Digital Co-Creation roadmap for the Federal Government

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EXECUTIVE SUMMARY OF THE DIGITAL CO-CREATION ROADMAP

The BELSPO BRAIN-be 2.0 BECODIGITAL project (2022-2024) focuses on connecting practical and scientific insights about **digital co-creation**.

In this document, these insights are presented in the form of a roadmap. This roadmap is divided into three parts: preconditions, mechanisms, and outcomes of digital co-creation activities. Each of these parts tackles an important issue in co-creation and together provide a series of guidelines for practitioners on how to implement this type of projects. The Preconditions part elaborates on the demographical characteristics and evaluative beliefs that can affect citizens' willingness to engage in digital co-creation with (semi-)governmental entities. Moreover, it offers insight into the co-creation activities (such as ideation, voting, deliberation and co-delivery) that might gain from introducing a digital option or alternative to invite citizen participation. The Mechanisms part presents methods and techniques that can be used to implement co-creation, as well as a visual model that practitioners can use to analyze co-creation cases. This part also provides detailed insights on the use of Artificial Intelligence in digital co-creation. The Outcomes part lists and classifies the outcomes that can be achieved from co-creation and provides practical guidance to navigate and use this classification. This part also provides insights and recommendations related to the perceived importance of outcomes and features of co-creation projects affecting them.

The roadmap is aimed at practitioners, researchers and citizens. As such, it is focused on providing scientifically sound content in a comprehensible manner and with a clear practical focus using real-world examples in each of its sections. This document summarizes the results and implications of the research conducted by BeCoDigital researchers which will be updated and made interactive in the form of the upcoming **Usable co-creation online toolkit** (D2.4.1).

1. INTRODUCTION

This roadmap is practical and scientifically grounded tool to support citizen co-creation through digital technologies. This document integrates the results and developments of the project **BeCoDigital** and aims to guide practitioners in how to better understand and implement co-creation initiatives.

WHAT IS CO-CREATION?

In this project we consider co-creation as defined by Torfing et al. (2019, p. 802):

"A process through which two or more public and private actors solve a shared problem, challenge or task through a constructive exchange of different kinds of knowledge, resources, competences and ideas that enhance the production of public value […] or services."

A tangible example of a co-creation initiative that nicely aligns with this definition can be found in the Corona Consultations organised by Sciensano between November 2020 and January 2021 at the request of the Minister of Health and his cabinet. During this two-phased co-creation initiative comprising of information sessions (phase 1) and debating moments (phase 2), a deliberate outtake of Belgian citizens discussed the desirability of mandatory COVID-19 vaccination, and the exclusion of citizens based on their vaccination status. The results of this knowledge and opinion exchange informed the minister and his cabinet members of the popular opinion on the issue.

As the example shows, co-creation processes can deploy a variety of participation methods (i.e., pertaining to the activities in which public and private actors are engaged such as discursive expression), sequencing arrangements (i.e., pertaining to the stages or phases in which activities are organised such as an information session to decently prepare citizens for active participation in debate), logics about the level of involvement and decision-making power (i.e., pertaining to stakeholders' allowed or allocated level of autonomy and power within the co-creation process, such as a mere advisory function) and digital tools or technologies (i.e., pertaining to the instrumental characteristics of a technology, such as collaborative boards used in support of a deliberative exercise) to solve these shared problems, challenges or tasks. However, the choices made in the process are not neutral as this roadmap will show.

WHO IS THE ROADMAP FOR?

This document is aimed at policymakers interested in co-creation, public servants involved in co-creation projects, researchers interested in the field and looking for scientific references, citizens interested in how co-creation works, and anyone who wants to learn about the potential of new technologies for co-creation.

The roadmap has been written as a document that is scientifically sound yet accessible. The different parts of the roadmap include descriptive sections, practical examples and literature reviews. Readers are encouraged to navigate the document focusing on aspects of their interest.

HOW TO READ THE ROADMAP?

The roadmap is divided into 3 main sections:

1. *Preconditions for digital co-creation:* This section provides an overview of important preconditions to consider when designing and commencing a co-creation project, from an internal (that is, the co-workers organising and supporting the project) and external (that is, the citizens participating) perspective. It identifies individual motivations for participation and (in)conveniences among key internal stakeholders.

2. *Mechanisms for digital co-creation:* This section focuses on the different co-creation methods available, the technologies that can be used to implement these methods, and how both elements relate to the different phases of co-creation. It provides a model representation allowing to compare and analyze co-creation projects. A more detailed part focused on Artificial Intelligence use in co-creation is referred to in the Appendix.

3. *Outcomes for digital co-creation:* This section presents a framework to classify and evaluate the various types of outcomes possible from a co-creation project, as well as citizens' perceptions of the importance of these outcomes. It then provides insights and recommendations on the features of co-creation projects affecting the outcomes.

2. PRECONDITIONS OF DIGITAL CO-CREATION

In this section of the roadmap, we first elaborate on when digital features in citizen co-creation offer outspoken advantages vis-à-vis their analogue (i.e., non-digital) counterparts. After all, a wide variety of design choices can be made in its organization. For example, different participation methods (i.e., pertaining to how citizens are activated, such as by voting or discursive expression), sequencing arrangements (i.e., pertaining to the number of steps in which activities are organized), logics about the level of autonomy and decision-making power (i.e., pertaining to citizens' allowed level of autonomy and the weight of their contributions), and digital tools (i.e., pertaining to the instrumental characteristics of a technology) might be considered to achieve particular objectives (e.g., inviting citizen feedback to ameliorate a public service). All these design choices can affect the often attributed or ascribed benefits of digital co-creation (i.e., allowing a time and location unbound opportunity for citizen participation).

Once we know about the occasions in which 'going digital' is of added value to co-creation, and, on the contrary, when it requires extra attention and case to raise spirits for participation, we can continue with for whom precisely this proves to be the case. After all, not all citizens are active, engaged, hyperconnected technophiles, and some require tailored strategies and continued support to engage. We outline the profile of citizens most and least likely to engage in (digital) co-creation.

2.1. DIGITAL CO-CREATION: WHEN DOES IT MATTER?

We start searching for relevant pre-conditions (*for whom)* when co-producing digitally at its design phase (*when)*. Through an experiment**,** 1,035 Belgian citizens informed us about *when* 'going digital' seemed to increase or decrease their willingness to co-create. Respondents were randomly shown one out of four one-minute videos. Each video invited them to the exact same local co-production initiative comprising four distinct yet sequential steps. This sequence consists of (a) sharing an idea, suggestion, or opinion for a municipal redevelopment project, (b) voting for those that looked most appealing, (c) discussing in-depth those that received the most votes with 40 fellow citizens and (d) helping to materialize and deliver the ideas discussed. However, the videos differed from one another in the way the steps were configured. As can be seen in Table 2.1, some were organized in an analogue fashion (taking place in the municipal or city hall), whilst others invited respondents to participate digitally (over an app or video conferencing tool).

Table 2.1. Overview of the step-wise configuration per video.

	Condition	Step 1 Ideation	Step 2 Voting	Step 3 Deliberation	Step 4 Co-delivery
1	Analogue	Analogue	Analogue	Analogue	Analogue
2	Mixed 1	Digital	Digital	Analogue	Analogue
3	Mixed 2	Analogue	Analogue	Digital	Digital
4	Digital	Digital	Digital	Digital	Digital

After watching their assigned video, the citizens were asked to indicate how likely they were to participate in each step on a scale from 0 to 10. Overall, they appeared most likely to lend their time to the voting in Step 2 (average = 7.10) and the ideation exercise in Step 1 (average = 6.26). Although still considered rather likely, the deliberation in Step 3 (average = 5.64) and co-delivery in Step 4 (average = 5.42) met with remarkably less willingness to contribute. Of course, these two steps required entirely different skills, such as building, structuring, and eloquently conveying an argument in group discussion. This might explain the differences because some people might, for example, be uncomfortable with this.

Delving deeper into the steps individually, our results revealed yet another difference: our respondents' willingness to participate in each of the steps also appeared dependent on a particular step's configuration. Particularly for the first two steps (i.e., ideation and voting), respondents estimated their likeliness to participate significantly higher when presented with the digital option to do so. In steps 3 and 4 (i.e., deliberation and co-delivery), this digital option fared no better than the analogue option inviting in-person contributions at the municipal hall as shown by Figure 2.1.

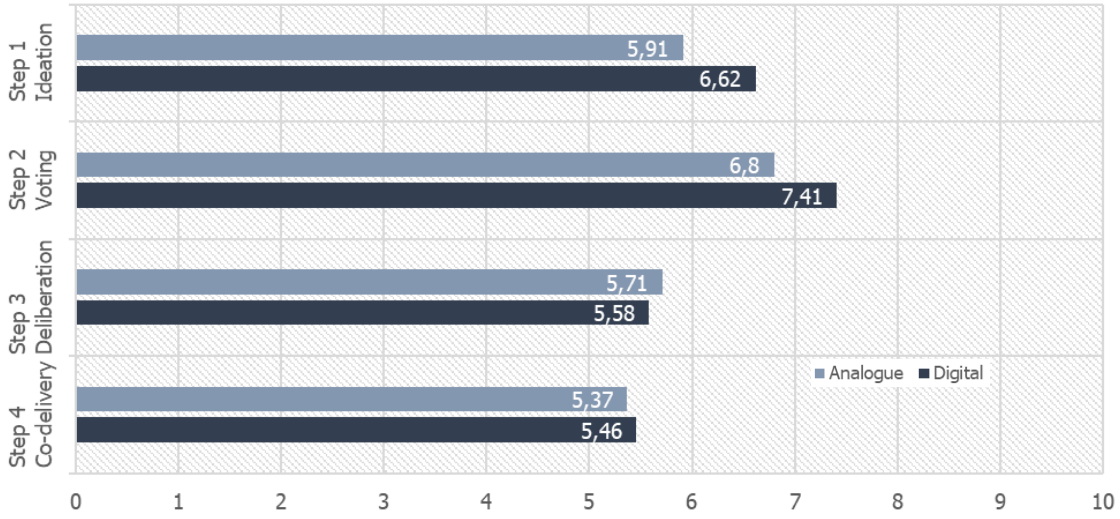


Figure 2.1. Willingness to participate per step and configuration (analogue vs digital).

This immediately raises the question of whether these findings apply similarly to each respondent within our 1,035 headed sample. Or, would it be possible to discern a digital inclusion and equity advantage that extends beyond steps 1 and 2 for those who, for example, lack time to co-create (e.g., single parents, professionals with large career commitments or young adults with a wide variety of hobbies)? Can digital participation lower the threshold for co-creation by offering a time and location unbound option to do so? And, if it does increase particularly over-solicited respondents' willingness to co-create, does this then prove generally applicable and, hence, step independent?

Our results indicate that while digital options can lower the threshold for those Belgians who lack time to participate in co-creation, this effect appears not generally applicable yet depends on the step or co-creation activity, with deliberation and co-delivery again faring worse than ideation and voting. Table 2.2 shows how respondents who perceived a time insufficiency would or would not consider participation in each of the four

steps if it were configured a different way (i.e., digital instead of analogue or vice-versa). The results of these questions are presented as percentages and tell us more about whether a digital alternative truly matters. Why step three (i.e., deliberation with 40 fellow citizens) fared seemingly worse than steps one and two, however, might be logically explained by the fact that the digital advantage partially disappears: the time unbound advantage then no longer applies given that video conferencing still requires a fixed time frame for people to join online. Admittedly, this assertion does not apply to the fourth step entailing co-delivery.

Table 2.2. Percentage of respondents with insufficient time to engage in citizen participation indicating whether they would (still) be willing to engage if the step would (not) have been organized digitally.

Config.	Question	Step 1 Ideation	Step 2 Voting	Step 3 Deliberation	Step 4 Co-delivery
Analogue	What percentage would participate if organized digitally while they would not participate analogously?	44%	56%	28%	22%
Digital	What percentage would not participate if organized analogously while they would participate digitally?	57%	52%	49%	36%
Combined	For what percentage of our subset will 'going digital' have a positive effect?	52%	53%	38%	28%

Note. When presented with an analogue step, respondents with insufficient time, indicating an unwillingness to engage, were asked whether they would consider engagement if the step was organized digitally. On the contrary, when presented with a digital step, respondents with insufficient time, indicating a willingness to participate regardless, were questioned whether they would also be willing to engage if the step was organized analogously.

From an inclusion point of view, these findings are highly relevant in that groups who decide not to participate, can cause reduced legitimacy and effectiveness of the co-creation process: reported data might be biased as certain voices or opinions might be over-represented whilst the needs and expectations of certain hard-to-reach groups remain partially or entirely under the radar. Therefore, we like to warn that while in some instances (such as ideation and voting), adding a digital alternative could be an interesting option, it may prove redundant in others (such as deliberation). Moreover, even though digital is increasingly popular, the desirability of confining participation to only a digital option should always be questioned. After all, depending on the characteristics of the targeted audience, 'going digital' does not only provide advantages but possibly also distinct inconveniences. That, of course, raises the question for what type of citizens a digital configuration marks a tipping point in favor of participation? Which pre-conditions lead some to co-create digitally yet scare away others? Departing from the findings above, we now delve deeper into *for whom* 'going digital' matters.

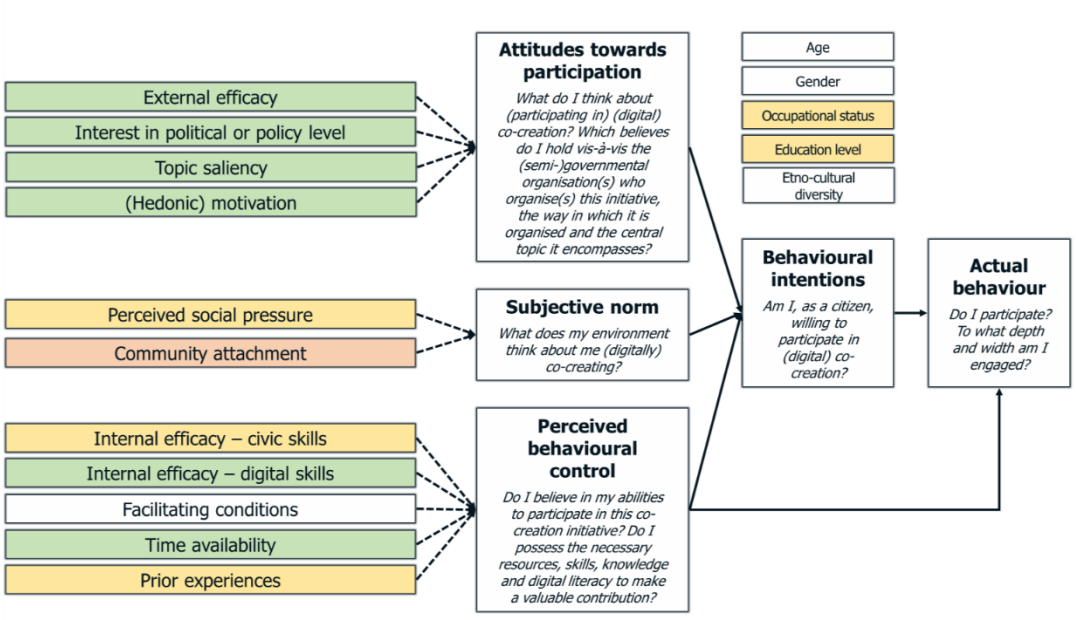
2.2. CITIZEN PRECONDITIONS: TO WHOM DOES DIGITAL MATTER?

2.2.1. A CITIZEN PRECONDITION FRAMEWORK

Building on research antecedents, we assembled a pre-condition framework to overview the diversity of pre-conditions affecting citizens willingness - and, hence, eventual behavior - to co-create with (semi-)governmental entities at local, provincial, regional, national or supra-national levels.

This framework departs from the idea that a person's behavioral intentions herald their non-routine behavior, such as participation in a co-production initiative through digital means. Behavioral intentions themselves are shaped by three evaluative beliefs: (a) attitudes towards the particular behavior, which, in this case, involves a weighing-up of the pros and cons of participation; (b) subjective or perceived social norm, which refers to the pressure to participate a person perceives to emanate from one's social environment and; (c) the estimation of one's ability to actually portray the behavior, also termed perceived behavioral control. Figure 2.2 shows that each category of these evaluative beliefs contains one or more pre-conditions that might affect citizens' intention to engage in digital co-creation. Furthermore, also personal features, such as gender or one's employment status, can impact the behavioral intentions equation.

Figure 2.2. Visual summary of citizen preconditions and how they affect citizens' willingness to co-create public policy and services digitally, inspired by Theory of Planned Behavior (TPB).



