



Foresight and design fictions meet at a policy lab: An experimentation approach in public sector innovation

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ABSTRACT

This paper depicts a theoretical and methodological experimentation approach developed at the EU Policy Lab of the European Commission's Joint Research Centre. The approach is first framed by its larger institutional context and positioned in a back-end space of public sector innovation. With an internal and self-reflexive departure point, our purpose is to outline it as catalyst of future-oriented explorations, simultaneously nurtured by evidence-based knowledge, and its own transdisciplinary set of experimentation concepts and practices. In addition, to allow for its observation in a practical stage, the paper showcases an empirical illustration of the approach in a forward-looking project for policy advice. #Blockchain4EU was an exploration of existing, emerging or potential applications of blockchain in industrial and non-financial sectors, with attention to plausible near future applications and scenarios, and focus on possible policy, economic, social, technical, legal and environmental impacts. The approach is anchored on desk and qualitative research throughout the project. But its primary outputs emerge from participatory foresight, collective vision building and co-creation workshops, and the prototyping of speculative artefacts through multi-stakeholder engagement. The purpose is to stimulate anticipatory governance frameworks in general, and push the frontiers of what is common practice in policy when considering emerging technologies.

1. Introduction

Policy-making nowadays faces extremely complex, dynamic and volatile challenges, increasingly overloaded with instances where 'facts are uncertain, values in dispute, stakes high and decisions urgent' (Funtowicz & Ravetz, 1993). Public sector innovation has gained traction in recent years as a new field for developing approaches not commonly used before to deal with this reality (Bekkers et al., 2011; Damanpour & Schneider, 2009; Osborne & Brown, 2013; Walker, 2014). Multiple initiatives were put in place or tested in this context, such as the development of structures or teams fully dedicated to provide or support this type of innovation inside or around governments and other public bodies (McGann, Blomkamp, & Lewis, 2018; Tönurist, Kattel, & Lember, 2017).

While this trend has grown and offered significant results in the past three decades, there is still an absence of peer-reviewed examinations on what it means to innovate from inside the public sector. There is still a significant shortage of in-depth analysis on what it means to achieve innovation via overlapping layers of knowledge and experimentation. Furthermore, and of the utmost importance for us, practitioners and decision-makers still have inadequate access to concrete examples of what it means to advance

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such form of innovation in circumstances where the topics at hand have highly indeterminate futures and there is need for anticipatory outlooks for better decision making.

The present paper attempts to address the three gaps through an internal and self-reflexive outline (Chia, 1996; Cunliffe & Jun, 2005) of an experimentation approach developed at the EU Policy Lab of the European Commission's Joint Research Centre, mixed evidence-based research and anticipatory knowledge materialisation for policy advice. It illustrates this said approach at both theoretical and empirical levels, and takes it into a practical stage by presenting the example of a research project in support to EU policymaking. The project is #Blockchain4EU, a forward-looking exploration of existing, emerging or potential uses of blockchain in industrial and non-financial sectors, with focus on impacts at policy, economic, social, technical, legal and environmental levels. It was anchored on desk and empirical research, including literature reviews and other types of content analysis, face-to-face and online interviews, online surveys, and multi-sited ethnographic explorations, but it was especially marked by our own novel integration of participatory foresight and generative design fictions.

The paper is organised as follows: Section 1 is focused on the broad field of public sector innovation as the background for this approach. Section 2 looks into the emergence public innovation entities, such as policy labs, and their potential to offer answers on what experimentation can be. Section 3 depicts a movement from the broad territory of public sector innovation into our own approach, developed on a path going from evidence-based research to tangible speculative futures. Section 4 holds a zoom into an empirical example of how the approach can be developed. We start by defining the project in question as forward-looking exploration. We detail workshops where collective future visions and design fictions were co-created with stakeholders. To finalise, we offer a glimpse into five speculative prototypes and other outputs that represent the project's future-driven connections.

2. Establishing positions within public sector innovation

The public sector has gone through re-evaluations of its approaches, capabilities and tools to deliver better and more effective results, and ultimately to achieve its mission of bringing about positive outcomes for society. A perceived imperative to innovate in how public sector can function or how its actors and processes can be informed and steered is now called for, often under the terms public policy or public sector innovation (OECD, 2015). This is coming not from a culture of 'innovation by accident', in reply to emergencies or via scattered individual initiatives. It is instead gradually based on sustained organizational commitments (Eggers & Singh, 2009), with support for frameworks such as 'mission-oriented' public policies that aim to gather different actors to discuss and tackle together major social, technological, environmental, and economic challenges (Mazzucato, 2018).

As concept, there isn't a consensus on exactly what 'innovation' is, how it can be operationalized or how it can be measured. It can often serve a legitimizing and mobilising role to introduce change in specific situations. It can, however, also contribute to more ambiguity, unclear objectives or inflated expectations, with some even labelling it as a 'magical concept', akin to 'governance', 'accountability' and 'networks' (Pollitt & Hupe, 2011). But as a practice, public sector innovation is definitely not new. Governments and public authorities have for the most part supported, guided and conducted what can be seen as 'innovations' in the public sector with an internal or external focus, via public sector outreach networks, and with, or towards, their stakeholders and other actors.

While acknowledging previous literature and methodological reviews about the status of public sector innovation, including insightful criticisms and possible ways forward (De Vries, Bekkers, & Tummers, 2016), the present paper is centred primarily on recent experimentation trends. This is linked with what might be framed as a back-end space for this particular type of innovation, and tied to specific methodological blends of anticipatory knowledge with speculative materialisations.

By this token, we want to start by connecting our proposal with possible definitions of innovation in the public sector. We look for instance at what the European Commission's Expert Group on Public Sector Innovation proposed by highlighting 'the process of generating new ideas and implementing them to create value for society, covering new or improved processes (internal focus) and services (external focus)' (European Commission, 2013). We look also into what OECD puts forward as an 'implementation by a public sector organisation of new or significantly improved process, methods or services aimed at improving a public sector unit's operations or outcomes' (OECD, 2016).

Furthermore, we place this proposal within the latest 'autochthonous' period of debate on public sector innovation (Hartley, 2005; Kattel, Cepilovs, Lember, & Tõnurist, 2018; Moore & Hartley, 2008; Pollitt, 2011), and to a certain degree, within the 'normative turn' underlining specific innovation policies (Daimler, Hufnagel, & Warnke, 2012; Kattel & Mazzucato, 2018; Kuhlmann & Rip, 2018).

Following these affiliations, our understanding of innovations in the public sector, whether internally or externally targeted, is that they primarily reflect intrinsic features connected to phenomena of legitimacy and trust, with their own set of political, legal, institutional and administrative constraints and enablers (Kattel et al., 2013). This results in the embrace of 'lead-and-learn' roles, not only when engaging wider sets of stakeholders, but also through a mobilization of as many policy instruments as possible to guide open-ended change towards desired future goals (Kattel & Mazzucato, 2018).

There is here a bigger focus on both innovative and forward-looking traits of policies, rather than simpler 'support-and-measure' administrative roles grounded on technical capacities to allocate or manage resources. Additionally, at the forefront of this same trend there is a limited territory for embracing driver or diffuser forces, such as competition among organisations dedicated to the same goals. Such forces are closer to change theory paradigms mainly within the private sector, which are heavily linked to narrow models of efficiency and productivity as those applied by 'new public management' reforms throughout the 1980' and 1990' decades (Drechsler, 2009).

The public sector still faces numerous hurdles to become a proponent of innovation on its own terms, such as unfavourable framework conditions, lack of real innovation leadership, insufficient evidence-based knowledge and data, or limited use of innovative processes, methods and tools (European Commission, 2013). Even with such hurdles, public sector organisations are increasingly

showing how to push innovation forward in different ways (Mulgan, 2007; Mulgan & Albury, 2003).

