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Public funding in collective innovations for public–private activities

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Abstract. Whereas in market-driven situations the private parties have an interest in driving innovations towards implementation, in the case of public concerns, it is often the public concern that initiates the innovation process. The issue for the public funding agencies is then to stimulate idea generation and the process towards implementation and impact. However, these innovation processes are complex, as they involve a multiplicity of public and private actors with different and sometimes conflicting concerns. Thus, the benefits and business cases are not immediately clear and this makes it hard to scale beyond the proof of concept. In this paper we examine and derive lessons learned based on a longitudinal case study of a series four EU-funded projects (ITAIDE, INTEGRITY, CASSANDRA and CORE) in the international trade domain that aimed to develop digital trade infrastructure solutions (data pipelines) to address security and trade facilitation challenges. For our case analysis, we adapt and extend Bryson et al.'s framework [1] on cross-sector collaborations. We show how each of these projects covered one part of the public–private innovation trajectory, moving the innovation from the *Initial R&D* stage, to the *Showcasing* and dissemination stage to attract critical mass, towards a *Turning point* stage when the business cases for further upscaling become visible. We identify continuities (i.e. continuity of network & vision, funding and process) as well as a number of alignments as important factors that drive collective innovation processes towards implementation and impact. Further research is needed to establish to what extent these findings are applicable in other contexts.

Keywords: Innovation, Public Concern, Public Funding, International Trade

1 Introduction

When we asked a manager from the Customs Administration of the Netherlands about the role of public funding, his response was very straightforward, namely that public

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funding should only be used for innovations that address public concerns and where the private sector is not able to provide the solution due to a lack of an immediate return on investment, and that public funding should not be used for initiatives that aim to advance the interests of individual commercial companies. While it is not the goal here to argue whether this view is right or wrong, this points to one of the very important functions of public funding, that is, to help address public concerns.

It is often not easy to draw a clear line between what lies within the realm of a public concern and what does not. Public concern can be broadly seen as something that reflects the needs of society, for example safety and security, health, safe environment (including flora and fauna) and economic prosperity. These needs are sometimes equal to private commercial opportunities, but not always. And when they are not, public funding would be beneficial to drive R&D and innovation. Public funding would be valuable to enable public concerns to be directly addressed, but it can also be valuable when these public concerns are indirectly addressed, for instance when innovation leads to commercial products, which in turn generate turnover that may lead to further economic growth. In addition, a business community that does not innovate will in the long term have negative impacts on the economy, thus also on society. Added to that complexity is that in the innovation process to address some public concern, there are a multiplicity of business and government actors with sometimes conflicting goals and business models [6]. Furthermore, in the initial stage of developing innovative concepts and solutions, there are many unknowns and the parties that invest are not necessarily those that will reap the benefits. It is thus hard to take the step from proof of concept towards implementation and impact [11]. And in this process it is no longer clear where the government needs to provide support in terms of funding or other incentives, such as legislation or knowledge dissemination [4], and where to leave it to the market to do the job.

This paper is largely empirically driven. In it, we examine and derive lessons learned based on a longitudinal case study of a series of four EU-funded projects (ITAIDE[1], INTEGRITY[2], CASSANDRA[3], CORE[4]) in the international trade domain that aimed to develop digital trade infrastructure solutions (data pipelines; see [5]) to address public concerns related to security and trade facilitation. For our case analysis, we adapt and extend the framework Bryson et al. [1] on cross-sector collaborations. Based on our case analysis we show how each of these projects covered one part of the innovation trajectory moving the collective innovation from the *Initial R&D stage*, to the *S*howcasing and dissemination stage to attract a critical mass, towards a *T*urning point stage when the business cases for further upscaling become visible. We furthermore identify continuities (i.e. continuity of network and vision, continuity of funding and continuity of process) and a number of alignments as im-

[1] See [14]
[2] http://www.integrity-supplychain.eu/
[3] http://www.cassandra-project.eu/
[4] http://www.coreproject.eu/

portant factors that drive the collective innovation process towards implementation and impact.