*Legend. Green = pre-conditions and demographical characteristics that **positively** influence a person's willingness to contribute to (digital) co-creation; the higher or more outspokenly present the attribute, the higher one's willingness.*

*Orange = pre-conditions and demographical characteristics that **negatively** influence a person's willingness to contribute to (digital) co-creation; he higher or more outspokenly present the attribute, the lower one's willingness.*

*Yellow = the effect of a pre-condition or demographical characteristic is **dependent** on what activity the co-creation step entails and whether this step is organized in an analogue, digital, hybrid or mixed way.*

2.2.2. VALIDATION OF THE FRAMEWORK BASED ON THE VIDEO EXPERIMENT

How did we arrive at this color coding presented in Figure 2.2, how should it be read and what does it imply for practice? Through the abovementioned experiment, we also questioned the 1,035 Belgian respondents about their demographical characteristics (such as age, gender and occupational status) and the pre-conditions presented in Figure 2.2. We assess how those associated with respondents' willingness to participate in ideation, voting, deliberation or lend a hand to co-delivery. We did this both in general terms and by differentiating those steps that were organized digitally or in an analogue fashion. Only in this way could we get a view of for whom digital may or may not have a potential impact.

First, as to citizen demographics, the results were striking. Apart from educational attainment and occupational status, all other variables included did not profoundly affect citizens' self-reported willingness to engage in the four co-creation steps. Occupational status thereby behaved the way we had foreseen as those not active on the job market prove significantly less likely to participate in deliberation and co-delivery, presumably because these types of activities place greater demands on skills that are acquired mainly through professional contexts (such as building an argument or letting your voice be heard eloquently). On the other hand, being unemployed increases participation likeliness in both steps, presumably because they still want to be useful to their communities during this interim period. Educational attainment, on the contrary, did not behave as expected as being highly educated (that is, having obtained at least a university degree) seemed to lower the willingness to participate despite this group usually possessing the necessary civic skills and background knowledge to do so. This observation occurs, however, mainly in analogue participation and is less outspoken in the digitally organized steps. Thus, for this group specifically, it seems sensible to provide an equivalent digital alternative for ideation, voting and co-delivery.

Second, as to attitudes toward participation, the results indicate a positive effect of each included condition with political interest and hedonic motivation standing out as greatest explanatory factors. The more one knows and is interested in the political level at which the (semi-)governmental organizer of co-creation operates, the more likely he or she will be to contribute. Next, when we anticipate a profound sense of enjoyment, fun or enrichment from co-creation, we will also be more willing to participate. Anticipated joy can, of course, come from getting captivated by a particular topic but also from learning to use or using a new digital tool or application. Finally, external efficacy, a basic confidence in the usefulness of investing valuable time and effort in co-creation, seemed to matter as much in analogue as in digital co-creation. Usefulness, on the one hand, emanates from a firm belief that the (semi-)governmental actor that invites co-creation (a) will be responsive to our demands and contributions, (b) has the means and sincere intention to involve us in a meaningful way and (c) can be trusted to perform decently, deliver qualitative services and bring about change when required. On the other hand, usefulness also stems from the personal conviction that citizen participation is an activity worth pursuing and that we, as co-creators, can bring about change. Therefore, for organizations or organizers that do not have great name recognition or visibility, it seems vital to clarify at what political level they operate, what exactly they do, and how this connects to people's day-to-day lives.

Third, as to subjective norm, we found high levels of community attachment negatively associated with willingness to participate. Although this finding contradicts the scientific consensus, we can explain it in the digital instances from the fact that these set-ups remove the possibility of human encounters or, at least, severely limit the possibility of interpersonal connection. Similarly, perceived social pressure contributes positively to a willingness to engage in analogue co-creation steps—when people do not meet in person and can directly assess our contributions, this obviously plays much less of a role.

Fourth, as to perceived behavioral control, our analysis indicated that self-efficacy—a firm belief in one's civic competences to contribute in a meaningful way—shows quite opposite patterns when we compare analogue to digital co-creation. Digitally, positively judging one's own ability to make a useful contribution appears to be mainly important when invited to ideation and voting activities. Analogously, its importance shifts to deliberation and co-delivery. This in itself is not so surprising as people are more visible and thus more vulnerable to the critical eye of others when these two steps are organized in-person (one might more easily start to doubt own's skills). As expected, digital competences greatly determine willingness to co-create digitally. Remarkably, trusting the organizers to provide support to deal with problems or concerns, failed to win over respondents. Regardless of when one trusted to be facilitated in the co-creation process or not, this did not alter one's willingness. Prior experiences then only seemed to matter when ask to participate in deliberation.

In sum, a genuine interest in politics or the policy level at which the organizing public entity functions, external efficacy, hedonic motivation and time availability stood out as the conditions to explain citizens' likeliness to engage in co-creation. When including digital features, digital efficacy (in a positive sense) and community attachment (in a negative sense) also played decisive roles. On the contrary, when sticking to analogue co-creation, perceived social pressure (in a positive sense) and one's education level (in a negative sense) seemed particularly important. Regardless the design, it therefore seems vital to clarify:

- … exactly how much time investment is required so that citizens maintain realistic expectations and do not disengage beforehand;
- … exactly where, how and to what extent participants can receive support throughout the co-creation process and their efforts;
- … how citizen contributions will (not) be used and processed and, just when and how this will be communicated so that they can assess for themselves whether participation is worthwhile and the organizers are inviting them with the right intensions and strength of action;
- … what they or significant others might gain from participation (e.g., acquiring new knowledge, skills or social contacts in a fun and engaging way).

Finally, providing a digital option to participate (either as alternative to an in-person one or as a complete replacement) appears particularly interesting to those Belgians who perceive they lack time to participate otherwise. At least, when the co-creation activity involves sharing ideas or voting. When it comes to discursive

expression and co-production, the observation does not seem to hold. This constatation provides clear guidance to co-creation organizers as not to plunge into the array of digital participation opportunities simply because it is the most fashionable and contemporary thing to do. Instead, one should consider the activities one wishes to involve citizens in and recognize a digital option might not be that suited.

2.2.3. GUIDELINES AND RECOMMENDATIONS ON THE FRAMEWORK'S USE WITHIN THE ROADMAP

The pre-condition framework above can serve as a useful instrument to gauge citizens' willingness to digitally co-create. At least, when we have a good picture of exactly who we would like to involve in our co-creation project and for which co-creation activities (such as citizens with a refugee background to help improve the quality of information on the asylum application process provided on the federal government's website). After all, different groups of co-creators can be differently motivated, inspiring different expectations regarding their involvement (such as a fright to think and discuss along in large groups in which members do not share the same experiences nor language). Knowing how specific groups or citizen profiles are likely (not) motivated allows digital co-creation organizers and facilitators to develop tailor-made strategies to address these audiences (such as by inviting one-on-one easily accessible reflection or offering the necessary translations to allow for participation). From an inclusivity point of view, we therefore recommend:

1. To describe the targeted citizen audience(s) in light of the conditions highlighted in the framework: Who do we really want to participate (for example, elderly people and their caretakers to reflect on the future of elderly care)? What specific demographical characteristics do these groups possess? How do these groups fare regarding the three sets of evaluative beliefs?

2. To categorize the implications of the above description exercise when deploying digital, analogue, hybrid or mixed co-creation designs: How are particular groups likely (not) motivated? We can, for example, expect that the older the participant, the lower their digital self-efficacy and, hence, the more difficulty to submit ideas through digital means. At the same time, enthusiasm to contribute ideas in a person-to-person way might rise within this particular group due to the nice opportunity it offers for social contact.

3. To identify and list potential inclusion strategies to circumvent or mitigate negative implications and inconveniences for the target audience (for example, to have a trained staff member visit the older participants and complete the survey together by tablet).

4. To rank and select the identified inclusion strategies based on feasibility concerns and resources restrictions (for example, staff and time availability, prior training needs, financial limitations, expertise, technological limitations and implementability).

The focus here is entirely on preconditions. We are aware, however, that conditions that arise throughout the process (e.g., a convivial atmosphere in discussion groups or thought-provoking side information one received

throughout the process) can also cause people to drop out or, on the contrary, find a renewed enthusiasm to go further or contribute more intensively. Yet, those throughput factors, are kept out of the equation as they are highly context-dependent and harder to grasp in overarching terms. In a way, this connects to the process outcomes described in WP3 (cf. infra).

3. MECHANISMS OF DIGITAL CO-CREATION

This section introduces a range of offline and digital methods that can be used to support policy or service co-creation. After a presentation and discussion of the pros and cons of each, we zoom on digital methods and lists technologies able to implement these methods. Co-creation methods and technologies are mapped to the co-creation phases they suit best. Lastly, acknowledging that co-creation requires the combination of multiple methods to engage stakeholders in an optimal way, we develop a modeling approach that can be used to visually represent co-creation processes and the methods they use. This makes it possible to visually identify shortcomings in co-creation processes and to visualize how methods can complement each other.

3.1. CO-CREATION METHODS

Simonofski et al. (2019) identified a range of 8 methods that can be used to co-create public services with stakeholders. Although these methods have been identified primarily with citizens in mind, they are applicable to other stakeholders as well. These methods are described below. For each, we discuss their advantages and disadvantages. These methods are flexible in the way they can be implemented and can thus be used at any co-creation stage (e.g., co-commissioning, co-design, co-delivery, co-assessment). However, we pinpoint the stages that are the best match for each method.

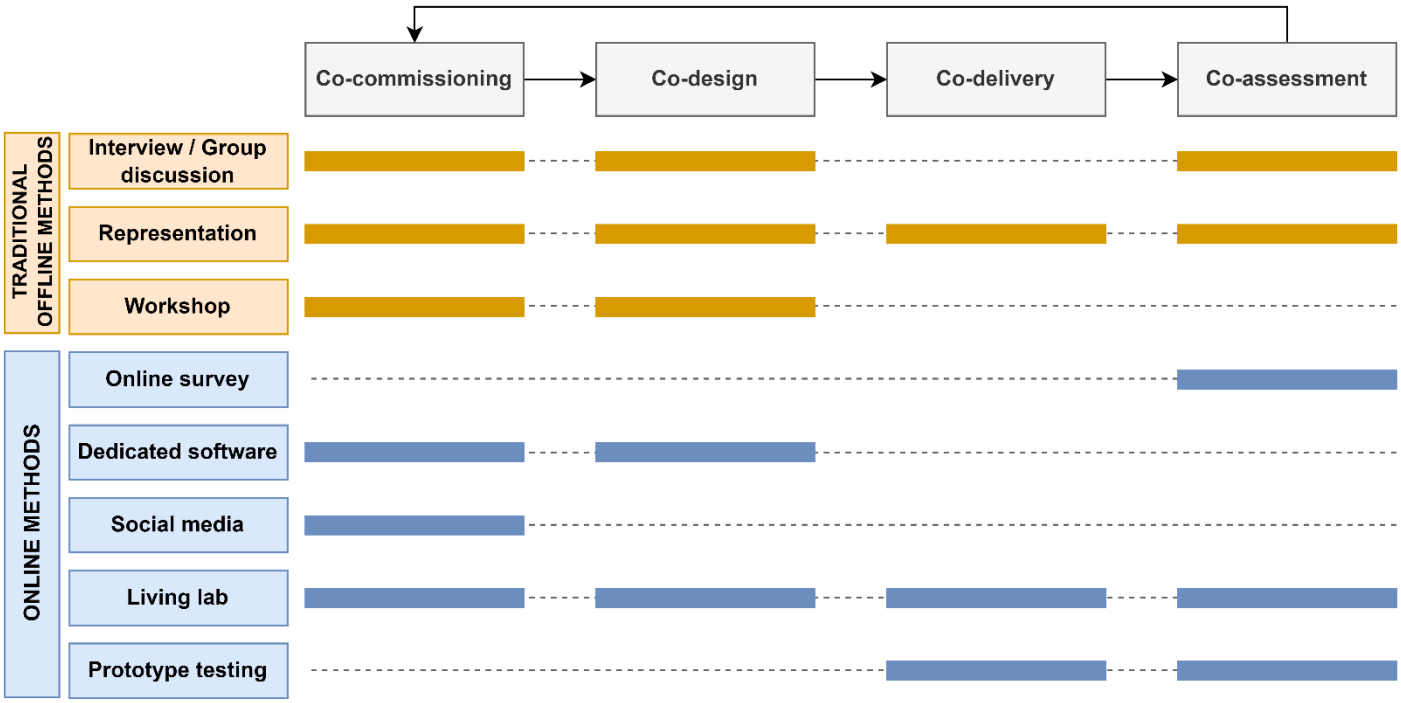


Figure 3.1. Best matches between co-creation stages and methods.

Interview / Group discussion. Interviews and group discussions are two direct interaction methods frequently used to collect and refine requirements about a digital service (Lallemand and Gronier, 2018). For example, Clarinval et al. (2023) used interviews with citizens to understand how they want to explore fellow citizens' ideas posted on digital participation platforms. Interviews and group discussions can also be used to easily discuss with proxy stakeholders. For example, Billestrup and Stage (2014) studied how software

developers carry interviews and group discussions with public servants as representatives of citizens because they assume that they know the citizens' needs. Lastly, interviews and group discussions can be used to evaluate the impact of a co-creation process when surveys are not suitable. Bessa and Machado (2022) conducted interviews with elderly and visually-impaired citizens, who could not participate on their own through a remote survey. They found that involvement in public service co-creation is positively related with satisfaction over service quality.

Representation in the project team. To give more influence to certain stakeholders (i.e., most often, the end-users of the public service or the citizens affected by the policy), Chan and Pan (2008) advocate for the identification of salient intermediaries representing these stakeholders in all policy/service development stages. A case in which the representation method is of special interest is hard-to-reach stakeholders. For example, Islind et al. (2023) developed a medical self-reporting application for cancer patients. Since involvement in design is too demanding for these stakeholders, the developers worked with the nurses taking care of them, thus aware of their problems and needs. Thus, following Simonofski et al. (2019), we would recommend using this method in specific cases. We also recommend selecting intermediaries that appear legitimate to the stakeholders they represent. Otherwise, these stakeholders might feel unfairly sidelined.

Workshop. The organization of workshops to interact with a selected group of representative stakeholders is a method often used to collect and refine requirements (Følstad et al., 2004; Oostveen and Van Den Besselaar, 2004). For example, Crusoe et al. (2020) organized a workshop to discover what information citizens arriving in a new city would want to have, in order to develop a corresponding service. Once the problem to solve is clearly identified, workshops can also be used to design a service using brainstorming and voting mechanisms (Lallemand and Gronier, 2018). The advantage is that this approach delivers a clear output that achieves consensus across the workshop participants. An important aspect is the facilitation of such workshops, in terms of steering the group toward the targeted output of the workshop. To make workshops more stimulating, creativity techniques such as using visualization tools as support or improvisation principles (Mahaux and Maiden, 2008) can be used, but require specific skills. We would mainly recommend this method in early stages of the policy/service development if the government has experience or access to external experience in workshop facilitation, ensuring that the workshop is well-received by the participants and effectively leads to consensus.

Online survey. Online surveys allow stakeholders to participate asynchronously and remotely, removing logistic and planning barriers to participation (King et al., 1998). Thus, they enable the large-scale participation of stakeholders in different policy/service development stages. This is mainly observed in the evaluation phase of public services (De Róiste, 2013). Requirements can be obtained from a more restricted number of representative stakeholders. However, a robust evaluation of e.g., the efficiency or user satisfaction over a public service necessitates a quantitative approach, and thus dozens or hundreds of stakeholders, especially if the evaluation compares the service to a benchmark. The survey can also be used to evaluate *a posteriori* co-creation process (Bessa and Machado, 2022). We would recommend using this method mainly to collect

stakeholders' feedback in the co-assessment phase. We also recommend combining it with a few interviews or group discussions to obtain richer insights into the figures obtained from the survey.

Dedicated software. In order to facilitate the large-scale participation of stakeholders, governments can deploy dedicated software that can take the form of e.g., platforms, applications, to gather citizens' ideas and needs (Berntzen and Johannessen, 2016). Shin et al. (2024) found that different types of software can be used, such as (1) crowdsourced mapping tools (i.e., to report and discuss local issues with a map as support), (2) place-based survey tools (i.e., to collect citizens' voices), (3) idea creation and deliberation tools (i.e., to build consensus and drive collective action), (4) analytical tools (i.e., to support decision-making by the co-creation commissioner, (5) co-funding tools (i.e., to initiate ideas that address local issues and fund their realization), and (6) decision-making and voting tools (i.e., allowing citizens to make decisions on proposals). These tools can be used mainly to understand stakeholders' issues and requirements and ask them to choose among alternative service designs. For example, in the context of public service development, Crowd-Centric Requirements Engineering (CCRE) platforms apply the crowdsourcing paradigm to collect, refine, and prioritize stakeholders' requirements (Snijders et al., 2015). Dedicated platforms are among the most attractive co-creation channels for citizens (Simonofski et al., 2019) and provide specialized features. However, deploying multiple platforms can imply important costs and different channels that stakeholders need to accommodate. We would therefore recommend avoiding having too many different platforms, and ensuring that they are seamlessly integrated.