The approach we want to put forward throughout this paper, as a mixed evidence-based research and anticipatory knowledge materialisation for policy advice, follows this push with focus on the last two hurdles mentioned above. It does so by framing these obstacles through the added value of an interdisciplinary unit entirely dedicated to lead innovation within the public sector: a policy lab inside a larger public structure committed to produce and manage evidence-based knowledge for policy, and, at the same time, a policy lab with its core projects rooted on experimental and collaborative assemblages of concepts and methods in a spectrum going from foresight to design for policy.

3. Answers from policy labs and some of their challenges

Some argue that innovation in the public sector became a ‘fashionable concept’ from Europe to South America, with hotspots in several North American cities such as Toronto, or countries such as Australia and New Zealand. Here ‘innovation units of one kind or another have blossomed among governments, industry and academia.’ (Pollitt, 2011, p. 36). While acknowledging the relevance of this debate, but not diving here into its merits, what we observe (Bazalgette & Craig, 2017; Fuller & Lochard, 2016; NESTA, 2014; Parsons DESIS Lab, 2013; The Rockefeller Foundation, 2014) is that recent trends in public sector innovation include indeed initiatives from governments, regions, cities or other public bodies to create new units, teams or platforms, with a specialised and explicit role to support or lead innovation efforts (Mulgan, 2007; OECD, 2015). Such new entities emerge under diverse labels, such as ‘government innovation teams’, ‘public and social innovation labs’, ‘i-teams’, ‘i-labs’, and many others. Yet they are regularly placed under the encompassing term ‘policy labs’.

These ‘labs’ can be centralised or decentralised, led by the public, private or third sector, or run across organisations and sectors, funded fully or partly by government or even depend on a host of different sources of income (Bason, 2010). Whatever their configurations, mandates and affiliations, these public innovation entities loosely follow common goals, however, for co-creating or supporting innovative policies or decision-making processes. In addition, they also strive to reveal and explore untapped resources and ideas in other horizontal or vertical structures of their institutions.

In this paper, we adopt indeed the label policy labs to define such ‘dedicated teams, structures, or entities focused on designing public policy through innovative methods that involve all stakeholders in the design process. Practitioners describe these efforts as design or evidence-based approaches, which place the end users at the centre of each stage of the policy-making process’ (Fuller & Lochard, 2016). Building upon this definition, other traits can offer, however, a more comprehensive idea of what is a ‘policy lab’. They include in particular the existence of spaces and opportunities entirely dedicated for experimentation and development of new ideas (Thenint, 2009), and also concrete efforts to mobilise stakeholders or partners from various fields. In this sense, ‘policy labs’ act as silo breakers, by standing as unique connectors between several relevant parties, or bringing together different disciplines and other sources of knowledge, in order to deal with tasks such as problem reframing through collective approaches, or the assessment of future concerns and early needs.

The EU Policy Lab was created in 2014 within this landscape, inside what now became the Foresight, Modelling, Behavioural Insights and Design for Policy Unit of the Joint Research Centre (JRC). The JRC is the European Commission’s Directorate-General dedicated to produce, provide and manage evidence-based knowledge and independent advice for the whole EU policy cycle, from agenda setting and implementation, to monitoring and evaluation. It exists by recommendation of the European Commission’s Expert Group on Public Sector Innovation, which explicitly called for the establishment of ‘an EU Innovation Lab inside the Commission to support, facilitate and foster more innovation in the work of the Commission Services’ (European Commission, 2013).

From its early days, the EU Policy Lab was defined as a creative, collaborative and experimental space and a way of working for innovative policy-making. Its objectives were: first, to analyse and co-create new integrated responses to policy problems and needs of the European Commission; second, to strengthen the ability of the Commission services to engage with a broader pool of stakeholders, including citizens, businesses, non-governmental organisations and others; and third, to foster cross-departmental cooperation and collaborative problem-solving within the Commission itself.

Given its institutional context, the work developed at the EU Policy Lab is often closer to a particular type of public innovation. It is mainly focused on an exploration of topics and approaches for policy support and advice by using different methodological expertise and skills depending on the project at hand, that is, a back-end space, rather than direct policy implementation via regulation or funding, for instance, or direct delivery of services to citizens and others on the ground, that is, a front-end space.

Criticisms may be directed to potentially lower complexity or risks associated to back-end spaces in comparison with front ones. But this configures a misjudgement of what is at stake when providing support to decision-making, compared to implementation for instance. Badly structured or poorly informed processes can only lead to an exponential multiplication of errors at the front-end. And this can be even worse if those who are ultimately responsible for the final policy stages, as funding or regulating for example, do not grasp the overall rationale of the innovation processes at the basis of their choices, or do not have proper information on what, why and how innovation takes place.

Throughout their emergence and existence in the past decade, policy labs have gone through several generations or stages (Bason, 2018; Ryan, 2018). They have often faced a number of challenges, demises and rearrangements. In some cases they have faced their own extinction or replacement by other types of innovation entities, due to their work simply running its course, as the Helsinki Design Lab (Steinberg, 2013) and DesignGov in Australia (Roberts, 2014) or due to shifts in priorities as in a substitution of MindLab by a Disruption Task Force (Guay, 2018). On top, a number of shortcomings have also been observed in these labs, such as the pursuit of ‘quick fixes’ at the expense of systemic or broader changes, overlooking power dynamics and conflicts with existing or legacy structures, loss of political patronage or legitimacy, or limited influence on the rest of the organisation due to isolation and in some

cases co-option (Kieboom, 2014; Mulgan, 2014; Timeus & Gascó, 2018; Tönurist et al., 2017). Simultaneously, practitioners and experts have often engaged in critical reflections about lessons learned and ways forward, in debates over a 'peak lab' and 'disillusionment' (Buerkli & Kaukab, 2017), or frustrations over actual impacts on public sector (Bason, 2016b).

But all in all, the main task of policy labs in general, and of the EU Policy Lab in particular, still stands strong at the core of public sector innovation. Our work is still framed by calls for action by several scholars and practitioners to rethink the necessary capabilities of the public sector for instance, through a diversity and crossing of expertise and skills, plus organisational flexibility or reinvention (Kattel & Mazzucato, 2018). We are still nurtured by demands for co-creation and participatory methods that foster experimentation in a broader sense within the policy cycle itself and stimulate broader engagements with society (Bason, 2016a; Christiansen & Bunt, 2012; Selloni, 2017). Our paths are still relevant when trying to offer non-predictive anticipatory explorations of uncertainty for policy, whether through new ways to use knowledge to future-proof decision-making at various governance levels (Miller, 2018), whether via new or renewed readings of foresight frameworks already established or tested in policy, as is also often the case of projects led at the EU Policy Lab (Bock, Bontoux, Nascimento, & Szczepanikova, 2016; Szczepanikova & Van Crielkinge, 2019).

4. Combining foresight and design fictions for anticipatory explorations

The EU Policy Lab works on alternative ways to analyse and co-create solutions for specific policy issues in the back-end of public sector innovation. It can be seen as an 'island of experimentation' (Tönurist et al., 2017) due to partial alignments with most of its institutional context. Even if always embedded in evidence-based frameworks, similarly to the rest of JRC as European Commission's research service, its projects and activities mainly strive to open up an often-constrained field of possibilities to generate outputs for policy support and advice at the European Commission.

Criticisms are sometimes directed at this rationale as a distortion of what 'experimentation' actually means when compared with 'traditional labs' applying rigorous experimental methods to test out scientific hypothesis. Moreover, it is common among both scholars and practitioners to make sharp differences between design-led and evidence-based policy labs, with the former focused on human-centred or intuition-based explorations (Bason, 2017), and the latter adhering to rigorous evaluation and testing such as RCTs / randomised controlled trials (McGann et al., 2018). But the EU Policy Lab's hybrid existence and its main projects generate evidence against the epistemological artificiality of this division, and offers significant combinations of both streams, as we will further explore.

