated goal, e.g. MMV aiming to eradicate malaria, may thrive better under a goal-end socialization approach as all partners often know their roles and responsibilities and those of others in order to reach a specific goal.

The insights concerning the operational and legitimacy activities, as well as the hybridity strategies lead to two innovation collaboration models. An overview of these two models is visible in Table 4.

6. Conclusions and discussion

The socio-technical transitions related to global health, climate and safety call for new partnerships that bring together resources

Table 4
Two innovation collaboration models for platform PDPs.

		Models	
Activities & Strategies		Ad-hoc partner coalitions (Lygature)	Continuous platform (MMV)
Operational and legitimacy activities		Initiating and formulating a project Actively build a network of partners Exploit and protect the outcome of a project Safeguard neutral position by constructing project plans Develop effective relationship management Remain neutral in project and partner selection where possible Showcase successful projects as a proof of concept	Attract project proposals from external parties Accommodate a project network Exploit and protect the outcome of a project Safeguard neutral position by constructing project plans Present the organization as a 'go-to' organization for a specific goal Focus on project selection rather than partner selection Showcase successful projects as a proof of concept
Hybridity strategies:	**Network building** **Socialization**	Actively recruit partners Construct contractual relations between all parties involved Create a shared identity Invest in interorganizational and personal ties	Attract partners Construct contractual relations between the intermediary and all partners, but not partners amongst themselves Create a shared identity Rely on functional divisions within projects

and expertise from organizations operating under different institutional logics. Prominent examples of such hybrid partnerships, in the shape of PDPs, are found in drug development regarding poverty-related diseases [1–3,9]. In this paper we set out to explore the activities and strategies that platform PDPs that act as orchestrators in hybrid networks employ to stimulate collaboration between heterogeneous actors.

In our investigation of two platform PDPs and their projects – the relatively new entrant Lygature's Pediatric Praziquantel consortium and the more mature MMV's DSM265 malaria consortium – we have identified different sets of operational and legitimacy activities to shape collaboration. Lygature represents an example of a PDP that actively builds diverse ad-hoc partner coalitions and invests in the quality of professional, contractual as well as personal relationships between all partners. MMV represents a continuous and focused platform for R&D related to the eradication of one high-profile disease, attracting rather than pro-actively searching for partners and professionally managing them primarily in bilateral contractual ways. In both cases we have seen that main strategies to create legitimacy are constructing project plans and delivering a well-perceived service. By emphasizing the project's shared goal, and clearly stating its role and responsibilities in the realization of the project, both platform PDPs achieved legitimacy with their project partners. Additionally, in the Pediatric Praziquantel consortium, the development of interorganizational and personal relationships with their partners contributed to the project's legitimacy. By contrast, the activities in DSM265 malaria consortium take place in the context of MMV's narrow scope of their organization's mission to become an almost obligatory passage point for collaborative networks targeting malaria.

The operational and legitimacy activities, influenced by the maturity and broadness of focus of the two platform PDPs we looked at, led to shaping two different forms of platform PDP innovation collaboration models. The models articulate strategies for platform PDPs to deal with hybridity in their networks and enhance collaboration. The varying institutional backgrounds of partners in a project pose specific challenges for platform PDPs as intermediary organizations, which by themselves start from a position of limited legitimacy. They can opt to either invest in creating close ties and a shared identity for these diverse partners and detaching them from their institutional background in a more means-end socialization approach (as we have seen in the case of Pediatric Praziquantel consortium), or to create a shared identity and goal yet also rely on functional divisions within projects in a more goal-end socialization approach (as we have seen in the case of DSM265 malaria consortium).

It is important to keep the maturity, or phase of development, of the platform PDP in mind when looking at the models we have described. PDPs are not static and may adapt their models, strategies and activities in response to a changing environment, their own experiences and maturity. Mature PDPs may find it easier to attract than actively approach partners for example, due to their well established and recognized position as well as extensive networks.

The insights into activities and strategies that PDPs working on neglected areas of research and development employ, can subsequently shed light on how policy makers can create a favorable environment for hybrid collaborations to thrive. Policy makers can look into ways of stimulating the formation and funding of PDPs, for example by collaborating with them, or by training skilled professionals that could contribute to the hybrid environments that they operate in. By stimulating hybrid collaboration, governments can address market failures inherent to poverty-related diseases R&D and contribute to a transition necessary for creating a well-functioning innovation system for poverty-related disease treatments.

The qualitative, explorative nature of our research design resulted in the exploration of two cases leading to rich descriptions, albeit with low generalizability. Rather, by selecting two cases we were able to identify two collaboration models that platform PDPs can apply, which serve as building blocks for further theorization about PDPs in hybrid networks. Our approach exploited diverse sources of data, allowing for data triangulation. The interviews have been conducted by one researcher, leading to a risk of biased interpretations and a decrease of internal reliability of the research [57]. We have limited this bias by transcribing interviews as soon as possible and by applying a transparent and consistent coding system. Furthermore, in one of the cases (Lygature) interviews were conducted face to face, whereas for the MMV case interviews were conducted via teleconferences. The different form of communication may have influenced the data, but we tried to reduce this risk by sticking to the same interview protocol and ensuring the same quality in terms of duration and in-depth conversation. The data generated by the survey among involved partners contains a confirmation bias, seeing as all respondents are already actors that have decided to get involved in a PDP project. However, since we were interested to see how partners within a project perceived a platform PDP as intermediary, we still think it is valuable data to confirm if they in fact do trust the work and neutrality of the intermediary.

We encourage future research endeavors into the role of PDPs or other types of transition intermediaries managing collaborative partnerships that target societal challenges. In the life sciences sector specifically, such partnerships are likely to become more important due to pressing problems related to antibiotic resistance, ageing populations, and rising drug prices [58–60]. Lessons learned from research on PDPs, as in this study, provide avenues for extending the range of PDP innovation models, especially in light of making such constellations sustainable. We have identified two models in our research, but different cases may lead to the formulation of additional models in future research. Furthermore, it would be interesting to investigate whether the influences we described make certain models necessary for PDPs with specific characteristics (e.g. in terms of broadness of focus and maturity), or if PDPs can choose to apply different approaches. Likewise, it would be interesting to create a better understanding of the change processes that organizations that enter PDP projects undergo, specifically if these develop stepwise, or if acceleration is possible and under which circumstances. Analyzing such partnerships in different sectors, and combining different logics, is equally important to advance our understanding of transition intermediaries in general, and the (in)effective strategies they employ in their challenging task to manage hybridity in the context of global, socio-technical transitions [22,61–63].

CRediT authorship contribution statement

Marjolein J. Hoogstraaten: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing. **Wouter P.C. Boon:** Conceptualization, Investigation, Supervision, Validation, Writing - original draft, Writing - review & editing. **Koen Frenken:** Conceptualization, Funding acquisition, Supervision, Writing - original draft, Writing - review & editing.

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Appendix A. Supplementary data

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