Social media. Social media provides arenas in which stakeholders are free to express themselves and exchange. It is thus disrupting numerous activities, including service development (Storey et al., 2010) and citizen-to-government relations (Bonsón et al., 2012). More and more citizens, organizations, and governments have a presence on social media. For example, the City of Namur and Belgian Federal Police have 29,000 and 263,000 followers on Facebook, respectively. Therefore, posts on social media to ask for citizens' input on a problem (co-commissioning) or a solution (co-design, co-delivery, or co-assessment) can get a much higher level of visibility and engagement than other methods. Beyond specific calls for participation on groups or pages, citizens express themselves without being asked to do so. Such input can be invaluable for governments seeking to better understand the concerns of the population. The drawback is that the content posted by citizens on social media is usually not so informative, consisting of a large part of rants and unjustified claims. Also, citizens express themselves in many different arenas (e.g., comments section, post on their profile page, post on a group), making data difficult to retrieve. There are still few solutions and little research on how to leverage citizen-generated content on social media for co-creation in a government context. However, one example is a tool developed by Simonofski et al. (2021) that automatically retrieves posts having specific hashtags on Twitter, runs automated AI-powered classifications on the posts, and visually presents results to policy-makers to help them make decisions. Still, due to the complexity of collecting valuable citizens' input on social media, we would recommend using it to issue very specific calls with manual monitoring of stakeholders' reactions and to advertise calls for co-creation initiatives using other methods.

Living Lab. The living lab is a co-creation method that was recently invented. A living lab is a "user-driven open innovation ecosystem based on business-citizens-government partnership which enables users to take active part in the research, development and innovation process" (European Commission, 2009). This method is often implemented in a local context, under the smart city umbrella, to explore the needs and ideas of citizens about innovative services (Cossetta and Palumbo, 2014). Living labs provide a collaborative space allowing multiple stakeholders to define problems, solutions, and experiment together in an iterative manner (Gascó-Harnandez, 2017). They require a physical infrastructure and the participation of stakeholders over a longer period (compared to the one-shot involvement observed in most other methods), which can be a challenge for stakeholder retention over the project. Nonetheless, living labs have a positive effect on the civic self-esteem and competency of participating stakeholders (Park and Fujii, 2023). For example, Ruijer et al. (2024) demonstrated how the living lab method can be used to define a local problem and reflect on solutions to develop to address it. This method remains less known among stakeholders. In line with (Simonofski et al., 2019), we would recommend using it in specific cases, when the longitudinal involvement of stakeholders is critical, and if the infrastructure can be reused for other co-creation projects as well.

Usability tests on prototypes. Prototyping is a method used to present an unfinished service to its potential end-users (Hartson and Pyla, 2012). van Velsen et al. (2009) suggested a user-centric requirement collection approach for the design of public services with a rapid prototyping tested through interviews, group discussions, or citizen walkthrough (i.e., walking end-user citizens through the interface of the prototype). Thus, prototype is highly efficient to support an iterative co-creation process, in which the co-assessment of a prototype feeds insights into a subsequent co-commissioning stage, paving the way for the development of a more suitable prototype and so forth. Prototyping has long been highlighted as an efficient method in scientific literature (Følstad et al., 2004; Oostveen and Van Den Besselaar, 2004). Several qualities of a prototype can be tested with potential end-users. For example, scientifically valid questionnaires such as SUS and CSUQ (measuring the usability of a digital service), or UEQ or AttrakDiff (measuring the user experience – understood as usability plus the emotional impact – of a digital service), and many others, are documented in (Lallemand and Gronier, 2018). We would recommend aiming for rapid iterations of prototype testing and refinement, with 5-8 participants (Turner et al., 2006), keeping more robust evaluation approaches for more mature prototypes, and only if it is justified by the objectives of the co-creation project. It is also possible to seek expertise from usability experts to assess the prototype (Lallemand and Gronier, 2018). However, this expertise is scarce, expensive, and is no substitute for an evaluation with end-users. We would recommend this only for critical services.

The table below summarizes the main advantages and disadvantages of each method, the figure indicates which co-creation stages are the best matches for each.

Table 3.1. Summary of the advantages and disadvantages of co-creation methods.

Method	Advantages	Disadvantages
Interview / Group discussion	• High applicability • Low skills required to put in place • Not so time-consuming for citizens • Allows getting individual views (interviews)	• Not so attractive for citizens • Time-consuming to get a lot of citizens • Less clear output
Representation	• High applicability • Low skills required to put in place • Not time-consuming at all for citizens • Provides a cost-effective solution for hard-to-reach stakeholders • Intermediaries can be mobilized across projects	• Risk of mismatch between the intermediary's perceptions and reality • Stakeholders might be frustrated to not be directly involved • Not so attractive for citizens
Workshop	• Clear output • Allows reaching consensus • The agenda is largely driven by the participants	• Time-consuming to organize • Requires the availability of multiple participants • Demands specific facilitation skills
Online survey	• Allows large-scale participation • Attractive to citizens • Allows robust measures and comparisons	• Results can be hard to explain since they consist of numbers without explanations • Needs be carefully designed before large-scale distribution since it is difficult to remobilize respondents in case of mistake
Dedicated software	• Allows large-scale participation • Attractive to citizens • Specialized features supporting different types of co-creation	• High cost • Novel channel for most stakeholders • Challenge of integrating different platforms
Social media	• Channel already known by governments and citizens • Comes at no or little cost • Large-scale participation	• Low quality of inputs • Inputs are scattered and difficult to retrieve exhaustively • Large amounts of unstructured data to process • Requires technical skills to process data if it is too large
Living lab	• Longitudinal involvement across the project • Supports iterative experimentation • Clear output	• High cost • Challenge of stakeholder retention • Less known method
Prototype testing	• Delivers a clear output • Attractive for citizens • Supports rapid iteration • Delivers scientifically valid measures of some qualities of the service	• Some evaluation methods are time-consuming to put in place • Requires specific expertise

3.2. TECHNOLOGIES FOR CO-CREATION

In order to implement the co-creation methods, a range of different technologies can be used. In this section, we describe four general types of such technologies and provide examples on how they can implement a given method within each co-creation phase that we identified as a good match for the method.

The study of Shin et al. (2024) shows that, already within the *Dedicated software* method, plenty of different technologies can be used. Therefore, to propose a more manageable overview of technologies, we instead describe below more general types, following (Lember et al., 2019), who have investigated the use and impact of technologies in the context of public service co-creation. The reader with a special interest in Artificial Intelligence (AI) can find a more fine-grained overview of AI uses in co-creation, illustrative examples, and practical guidelines to implement AI in co-creation in Appendix 1.

Sensing technologies. Sensor technologies refer to smart or wearable devices that make it possible for stakeholders (in most cases, citizens) to collect data in a new way. This follows the idea of "citizens as sensors" (Goodchild, 2007), in which citizens are "used" to jointly map a territory (Sieber and Johnson, 2015). Data can be collected either automatically or manually. For example, in the "Curieuzeneuzen in de tuin"[1] project, thousands of volunteering citizens have installed sensors in their backyard (i.e., automated data collection) to provide a collective picture of soil quality in Flanders. In the "Databusters"[2] project, citizens use an application to collect geolocalized data manually on the field. The application has been used to, e.g., map the road signs in a municipality. The collected data can be used to diagnose and better understand a problem, to develop a data-based service, and to evaluate the impact of a policy or a service (i.e., by comparing it with data collected before).

Communication technologies. Communication technologies enable machine-mediated interaction between a government and stakeholders, or across stakeholders. There exist a variety of communication tools. Some are already ubiquitous, such as videoconference tools, phone, or social media. Others rely on well-established paradigms but are much less widely used. They include, for example, websites on which stakeholders can raise issues, discuss ideas, or vote (Berntzen and Johannessen, 2016, Shin et al., 2024). Yet others come in the form of emerging technologies. For example, Simonofski et al. (2024) investigated how Extended Reality, that encompasses Virtual Reality and Augmented Reality, can be used to involve citizens in urban planning projects. This technology can be used to collaborate with citizens around design alternatives that they could help refine. Another example is the Citizen Dialogue Kit (Coenen et al., 2019), which consists of small displays deployed in the urban environment and running a survey asking the opinion of passersby. Depending on the question asked, this can be useful to e.g., better understand an issue or evaluate the impact of a policy or a service.

Processing technologies. Processing technologies encompass technologies that are useful to make sense of large quantities of data, such as big data analytics, cloud computing, and machine learning. Although some co-creation methods have the advantage of enabling large-scale participation, this also comes with a data overload

[1] https://curieuzeneuzen.be/waar-we-meten/tuin/
[2] https://www.futurocite.be/databusters-appli-chasseurs-donnees/

challenge for the government who will have to exploit the data. This is a problem when the data is unstructured, in the form of text such as a set of ideas proposed by stakeholders. Machine learning techniques can be used on such data to e.g., identify the main topics (Shin, 2023), which can be visually presented to support decision-making (Simonofski et al., 2021). This is also a challenge for the stakeholders contributing data. If the data is too vast for them to make sense of, they are more likely to contribute redundant data, only feeding more into the data overload issue. Processing technologies can alleviate this issue by e.g., recommending similar data to help stakeholders spot contribution identical to theirs (Bono Rossello et al., 2024), or providing interactive data exploration mechanisms based on the "overview first, zoom and filter, then details on demand" paradigm (Clarinval et al., 2023).

Actuation technologies. Actuation technologies can perform physical actions independently from a human, even though its sequence of actions might have been programmed by a human. A well-known example is robots used on production lines, which, once started, can move autonomously. Examples are rarer in the context of public service co-creation, but one that has recently gained prominence is 3D printing. This technology allows cheap and rapid prototyping, which is convenient to support rapid co-creation iterations. For this reason, they are found in living labs (Gascó-Hernandez, 2017).

We illustrate below how some of these technologies can be used to implement digital co-creation methods, based on the best matches we identified. We do not address the case of interviews / group discussions, representation in the project team, nor workshops because they are traditionally offline methods. However, interviews or representation could be supported using e.g., videoconferencing tools or communication platforms. As for workshops, we strongly recommend organizing them in person since they aim at reaching consensus and can necessitate to work with supporting resources. The purpose of the examples we discuss below is to illustrate a few of the possible ways of implementing co-creation methods. We do not claim that these are the unique nor the most efficient implementations.

In the case of an **online survey** (1), communication technologies, such as a questionnaire tool or the aforementioned Citizen Dialogue Kit, could be used to collect stakeholders' opinion on the policy/service quality and its impact. **Dedicated software** in the form of communication technologies could be used to collect and refine requirements (2) in the co-commissioning stage (e.g., a CCRE platform), or to present different design alternatives (3) on a dedicated website during the co-design phase. Stakeholders would be invited to share their opinion and vote for their preferred design. In the case of **social media** (4), processing tools can be used to extract and make sense of the vast amount of content posted by stakeholders. As for **living labs**, they are designed to involve stakeholders over longer period of time, and thus over the course of multiple co-creation stages and even iterations. Sensing technologies, such as a kit of specific sensors, could be used to actively involve stakeholders in the collection of data that would help to better understand the problem (5). Based on this, actuation technologies such as 3D printers can be used to generate prototypes to compare design alternatives (6) or produce the service (7). Stakeholders could be involved again in another data collection with sensors to assess the impact of the service (8). Lastly, in the **prototype testing** method, communication

technologies such as videoconferencing or chats can be used to exchange feedback with stakeholders when the service is being developed (9) and to support a remote evaluation of the service quality (10).

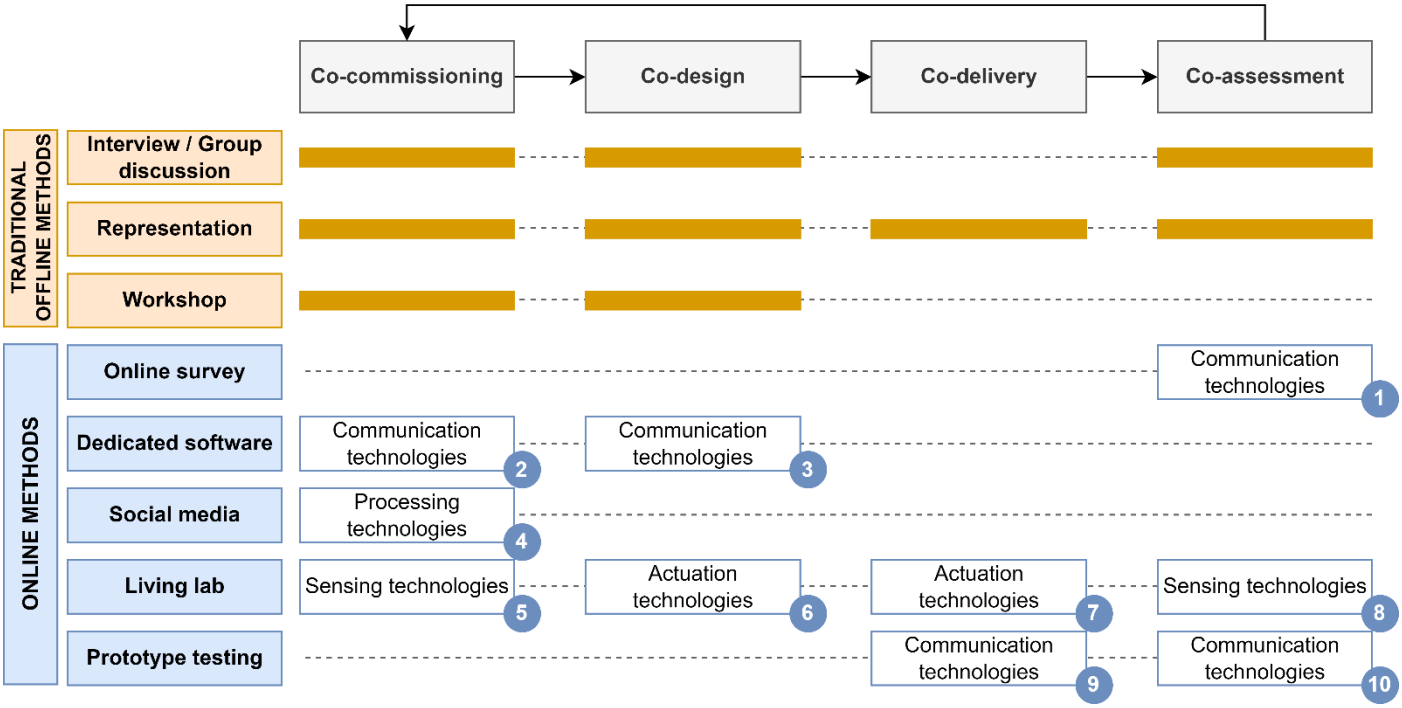


Figure 3.2. Best matches between co-creation stages and technologies.

3.3. A NETWORK-BASED MODEL TO VISUALIZE CO-CREATION METHODS

Digital co-creation methods have advantages, notably the scale of participation they enable. However, they do not provide a perfect solution to all co-creation challenges. Often, the combination of digital methods with traditional offline methods is a better approach to reach a broader audience and a higher rate of success. Yet, combining different online and offline methods is a complex task. This hybrid approach demands a good characterization of all elements involved in the implementation of the different methods.

In these scenarios, detailed information regarding the implementation could help practitioners in charge of organizing co-creation to (1) implement a combination of participation methods more effectively, and (2) evaluate previous co-creation projects to list the necessary elements in the planning phase.

To this end, we created a simple graphical model to describe the different methods applied during their implementation phase (Bono Rossello et al., 2023). It is a so-called network-based model. Network models are composed of two kinds of elements: **nodes and edges**. **Nodes** are the agents composing the network, in this case the main elements of the co-creation process, namely stakeholders, tools or platforms. **Edges** represent the relations between agents.

3.3.1. A NETWORK-BASED MODEL TO VISUALIZE CO-CREATION METHODS

Nodes. During the co-creation process, different stakeholders are involved: citizens, policy-makers, external stakeholders, and facilitators. In our model, we group stakeholders based on their roles in the co-creation process given that their role will define their importance within the co-creation. We define as nodes of our model any kind of stakeholder that generates, provides, or collects information. We define 4 types of nodes that represent different roles in the implementation of co-creation methods.

- **Target audience:** Group of citizens targeted by the co-creation process and its outcome. Depending on the goal of the co-creation, the target audience might represent the whole population or a specific part of it.
- **Participants:** Citizens who are directly involved in one or multiple stages of the co-creation process.
- **Facilitators:** Stakeholders who collect information and coordinate the co-creation process.
- **Platform / tool:** Elements of the co-creation process that receive, provide or analyze information but are not active in nature. This is the case of prototypes or artifacts that are generated as outcome of a given process.

Edges. The second element that constitutes our model concerns the connections between the different stakeholders. These connections are represented by edges in the model. In co-creation, there might exist different kinds of relations between the stakeholders. We defined the following types.

- **Communication:** Communication is seen as any sharing of information, such as a discussion between two stakeholders or interaction between stakeholders and platforms / tools.
- **Action:** Interactions that are directly related to the creation of a service or another stakeholder actions. Usually, this consists in processing information or selecting proposals.
- **Representation:** Unilateral connection that defines how accurately the attributes of the targeted citizens are represented by the direct participants.