What we intend to discuss is not the EU Policy Lab approach. This structure benefits from several approaches that emerge from the competences of its members within its core disciplinary fields. What we present is instead one of the multiple approaches developed at the EU Policy Lab, grounded on mixed evidence-based research and anticipatory knowledge materialisation for policy advice. Within it, assumptions of 'experimentation' go beyond these strict interpretations, when it comes to the processes and tools applied with concepts and methods from different disciplinary traditions. We adhere to the notion that policy labs have alternative 'experimental cultures' (Quaggiotto, Beurs, & Christiansen, 2017), and even risk admitting these kind of structures can sometimes dive into 'experimentalism as an ideology for how we should shape the future' (Leadbeater, 2014). In such an innovation frame, an approach as the one advanced here has to refute this kind of dichotomies, and integrate elements from evidence-based knowledge in its own experimentation processes. This will allow out-of-the-box outputs able to establish their own heuristic existence inside public sector, with a transdisciplinary, participatory or anticipatory trends utterly recognised as valid and valuable.

This approach is based on a tradition of evidence-based foresight, and in particular non-predictive future-oriented technology analysis when applied to policy contexts (Cagnin, Havas, & Saritas, 2013; Glenn & Florescu, 2017; Scapolo & Cahill, 2004). One of its main purposes is to assist decision-makers to devise effective responses and to be better prepared to anticipate and shape desirable futures (Könnölä, Smith, & Eerola, 2009), especially when it comes to uncertain or disputed pathways and possible impacts of technological developments on society taken dimensionally or as a whole (Porter et al., 2004). Here we position ourselves in the realm of 'anticipatory governance' (Guston, 2014; Schaper-Rinkel, 2013), looking for broader paths to 'collectively imagine, critique, and thereby shape issues presented by emerging technologies' (Barben, Fisher, Selin, & Guston, 2008, p. 992).

But this approach is also grounded on an experimentation field of design dedicated to imagine and shape possible futures through a human-centred and creative exploration of material artefacts. In recent years design as way of thinking and creating innovation for nearly any context or types of organisation (Kimbell, 2014) has been transposed into public sector innovation with weighty results (Bason, 2017). Most design-based processes in policy have been quite successful when developing and exploring early-stage ideas, by engaging with people and organisations in all possible stages, including research, idea generation, iterative prototyping, and policy development (Kimbell, 2015). Yet our use of design frameworks is not a direct descendent from how most public sector innovation make use of design concepts or methods. Here we owe much more to scholarly efforts oriented to advance future-oriented methodologies through design concepts and methods when thinking about, or addressing frontier challenges and opportunities of emerging technologies (Selin, 2008).

Recent research programmes have now widely explored how design can help to highlight social and policy issues through creative methods that are tactile, visual, virtual or experiential (Selin & Boradkar, 2010). In similar directions, other projects have experimented with notions of 'material deliberation' for related purposes by incorporating embodied, aesthetic and affective dimensions in future-oriented and participatory processes, as for example thought-provoking walking tours, crowd-sourced photography, cultural probes, generative toolkits and artefact-based instigation materials (Davies, Selin, Gano, & Pereira, 2012; Davies, Selin, Gano, & Pereira, 2013; Gaver, Boucher, Pennington, & Walker, 2004).

All combined, there is now a community of scholars and practitioners invested in bridging foresight and design through collaborative projects, publications, exhibitions, and other activities, without fear of crossing epistemological boundaries when affirming their experimentation traits. This happens, for instance, in transdisciplinary dialogues around the merging of design and futuring

practices (Selin, Kimbell, Ramirez, & Bhatti, 2015). This happens also in intersections of art, design and information and communication technologies, which explore how to build, draw, write and play with possible futures via interactive visualizations, simulation models, gaming architectures, material prototypes, facilitated experiences, and other techniques invested in experiential futures (Selin, 2015).

It is here where we finally position our experimentation and link it with public sector innovation. In the past decade multi, inter or transdisciplinary fields of foresight and design have developed a 'more intimate and collaborative relation' (Candy & Dunagan, 2017). For instance, practitioners from qualitative foresight have increasingly used prototyping and other visual and material techniques to co-create futures scenario experiences. On the other side, innovative designers have integrated forward-looking qualitative research, empirical scenario building, and a myriad of other anticipatory and 'futuring' tools, to reframe and imagine what comes next, and how to communicate it.

Our reflections and practices at the EU Policy Lab are connected to these dual efforts from foresight and design fields alike. It happens when opening spaces of debate on emergent or potential worlds, and when dealing with how to inform or create policy frameworks on, with, and for, these worlds. But also absorbing that 'all design to some extent is future oriented' (Dunne & Raby, 2013, p. 3), our hybrid experimentation space is further influenced by teachings from other fields that are classified as 'critical design', 'speculative design', 'experiential futures' and, especially, 'design fictions'.

The similarities between these last fields are more substantial than their differences, and depend often on specific project or desired outputs. In their first definitions, 'design fictions' are underlined as 'a mix of science fact, design and science fiction (...) a kind of authoring practice that recombines the traditions of writing and story-telling with the material crafting of objects' (Bleecker, 2009), or more succinctly, as 'the deliberate use of diegetic prototypes to suspend disbelief about change' (Sterling, 2013). But as overlaps unfold, sources for experimental anticipatory frameworks also expand to absorb into their scenario or storytelling outputs, not only in print material, images, and physical artefacts, but also in installations, immersive theatre, digital simulations or serious games, all to make available thoughts, feelings and insights on possible or probable futures (Candy, 2010).

Here we are definitively closer to the broader goal of co-creating 'possible futures and using them as tools to better understand the present and to discuss the kind of future people want, and, of course, ones people do not want' (Dunne & Raby, 2013, pp. 2–3). This is what both our larger institutional context and mandate on evidence-base advice for policy claims for. This is also what the aim to open up the meaning and use of experimental concepts and methods requires in our approach. Taking as an assumption that our work at the EU Policy Lab has strived to combine foresight and design fictions within our particular research and policy territories, we apply a multi-method futures approach that is grounded not merely on empirical evidence, but also on pushing forward the boundaries of what's possible in the specific back-end space of public sector innovation where we usually operate.

5. #Blockchain4EU: zooming in on practical developments of our experimentation approach

5.1. Definitions of a forward-looking exercise

In order to offer a comprehensive and empirical outlook of our experimentation approach, we will now move into the conceptual and methodological presentation of a project where the main traits of the approach are at the forefront. Additionally, we will do it by highlighting participatory frameworks we consider central for an effective intersection of the work streams of foresight and design fictions. To generate a robust anticipatory blend of evidence-based and experimental knowledge, which can be relevant and meaningful not only for policy makers, but also for the widest set of stakeholders, our work was as grounded as possible on the wide collaborative activities. It was paramount for us to have zones in which actors with the most diverse backgrounds and experiences could work together, as cross fertilisation offers substantial results when the right collective mind-set is triggered.

Participation can be demanding for most of our stakeholders. From developers and entrepreneurs, to business representatives and even policy-makers, a big fraction of their time is spent with pressing issues of their own organisations. We need to show how their presence is not only central to open up the process, but also how their inputs will be effectively absorbed. This requires sound planning and execution of any participatory exercise, including a transparent implementation of adequate tools, which in turn need an adequate allocation of resources and time planning. But in dealing with dynamic, complex and long-term challenges, we need to open up not only policy to new processes, but also to go beyond the pool of 'usual suspects'. This push comes from our embrace of a more encompassing definition of what is openness, in particular when discussing who gets the right to generate knowledge in support of decision-making in policy contexts (Eerola & Miles, 2011).