The remainder of this paper is structured as follows. In section two, we present our conceptual framework, which is an adaptation and extension of Bryson et al.'s [1] framework of cross-sector collaboration. In section three, we present our case methodology. In section four, we present the summary of our case findings. We end the paper with a discussion and conclusions.

2 Conceptual framework

In this paper we examine innovation processes that are intended to address a public concern and the role of public funding in such processes. A widely accepted definition of innovation is that innovation can be seen as "… an idea, practice, or object that is perceived as new by an individual or other unit of adoption" [10, p. 12]. Although this definition is a useful starting point, it refers to innovations in general and not specifically to those that are intended to address a public concern; we will come back to this point later in this section. An innovation development can be seen as a process that consists of all activities and impacts that arise from the recognition of a need or a problem, through the research, development and commercialisation of an innovation, through the diffusion and adoption of the innovation by users, to its consequences [9]. The duration of an innovation process can vary and can be as much as 15 or more years [8]. Trialability is a key concept from innovation management research [9]. Trialability means that the adoption of a technology innovation critically depends on the level at which organisations can first try out the new innovation in a confident environment and with low investments. In our cases, public funding provided such a confident environment.

More than half a century ago, [7] introduced the term collective action and suggested that such collective action is necessary among organisations to increase the speed of innovation. Looking at institutional innovation, [3] identified a number of processes related to mobilising collective action, namely framing contests, construction of networks, enactment of institutional arrangements, and collective action process. Building on the collective action view, [13] further suggest that collective innovation from initial R&D to implementation can be traced when looking at a continuum of projects. While some projects taken in isolation may appear to result in a collective action failure [2], by taking a longitudinal and cross-project perspective these projects are a necessary step in the innovation trajectory that leads these innovations from initiation to implementation [13]. In addition, the need to organise vision in the collective action for digital trade innovation is also highlighted [15]. Regarding innovations in highly regulated domains such as international trade, multiple levels also need to be taken into account [12] to reflect government influences and regulatory concerns.

[1] explain how cross-sector collaboration involving parties such as businesses, non-for-profit organisations, communities and government is becoming increasingly important for tackling complex societal challenges. Based on a thorough literature review, they develop a framework for understanding cross-sector collaborations. The

framework builds on the following key concepts: initial conditions, processes, structures and governance, contingencies and constraints, and outcomes and accountabilities.[5] The framework presents a suitable starting point for our analysis as it explicitly captures concepts that help to trace the progression from initial conditions towards outcomes and accountabilities. This is in line with our goal to illustrate the progression of public–private innovations from initiation to implementation. Furthermore, the concept of initial conditions is particularly useful, as it will allow us to capture the public concern (e.g. safety and security) and public funding that triggers collective public–private innovation processes. Bryson et al.'s [1] framework is also limited, as it does not explicitly allow an analysis of a multiplicity of projects that taken together can achieve transition towards implementation [13]. Furthermore, the multilevel nature of government is also not explicitly included [12]. The figure presented below shows our initial conceptual framework.

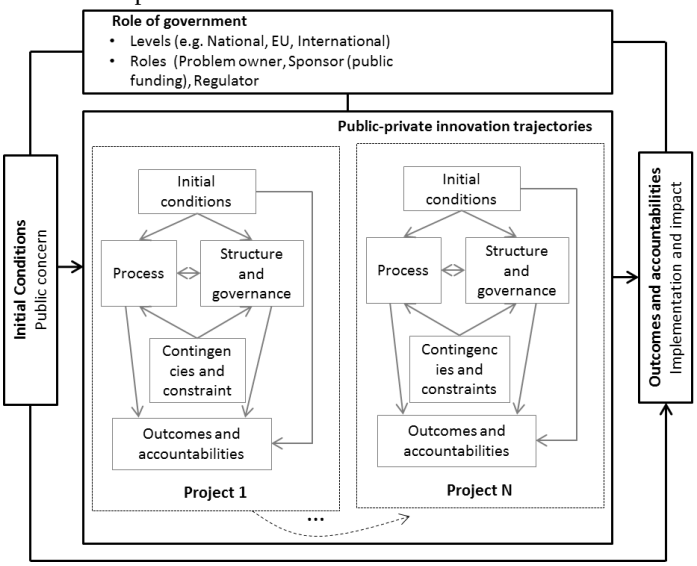

Fig. 1. Initial conceptual framework for public–private collective innovations adapting and extending the framework of Bryson et al. [1].