In visual representations of the model, edge thickness varies to denote different connection strengths.

3.3.2. VISUAL REPRESENTATION OF THE MODEL

In visual representations of the model, **nodes** are represented corresponding to stakeholders are represented by a circle. Its color varies according to the stakeholder in question. The target audience is colored orange, the participants are blue, and the facilitator appears green. Platforms / tools are depicted by red rectangles. As for **edges**, they are represented by a line of different style according to the type of connection they represent. Solid black lines represent communication, dashed black lines depict action relations, and orange dotted lines correspond to representation. Edge thickness varies to denote different connection strengths.

The figure below shows a generic visual representation of the model.

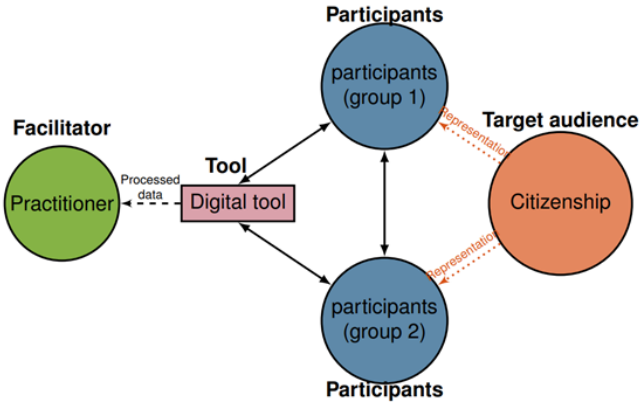


Figure 3.3. Generic visual representation of the network-based model.

3.3.3. APPLICATION OF THE MODEL

One of the main goals of our model is to become a useful tool for co-creation practitioners. When using the model, they need to define the different elements of the model, which demands an understanding and prior analysis of the co-creation implementation setup. This in itself can be seen as an interesting asset. This is exemplified in the definition of target audience nodes, which is clearly useful to identify who are the people to be involved in the participation process. Another important aspect concerns the differentiation between communication and action connections. In these cases, the difference between participants only communicating or taking active actions might help to assess the level of participation achieved by the participation method (Lago et al., 2019).

In order to apply the model to the case of a specific co-creation project, one can follow the three following steps.

1. **Define the nodes**. The first step is to define which are the main stakeholders and their roles in the co-creation process. Start from the target audience identifying which are the group(s) that the co-creation process is aiming at. Based on that target audience, create the node(s) of participants. If the participants are selected based on different groups of target audience, divide them into groups. Then, determine if there is any tool or platform used in the represented co-creation stage(s). Finally, identify the facilitators, separating them into multiple nodes if there is any difference in their roles or activities.

2. **Make the connections.** The second step is to create the connections between the nodes. The main benefit of this step is to re-evaluate the definition of the nodes, as the connections demand the understanding of the role of each group.

3. **Visualization.** The last step allows reevaluating the co-creation strategy or spot any modeling flaw. Based on the outcome of the visualization, some errors or inconsistencies in the definition of the nodes and connections can be assessed (e.g., missing stakeholders).

3.3.4. MODEL APPLICATION EXAMPLES

this section, we demonstrate how our model can be applied to represent co-creation projects and help to identify missing stakeholders (Case study 1 and 2), combine methods (Case study 3), and evaluate different types of target audience (Case study 4).

The methods and technologies used in these examples are summarized in the following table.

Table 3.2. Methods and technologies used in the case studies.

Case	Methods	Technologies
E-health service	Interviews	None
Digital portal La Louviere	Interviews	None
Let's prepare Brussels	Online survey, Interviews	Communication technologies
Health data project	Online survey	Communication technologies

IDENTIFY MISSING NOT FULLY COVERED TARGET AUDIENCE

CASE STUDY 1: E-HEALTH SERVICE (THE NETHERLANDS)

This case study was presented in (van Velsen et al., 2009). It provides a scenario where a requirements engineering approach is applied to create a social support digital service in the Netherlands. The participation process consists of interviews with citizens and public servants, a low-fidelity prototype, and a citizen walkthrough. To ease the visual representation, we only focus on the interviews part, corresponding to the co-commissioning stage.

Define the nodes. The target audience consists of citizens with special needs and public servants involved with the developed service. The participants are divided into citizens and public servants, as two different kinds of interviews are conducted by a facilitator. The facilitator also has a tool to work with user requirements.

Make the connections. We can identify the representation relation between the target audience and the selected participants, in both cases this connection is strong as there are two identified groups of participants that correspond to the profiles of the target audience. The method used is the semi-structured interview, so we can establish a two-way communication between interviewees and interviewers. Then, based on the information obtained, the facilitator practitioners create the user requirements using the tool, which is considered as an action relation.

Visualization. The previous steps provide the following model representation. From this representation we can see how both target groups are interviewed and thus considered in this stage of the co-creation project.

At the same time, it is noticeable how the action of drafting the user requirements is solely performed by practitioners, based on the information gathered by the interviews.

We can thus observe that while the input from both types of participants is taken into account, their role in the process of drafting these requirements is mainly as data providers rather than active participants.

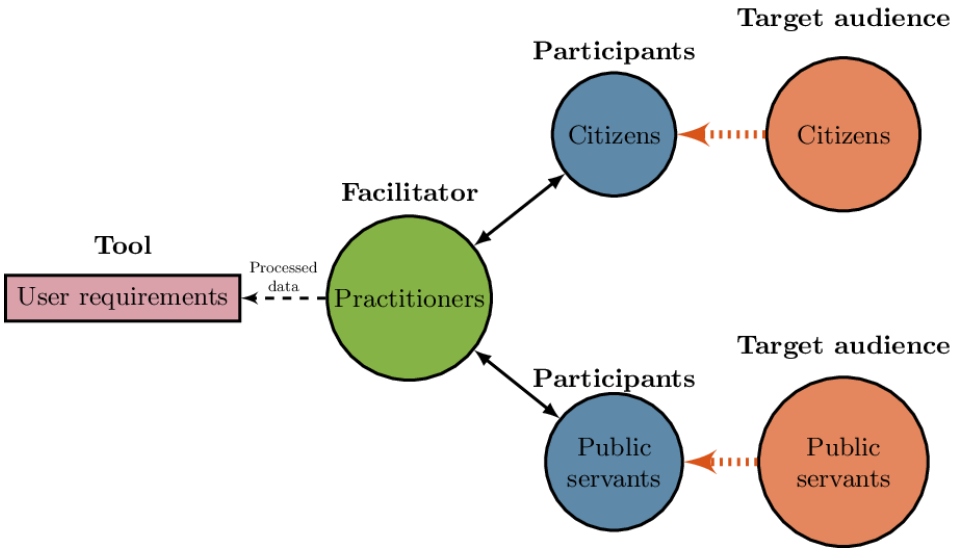


Figure 3.4. Visual representation of the E-health service (The Netherlands) case.

CASE STUDY 2: CREATION OF A DIGITAL PORTAL (LA LOUVIERE, BELGIUM)

This case study focuses on the implementation of a digital government strategy in the city of La Louvière (Belgium), which includes the development of a digital portal allowing citizens to perform certain administrative procedures autonomously (Simonofski et al., 2018). Three different methods were applied during the implementation process, namely interviews / group discussions, prototyping, and an online survey. We focus on the interviews / group discussions to provide a proper comparison with Case study 1.

Define the nodes. Concerning the target audience, similarly to the previous case, the main targeted group were citizens and public servants. Notably, in this case, the citizens' target audience was larger, as the service is aimed at a broader group. There are also direct participants corresponding to the public servant's target audience, a facilitator conducting the interviews, and a tool to support working with the requirements.

Make the connections. In this case study, there is no connection, i.e., a lack of direct participation, to the citizens' target audience. The researchers involved in the case study regretted that not all public servants interviewed were actively involved in the creation of the digital portal. This implies a weaker representation connection. The method used is the semi-structured interview, so we can establish a two-way communication between participating public servants and the facilitator. Then, based on the information obtained, the facilitator creates the user requirements using the tool, which is considered as an action relation.

Visualization. When applying the model to this case study, some potential issues are easily spotted. For instance, the fact that there is a complete group of the target audience that is not connected to the process,

or that there is a weaker representation connection between the other group of the target audience and the participants. Interestingly, this is in line with the mains remarks and recommendations from (Simonofski et al., 2018), showing the evaluation potential of the model visual representation.

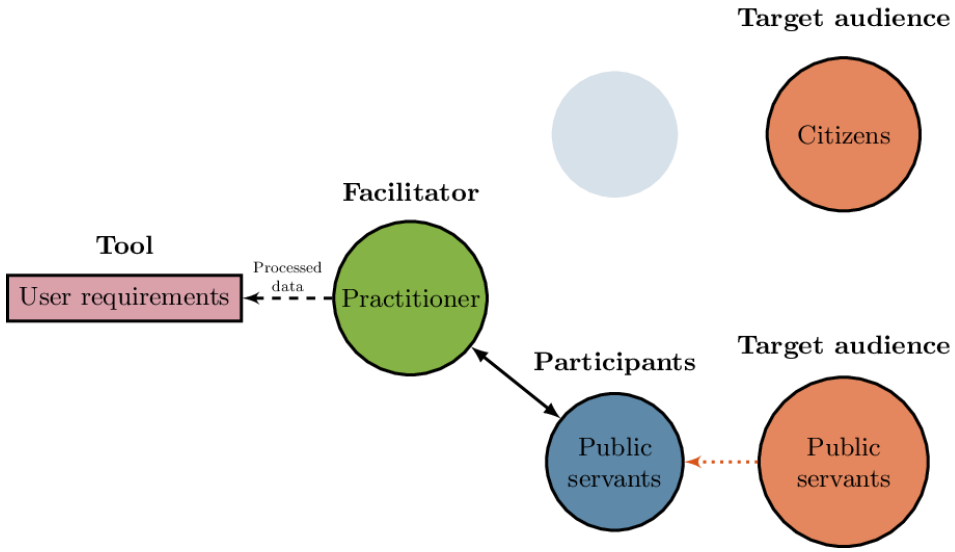


Figure 3.5. Visual representation of the Creation of a digital portal (La Louviere, Belgium) case.

COMBINING DIFFERENT CO-CREATION METHODS (CASE 3: LET'S PREPARE BRUSSELS)

CASE STUDY 3: LET'S PREPARE BRUSSELS (BRUSSELS, BELGIUM)

This case study showcases an initiative of the Brussels Region (Belgium) to design new environmental projects in the post-covid context[3]. In the first part of this participation process, a survey was carried out. This survey was performed by a dedicated company and Bruxelles Environnement, who selected participants in different manners. The survey was performed in 3 different modalities, namely via a digital platform and Internet or phone surveys.

Define the nodes. The target audience was the citizens of Brussels. The participants are divided into 3 groups based on the method used for the interview. A facilitator organizes the Internet and phone surveys while a tool is used for the digital platform survey. Then, another facilitator groups the results from all surveys and uses a tool to process the data and do the reporting.

Make the connections. The representation from citizens chosen for the survey digital platform is lower, as the data indicated a clear bias in their selection, while the participants interviewed by telephone have a stronger communication connection, as the average duration of their interaction (37 minutes) was considerably longer than the ones by internet (18 minutes). Besides these representations connections and the two-way connections between participants and the facilitator or the survey platform, there are one-way connection between the platform and this facilitator toward the other facilitator who aggregates the data. This latter facilitator has an action connection with the report.

[3] https://letsprepare.monopinion.brussels

Visualization. The visualization of the model clearly highlights weaker connections, that allow comparing different co-creation methods. It shows that there can be a representation bias with some methods, highlighting the importance of not relying solely on digital platforms for optimal coverage of the target audience.

We can observe the difference of the different methods. In terms of connections with citizens or different types of gathering information (via a platform or practitioners).

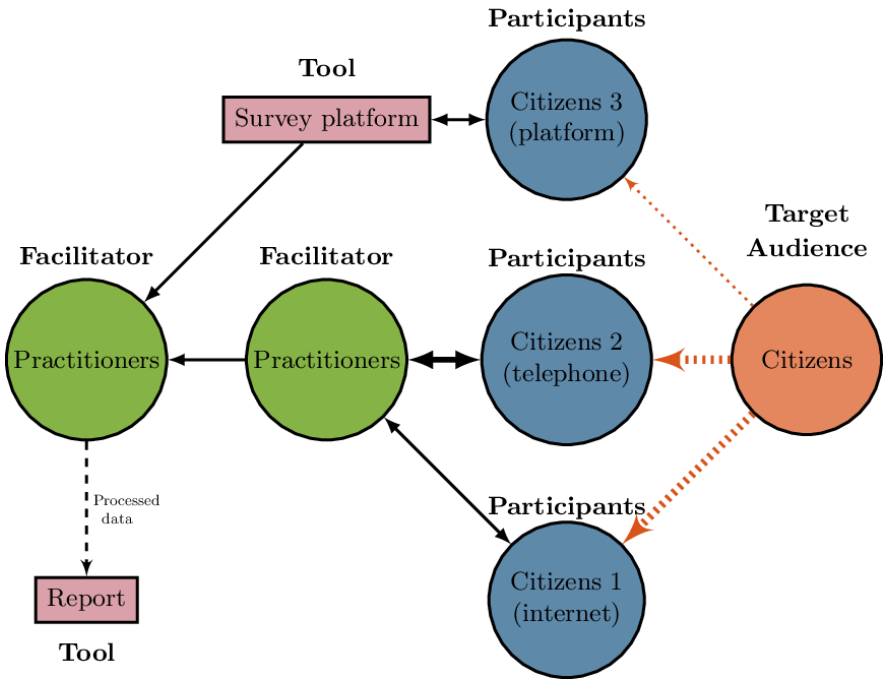


Figure 3.6. Visual representation of the Let's prepare Brussels (Brussels, Belgium) case.

EVALUATING DIFFERENT TYPES OF TARGET AUDIENCES (CASE 4: HEALTHY DATA PROJECT)

CASE STUDY 4: HEALTHY DATA PROJECT (FRANCE, BELGIUM, UNITED KINGDOM)

This case study describes a public e-consultation related to the reuse of citizen health data[4]. The consultation focused primarily on France, Belgium and the UK. A common survey platform was used to gather all the contributions supported by a large-scale communication campaign.

Define the nodes. The target audience is divided into 3 groups based on nationality. Each is represented by a set of participants. A common digital platform collects the survey data, that is then used by the facilitator to do the reporting.

Make the connections. There are representation connections between the target audience groups and the participants, two-way connections between the participants and the digital platform, a one-way connection between the platform and the facilitator, and an action connection corresponding to the reporting. The strength

[4] https://ourhealthydata.eu

of the representation connection is based on the number of participants from each country as there was no more information available due to the anonymity of the survey.

Visualization. The model visualization shows the central importance of the survey platform as it is the main interaction with participants and the whole data collection goes through this platform. It highlights weaker representation connections for France and the UK.

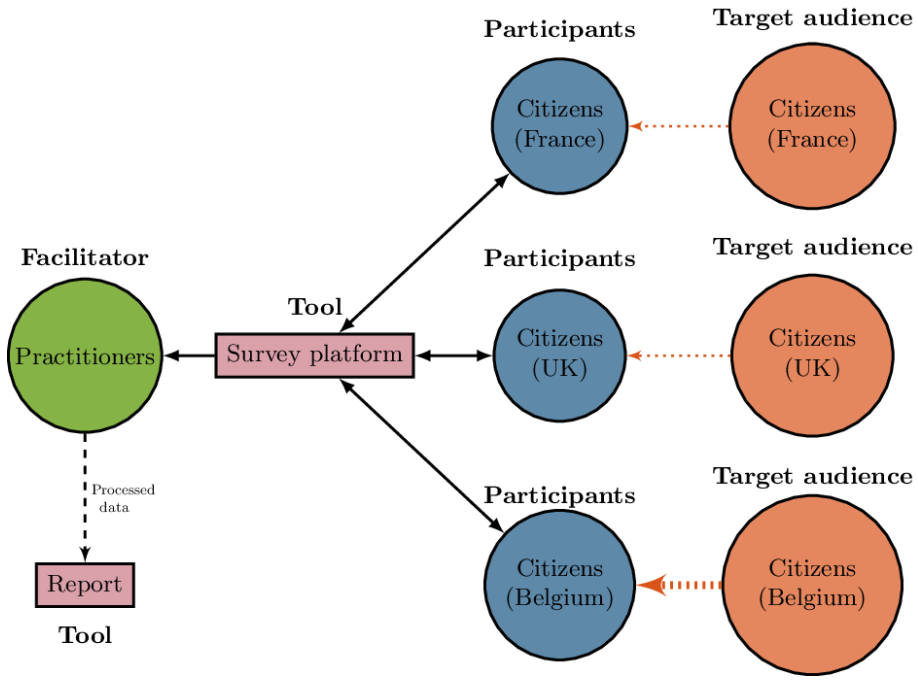


Figure 3.7. Visual representation of the Healthy data project (France, Belgium, United Kingdom) case.