#Blockchain4EU: Blockchain for Industrial Transformations (Nascimento, Polvora, & Lourenço, 2018) stands as a project where we can observe our experimentation approach in a large panorama. It was coordinated and developed by the EU Policy Lab as a JRC project for policy support, in direct partnership with the Innovation Policy and Investment for Growth Unit of the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship & SMEs (DG GROW).

The project ran from March 2017 to May 2018 and it was envisioned from day one as a forward-looking exploration of the complexity and uncertainty surrounding blockchain-based applications within industrial and non-financial sectors. Blockchain is essentially a database in which multiples types of data or transactions can be added, synchronised and run almost simultaneously across distributed networks of multiple nodes of peers. We do not aim to explore this technology in depth with this paper, so for a more detailed account please refer to the #Blockchain4EU main report.

Our underlying goal was to generate anticipatory knowledge on a fairly unique emerging technology, with ongoing internal disputes, scarce available data, partial or contradictory forecasts, and intricate links with other dimensions. On top, there was also a clear policy demand from our DG GROW partners to address potential future disruptions triggered by blockchain on their strategies and

initiatives of digital innovation for Small and Medium-Sized Enterprises (SMEs) and across industrial sectors (European Commission, 2016, 2017a).

This all pushed us to mobilize and further develop our approach in support of the following goals: to map existing and emerging blockchain applications for industry across specific sectors; to scan for and explore possible future scenarios of production, distribution and use; and to identify and assess prospective funding, regulatory or other options for industrial policies. Following our affiliations in public sector innovation, we meant not only to explore a technology fraught with uncertainties, but also to address the pressing policy needs of the project through other paths. This prompted the use of a transdisciplinary toolbox that would adapt to the peculiarities of our subject, while also allowing us to move from an evidence-based approach to full experimentation and back whenever necessary (Loveridge & Saritas, 2012; Tuomi, 2012; Loveridge & Saritas, 2012; Tuomi, 2012).

We first made use of traditional primary and secondary research tools to work on our exploration of possible futures for better decision-making. Here we drew heavily from empirically-oriented critical science and technology studies (Nascimento & Polvora, 2013), as well as from behavioural insights (Lourenço, Ciriolo, Almeida, & Troussard, 2016), on top of the fields of foresight and design in which the approach is grounded. It included literature reviews and other types of desk research, 63 face-to-face and online open-ended interviews, 2 semi-structured online surveys with 94 replies all together, and multi-sited ethnographic explorations (Marcus, 1995) in blockchain organisations and events.

When considering evidence-based knowledge, this type of research is mostly recognized as adequate for qualitative data gathering, and we adhere to this epistemological stance. But following our hybrid approach, such first methodological set was promptly accompanied in a second phase by empirical foresight methods, from horizon scanning to generative vision building, all equally targeted to produce evidence-based knowledge towards a particular 'future gazing' (Selin, 2014). Moreover, grounded on our multi-stakeholder engagement processes for co-creation, outputs from these two phases were transported into collaborative design processes rooted in fictional terrains of speculative or critical design, which later resulted in prototype artefacts informed by evidence-based knowledge, and also extra vision building activities with other qualitative methods for foresight (Popper, 2008, 2008).

5.2. Workshops to co-create visions and fictional artefacts

Enabled by our initial primary and secondary research outputs, alongside inputs from our earlier horizon scanning instances, we devised a series of co-creation activities via the targeted engagement of individual and collective stakeholders with diverse backgrounds and interests on blockchain. These activities helped us to methodologically steer the experimentation through collective vision building exercises with such stakeholders. Our drive was to explore, express and test visions on tomorrow possibilities of blockchain, and in the same setting, to make use of experiential practices through tangible elements 'for making sense of the future' (Sanders & Stappers, 2013).

This part of the process started with a first workshop (July 2017)¹ dedicated to mapping present and future challenges and opportunities of blockchain applications across sectors. And it ended with a third workshop (March 2018)² oriented towards broader debates on policy strategies for digitisation of industry and businesses, with special focus on technology adoption and SME innovation.

Based on a purposive sampling technique, 34 participants were selected for the first workshop to act as snapshot of what we observed as a larger blockchain ecosystem in industrial sectors at the time. The group included: technical experts or developers; social, economic, ethical and legal researchers; entrepreneurs and investors; business and labour representatives; and policy actors at local, national and EU levels, highly interested or already engaged with blockchain. Key outputs were the mapping and discussion of collective visions to inform policy. This helped us to identify present and future possibilities of blockchain applications with a sweeping lens that covered policy, economic, social, technological, legal and environmental (PESTLE) dimensions, as well as factors that could support or hamper development and uptake of blockchain based solutions for specific industrial and non-financial sectors. The co-creation included a generative use of 2D elements for collages in collective canvases and timelines (Sanders, 2000; Sanders & Stappers, 2013), and 3D elements framed by LEGO SERIOUS PLAY application techniques for metaphoric model building (Kristiansen & Rasmussen, 2014).

Based again on a purposive sample, the third and final workshop had 23 participants mainly drawn from a pool of stakeholders leading EU digitisation or SME innovation trends, including industry, startups and SME representatives, European networks or collective initiatives, think tanks, business consultants, and intergovernmental and international organisations. Our goals were to better grasp how blockchain could fit in present and future digitisation landscapes, how it could affect or impact actors operating in more established sectors, and also test concepts, challenges and opportunities that were already on our radar after previous activities. Once more we used generative techniques with 2D and 3D elements for collective vision building. But we also chose to centre subsequent debates at the workshop through backcasting of plausible ideal scenarios, a semi-structured focus group on plans for policy engagement, and roleplaying exercises on disruptive scenarios and possible paths for action (de Bono, 2016; Kaivo-oja, 2017). All this helped to better define and tailor the project's final outputs to these and other industrial, business or policy actors not currently engaged with blockchain, but particularly to those who may be first affected by its potential developments, or those who could be interested in testing, or advising on testing, this emerging technology.

At the centre of this whole process was, however, the second workshop (November 2017)³, where we can find the intersections of

¹ <https://blogs.ec.europa.eu/eupolicylab/first-workshop-of-blockchain4eu-blockchain-for-industrial-transformations/>.

² <https://blogs.ec.europa.eu/eupolicylab/third-workshop-of-blockchain4eu-blockchain-for-industrial-transformations/>.

³ <https://blogs.ec.europa.eu/eupolicylab/second-workshop-of-blockchain4eu-blockchain-for-industrial-transformations/>.

foresight and design fictions that better depict our experimentation. The workshop took place over two days at FabLab Brussels of Erasmusschogeschool, a makerspace where we could empirically enact critical interventions on the goals and applications of a particular technology (Nascimento & Pólvara, 2018). The emphasis was placed on the material exploration of near future scenarios of creation, production, distribution and use of blockchain applications within industrial sectors previously selected. The process was mainly set apart from creativity-only driven methodological affiliations following our knowledge-based pillar. Its structure was built upon some of the forward-looking outputs of the first workshop, to get a funnelling perspective into which sectors, drivers, challenges or opportunities could matter more within short or medium-term timelines. But most crucially, the structure of this workshop was tied to the evidence amassed through the project's research streams. This brought us our preferred understanding of the design context and allowed the research findings to inform the design process itself, even when still acknowledging the existence of alternative views during the process that could opt for a different approach (Sanders, 2017).

Our final goal was to co-create prototypes that could physically represent and exemplify in tangible and interactive ways how blockchain could exist in near future scenarios in specific sectors. With this in mind, we invited 2 lead designers per prototype to work with us on material and conceptual elements before, during and after this workshop. The designers all brought different profiles and skills into the larger collective process, from service to product and materials design to speculative research. But to guarantee an even larger diversity of competences and perspectives, we also engaged 5 technical experts, 5 industry stakeholders, and 5 economic and social researchers. They were all divided proportionally per group. This diversity stimulated multi, inter and transdisciplinary discussions, which later propelled the broader scope of all design fictions in the project.