The above framework builds on [1] in the following way. First, inspired by [1], we look at the process from initial conditions/public concern (left-hand part of Figure 1) towards outcomes and accountabilities (right-hand part of Figure 1). We also incorporate the view that a succession of independent projects can together lead to the scaling up and implementation of the solutions (based on [13]). This is captured in Figure 1 by the block labelled public–private innovation trajectories, where the trajectory con-

[5] In Bryson et al.'s [1] framework, each of these categories is further detailed into subcategories. For the sake of simplicity, we utilise only the high-level categories for building the adapted conceptual framework that we use in our analysis.

tains a number of projects (1...N). At a project level, we again utilise the concepts of Bryson et al. [1] to capture how each individual project (comprising a project-specific set of actors) moves towards specific outcomes. Finally, we explicitly add the government (role and level) in our framework. The levels (national, economic zone (e.g. EU), international) are added to capture the level from which the funding or other source of government influence comes with respect to the innovation trajectories under analysis. In addition, in the conceptual framework we explicitly define three government roles to show that the agency providing the funding is not necessarily the same as the agency that owns the problem (i.e. the agency responsible for addressing certain societal problems) and drafts the regulatory and legislative frameworks.

3 Method

We conducted our case study in an interpretative, processual tradition [16]. The context of this study is a series of four EU-funded projects (ITAIDE (2005-2010), INTEGRITY (2008-2011), CASSANDRA (2011-2014), and CORE(2014-2018)) that were initiated to look for innovative digital innovations solutions to address the safety and security concern in international trade. The Customs Administration of the Netherlands played a key role in all these projects driving eCustoms innovation. A number of university and business partners also remained involved in the continuum of projects, while the network grew.

In the ITAIDE project (17 partners), the idea of reusing business data for government control purposes (also referred to as piggy-backing) was introduced and four living labs with beer, pharmaceuticals, paper and food were used to develop initial ideas and pilot these in a real-life setting [14]. While the innovations that were developed and piloted in ITAIDE showed how they solve the trade facilitation and security concerns, the business cases were not clear enough for parties to pick up the ideas further and there were also legislative constraints.

INTEGRITY (15 Partners) was started as an independent project, but through the involvement of the Customs Administration of the Netherlands some of the lessons learned from ITAIDE were also considered. In INTEGRITY, the UK Customs authority was also a partner and the idea of the data pipeline was born [5]. The data pipeline is an "an IT innovation to enable capturing data at the source" ([6], p. 14). Governments can use data pipeline information for government control purposes. In INTEGRITY, terminal operators were involved in piloting the solutions, but further upscaling and implementation of the solution was not achieved.

In CASSANDRA (26 partners), the data pipeline idea was further piloted, showcases were developed and a lot of effort was spent on disseminating the data pipeline to a wider business and government audience and on awareness building. The development of the Customs Dashboard (a special interface that the Dutch Customs authority uses to access data from the data pipeline) was initiated to allowed Customs to view data pipeline information.

CORE (81 partners) was initiated as a demonstration project with the goal to do large-scale demonstrations. Various data pipelines were piloted and business parties are now investing in developing their own pipeline solutions. One of the pipelines that

is now being rolled out is a block-chain enabled global data pipeline. In addition, the Dutch Customs authority, based on its experiences in these earlier projects, has decided to invest in its own operational Customs Dashboard that can interface with data pipelines. As such, the CORE project can be seen as a *Turning point* where business cases are becoming clear and business and government organisations are investing their own resources to move these innovations towards implementation.