4. OUTCOMES OF DIGITAL CO-CREATION

This section introduces the wide range of outcomes that can be achieved at different levels by engaging in (digital) co-creation. These outcomes can be observed at the level of individual participants of the co-creation process, the process in itself, and beyond. Afterward, we report on how citizens perceive the importance of these outcomes, as well as factors affecting the achievement of outcomes. Based on this, we formulate recommendations for practitioners to help them make decisions on the co-creation design based on the outcomes they want to prioritize.

4.1. OUTCOMES OF CO-CREATION

Carrying a co-creation project can lead to many different outcomes at various levels. Indeed, existing research has contributed valuable insights into the diverse outcomes that can emerge from digital co-creation initiatives. For example, Bentzen (2022) identified three crucial outcomes, namely innovation, ownership, and trust, underscored by continuous involvement but undermined by its discontinuity. Best et al. (2019) explored stakeholder salience's impact on value co-creation, recognizing micro, meso, and macro-level gains and highlighting challenges in expectations and government reforms. Irvin and Stansbury (2004) delved into the advantages and disadvantages of co-creation, emphasizing better policy outcomes through citizen involvement but acknowledging potential challenges such as cost and bias. To regroup and classify the outcomes into a practically usable framework, we follow the approach of Voets et al. (2008), who have developed a framework to characterize the performance of policy networks. Three types of outcomes are described, each at three levels of assessment (i.e., in the form of a 3x3 matrix).

Table 4.1. Structure of the outcomes framework.

	Micro level	Meso level	Macro level
Product outcomes			
Process outcomes			
Institutional outcomes			

Levels of assessment. The **micro** level refers to the individual participants in the co-creation projects (i.e. individuals participating as citizens or service users, but also individuals participating as representatives of an organization such as an official of a public service organization). The **meso** level refers to the public service system or co-creation network in which the individuals and organizations involved participate (so this does not include the political or administrative leaders if they are not directly involved in the co-creation project). The **macro** level refers to the broader group of citizens, organizations and actors, including those who do not participate in the co-creation project but are directly or indirectly affected by it (e.g., citizens, political leaders).

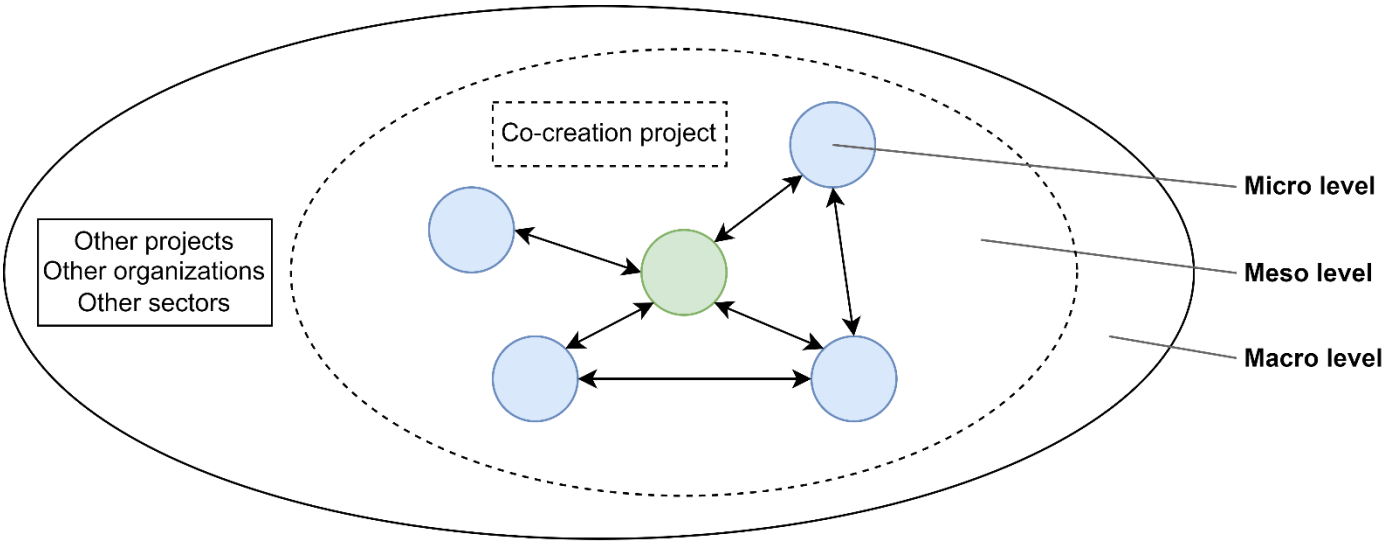


Figure 4.1. The three levels of assessment of co-creation outcomes.

Types of outcomes. The **Product** type is concerned with the efficient attainment of the goals of the co-creation. These goals can change during the co-creation process. The **Process** type relates to the democratic quality of the co-creation. Lastly, the **Institutional** type encompasses the relational aspects of the co-creation.

The tables below list 18 co-creation outcomes identified by thoroughly reviewing recent scientific literature. Each outcome is defined for each assessment level with a question that a co-creation practitioner can ask to evaluate the extent to which the outcome has been reached for this level. These tables can be used *ex ante* as a checklist to get an overview of possible outcomes, select high-priority outcomes, and plan actions toward reaching these outcomes. They can also be used *ex post* to evaluate a co-creation project against the outcomes deemed important. More precisely, the different levels and types of outcomes all serve their own purpose when it comes to practical application of the framework. The micro-level applies to the experience of individual participants and can therefore be used as an evaluation guide for citizens. The meso level applies to the co-creation network and is most useful for practitioners as a tool during the setup of an initiative. The macro level is most useful for political and administrative leaders, and researchers, to determine the positive influence of co-creation outside of their network. While product outcomes map the direct goals of an initiative, the process outcomes can be seen as the tools (or even conditions) to achieve the product outcomes. Institutional outcomes are also important measures for success, although achieving these is often a byproduct of an effective co-creation initiative.

4.1.1. PRODUCT OUTCOMES

The explanation for product outcomes from a classic performance point of view (Voets et al., 2008) and is influenced by the perspective of New Public Management. Product outcomes are derived from production-oriented logic by emphasizing the attainment of direct goals through an efficient and effective process. The product outcomes can also be described as the pre-determined goals of co-creation.

Table 4.2. List of product outcomes.

Product outcomes	Micro level	Meso level	Macro level
Effectiveness (Voorberg et al., 2015; Torfing et al., 2019; Irvin and Stansburry, 2004)	Have the individual needs and expectations of participating users been met?	Have the shared objectives or goals been achieved?	Do external stakeholders and community members perceive the policy problem to be better addressed?
Efficiency (Voorberg et al., 2015; Torfing et al., 2019; Petrescu, 2019)	Do participating users perceive the benefits to exceed the costs?	Has the initiative led to an efficient or cost-saving solution?	Has the initiative improved the efficiency of service delivery or resource allocation?
Innovation (Bentzen, 2022; Best et al., 2019; Torfing et al., 2021)	Has the initiative introduced new ideas, solutions, or methods that benefit users?	Has the initiative introduced new ideas, solutions, or methods that can be applied by policymakers?	Has the initiative introduced new ideas, solutions, or methods that benefit the public service system beyond the initiative?
Learning (Voorberg et al., 2017; Irvin and Stansburry, 2004)	Have users acquired new knowledge, skills, or insights?	Did the initiative contribute to policymakers learning about participants' needs?	Have users, organizers, and policymakers acquired new knowledge, skills, or insights that can be used beyond the initiative?
Personalization (Petrescu, 2019; Radtke et al., 2023)	Have individual users been able to customize or tailor the co-produced solutions to their needs and preferences?	Did the initiative contribute to a solution that better fits the wants and needs of different groups?	Did the initiative contribute to service delivery that better fits the wants and needs of different groups?
Satisfaction (Voorberg et al., 2015; Kang and Van Ryzin, 2019; Palumbo and Manna, 2018)	Are individual users satisfied with the solutions?	Did the initiative contribute to satisfaction on the policy issue among participants?	Are stakeholders and the broader community satisfied with the outcomes and experiences of the initiative?

4.1.2. PROCESS OUTCOMES

While the New Public Management view on co-creation is useful in assessing the direct goals, there are other important dimensions in co-creation outcomes as well. The process and institutional outcomes find their basis in the work by Hood (1991). A significant second aspect of co-creation are the process outcomes, which help protect values such as fairness, honesty, and mutuality. How a process is organized and experienced are, beyond outcomes in itself, also sometimes conditions for effective product and institutional outcomes.

Table 4.3. List of process outcomes.

Process outcomes	Micro level	Meso level	Macro level
Conflict resolution (Steen and Tuurnas, 2018; Petrescu, 2019; Laud et al., 2019)	Were conflicts between users addressed and resolved fairly and effectively?	Have mechanisms been put in place to resolve conflicts during the process?	Has the initiative contributed to resolving conflicting opinions in the broader community?
Democratic accountability (Voorberg et al., 2015; Best et al., 2019)	Were users held accountable for their ideas and actions?	Were decisions made democratically by users?	Did the initiative contribute to the government's ability to defend decisions on a democratic basis?
Inclusiveness (Thijssen and Van Dooren, 2016; Torfing et al., 2019; Steen and Tuurnas, 2018)	Were all relevant users given equal opportunities to participate?	Have mechanisms been put in place to ensure all relevant participants were involved?	Did the initiative ensure that the voices of different groups were included in policymaking?
Legitimacy (Best et al., 2019; Røiseland, 2022)	Was the initiative perceived as legitimate by users?	Were the digital tools and methods used considered legitimate?	Did the solutions provide a legitimate basis for decision-making?
Resource integration (Laud et al., 2019; Petrescu, 2019)	Could users bring in valuable knowledge and experience?	Were the resources of participants integrated effectively?	Did the initiative enable citizens to contribute valuable knowledge to policymaking?
Transparency (Engen et al., 2021; Järvi et al., 2018; Steen and Tuurnas, 2018)	Were users provided with sufficient information about decision-making?	Have mechanisms been put in place to provide participants with information about the digital process?	Did the initiative contribute to transparency in policy creation and governmental decision-making?

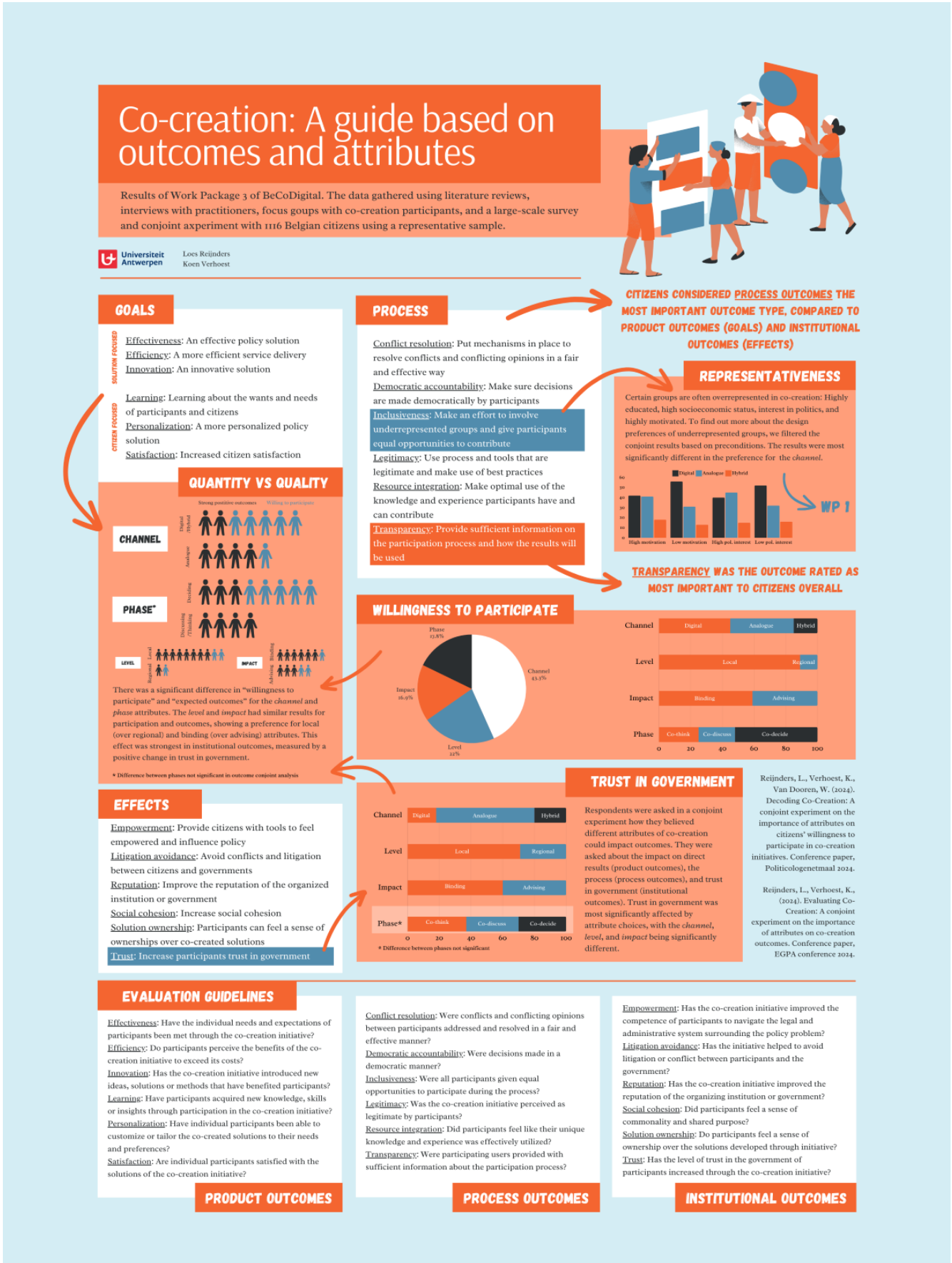
4.1.3. INSTITUTIONAL OUTCOMES

The third outcome type is tied to the resilience and robustness of the system in which co-creation takes place. By affecting the beliefs and behavior of participating users during and after co-creation, the institutional outcomes can also be described as long-term effects or byproducts. Although institutional outcomes are often not pre-determined and intended, they are still important for the continuation of the system in which co-creation takes place.

Table 4.4. List of institutional outcomes.

Instit. outcomes	Micro level	Meso level	Macro level
Empowerment (Engen et al., 2021; Laud et al., 2019; Järvi et al., 2018)	Has the initiative improved users' competence to navigate the legal and administrative system?	Has the initiative enhanced users' ability to defend their interests against the government?	Has the initiative contributed to citizens' ability to defend their interests against the government?
Litigation avoidance (Irvin and Stansburry, 2004)	Has the initiative helped avoid litigation between users and the government?	Have mechanisms been put in place to avoid litigation between users and stakeholders?	Has the initiative helped avoid litigation between the government and citizens?
Reputation (Best et al., 2019)	Has the initiative improved the reputation of the organizing entity?	Has the organization of the initiative improved the reputation of the government?	Has the initiative improved the reputation of the broader policy sector?
Social cohesion (Voorberg et al., 2015; Torfing et al., 2019)	Do users feel a sense of commonality and shared purpose?	Have mechanisms been put in place to create a sense of commonality in the initiative?	Has the initiative promoted social cohesion and community building?
Solution ownership (Bentzen, 2022; Irvin and Stansburry, 2004)	Do users feel a sense of ownership over the solutions developed?	Have users been informed about who owns the solutions and their implementation?	Do community members feel a sense of ownership over broader policy issues?
Trust (Bentzen, 2022; Kang and Van Ryzin, 2019; Irvin and Stansburry, 2004)	Has the level of trust between users increased?	Has the level of trust in the policy issue improved?	Has the level of trust in the public service system or network increased?

Below, we provide a practical and visual guide demonstrating how the outcomes framework can be used.



4.2. PERCEIVED IMPORTANCE OF CO-CREATION OUTCOMES

In the end, the question of which outcomes are most important, i.e., should be prioritized in a given co-creation project, is at the discretion of the practitioners who organize the co-creation. This prioritization may be done according to multiple criteria. We propose that one such criterion could be the importance of the outcomes as perceived by the citizens who are impacted by the co-creation project. To help practitioners willing to take this criterion into account, we have surveyed more than 1,000 citizens to uncover which co-creation outcomes they deem most important.