The workshop's main challenge was to build artefacts that could simultaneously serve two main objectives: first, to inform or agitate current views on blockchain, not only of policy makers at several governance levels or other relevant stakeholders; and second, to help frame blockchain applications according to the EU Industrial Policy Strategy, along with the shaping of options for policy responses within the institutional remit of DG GROW and other relevant European Commission services.

Primary audiences for the prototypes were policy makers and political agents at EU, national and local levels, already engaged, potentially interested in dealing with, or working in sectors that may be impacted by blockchain. Main secondary audiences were SMEs or enterprises already developing or purchasing blockchain applications, potentially interested in doing so, or operating in sectors that may be impacted by its deployment. Other secondary audiences included industry, business and labour organisations, research and innovation bodies, and specialised or general media outlets. In this context, even without finalised prototypes, the third workshop also served as testbed for how the above audiences could react or interact with artefacts like this, having most of the workshop exercises and debates informed by ideas and questions that surfaced during prototyping.

5.3. Prototyping and prototypes in a policy context

In the context of our experimentation approach, and above all, within our specific blend of foresight and design fictions, none of prototypes was ever assumed as an accessory element for the project's success, compared for example with more traditional research streams also embraced from day one. They were all core components that increased the range of our forward-looking ambition, while also providing better ways to communicate about blockchain by provoking thoughts, feelings and insights on possible or probable futures. And they became critical elements to expand our own notions on blockchain and its disruptive potential, during our interactions with experts and stakeholders via the material mediation properties of these same artefacts (Ihde, 1990; Verbeek, 2005).

When prototyping is used in policy contexts, it usually means piloting and testing of services before full implementation or scaling up stages. It allows learning from initial errors, reformulating or improving implementation, and devising more robust plans (Bason, 2010). This might happen at multiple phases of a research project or an experimental intervention embedded in one or more public or hybrid sectors. It generally involves creations going from quick and cheap wireframing websites or low-fidelity mock-ups, to fully fledged services nearly ready for deployment. It points to adaptations to real contexts, reducing response delays, or avoiding user experience incompatibilities. Actors such as lay citizens, public officers, experts, service providers or third-party stakeholders are commonly called in to trial such prototypes. Common techniques include, for instance, role playing, user journeys, contextual mappings, or other similar methodologies. The purpose is to fine tune and iterate possible options, and ultimately to obtain the best possible evidence in order to move from plausible proofs-of-concept into working solutions (Blomkamp, 2018; Selin et al., 2017).

But there are also other uses for prototyping in policy-related or governmental contexts, even if less tested or visible. In the case of back-end spaces of public sector innovation as the one where the EU Policy Lab regularly operates, but also in the case of front-end spaces where other policy labs and public innovation entities exist, it can entail the creation of fictional artefacts intended to trigger forward-looking discussions into the possibility or plausibility of yet to be fully fledged realities. This is how our experimentation approach came to a full existence in this project, connecting the use of more traditional foresight techniques with a full embrace of what design fictions could offer us.

In essence, the prototypes allowed us to establish to not predict futures or create entirely directional maps for tomorrow, but to build instead policy compasses for years ahead. And above all, as co-creations produced on top of multiple knowledge sources, they also helped us to open up multiple discussions in our own space of policy support and advice. They act in this sense as catalysts for better informed decisions on preferred directions for future decisions (Dunne & Raby, 2013), and are formalized as learning devices attached to imaginative leaps, rather than monolithic representations of tomorrow which are not appropriate to critically inform emergent realities (Kimbell, 2015).

A question was constantly asked in this regard, however. Why the effort to develop fictional objects and systems in the blockchain space, and not just to analyse and showcase what already exists? Multiple answers were and are still possible, and this was in fact one of our crossroad moments.

As a policy-oriented project in a particular institutional context, we had to consider the sensitivity of picking or highlighting specific players or applications, also taking into account nascent and uncertain traits of this technological field. We looked into multiple existing applications and the organisations behind them throughout the project, not only through our desk and qualitative research, but also through the stakeholder engagement and collaborative activities such as the workshops. So we were fully aware of what existed or was empirically possible, but decided not to go down this path.

Our main argument is that the purposes to produce prototypes for policy are different from the ones pursued by technical or commercially driven projects. Prototypes can be a more understandable and compelling way to explain how something might work (Chari, 2017; Kimbell & Bailey, 2017). In creating this kind of design fictions on top of blockchain, we address different challenges and ask different questions from those who place their focus on functionality or intricate proofs of concept. The goal of our experimentation was not to create artefacts that addressed traits of blockchain, such as immutability, time-stamping, decentralisation or automation. We targeted instead prototypes that could allow for a comprehensive take on relevant PESTLE questions surrounding blockchain.

What is more, all prototypes had to consider not only trends on the use of this particular technology, or the conditions in which it might happen in the near future, but also real problems in industrial sectors where blockchain could be tested and applied in search of solutions. This is how we assumed the prototypes could better inform and support the policy demands that always stood as backdrop to our experimentation. From the first methodological formulations onwards, we internalised that 'prototypes confront theories, because instantiating one typically forces those involved to consider several overlapping perspectives/theories/frames (...), [they] confront the world, because the theory is not hidden in abstraction (...), [that] a prototype can change the world, because in interventions it allows people to experience a situation that did not exist before' (Sanders & Stappers, 2014, p. 6).

As such, on a higher level each prototype had to be capable to illustrate a potential application in its respective sector. This had to be done preferably by taking into account future adoption or upscaling scenarios, and by showcasing properties inherent to what most see as blockchain based applications. But on a lower level, our main interest was that each prototype could also represent an accessible entry point for the subject at hand, that is, probable, and above all, plausible applications of an emerging technology within specific industrial and non-financial sectors (Selin & Pereira, 2013). The existence of these prototypes was always meant to allow non-experts to understand what they do, how would they work, how they might address, solve or pose specific problems, in what kind of scenarios would they exist, who would be the actors involved and those excluded, and so forth.

5.4. Inclusions and boundaries in collaborative speculations

The second workshop was our key moment of experimentation. Starting with nine sectors previously selected from research and the first workshop, we narrowed them down to five: energy, transports and logistics, creative industries, advanced manufacturing and health. These sectors were not only more adapted for the development of design fictions for our policy purposes, but also where our foresight exercises showed that the maturity and visibility of existing applications would make it simpler to link speculative artefacts with real scenarios, also taking into account the heterogeneous audiences who could later interact with them. We assumed from the start a 'careful management of the speculation' in the prototypes to avoid their implausibility, and instead connect them to a rationale for 'analysing, critiquing and re-thinking contemporary technology' (Auger, 2013, p. 12).

The workshop had 25 full time participants overall, plus 7 supporting graduate and post-graduate students from the Erasmus-school where it happened. Each prototype was assigned to one interdisciplinary group composed of 5 participants. As previously explained, each group included 2 designers, 1 technical and 1 industry expert stakeholder, and 1 social or economic researcher. On top, between 1 and 2 policy makers from different European Commission services briefly joined each group in the first morning of the workshop. The idea was for them to offer input on policy files or ongoing initiatives relevant for the design context, and to insure reality-check moments on earlier debates.

The 2 guest designers led the process during the whole workshop in each of the groups, based on a design brief produced by the EU Policy Lab a month earlier. The brief was meant to guide the co-creation processes through our own intersection of foresight and design fictions, but also drew from a larger set of empirical science and technology studies and behavioural insights. The brief included: the project's summary and relevant policy actors; workshop's key objectives; overview of selected industrial sectors or use cases; composition and suggested internal rules for groups; target audiences and potential uses of the prototypes; material and technical guidelines for two versions of the prototypes; desirable conceptual configurations for the prototypes and possible PESTLE questions as inspiration for each group; and a list of deliverables to be provided at the end of the workshop, such as mock-up first versions, plus descriptions and storylines for each prototype based on a predefined template. The same designers worked with us before to prepare the workshop, and were responsible to remotely work on and deliver a final prototype version after three months. The final version was informed by the first version and in primary collaboration with other members of their group.