The data collection took place over a period of 12 years. All the authors were involved in at least one of the projects but with different levels of involvement and roles. The authors had access to rich data. This included participation in meetings, redesign sessions, extensive interviews and document analysis in the context of the various demos, workshops and events organised by these projects. The data analysis was performed through the conceptual lens of the framework presented in section two in a number of iterative loops. In order to deal with biases, we benefited from the fact that one of the senior researchers in the team was involved in a limited way in only the ITAIDE project and followed the other projects remotely. As such, this researcher was very instrumental in questioning the assumptions. This led to us to sharpen the analysis and the presentation of the findings.

4 Case analysis

Figure 2 below summarises the results of our case analysis by using the conceptual framework presented in section two. In our analysis, we also identified a number of continuities and alignments that were instrumental in moving the innovation from initiation to implementation. These have therefore been added to Figure 2 and will be explained later. It is important to highlight that unlike commercially driven ideas, where parties can come together, develop a solution and attract investors to bring an idea to the market, when it comes to innovations that are intended to address a public concern, the government has identified the concern but needs to search for ways to address it. In our case, the public concern relates to increasing safety and security, and the EU-funded projects that we discuss were intended to stimulate the development and upscaling of solutions to address safety and security challenges. Looking at the role of government in initiating the innovation trajectories under analysis in our case, this relates to the EU level (see top level of Figure 2). In Figure 2, we use dotted lines to indicate other levels such as national and international, as these can also be sources of public funding, but for this paper they are beyond the scope of our analysis. At the EU level, we explicitly capture that in our case while the funding was provided by DG Research, the problem ownership related to safety and security lies with other DGs (such as DG TAXUD and DG Home), which play an important role setting EU objectives related to societal goals and regulatory frameworks.

