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RESEARCH ARTICLE

Value Profiles as Tools to Understand and Guide Societal Decision Making: Applications for Circular Economy Transitions

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Abstract

Complex transitions toward circular economy face implementation challenges despite broad goal support, stemming from conflicting interests and difficulty making values explicit. We developed a framework combining decision support methods with participatory approaches to systematically document stakeholders' factual beliefs and value judgments. The framework organizes policy-relevant information as interconnected objects: actions, scenarios, nodes, hypotheses, impacts, priorities, and value profiles. We tested this approach with Kausal Platform by analyzing 18 Finnish parliamentary candidates' responses to two environmental policy questions from a voting advice application, documenting their reasoning within the framework structure. Analysis of the 36 contributions produced an insight network of 23 nodes and 12 value profiles. The framework revealed apparent conflicts that stemmed from different assumptions rather than different values. This distinction enables more focused debate and sense-making. The approach is relevant for circular economy transitions, where multiple stakeholders must coordinate across value chains and complex trade-offs exist between environmental, economic, and social impacts.

Keywords Decision support · Circular Economy · Climate Change · Municipalities · Open Policy Practice · Insight Network · Value Judgement · Priorities

1. Introduction

Complex societal transitions, whether toward circular economy or climate neutrality, often face implementation challenges on the local level even when high-level goals receive broad support. The decision situations are difficult for decision makers, because the issues are complex, controversial, long-term, and beyond the established local administration. Actions are needed now, they change everyday life in profound ways, their costs spread unevenly, and the benefits and their distribution are uncertain and often delayed.

Williams (2019) identified five deficiencies in circular economy activities which cut across resources and actions: a lack of a) political support, b) joined-up regulatory framework, c) common standards, d) data and e) institutional capacity. Also, businesses and policy-makers see hesitant company culture and lack of consumer interest as key barriers on a circular economy (Kirchherr et al., 2018).

On the other hand, global polls have demonstrated that 80 % of the global population think that their leaders should take more actions to mitigate climate change (UNDP, 2024). In the light of this result, "lack of consumer interest" seems to be a shallow interpretation of market behaviour rather than a genuine value of the people.

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All these deficiencies and barriers are especially sensitive to the information and understanding available, while they are less dependent on technological or physical solutions. Therefore, an approach to alleviate the deficiencies should especially focus on improving the information landscape of circulatory economy decisions. Local governments need help in finding actionable solutions and avoiding destructive ones in an uncertain situation with high stakes and differing valuations of stakeholder groups.

There is an increasing number of city-level strategies of circular economy (Petit-Boix and Leipold, 2018). Therefore it has become important to understand what they aim to achieve and how they are actually doing. Circular economy is often described as processes and activities to increase material efficiency by reducing, reusing, recycling, and recovering. These activities can happen in different scales, namely micro (consumers and companies, meso (regional and industrial ecosystems), macro (national and global). (Kirchherr, 2017)

Circular economy takes a long-term and inter-disciplinary orientation to complex problems, and this has been seen as a major strength of the approach (Köhler et al., 2019). This emphasises the need for long-term multi-dimensional, multi-stakeholder assessments. Therefore, the assessment tools should manage the complexity and offer manageable views on the whole but also on the details. In cities, circular economy has materialized as principles like regeneration, sharing, optimizing, looping, virtualizing, and exchanging (Prendreville et al., 2018).

In this study, we aim to collect good practices from established frameworks and methods related to decision support in general and circular economy in particular to help cities with challenges described above. We especially study methods to combine values, priorities, and factual beliefs with causal networks that are used in impact assessments. Our approach is inspired by pragmatism, a philosophical approach that emphasises the practical value of analysing the world and the co-creation of knowledge (Baggini, 2019). There is also a rich literature of co-creation approaches in public governance (e.g., Noveck, 2009).

This work focuses on understanding the situation, motivations, and possible actions and giving clear recommendations, which are conditional on the values selected. In contrast, it is not concerned about how to gain political agreement or how to actually govern the process after recommendations are given. But it is assumed that those tasks are easier if there is a comprehensive and relevant information source available for all stakeholders.