We strived for all participants to have an equal say in developing their group's prototype during and after the workshop. As such we asked everyone to contribute as much as possible to all activities of material and conceptual development. The key objective of this forward-looking co-creation exercise was to build a collective vision of what a final prototype would be, and decide on its specifications, functions, and goals. But we also wanted to ensure the prototypes existed not only as technical artefacts, but were able to reflect ongoing or likely larger debates on blockchain, from industry to academic fields, from negative to supportive viewpoints. All five prototypes ended up as intended, that is, as manifestations of multi, inter and transdisciplinary inputs coming from design, technical, industrial and social and economic knowledge, something only possible through the diversity brought to the debate by group members (Nascimento & Pólvara, 2016; Nascimento et al., 2016).

As instigators of the process, we started by offering ideas on potential use cases, applications and topics for the conceptual and material debates and developments in each group. On top, we also defined boundaries on feasibility, given that all groups had to

produce a first materially tangible version of their prototype at the end of the workshop. But we left it to each group to decide where to take the prototyping concept during and after the workshop, and especially which blockchain properties and functions could be demonstrated or simulated. Drawing again from research streams and the first workshop, the only request we had for the groups was to address a set of PESTLE questions when conceptualising and designing their prototype, and to embed the questions as much as possible in the prototype, even if redefining some of them, or considering only a fraction.

First versions of all prototypes had to be physically showcased and orally presented in plenary mode at the end of the workshop. Final versions were completed and delivered on the deadline. Open and constant communication between us and the lead designers ensured no major deviations occurred to the goals of co-creating prototypes as forward-looking artefacts for policy support.

There were no predefined rules or limitations on materials, volumetric or operational procedures for the final versions apart from: solid internal structure and resistant external parts; simple to carry, assemble and disassemble when required; low power requirements in order to function over significant periods of time; easy to operate by lay people; and accessible for the largest number of users and audiences. Even though some final versions got close to it, none had to demonstrate real functionality, provided they were able to simulate it, and be identifiable with blockchain.

Based on a set of materials and tools provided by us, or available at FabLab Brussels, first versions were mainly low fidelity 3D mock-ups with a few core components or functions already mapped. But final versions were required to have materially tangible and interactive existences. Such existences had to illustrate main fictional functions with stable forms responsive to external inputs.

5.5. A glimpse of the prototypes and their scenarios

Five final prototypes were co-created at the end. They became physical objects that illustrate in tangible and interactive ways near future scenarios of blockchain applications on five industrial and non-financial sectors of energy, transports and logistics, advanced manufacturing, creative industries, and health. In addition, the groups co-created additional information and outputs for each prototype, all now available online with other research and communication materials, including five infographic posters and five videos produced by the EU Policy Lab as unified and additional entry points for policy-makers and others to interact with the prototypes.⁴ All of these outputs, including the main objects themselves, plus accompanying text, graphic, video, or coding elements, are available for general for use or consultation under an EU Public Licence (EURL)⁵, and where not applicable, under a Creative Commons Attribution-Share Alike 4.0 International (CC BY-SA 4.0)⁶, apart from where otherwise stated. The names and institutional affiliations of experts, stakeholders, or any other actor who collaborated in the co-creation of these elements is always disclosed in major publications, supporting materials, online platforms, or events, where the prototypes are presented.

In direct relation with an ambition to provide anticipatory knowledge of easy access, we regularly opt to present all prototypes to policy stakeholders and other audiences via 'what if?' inquiries, followed by short introductions of what they are supposed to do or offer as services. In most occasions and formats the five prototypes are textually or orally communicated as follows:

Gigbliss⁷ (energy): 'What if your hairdryer could save you money by trading energy with power grids or even other hairdryers? Gigbliss is an IoT suite that offers three models of the same hairdryer, AUTO, BALANCE and PLUS, linked to three distinct economic models of energy consumption, management and trading.'

Bloodchain⁸ (transports and logistics): 'What if you could trust a drone, to help you collect, transport or donate blood through an encrypted system? Bloodchain is an assets management system designed to deal with multiple points of supply and demand for the collection and transport of blood and other highly sensitive biological materials.'

Gossip Chain⁹ (creative industries): 'What if you could register, validate and use gossip as valuable information in your own neighborhood? Gossip Chain allows anyone to submit rumors to a localized blockchain and then combines people's reputations and prediction markets to assess and register the information's value and reliability.'

Vantage Point¹⁰ (advanced manufacturing): 'What if you could access all information you need before repairing something like a second hand scooter? Vantage Point is a platform tackling data sharing, interoperability and integrity in manufacturing systems by storing products' digital twins and providing distinct information based on specific actor's needs.'

Care AI¹¹ (health): 'What if you could anonymize your personal health data and share it in exchange for professional healthcare? Care AI is a service providing access to basic healthcare in exchange of anonymized personal health data, later connected through smart contracts to a data marketplace for public and private third-party entities.'

All prototypes stand as unique artefacts to depict a set of blockchain features, such as immutability, time-stamping, decentralisation or automation, while also offering reflection and provocation points with relevant PESTLE questions on their proposed fictional application. These elements may not be the easiest to convey textually, but we will now zoom into two prototypes to better showcase how we achieved the intersections of foresight and design fictions that are central in our approach.

⁴ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/>.

⁵ <https://joinup.ec.europa.eu/collection/eupl/eupl-guidelines-faq-infographics>.

⁶ <https://creativecommons.org/licenses/by-sa/4.0/>.

⁷ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/gigbliss/>.

⁸ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/bloodchain/>.

⁹ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/gossipchain/>.

¹⁰ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/vantagepoint/>.

¹¹ <https://blogs.ec.europa.eu/eupolicylab/blockchain4eu/careai/>.

Taking the example of the Bloodchain prototype in the transports and logistics sector, one of its functions is to allow donors to securely register their blood types into a distributed blood bank that could manage supply and demand in real-time. In the scenario proposed by its co-creators alongside the material artefact, donors submit personal and medical data to the system with an encrypted key. Participating hospitals running nodes can set up an internal notification system composed by the desired blood type and other essential data that can be added to the system. In this prototype, the use of a permissioned blockchain for the identity management of each patient could maintain people's privacy until after they had consented to a particular donation, and otherwise keep their blood type separate and unlinked from their personal identity or medical data. Another part of the system allows for an autonomous fleet of drones to be sent out to people's homes, in order to provide options to remotely collect the blood and return it to the hospital for checking and use. In the prototype's material configuration, in order to simulate a real time supply and demand chain experience, the collected blood bag includes a QR code that the donor must scan via the Bloodchain app to register their donation and validate the legitimacy of their donation also in real time (Fig. 1).

The material existence of Bloodchain allowed us to raise several PESTLE questions grounded on the experiential anticipatory qualities it offers, via its customized user journey intersected with a few engagement artefacts. For example, considering a social dimension, Bloodchain was designed to enhance privacy and trust in a blockchain-based system, while also providing a reassuring and convenient experience for blood donors. But how could the transport of sensitive materials via autonomous fleets impact people's trust in their collection and delivery? Or what kind of behavioural changes would be needed for a solution as Bloodchain to be adopted in a near future? Now considering an economic dimension, we can also raise questions on the potential monetisation or tokenisation of a transport service. How would existing transport systems be affected by a new coordination system such as Bloodchain, which is able to streamline and optimise supply and demand? Or yet, how could the transport of blood or other sensitive specimen happen through autonomously distributed networks of carriers and routes already in place for other purposes?