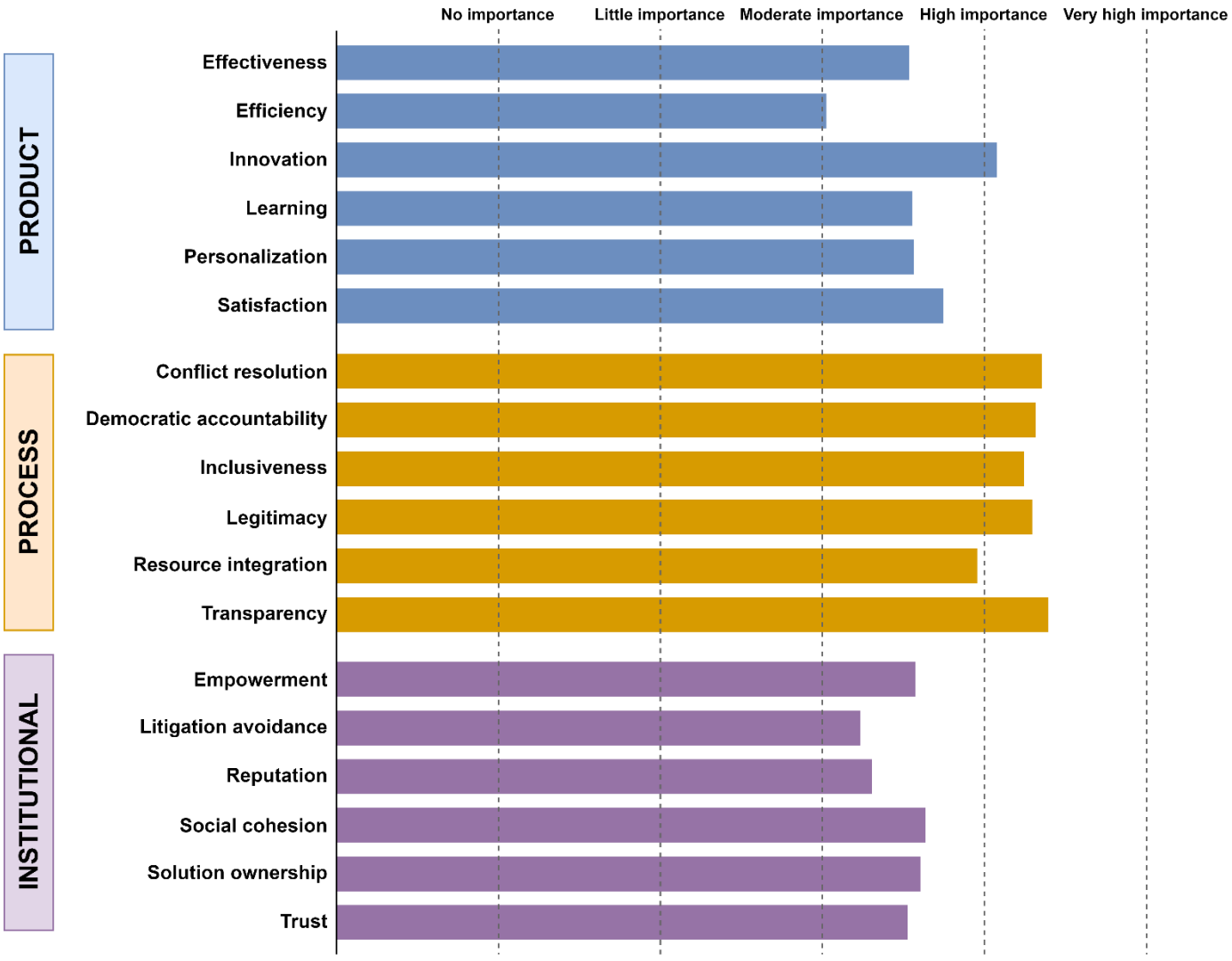


Figure 4.2. Importance of outcomes as perceived by citizens.

Process outcomes are overall rated to be the most important. Product outcomes and institutional outcomes were rated similarly, although "efficiency" was received a lower rate than other product outcomes. Process outcomes, although categorized as outcomes, can also be considered conditions for successful product and institutional outcomes. Despite the variation in importance, every outcome was rated on average between moderately important and very (high) important. This highlights the relevance of the outcome framework as all outcomes resonate with citizens. This signals that the outcomes that are being targeted, particularly at the

micro-level (where the immediate impact on individuals is most felt), align well with citizen priorities. **The most important outcome, according to citizens, is transparency, yet none of the practitioners we interviewed in the BeCoDigital project had specific checks or evaluation for transparency.** This draws attention to a potential misalignment between what citizens value and what practitioners prioritize in co-creation.

4.3. CO-CREATION FEATURES AFFECTING OUTCOMES

We investigated which features of a co-creation project would have, according to citizens, a positive effect on product, process, and institutional outcomes. We have studied the co-creation channel (analogue, hybrid, or digital), the impact (binding or advising), the government level (local or regional), and the co-creation activity (co-think, co-discuss, or co-decide). For each feature, we asked citizens to compare several examples of co-creation projects (i.e., differing in terms of the considered feature) would (1) lead to the best results (product outcomes), (2) have the best organized process (process outcomes), and (3) increase participants trust in government the most. Based on these results, we can draw conclusions about which attributes are viewed the most positively according to citizens.

Table 4.5. Methods and technologies used in the case studies.

Feature	Definition	Findings
Channel	Use of technology in the communication between stakeholders	A larger share of citizens was willing to participate in digital or hybrid initiatives Hybrid or digital co-creation does not lead to better outcomes Analogue (i.e., non-digital) co-creation leads to better institutional outcomes
Impact	Degree to which the co-creation organizer is constrained by the inputs of participating stakeholders	A larger share of citizens was willing to participate in binding initiatives Binding co-creation leads to better institutional outcomes
Level	Level of government on which the co-creation organizer operates	A larger share of citizens was willing to participate in local initiatives Local co-creation leads to better outcomes Both the willingness to participate and expected outcomes had a very strong significant effect in local initiatives
Activity	Action performed by the participating stakeholders	A larger share of citizens was willing to participate in co-deciding The activities do not differ in terms of outcomes

Based on our findings, we formulate the three following recommendations.

Prioritize decentralized participation models. Practitioners should recognize the importance of local initiatives in driving better outcomes of all three types: product, process, and institutional outcomes. Local initiatives were consistently rated higher by respondents, suggesting that citizens feel more connected to and invested in initiatives that directly impact their immediate needs and communities, and more citizens were willing to participate in local initiatives over regional ones. This finding should encourage policy-makers to prioritize decentralized participation models, where citizens feel a stronger sense of ownership and influence over policy decisions.

Go for analogue and binding models to favor institutional outcomes. The preference for binding initiatives in institutional outcomes shows where the value lies in organizing a binding co-creation initiative, as opposed to an advising one. A binding initiative can help people to have more trust in their government, and possibly also other institutional outcomes, such as making citizens feel more empowered and improving social cohesion. This also applies for the channel, where analogue co-creation was found to lead to better institutional outcomes. For long term effects and changes in beliefs amongst citizens, it is most effective to organize in-person (analogue) and binding co-creation initiatives.

Define intended outcomes upstream. There is a need for mapping intended outcomes prior to organizing a co-creation initiative and choosing attributes depending on these. This strategic alignment can help practitioners to better tailor their initiatives to meet the specific goals of their co-creation efforts, optimizing both citizen satisfaction and policy effectiveness.

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APPENDIX

APPENDIX 1. USE OF ARTIFICIAL INTELLIGENCE IN DIGITAL CO-CREATION

Digital technologies represent an opportunity to enhance and enlarge the scope of co-creation, as they make several operational processes more efficient thanks to the use of digital and online platforms (Naranjo Zolotov et al., 2018). Online platforms allow more direct and interactive feedback from citizens (Simonofski et al., 2021). Sensing technologies can help citizens to provide more concrete evidence of specific issues (Kamel Boulos et al., 2011), while actuation technologies, such as 3D visualization or 3D printing, provide an affordable way to share and develop prototypes (Rayna et al., 2015). All those are examples of how these technologies can ameliorate the co-creation process. Among these new technologies it is acknowledged that Artificial Intelligence (AI) has the potential to not only increase the scale of participation, but also to empower partaking stakeholders by making participation more inclusive, more transparent and by improving its quality (Van Noordt & Misuraca, 2022).

AI allows stakeholders to access and comprehend larger amounts of data, providing balance to the difference in resources between stakeholders and governments (Duberry, 2022). For example, recommender systems and chatbots simplify and support interactions in online platforms, making the experience more efficient and easier for citizens (Ito, 2023). Summarizing, translating or providing feedback are other simpler ways AI can improve co-creation by equalizing the difference in cognitive capacities across participants (Anastasiou et al., n.d.). Aside from these benefits, there also exist greater risks in using AI in the public sector using more traditional technologies. AI-based recommenders can nudge discussions toward predefined topics (Pariser, 2011), and the lack of explainability and transparency in certain algorithmic processes might affect trust on the validity of these activities (Ehsan et al., 2021). In fact, AI is a broad term associated with several technologies that do not necessarily share the same characteristics and social impacts.

This part of the roadmap aims to shed light on the current and potential uses of AI in co-creation. We focus mostly on online dedicated platforms (Gil et al., 2019; Simonofski et al., 2019). These platforms are present in different stages of co-creation and are a perfect example of technology bringing challenges to co-creation that could be tackled by using AI.

A.1.1. WHAT CAN BE DONE WITH AI

AI is a term that encompasses a large number of technologies (e.g., machine learning, NLP, chatbots, etc.). To provide a more practical approach to the role of AI in co-creation, this section focuses on characterizing the use of AI in co-creation based on its role (helping or replacing the human) and its scope (at the individual or collective level). Then, based on the different types listed, this characterization can guide the choice of the AI technologies that could fit best those conditions.

TYPES OF AI SOLUTIONS FOR CO-CREATION

We developed a typology of potential uses of AI in online dedicated platforms supporting co-creation. These platforms allow stakeholders to formulate and react to contributions, usually presented in the form of ideas related to new or existing policies or services. The typology is defined by two main dimensions.

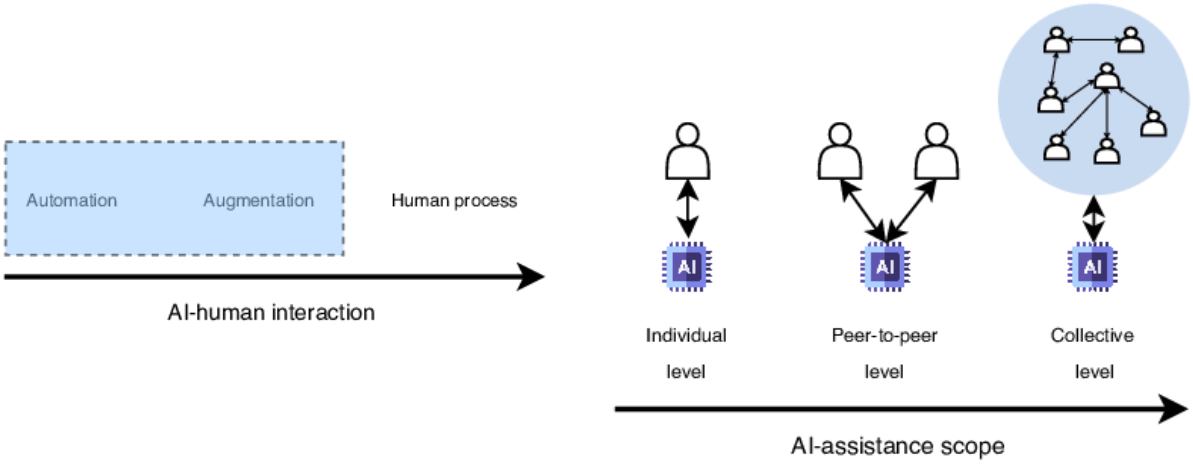

Figure A.1. Dimensions of the typology.

The first dimension, **AI-human interaction**, considers the share in control and influence between human and AI while performing a given task, going from fully automated to human based. We characterize the role of AI under the definition of the task being enhanced. For instance, the classification of contributions can be fully *automated* by an AI system if the process is fully AI-driven. On the other hand, if classifying contributions is part of a larger task evaluating the sentiments of citizens, this latter task would be *augmented*, rather than fully automated, by the AI if most of its remaining steps are carried out by the human. The two envisioned scenarios can be summarized as follows.

Automation. The task is fully automated by the AI with no human intervention (Johnson et al., 2020).

Example: The topic classification of contributions, e.g., (Romberg & Escher, 2022), where the classification task is completely automated and carried out by a Natural Language Processing (NLP) algorithm.

Augmentation. The task performance of the human is improved thanks to the collaboration with the AI (Johnson et al., 2022).

Example: The AI-based argumentative feedback for citizens presented by (Borchers et al., 2023). This AI tool evaluates contributions from citizens based on how well they address certain topics in their text. Thanks to this analysis, citizens can edit their contributions, improving the quality of their text.

The second dimension of the typology, **AI-assistance scope**, is associated to the level of granularity at which the AI solution is implemented. This dimension has the following as possible values.

Individual level. The AI system affects and interacts with an individual participant, enhancing their participation at a cognitive or informational level.

Example: The previously mentioned feedback system from (Borchers et al., 2023) uses individual information in their assessment and improves the individual's contribution of each citizen.

Peer-to-peer level. The AI system affects and interacts with multiple individuals in one way or another based on their individual needs and information. It focuses on improving the interaction and communication between stakeholders (e.g., citizen-to-citizen interaction), or between stakeholders and the organizers of the co-creation (e.g., citizen-to-government).

Example: Recommender systems (Egger & Yu, 2022) connect different users by comparing their individual information.

Collective level. The AI system affects and interacts with the co-creation process as a whole. It focuses on the global outcome of the collaboration.

Example: The use of network analysis to represent ideation dynamics in an ideation process, as the information and outcomes of these analysis concern the overall process (Shin & Rask, 2021).

The typology provides six ideal types of AI solutions summarized in the following table. We delve into more detail within each type and discuss the opportunities and risks they involve.

Table A.1. Typology describing AI use in digital co-creation.

	Individual level	**Peer-to-peer level**	**Collective level**
Automation	**Processing tools** Processing information that facilitates the individual tasks of the participants during the participatory process *Example:* Topic analysis *Implementation:* Summarize a selected proposal	**Recommendation tools** Generating potential links in terms of proposals or users *Example: Recommender systems* *Implementation:* Find similar proposals/similar users	**Analysis tools** Generating quantitative indicators related to the outcome of the co-creation process *Example:* Network analysis *Implementation:* Identify topics and key contributions
Augmentation	**Individualized feedback** AI interaction to improve the performance, motivation of knowledge of individuals *Example:* Individual performance feedback *Implementation:* Feedback on the suitability of a submitted idea	**Enriching feedback** AI interaction to trigger knowledge relations and enrich the individual and collective inputs *Example: Bounder spanner recommendations* *Implementation:* Provide relations with other potential topics	**Collective feedback** AI interaction based on processed collective data to optimize the overall participatory process *Example: Feedback based on ideational dynamics* *Implementation:* Feedback to develop more current ideas or move toward unexplored topics

PROCESSING TOOLS

Processing tools can be seen as any AI-based solution that automates tasks, such as the processing or generation of information, at the level of individual participants. The task associated with the AI (e.g., the labelling of the citizen's proposals or summary of text) is fully automated.

One of the main issues of digital co-creation platforms is information overload, where large-scale participation involves a huge number of contributions to process (Davies et al., 2021). As a result, access to fellow participants' contributions can be complicated and discouraging. In this context, processing tools can be very practical, as the main goal of these systems is to process and accommodate high amounts of contributions. The use of Natural Language Processing (NLP) techniques and chatbots have emerged as ideal instances of AI technologies for this kind of tasks (Cortes-Cediel et al., 2020).

NLP is a technology that has demonstrated to be very effective in processing and summarizing unstructured text contributions (Egger & Yu, 2022). NLP can be used to label or summarize participants' contributions (Arana-Catania et al., 2021; Romberg & Escher, 2022). Chatbots can be part of these automated tasks by providing a simpler interface with the NLP algorithm.

Opportunities: Processing tools might help individual stakeholders to navigate vast amounts of information, balancing the disparity in the access to resources across stakeholders (Savaget et al., 2019). Additionally, individualized approaches relying on individual data can be better evaluated and regulated (Gupta & Woolley, 2021).

Risks: Processing tools might be potentially dangerous depending on the type of technique used (Sarker, 2022). Rule-based chatbots, i.e., chatbots that have a limited and regulated range of instances, are less performing than their machine learning counterparts but can be programmed to ensure correct and legal answers (Følstad et al., 2023). Contrariwise, generative AI chatbots have shown an enormous potential, providing very personalized and human-like interactions, but they might present symptoms of hallucination or bias in their answers. This balance between performance and robustness is an important aspect to evaluate before the implementation of this type of AI-driven solutions.

RECOMMENDER TOOLS

Recommender tools automatize tasks involving several participants, while keeping the focus of their actions on the individual needs of each participant. This type of AI systems is commonly associated with automatically creating connections between participants or making links between subjects.

During deliberation or ideation activities, automated processes can be used to connect participants and contributions (Arana-Catania et al., 2021), or to help participants to connect with fellow participants having similar opinions (Romberg & Escher, 2022).