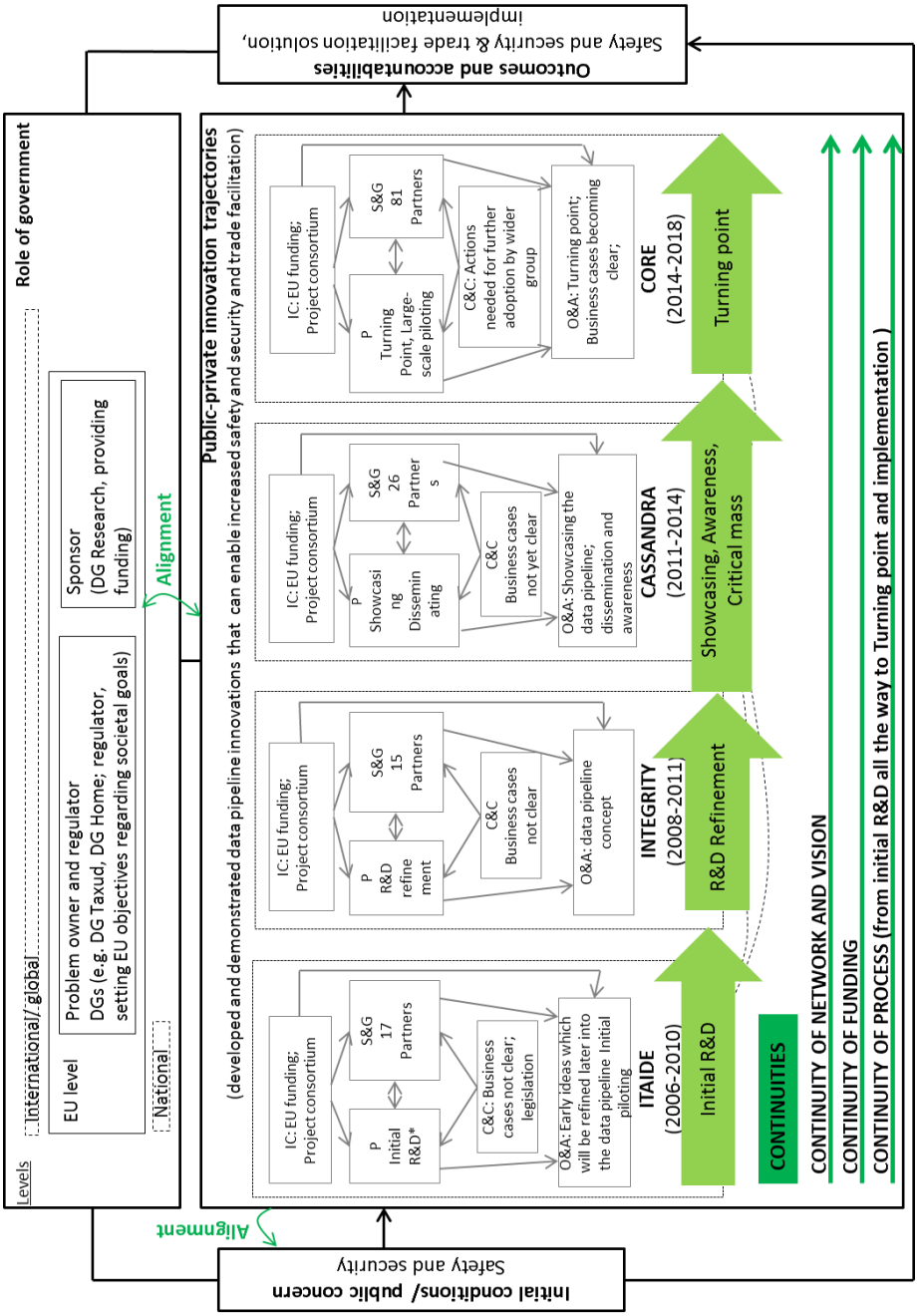

Fig. 2. Empirical model based on adapted and extended conceptual framework of Bryson et al. [1].

We now look at the continuum of the four EU projects and derive a number of observations by looking at the perspectives of process (P), structures and governance (S&G), initial conditions (IC), contingencies and constraints (C&C), and outcomes and accountabilities (O&A) (see Figure 2).

Taking the process (P) perspective from the framework and looking at the continuum of projects, we see that the projects progressed through a number of stages, such as the *Initial R&D* stage in ITAIDE, where initial ideas were developed and piloted in real-life situations; the *R&D refinement* stage, where the ideas further crystallised (the data pipeline idea in INTEGRITY) and were piloted; the *Showcasing and dissemination stage*, where showcases were developed and ideas disseminated to attract further critical mass (CASSANDRA); and the *Turning-point stage* in CORE. Here, a *'Turning point'* is the moment that individual parties take over the next step and use their own resources to further scale up parts of the solutions developed, rather than relying on public/private funding for this upscaling step.[6]

Thus, we see that in the progression towards upscaling and implementation, it was important to have *continuity of the process*[7] in terms of proceeding from one stage of the innovation process to the next stage (i.e. from the *Initial R&D* stage towards *Turning point* stage). Although in our case we do see such continuities, these are not necessarily guaranteed. If funding efforts are focused only on supporting Initial R&D and no progress is made towards the next step, this may lead to the proliferation of ideas and only limited progress towards implementation.

Looking at the structure and governance (S&G) perspective, we can trace the evolution of the network. While the network was relatively small in the *Initial R&D* stage (ITAIDE, 17 partners) and the *R&D refinement stage* (INTEGRITY, 15 Partners), the network expanded further in CASSANDRA (25 partners), where further showcases were accumulated and the idea of the data pipeline was further disseminated to create awareness. This was crucial for making the ideas tangible and getting more and more parties on board, which resulted in the further growth in the number of parties interested in committing to the idea and engaging in large-scale piloting in CORE (81 partners).