Decision analysis is a well-established field of research and practice, where a key idea is to describe relationships between an action, relevant causally related variables, and decision maker's valuations about the variable outcomes in different counterfactual worlds where the action is or is not implemented. The differences between the outcomes in these counterfactual worlds are called the impacts of the action. We use this approach of causal modelling, and implement it by using influence diagrams (Pearl, 2005). Open policy practice is a version of this approach, emphasising openness and participation and previously used on health impact assessments (Tuomisto et al., 2020).

Circular economy assessments and policies are often deeply rooted in business-as-usual, although more action-oriented methods are needed for faster transition (Suarez-Eiroa, 2025). Techniques of futuring can help in this work. It also gives guidance to the current work. Assessment methods need to enable the assessment of transformative actions, not just tweaks to the status quo. Theory of change gives freedom for this.

Theory of change is an approach to understand the causal links between actions and desired outcomes. It has been used especially in the field of community initiatives since the 1990s. Stein and Walters (2012) defined theory of change as "a way to describe the set of assumptions that explain both the mini-steps that lead to a long term goal and the connections between these activities and the outcomes of an intervention or programme". They also identified four typical use cases: strategic planning, monitoring and evaluation, description and communication, and learning.

Oberlack and coworkers (2019) concluded that theory of change is important in realising the transformative ambitions and expectations of science in the 2030 Agenda, but the processes require sufficient resources as well as willingness and open-mindedness among stakeholders. An interest in this study is to test how technical support tools could help utilise the theory of change more effectively.

We also considered the so-called wiki questionnaire method (Salganik and Levy 2015), which is based on pairwise comparison of alternatives. A strength is that the method takes a probabilistic approach by defining priorities as Bayesian probabilities that a decision maker will prioritise one option over another. Then, a priority model can continually be updated based on observations.

The work in this article is a proof of concept. We first describe a use case to demonstrate the challenges and needs municipalities often face with decisions related to circular economy or climate change. This insight is based on the discussions of Kausal staff with more than a hundred municipalities around the world related to

their climate work challenges. Then, we build a theoretical framework that aims to answer the local needs by combining existing methods and good practices into a systematic whole. In the methodology section we describe how this method was tested and evaluated by analysing data from a voting advice application. In the results section we describe lessons learned from the practical work. Finally, we discuss the challenges and opportunities of the method.

The study has three research objectives. 1) What is an information framework that combines causal inferences of actions with expressed and also revealed values? 2) What opportunities and challenges occur when implementing the framework to an actual political argumentation in the context of climate and circular economy? 3) What further development needs are identified for an online tool implementing the framework?

2. Use case: a city with a circular economy target

Imagine a city that has ambitious sustainability goals and is now in the process of developing a new action plan. The goals were set in the city council in a political process. There has been strong public support from citizens and also from the council to have ambitious goals (left side of Figure 1). However, the discussion has been on an abstract level without much detail about how to actually reach the target. Now the city staff needs to develop the goals into practical and actionable work that also takes into account the local conditions.

The civil servants want to have an open and participatory process, but they are also afraid that the process may be difficult to manage when the practical implications of the desired green transition become tangible. The political divisions may burst up and poison the civilised and rational discussion the organisers hope to achieve. Yet, they understand that if they write an ambitious plan without consulting citizens, it will be very difficult to implement because of opposition and non-compliance later on.

Therefore, the city wants to have a process that supports rational and sincere discussion and freedom of speech but at the same time discourages personal attacks, disrespectful behaviour, and misinformation. There is also a clear need to have a holistic view including outcomes related to health, equity, biodiversity and other important complex issues.

The city especially wants to avoid destructive policies, i.e., policies that may sound like good ideas or be popular but with careful scrutiny, would be assessed to cause a lot of harm and waste of resources. In brief, the city wants to have a process illustrated on the right side of Figure 1.