Opportunities: Recommender tools may have a great impact in co-creation as they help to overcome information overload (Chun & Cho, 2012) and the lack of real-time discussions (Aitamurto et al., 2017). The generation of connections between similar ideas and users might help to enrich debates and to optimize the share of opinion and knowledge.

Risks: The use of recommender tools has shown a tendency for filter bubbles and eco-chambers (Pariser, 2011). That is filtering information based on personal characteristics and preferences and thus isolating citizens from different perspectives and opinions. Moreover, recommender systems heavily rely on how they are tuned. As such, the implementation of recommender systems must be transparent and properly designed (Ehsan et al., 2021).

ANALYSIS TOOLS

Analysis tools are associated with tasks that affect the overall co-creation process and all participants.

In an example of practical implementation, (Amarasinghe et al., 2021) use network modeling to characterize the ideation process in citizen science, identifying main contributors and important ideas thanks to the network topology. In co-creation, these indicators can also be used to compare the evolution of different aspects of the process and to envision real-time actions to improve the quality of the activity. For instance, to monitor the dynamics of a participatory budgeting process (Shin & Rask, 2021), facilitating the evaluation of its outcomes.

For example, Koch et al. (2013) have studied the case of the Aufbruch Bayern platform, which allows citizens to post and react to ideas for the city. To better understand how citizens interact on this platform, the authors have classified them according to their level of activity. For example, passive users have low activity on the platform, idea generators contribute many ideas but rarely interact with others' contributions. Motivators contribute few new ideas but frequently react to others' contributions. Then, a network visualization was built to show interactions between users (i.e., two users interacting means that one reacted to the other's contribution). The weekly evolution shows how the platform grows over time.

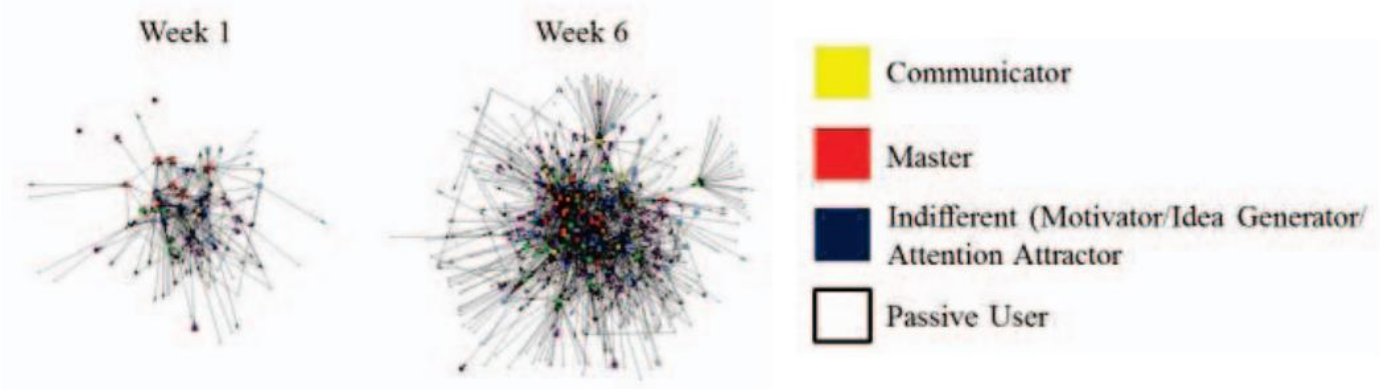

Figure A.2. Analysis of the activity on a co-creation platform (from (Koch et al., 2013)).

Opportunities: Analysis tools could provide stakeholders with a way to understand and process more comprehensive data without the intervention and processing from the government. This new paradigm would help stakeholders to have a more active involvement and knowledge of the overall process (Havrda, 2020), by relying less on the resources directly provided by the co-creation organizer. This could bring more autonomy and balance the power disparities during the co-creation process.

Risks: Analysis tools work with collective indicators generating global information that may fail to provide detailed and particularized information of all different stakeholders. In this sense, these tools that provide a synaptic description of a given process can promote the masking of minorities and reduce the diversity of stakeholders' input if they are too much relied on. As such, relying excessively on this kind of approach could be counterproductive in terms of diversity of inputs and participation.

INDIVIDUALIZED FEEDBACK

Individualized feedback groups AI solutions in which there is a collaboration between the human and the AI to carry out a given task at an individual level.

Within the co-creation field, several chatbot solutions aiming at this augmentation of the individual experience have been proposed (Androutsopoulou et al., 2019). For instance, (Borchers et al., 2023) provide an example of NLP approach which helps citizens to understand if a contribution fits into a given topic, augmenting the performance of the participants and resulting in a more elaborated argumentation during the discussion.

Opportunities: Individualized feedback can help stakeholders to improve and enhance their comprehension of given topics and provide them with the right tools to express their views. Based on the nature of these solutions, this approach also ensures that the output generated is supervised by the stakeholder, helping to improve trust and transparency in the use of AI (Molina & Sundar, 2022).

Risks: The supervised approach that individualized feedback solutions implement does not exclude them from inserting bias into the process or influencing the actions of participants (Barredo Ibanez et al., 2021). This influence, and any possible bias integrated during the design of the AI system, must be evaluated prior to the implementation.

ENRICHING FEEDBACK

Enriching feedback defines a type of AI solution that enhances tasks by interacting with several participants. This can be done in the form of information snippets or by directing participants toward certain discussions. Enriching feedback can help to enlarge the knowledge and scope of the contributions with less impact from algorithmic outcomes.

For example, Wahl et al. (2022) use AI-generated stimuli from other perspectives to affect the idea outcome in innovation, providing early examples of these types of applications. Siangliulue et al. (2016) use machine learning to create an interactive solution space that helps users to enhance the quality of their interventions.

Opportunities: Enriching feedback types of approaches could be used during the ideation or the co-delivery phase in a co-creation project. These AI systems could bring additional information and help to generate associations between participants.

Risks: Unfortunately, as in the case of individualized feedback, there is still the risk of enriching feedback tools biasing the outcome toward more common solutions, neglecting minority views on certain subjects. Precisely, the fact of not providing direct outcomes, but influencing the citizen's behavior, makes these approaches hard to evaluate and to measure their actual impact in discussions and interactions.

COLLECTIVE FEEDBACK

Collective feedback is a type of AI-based solution that helps to improve the overall performance of the co-creation activity by interacting with stakeholders and the co-creation organizers. This implies helping to use and comprehend collective outcomes of the different stages of co-creation. That is for instance to influence the collective behavior of participants, e.g., promoting certain topics that are being underdiscussed, so to improve some aspects of the service or policy being developed.

Works on AI and machine learning have explored how ideation dynamics evolve and in which way AI feedback can help to improve this overall process (No et al., 2017). Based on the computed novelty of contributions or the number of comments on certain topics, collective feedback systems encourage new contributions toward certain areas. Other approaches of collective feedback work as discussion support systems aiming at enhancing the consensus and integration of ideas during deliberation phases (Ito, 2023).

Opportunities: In co-creation, individual interests of stakeholders are sometimes hard to convey into more general and aligned ideas (Aitamurto, 2016). While more advanced concepts of collective feedback are not yet applied to co-creation, promising results can be seen in AI-based agents facilitating crowd discussions (Ito et al., 2022) or the use of moderation by AI (Molina & Sundar, 2022).

Risks: One of the reasons why collective feedback solutions are still very scarce is that collective indicators are very hard to define and might lead to bias from powerful stakeholders. The definition of global indicators must be co-evaluated to avoid power dynamics to affect the design of the AI algorithm.

A.1.2. PRACTICAL USES OF AI IN CO-CREATION PROJECTS

At this point, we have presented a typology of the potential types of AI solutions, what could be their implementation in co-creation and developed potential benefits and risks associated with these implementations. This section puts the typology into practice by mapping the types to the stages of co-creation based on the main mechanisms associated with them. Then, we assess the current use of AI in co-creation by using the typology as an evaluation tool.

The figure below displays a mapping of the different types of AI tools and the phases of co-creation processes. This mapping is not exhaustive, as other types could be associated with these phases, but it shows the best matches we identified between co-creation phases and types of AI implementations.

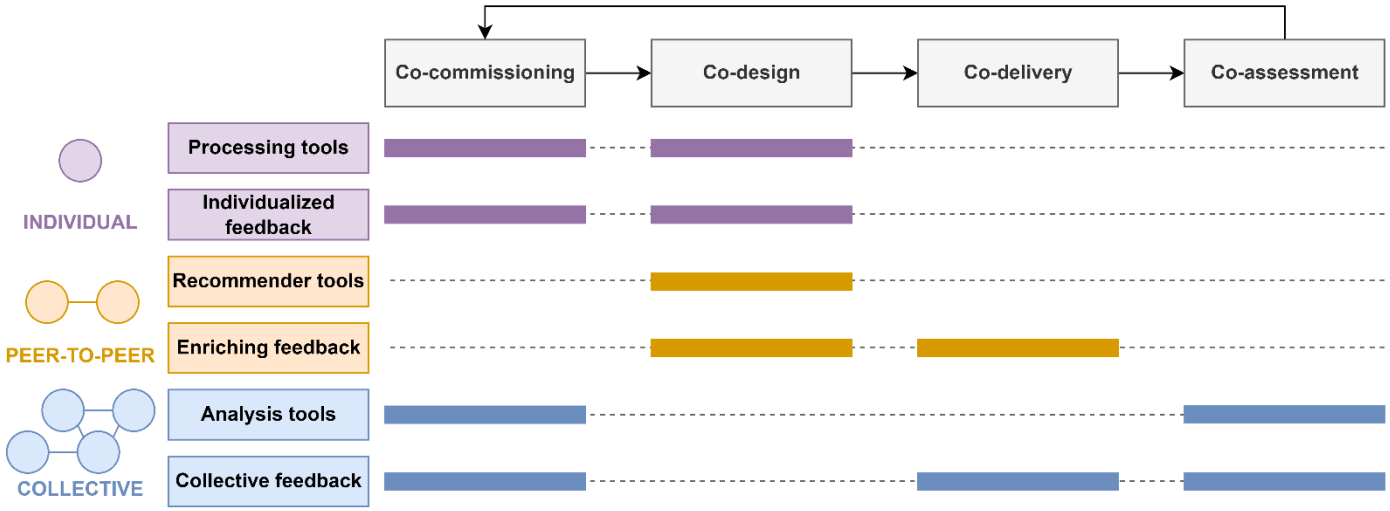

Figure 2.2. Best matches between co-creation stages and types of AI use.

Co-commissioning. The co-commissioning phase includes activities in which public and private actors consult on shared problems, mutual challenges or common tasks; identify problem-solving strategies and prioritize stakeholders, needs to address, outcomes to achieve, and resources to use.

This phase requires an efficient sharing and analysis of information by all stakeholders prior and posterior to their interventions. Stakeholders' contributions can be enhanced by individual AI tools to provide them with enough information about the problems being considered. This can be achieved by individual feedback in the form of online chatbots. In large scale projects, this phase can also benefit from automating individual tools, such as classification and summarizing of contributions, so the information being produced is easier to analyze and comprehend. Namely, the use of collective tools in the form of analysis tools could be particularly interesting as their outcomes could be provided to different stakeholders during this phase or to evaluate the results of different co-commissioning stages.

The type of collective feedback tools has also potential to be used during the co-commissioning phase. In that case, the augmentation aspect requires some further investigation so to evaluate how these tools can help the

functioning of this collaborative process without steering the outcomes based on certain interests or masking minorities.

Co-design. The co-design phase represents the planning of the configuration and of the future execution of the service. During this phase the main mechanisms implemented are: (1) the consultation and ideation of service design elements, and (2) informing and equipping the stakeholders with the right tools for the decision-making (Linders, 2012). Each of these mechanisms can be enhanced differently by AI-based solutions.

During the consultation and ideation part, the main focus is on receiving feedback from the different stakeholders, while reinforcing their interactions to improve the quality of the final outcomes. Processing tools and individualized feedback are two different approaches to precisely provide information to the stakeholders regarding the current ideation topics and to enhance their contributions. Recommendation tools and enriching feedback might help to create more links between participants and to enhance the collaborative nature of this part of the co-creation process.

Informing the stakeholders and equipping them with the necessary knowledge is heavily associated with processing tools and analysis tools. Processing tools can make stakeholders aware of the essential information during the co-design phase and, given the individual nature of this type of AI-driven solution, the information can be more personalized. Then, analysis tools can help to empower these stakeholders by providing also a broader knowledge of the co-design phase.

In both cases, the main goal is to enhance stakeholders' interaction and not to condition it to the AI-driven applications. This means improving interactions, not moving the stakeholders toward a more passive role by making them only a data provider

Co-delivery. The co-delivery phase is focused on the execution of the service being co-created. This can be achieved via crowdsourcing or by the government acting as an integrative co-delivery ecosystem. In both cases, this phase requires the active involvement of stakeholders and the communication between them and the government institutions. This coordination, and the optimization of the resources and knowledge, are important aspects for the success of this part of the co-creation process, which could be improved using collectively focused AI solutions.

From an implementation point of view, during this phase of delivering the service, it is simpler to provide clearer guidelines for collective feedback solutions. This phase, focused on the execution of previously planned services, presents less problems in terms of potential bias generated by the AI than the co-design phase. During the co-design phase, bias from collectively driven AI systems can benefit more powerful stakeholders by steering deliberation towards certain topics. Contrariwise, during the co-delivery phase, the definition of the outcome has already been discussed. This makes the use of collective AI-based feedback AI more suitable at this stage.

Co-assessment. In the co-assessment phase, stakeholders participate in the assessment and monitoring of the service being delivered. This can be developed thanks to the use of citizen reporting and/or by relying on participatory open data approaches.

Thanks to the use of collective automated solutions, the participants can obtain more concise information to develop their assessment tasks in this phase. These solutions, such as network analysis, provide a good overview of the collective process and its outcomes. This makes it easier for the different stakeholders to provide more informed assessments. Having access to processed data and the evaluation of predefined outcomes can help to empower citizens to move from simple data providers to active participants of this phase.

Additionally, the use of collective AI-based feedback can make the experience of the co-assessment more efficient and simpler for the citizen. These tools augment collective tasks by providing useful information and guidance. For instance, these tools can provide access to indicators based on the interest of the citizen or to point towards elements of the co-creation process that could be of interest to that stakeholder.

A.1.3. EXAMPLES OF AI USE IN CO-CREATION

In this section we evaluate some illustrative cases of digital platforms and their use of AI solutions.

ILLUSTRATIVE CASE 1: EMPTY HOMES TAX (VANCOUVER)

The Empty Homes Tax was a project from the City of Vancouver (Canada) created in 2018-2019 aimed to improve the housing affordability in the city. The idea was to create an annual tax associated to empty or under-utilized residential properties in order to generate a budget to spend on affordable housing projects.

To design projects where to invest this budget, the City of Vancouver used a digital platform developed by Go Vocal (formerly CitizenLab) to collect potential project ideas from citizens. The online platform allowed citizens to post, like, and comment on ideas regarding new housing projects. These ideas were to be summarized and shared with the city council.

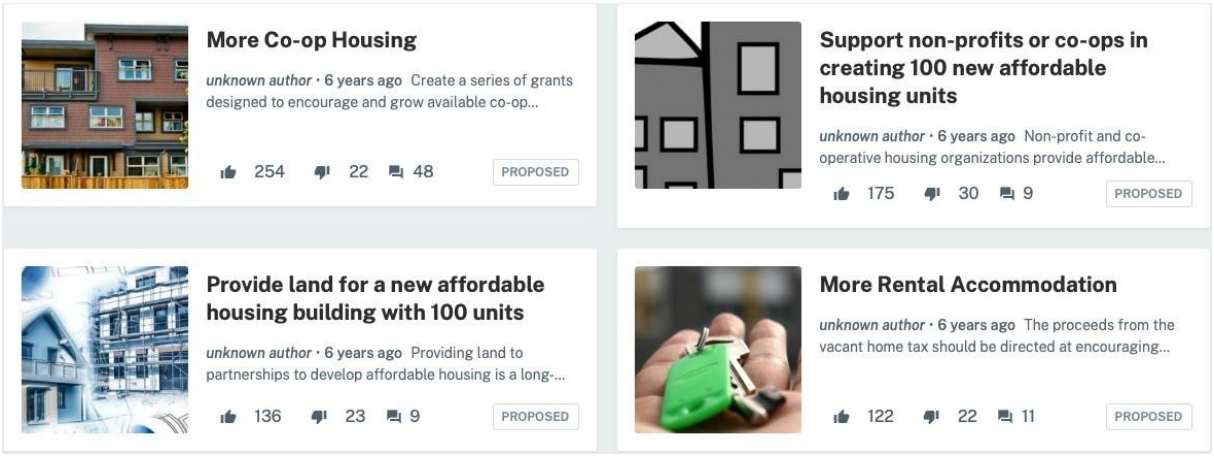

Figure A.3. Illustration of the platform used in the Empty Homes Tax case.