What is also key in our is case that some organisations and key people from these organisations remained involved throughout all the projects and sustained the vision. In the continuum of projects that we analysed, there were a few key individuals and organisations that had a vision and were able to carry on the ideas from one phase to another and attract critical mass and funding along the way. That was especially important in the last project, where the network grew significantly and there was a danger of losing focus. As such we see *continuity of network and vision* as key elements

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[6] The R&D stage can be preceded by invention stage where some specific technology is invented and developed (e.g. the Smart container seal was developed by a commercial organisation before piloted in ITAIDE). If in the context of addressing a public concern it is discovered that there is a need to invent new technologies but there is no business drive for businesses to invest in this stage, public funding could be useful to stimulate the Invention stage as well.

[7] We do not see the process as linear, as it can evolve in a number of iteration loops.

for the success of the innovation trajectory under analysis. Continuity of vision and network does not mean that the network remained static and was limited to the same parties; on the contrary, the network grew to include new people and organisations. This was crucial for accumulating a critical mass of parties that subscribed to the idea and were ready to co-invest in the further demos and piloting.

Looking at the initial conditions (IC) (Figure 2), securing funding was key for each individual project. *Continuity of funding* throughout the different projects is another continuity that was essential for bringing the innovation process from initial R&D towards implementation. This was crucial, as without this continuity of funding the process could have stopped at an earlier stage, before the business models were clear and the industry was ready to pick up and invest in the further implementation and upscaling of the solutions. By funding we mean both public and private funding. Had funding been stopped too early, all the earlier investments could have become sunk costs. In the continuum of projects that we discussed above, it was important that the government continued to invest, but it was even more important that in this continuum businesses became increasingly interested and co-invested millions in this process, and that the network grew indicating that more parties started to believe in the ideas. Thus, gaining commitment from businesses to participate and invest in the public–private innovation trajectory is as crucial as the funding agency that provides the public share of funding the initiative.

Regarding contingencies and constraints (C&C), the lack of clear business cases was also one of the key issues, as scaling up could not occur until some of the network partners saw clear value and were willing to further invest. The business cases started to become clear in CORE. It is still a challenge to engage more businesses and government organisations, but this process is currently being driven by pioneering businesses or pioneering governments as part of their own activities. A further challenge was how to perform data analytics on such large data volumes provided by data pipelines. This challenge still needs to be tackled.

Finally, looking at outcomes and accountabilities (O&A), the first three projects achieved project-specific outcomes. Although these outcomes in isolation were not enough to achieve the implementation of a solution to address the societal concern, they were important stepping stones towards implementation in CORE and beyond.

To summarise, we identified three types of continuities – namely *continuity of network and vision*, *continuity of funding* and *continuity of process* (from *Initial R&D* towards the *Turning point*) – as important success factors. We also identified two alignment processes that appeared important and that we discuss below.

Alignment of innovation trajectories with problem sponsor and problem owner: at the EU level, there are two DGs that are crucial for the public–private innovation trajectories: DG Research & Innovation, which provides the public funding, and the DGs that are the problem owners in the problem domain. While it is clear that there will be a lot of pressure to align the project with the DG that provides the funding (through regular review cycles), the alignment with the DGs that own the problem is also crucial for moving towards implementation in the problem domain. And we would argue that not only alignment but tight alignment with the DGs that own the problem is needed. For example, during ITAIDE, links were established with the

problem owning DG and there were regular interactions, but the alignment was not very tight, as the innovation agendas had different time frames and priorities. It was therefore difficult to absorb the results of ITAIDE and move towards implementation. The innovators learned from this experience and made explicit efforts in the subsequent projects to achieve tight alignment. Ultimately in CORE a tighter alignment was achieved, which improved close communication lines and tight alignment between the innovation agenda and concerns of the problem owner DG and the efforts in CORE. However, this link is still not sufficient to align the policy agenda with the outcome of research. That alignment is crucial, especially in highly-regulated domains, such as the area of Customs. The support of the regulator is crucial for ensuring the adoption and upscaling of the innovations and realising further impact. Without such support, even the best solutions on paper will be hard to implement.