Taking now the example of the Vantage Point prototype in the advanced manufacturing sector, it was designed to address the opaqueness of manufacturing chains. Much of the information within these chains is currently kept within silos, fragmented and disconnected across multi-actor, multi-sited systems. Considering the scenario developed by its co-creators to complement the material artefact, by storing a digital twin of products or product parts in a blockchain system, Vantage Point would allow several elements in a manufacturing process to be tracked and traced at every point through their usages or life-cycles. A tamper proof and complete historical record of a consumer product would then be available for every stakeholder, such as users, retailers, insurance brokers, factory owners, and so on. This record would include material properties, compliance or certification documents, intellectual property rights, among other elements. As promoter of decentralisation, the system would grant each stakeholder access to a particular 'vantage point', dependent on previous allocated permissions, and adapted to their needs through the cryptography of private keys (Fig. 2).

Vantage Point enabled us to elaborate on a number of reflections on top of its physical traits, interactive features and supporting

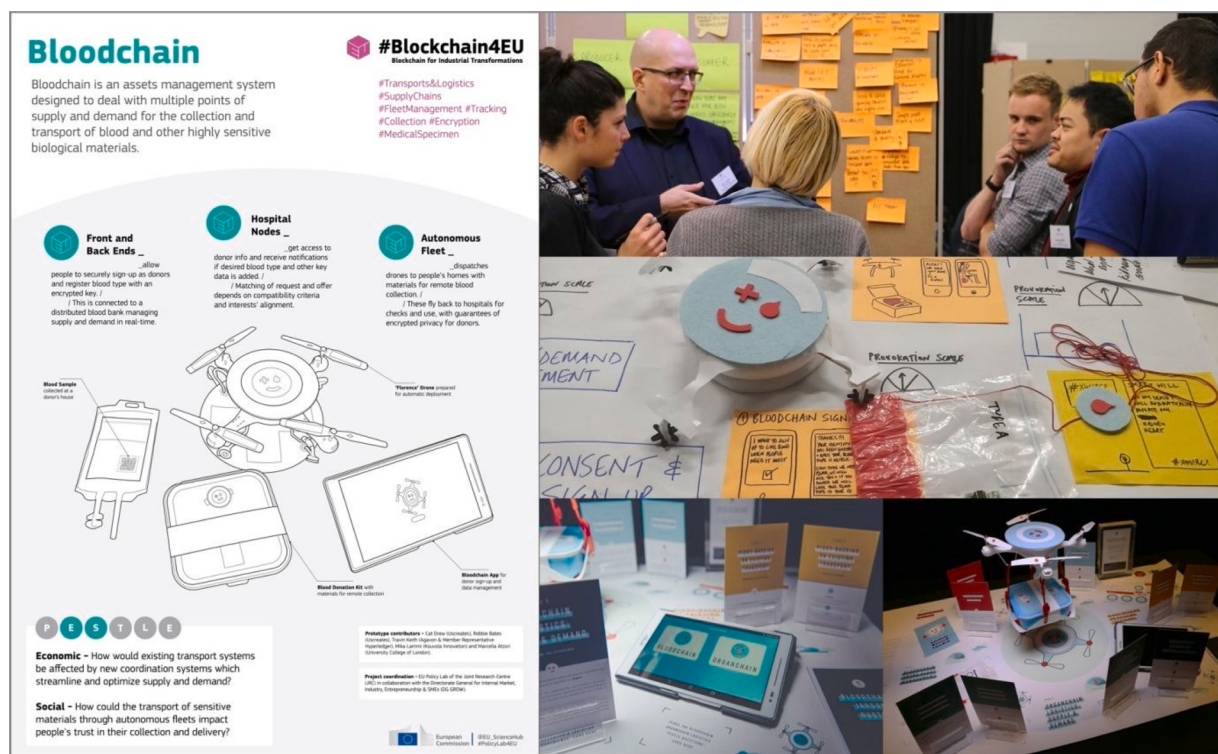


Fig. 1. Main infographic of Bloodchain; group members with student; first version of the prototype; and details of the final version (clockwise, left to right).

storylines. These included for instance potential environmental impacts of a blockchain application such as the one contained within its wood and acrylic panels. How could it support the ethical production, consumption and disposal of consumer products, and ultimately enable new models for a circular economy? How could distributed forms of data sharing stimulate the adoption of cradle-to-cradle systems in manufacturing chains? Yet when moving into policy relevant inquiries, we can pivot into asking: how could it reinforce data exchanges across borders, while also help to combat intellectual property infringements? Or how could this tamper proof record feed into existing data platforms used by public authorities and bodies to check regulatory compliance? And finally, if we decide to cross into technically-driven interrogations, we can even imagine simple questions on: how complementary data management platforms as the one provided through Vantage Point could help to ensure accuracy and validity of original information?

The five prototypes are now identified as a substantial step forward in decision-making contexts that need to consider future scenarios of blockchain for industry / non-financial sectors, just by allowing or instigating reflections grounded on specific material realities. Via their interactive features, on one end, and the scenarios proposed with them, on the other, they offer a wide experiential platform to push the frontiers of what's common practice in policy when looking into emerging technologies and thinking about what to do with and for these same technologies. They were even recognized at a high policy level, with an explicit acknowledgement of our forward-looking approach as significant to identify and assess potential opportunities and challenges of Blockchain and other Distributed Ledger Technologies in support of EU decision-makers, within the European Parliament's Resolution 'DLTs and Blockchains: Building Trust with Disintermediation' (European Parliament, 2018).

All prototypes were used in physical exhibitions, interactive sessions and other showcasing events, with the purpose of triggering and stimulating debates from policy to industry or research contexts. These contexts comprise for instance the project's and prototype's first presentation in May 2018 at the Berlaymont, European Commission's headquarters, or the EU Industry Days organised by DG GROW on February 2019, gathering more than 1500 stakeholders from across Europe and beyond, from industry, trade, national and regional authorities or civil society. Moreover, the prototypes were used through virtual engagements to stimulate future thinking at large, via the #Blockchain4EU project's webpage, and other EU Policy Lab, JRC or European Commission online channels.

Their full description and proposed scenarios for existence are included in a JRC Science for Policy Report (Nascimento et al., 2018). Together with text and images from the fictional outputs, the document also has an overview on features and challenges of blockchain, an exploration of existing, emerging or potential blockchain applications in nine industrial and non-financial sectors, key insights for industrial transformations, and strategic recommendations for policy. All this information is accessible not only to EU policy-makers with direct stake in the blockchain space, but also to other policy actors at international, national or local levels, practitioners and researchers from technology assessment to decentralised autonomous organisations, collective and individual stakeholders with focus on blockchain in general, or audiences only interested in specific sectorial applications.