Given the amount of data being generated and processed, the platform incorporated the following AI solutions (based on NLP algorithms) to better process the proposals:

- *Classification of proposals (processing tool)*: Each input was added to one or more classes of proposals.
- *Similarity (analysis tool)*: Different idea proposals got compared based on the words used. This allowed grouping proposals, avoiding duplicates, and unveiling patterns.
- *Summarizing (processing tool)*: Ideas submitted got automatically summarized to help in their analysis.

This is a good example of using an AI explicitly designed to support and augment the outcomes of ideation while trying to reduce the influence of the AI system in the ideation. The AI role is limited to facilitating the generation and analysis of the citizens' ideas. The less appealing aspect about this case is that the AI tools are mainly thought for the processing of the data from the city and practitioners' point of view, with no explicit goal of empowering the citizens via their use.

ILLUSTRATIVE CASE 2: BETTER REYKJAVIK

The Better Reykjavik platform was built using the Your Priorities web application, developed by the non-profit Iceland-based Citizens Foundation. Overall, Better Reykjavik is an online participatory social network that has hosted several citizen-government initiatives, such as the co-creation of the City's education policy in 2017.

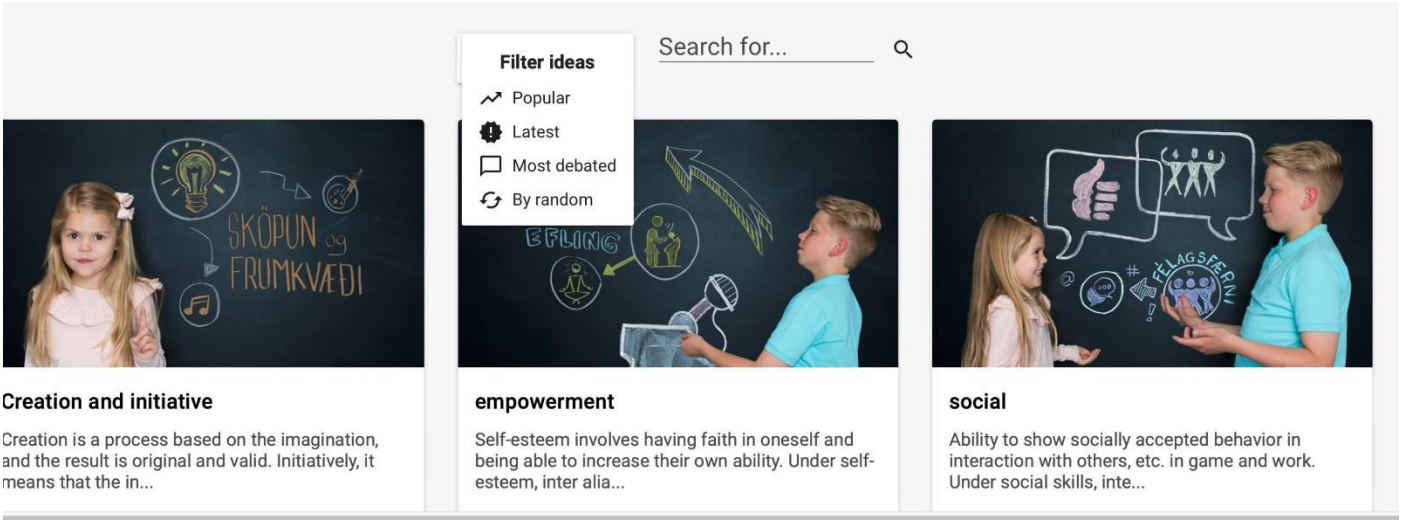

Figure A.4. Illustration of the platform used in the Better Reykjavik case.

The digital and AI-based tools used in this platform have been updated several times. The AI-based solutions integrated to the platform are the following:

- *Machine Translations (processing tool)*: Ideas and interactions can be translated to a large range of languages
- *Recommendations and Notifications (recommender tool):* Citizens get notifications and recommendations based on their posts.

- *Speech-to-Text (processing tool):* The platform provides a system to convert speech into text to the citizens' input.
- *Toxicity Detection (processing tool):* The ideas' platform disposes of a machine-based detector of toxicity and hate speech.
- *Cluster Analytics (analysis tool):* The data collected can be clustered based on some parameters chosen by the practitioners.
- *GPT-4 powered chat interface (individualized feedback):* Chatbot to improve the accessibility of the citizens to the platform.

Overall, this example provides sophisticated tools to enhance, primarily, ideation activities. An advantage of this example, mainly in terms of transparency, is the personalization of the recommendation and clustering systems, while all the AI-based algorithms are also available in open source. Both aspects help to transmit the idea of trust and transparency to the users. At a task level, the main difference with the Empty Homes Tax case is that some of the tools are also designed for improving the accessibility of citizens to these platforms and are not exclusively targeted for the co-creation organizers.

ILLUSTRATIVE CASE 3: WEBERPLATZ REDEVELOPMENT (ESSEN)

The city of Essen created a web platform to find a consensus among the diverse stakeholders regarding their needs and desires about the redevelopment of Weberplatz. To improve the understanding and comprehension of the architectural design and the impact of the square, the platform incorporates a 3D-Online and Augmented Reality (AR) model of the square.

By using an AR and 3D online approach throughout the project stages, the advantages and disadvantages of the project proposals can be explained in an interactive manner, thereby reducing information asymmetries between stakeholders and improving overall decision making. More specifically the platform incorporated:

- 3D visualization.
- Interaction and notation directly into the platform.
- Visualization of the expected temperature and air current within the square.

Through the platform, ideas, hints, and interests can be digitally added directly to the model. Thanks to the use of AI processing tools all these elements are transformed into visualizations which help citizens to understand their impact in the project. This approach exemplifies a different way AI can be of help in these platforms. The analysis and processing of information is not only related to text but, as in this case, it can be used to provide better visualization and more practical information to citizens.

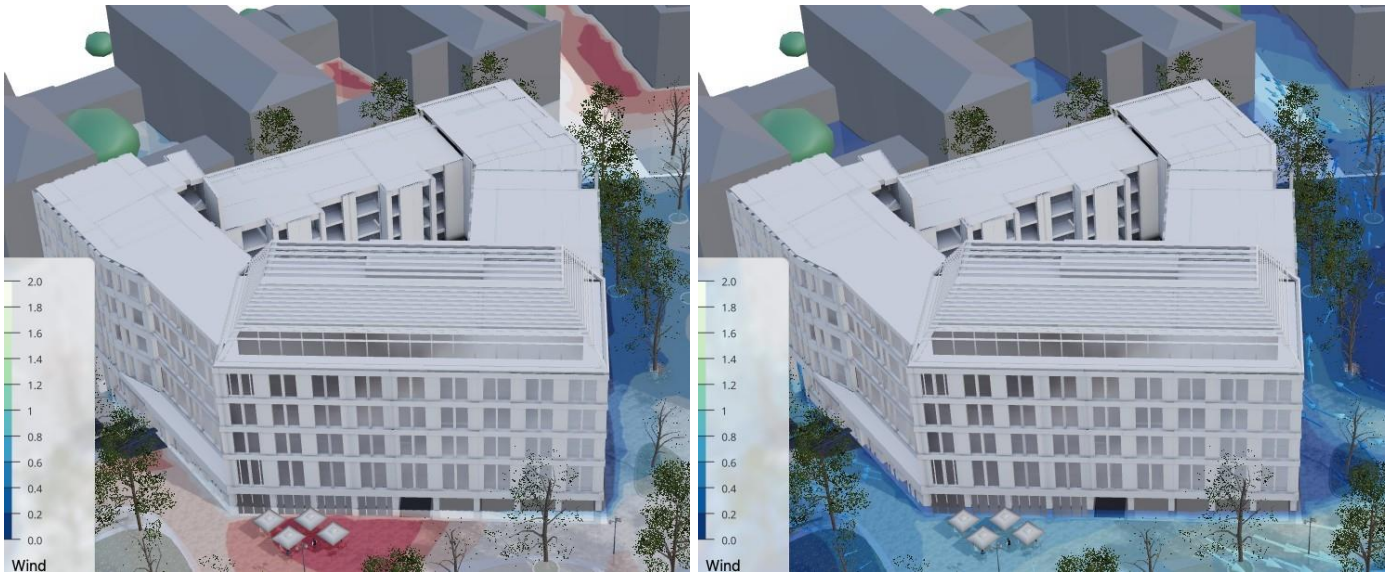

Figure A.5. Illustration of the platform used in the Better Reykjavik case.

A.1.4. HOW TO IMPLEMENT AI IN CO-CREATION?

In this section we evaluate some illustrative cases of digital platforms and their use of AI solutions.

While most AI applications in co-creation are designed to handle very specific individual tasks (e.g., recommendation of others' ideas (Cantador et al., 2017)) their influence can be vast at a social level (König & Wenzelburger, 2020), influencing how citizens and stakeholders take part in the co-creation process. As such, it is not only about designing an AI system in online participation platforms that is functional, but it is crucial to consider the social relations in which this system is embedded (Ehsan et al., 2021).

We provide guidelines and principles on how to build an overall AI architecture for dedicated online platforms taking into account the co-creation process that these platforms support (Poblet & Plaza, n.d.). We define an architecture as the set of structures and systems that compose the different AI-driven functionalities. With our design principles we aim to provide guidelines regarding the main elements that should be part of these structures, and their essential functionalities in the context of co-creation.

We can group the principles into two main sets. First, a set of principles associated to the **context and the objectives of the platform**, where the principle of Purpose-driven architecture (DP1) is realized by the principles of multilevel structure (DP2) and the dynamic allocation of AI actions (DP5). Then, a set related to the **participants and their relationship with AI**, which includes the principle of communication and transparency (DP3) being associated with the principle of human power control (DP6) and the principle of cognitive and informative balance (DP7). Lastly, the principle of collective and outcome monitoring (DP4) acts as a link between the set of principles related to the context and the participants.

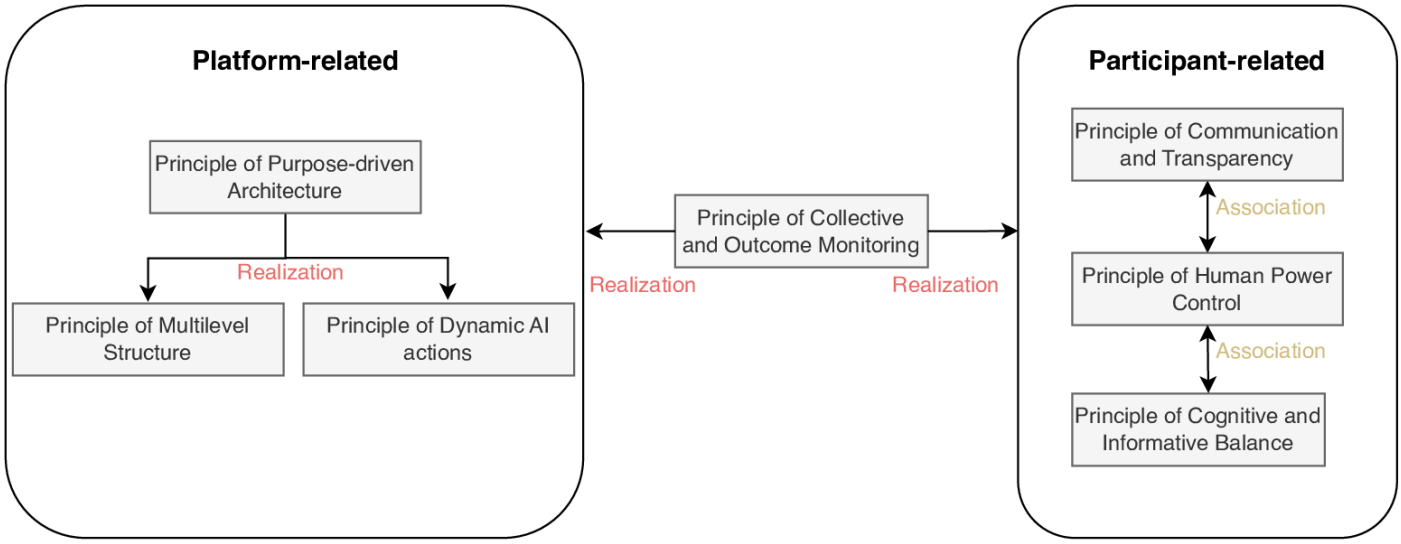

Figure A.6. Set of design principles guiding the implementation of AI solutions in co-creation.

PRINCIPLE 1 - PRINCIPLE OF PURPOSE-DRIVEN ARCHITECTURE

This principle proposes to define the objective and attributes of a given task, and then selecting the adequate technical solution for that task.

According to this principle, the architecture of the digital co-creation platform and the AI tools must be defined based on the main goal of the co-creation (i.e., high quantity of ideas, promotion of discussions or solving complex issues) and the level of activity expected from the stakeholders. This also means being defined based on the type of contributions and interaction expected from stakeholders (e.g., comment on existing topics, submit new ideas, engage in discussions).

Example: Selection of a chatbot to improve the access and use of a platform by citizens. Chatbots powered by Large Language Models (LLMs) might have good performance and provide user-friendly interactions but the outcome from the chatbot might be false. Rule-based chatbots provide less friendly interfaces but the validity of their outcomes is more robust.

PRINCIPLE 2 - PRINCIPLE OF MULTILEVEL STRUCTURE

AI solutions have the capacity to improve the functioning of digital platforms at different levels: at the collective level (e.g., monitoring the number of ideas or the topics being discussed), at the peer-to-peer level (e.g., providing connections between participants) or at the individual level (enhancing individual contributions). By following this principle, the different uses of AI should be structured based on different levels of application. This avoids conflicting actions (e.g., one system promoting interactions while other encourages individual contributions) or an information overload affecting citizens (e.g., providing several types of stimuli to participants rendering the experience overwhelming to citizens).

Example: Implementing a recommender system to better navigate contributions and a chatbot to help in the use of the platform. A potential issue would be a recommender system providing you with similar ideas, and a chatbot encouraging the user to provide new and unique contributions.

PRINCIPLE 3 - PRINCIPLE OF COMMUNICATION AND TRANSPARENCY

One of the main problems regarding the use of AI in the public sector, and many other domains, relates to the transparency and trust in the systems being deployed. This principle encourages active communication about the use and the objective of any AI-based application implemented in co-creation.

Example: The citizens should know if there are artificially generated proposals or if there is an algorithm selecting the content they see while navigating the platform.

PRINCIPLE 4 - PRINCIPLE OF COLLECTIVE AND OUTCOME MONITORING

Given the uncertain outcome of some AI solutions being implemented, the effects of the tools being used might not have been fully foreseen. This principle proposes the definition and monitoring meaningful collective indicators (KPI) related to the purpose of the platform, so to guide the actions carried out by the AI (e.g., coordinate participants' interactions or clustering of contributions). This is to avoid undesired outcomes such as polarization or minority under-representation. Ideally, these indicators should alert of any undesired outcome before its consequences are too important.

Example: In systems involving interactions of citizens with chatbots or recommending systems, monitor that the suggestions of these systems is not generating opinion bubbles or over-polarizing citizens.

PRINCIPLE 5 - PRINCIPLE OF DYNAMIC AI ACTIONS

The actions led by AI-driven systems (e.g., enabling communications, suggesting interactions or informing participants) that can be carried out at a given time are limited. Similarly to the second principle, this principle proposes to adapt them (not only in structure but in time) to the co-creation phase the type of project, so to avoid overwhelming citizens with excessive stimuli.

Example: During the co-commissioning phase, chatbots can help to show information about the topic of discussion or potential ideas. Then, this information becomes redundant for the citizen and the role of the chatbot should evolve accordingly.

PRINCIPLE 6 - PRINCIPLE OF HUMAN POWER CONTROL

This principle suggests that the platform must allow the supervision of the outcome of the AI systems by participants (e.g., validating automated tasks such as labelling of proposals). The participants should be allowed to supervise/modify any input inserted into the system coming from their data and/or actions. We can operationalize this principle in several manners, either by inserting the human in the loop (augmentation), e.g.

using AI only as support in writing a proposal, or by allowing the human to validate the outcome of the task (automation), e.g. approving the automatic labelling of a proposal.

Example: Allow the validation by citizens in the automatic labelling of contributions or being able to switch off some features such as recommendations in the platform.

PRINCIPLE 7 - PRINCIPLE OF COGNITIVE AND INFORMATIVE BALANCE

In their interaction with stakeholders, AI systems should attempt to provide actions or information to balance the differences in knowledge and information between the different actors of the co-creation process. This means to provide help at the cognitive level (i.e., comprehend the data being generated and potential patterns) as well as the information level regarding the topics of discussion. A similar goal that can be achieved by following this principle is to help to reduce the information asymmetry between stakeholders and co-creation organizers (Duberry, 2022).

Example: Provide the same tools regarding clustering and analysis of contributions also to stakeholders (resources). Provide additional information regarding topics of discussion to stakeholders who are willing to participate.