Alignment with the public concern and with the innovation trajectory and vision: we found out that it was necessary to constantly match the innovation process steps covered in each project to the source (the reason, the initial conditions/public concern) of funding. We found out, in particular in CORE, due to the many new actors that entered the project it was initially difficult to keep them focused on the initial concept, which made it difficult to keep track with the initial idea. Thus, continuous checks and balances are crucial, especially as the network grows and more actors are involved in piloting. Related to alignments, it is our view that in all these steps it is possible to find a balance between public and private interest, shared benefits: trade facilitation and safety/security are two sides of the same coin. This, of course, will not always be the case in R&D related to public concerns, but in the case of the data pipeline concept this was a fruitful outcome.

5 Discussion and Conclusion

In market-driven situations, innovations can start with inventions where some party develops a new technology and then looks for investors who have an interest in this innovation and will enable it to grow. In the case of public concerns, it is not the private market but the public concern that initiates the innovation process. The task of public funding agencies is to stimulate the generation of ideas and then stimulate the process of moving these ideas towards implementation and impact.

In this paper, we examined and derived lessons learned based on a longitudinal case study of a series four EU-funded projects (ITAIDE, INTEGRITY, CASSANDRA, CORE) in the international trade domain that aimed to develop digital trade infrastructure solutions (data pipelines) to address safety and security challenges. In the approach followed in these projects, trade facilitation was included as an additional public concern that was taken into account in shaping the solutions. For our case analysis, we adapted and extended Bryson et al.'s [1] framework on cross-sector collaboration. We extended this framework by explicitly acknowledging that the progression of innovations from Initial R&D towards implementation can span multiple independent projects that individually can achieve limited outcomes but together can be seen as part of innovation trajectories that move innovations towards implementation. Based on our case analysis, we identified continuities (i.e. continuity of network

and vision, continuity of funding and continuity of process (from Initial R&D towards Turning point and implementation)), as well as two alignments of the innovation trajectory (i.e. alignment with the project owner and project sponsor, and with the public concern), as important success factors.

As discussed, trialability is a key concept from innovation management research [9]. Trialability means that the adoption of technology innovation critically depends on the level at which organisations can first try out new innovations in a confident environment and with low investments. In our cases, the public funding provided such a confident environment, where a complex network of public and private actors could experiment, develop solutions, test them in real life and learn. In this process, the uncertainties and ambiguities were gradually reduced, and the showcases attracted critical mass and further funding. This process made it easier to reach a Turning point where the business cases gradually become more clear, which made it easier for parties to take the next step and proceed with further implementation and upscaling with own investments.

Although in the projects that we analysed we saw continuity of network and vision, continuity of funding and continuity of process, such continuities are not guaranteed. These continuities need to be carefully managed as they may be endangered when moving from one project to another. As a result, the vision, as well as the earlier efforts and investments, may be lost or insufficiently utilised. For example, if the funding and efforts are mainly focused on the R&D stage – or are devoted to more fundamental research or broadened to adjacent fields – and no steps are taken towards the Showcasing and dissemination stage to build awareness, or towards the Turning point stage, then it is likely that a lot of ideas will be generated but limited impact in terms of scaling up and adoption will be achieved. Similarly, if there is continuity of funding but not of network and vision, this may lead to a situation in which know-how and expertise are not efficiently utilised when moving towards implementation.

In discussions it was suggested that after the Initial R&D stage, the government could step forward and assume the role of an investor by taking the risk and investing, but if the project is successful the government would be one of the parties realising the gains and with the gains, the financing of a next project can be assured. Whereas different scenarios may be possible, we consider that continuity of vision and network, continuity of funding and continuity of process from Initial R&D to Turning point, as well as the alignment processes that we identified, are crucial for moving towards implementation and impact.

This study was largely empirically based and the lessons learned are limited to the four projects under analysis. Further research is needed to establish the applicability of the findings in other context and domains. However, the lessons learned can be insightful also for other initiatives where public funding is used to facilitate the development and upscaling of innovative solutions to address some public concern.

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