Nevertheless, the best way to grasp what the anticipatory design fictions are, which challenges and opportunities they might pose in

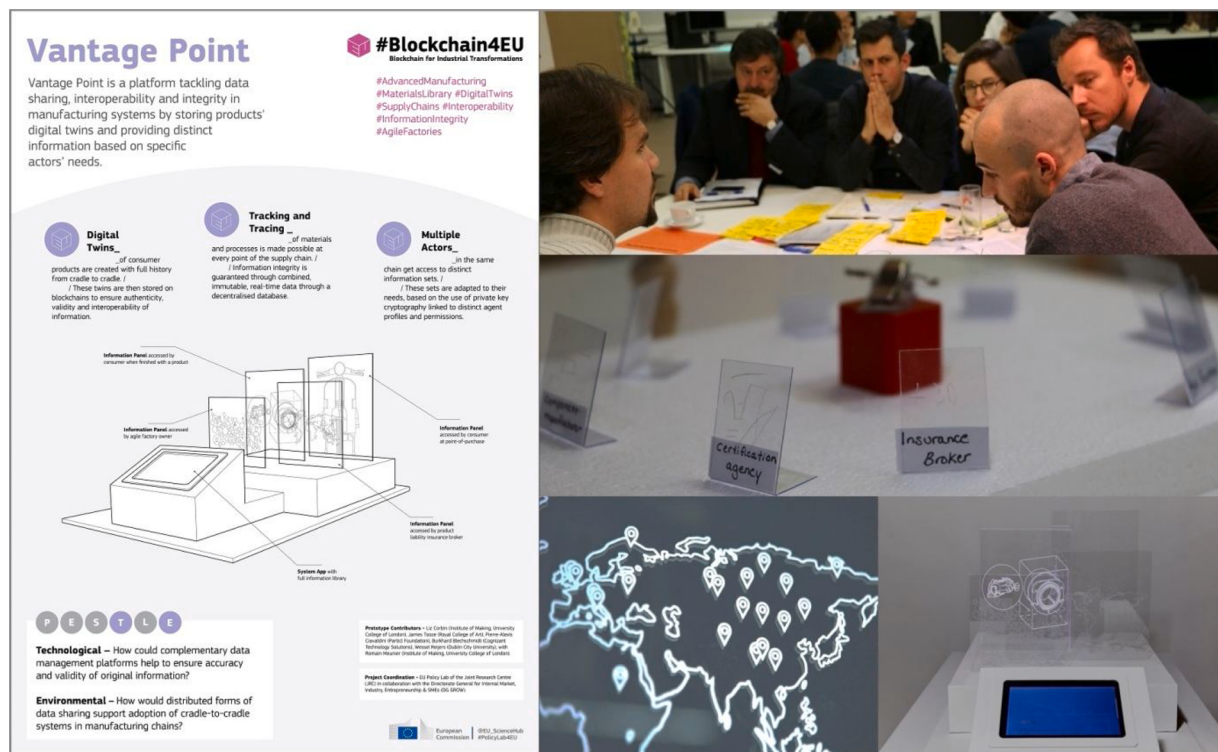


Fig. 2. Main infographic of Vantage Point; group members with policy-makers; first version of the prototype; and details of the final version (clockwise, left to right).

their respective sectors, and above all, which discussions they are able to trigger around policy, economic, social, technical, legal or environmental impacts, is still, and will surely continue to be through interaction. Facing the physical prototypes in person, pushing buttons, playing with apps, getting hold of what each group produced as artefacts even beyond the prototypes themselves, is admittedly the best way to take advantage of what was co-created.

6. Concluding remarks

The approach put forward in this paper starts with a goal to innovate in the public sector, especially in its back-end space where a primary task is to provide advice to policy-makers who may afterwards act upon outputs of innovation processes. We develop the concepts and processes of this approach through a policy lab with a rather unique institutional context and mission, the EU Policy Lab of the European Commission's Joint Research Centre. This is both a tangible structure and a way of working towards innovative methodological experimentations. And this is also a unit and a team that exists inside a large public research service, in which the main focus is to produce and manage evidence-based knowledge for policy-making inside a larger public international organisation.

We strived to position our approach on top of this context as a particular experimentation that is surrounded simultaneously by: its own public innovation commitments; the JRC's larger mission; and the Commission's priorities. But we also did it by having the experimentation simultaneously driven by: its own combination of evidence-oriented research with innovative transdisciplinary processes; its reading of emergent and often uncertain realities as stream that requires anticipatory knowledge for robust governance; its indications on how participatory and collaborative methods are essential to enlarge, diversify, and open up policy; and finally, how it embraces imaginatively experiential zones when building outputs such as tangible design fictions that can generate, inform or transform the views of stakeholders and other audiences, and in due time, instances of decision-making.

This is shown through the paper's three initial sections at both theoretical and empirical levels. It is further taken into a practical stage in the fourth section, with the example of a knowledge-based project conducted for policy advice in partnership with another Commission service. The project was #Blockchain4EU: Blockchain for Industrial Transformations (Nascimento et al., 2018). This project was set from start to end as a forward-looking hybrid exploration of existing, emerging or potential applications of blockchain in industrial and non-financial sectors, with focus on plausible near futures and on possible policy, economic, social, technical, legal or environmental impacts.

The approach is kickstarted in the project through a stream of desk-based research with instances of online and face-to-face qualitative research. This is followed by horizon scanning and participatory foresight activities, including collective vision building and future scenario explorations in co-creation workshops with a robust and diversified multi-stakeholder engagement. It closes with collaborative prototyping of design fictions, materially and symbolically embedded in evidence-based knowledge. With all this we intend to provide anticipatory support for policy-making. On one hand, we strive to do it by countering traditional 'wait-and-see' attitudes in governance circles when faced with frontier or early-stage technologies. On the other hand, we also attempt to do it by laying a path for future thinking, and providing alternative options for forward-looking capacity building in other services of the Commission so they are able to better incorporate this kind of experimentation outcomes.

The route between a back-end space of public sector innovation, and the practical use of speculative prototyping for policy advice, may not be the most straightforward to represent. And this is more challenging given the impossibility of reproducing here the tangible existence of each artefact, or transmitting appropriately what interactions with such artefacts may cause on individual or collective actors. But to fully grasp our whole approach, and how its stages and activities fit in a bigger scheme, we need to observe its full potential when developed on an empirical level. This is also where its major impacts on policy were achieved. In addition to an European Parliament acknowledgement signalled before (European Parliament, 2018), the project's empirical insights were also recognised in the European Commission, through initiatives as the Call 'Blockchain and DLTs for SMEs' (European Commission, 2018) that offered financial support for the development of Blockchain applications, or the Commission's Communication 'A balanced IP enforcement system responding to today's societal challenges', which references the project for decision-making on how blockchain might strengthen transparency in supply chains and intellectual property rights (European Commission, 2017b).

Moreover, the focus put on the practical bridge between foresight and design fictions is also crucial. This bridge is where we can observe the heuristic differentiation factors of our approach. Concepts gain material forms and the experimentation path is allowed to become experiential through such a bridge. A thorough understanding of the proposed approach also benefits from a deep dive into a multi, inter, and transdisciplinary nexus. The connection among these two futuring approaches is not only crucial for the extended dimensions of our anticipatory outputs. It is also accountable for letting other crossings occur within the approach itself. This is due to the lack of epistemological sovereignty concerns, or even an absence of conflicts on which parts inform, or get the right to inform the others. All components of the approach become dialogically intertwined when developed through projects like this, and in order, we see information loops capable to trigger not only internal openness, but also to open up communication channels for sharing experimentation with external realities.

We benefit from these information loops to instigate mutual learnings on any empirical and theoretical explorations, not only within the Lab, the JRC or other services of the European Commission, but also with other international institutions, peer structures, decision-makers, practitioners, researchers and stakeholders. When facing criticisms that experimentation in the public sector is not robust, that it is heuristically incapable to address regular scientific concerns such as systematic organisation, or show best practices such as reproducibility and replicability, we see this as a good starting point, under the assumption that sharing experimentation may be a crucial first step on the impact of evidence.

As proponents of this approach, we will never be able to guarantee any of these characteristics in all circumstances, nor do we assume this as a purpose. But we believe that our hybrid qualities can at least provide elements for more resilience. The dual mission of

the public innovation unit where the approach was developed is to experiment with ways to support policy-making, and to work with and for evidence-based knowledge. As such, these two pillars should configure a bi-directional effort. Together with an investment to ground experimentation on evidence-based knowledge, resources to offer back the same type of knowledge should be available. This should be done not merely through experimentation outputs, but also with depictions of the innovative processes behind them. Between debates that are highly epistemological at times, and as applied as they can possible be, in others, we hope at least to contribute in this way to public sector innovation, especially, its back-end space.

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Declaration of Competing Interest

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