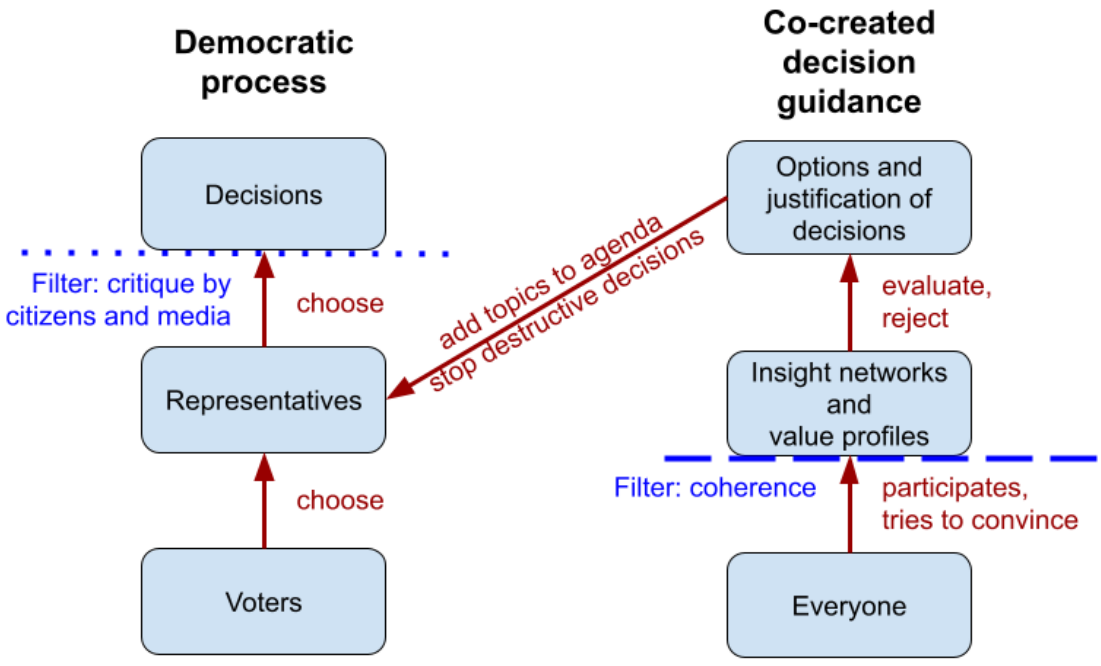

Figure 1. Linkages between the traditional democratic process and a new process with co-creating shared understanding and value profiles. See text for details. Source: the authors' work.

Although the use case has a clearly local scope with decisions made within the city, the city staff acknowledge that all local actions inevitably have global impacts, mediated via material flows and greenhouse gas emissions. Therefore, the city staff keep this question in the heart of public co-creation sessions: what advice would a large, well-informed group of global rational people give to our city, if they have mankind's best interests in their minds? Acknowledging that the values of mankind are diverse (e.g. Rydenfelt & Nyfors 2024), the city might include global aspects by referring to, for example, the international human rights, climate agreements, or national legislation.

3. Discussions with cities

Kausal Ltd provides software as a service for municipalities' climate and sustainability work. In this role, we have seen how municipalities often declare fairly ambitious greenhouse gas emission reduction targets but then struggle to develop climate action plans that would actually produce enough impact to meet the targets. We have tried to understand the pain points and potential solutions to this problem. We have talked with our customers and other municipalities in Europe, North America, and Australia about the challenges and how climate action plans are being developed, approved, and implemented.

Based on these discussions, we had documented their lessons learnt when promoting climate actions in the decision making process. This had given us practical insight, which had then been used to reflect the more theoretical considerations and also had given understanding on what kind of frameworks and tools would be needed and beneficial for cities in practical sustainability and circular economy work. Our discussions have identified similar challenges and barriers as mentioned in Introduction.

These discussions were used as motivation and guidance for the current study. We aimed at developing a framework that could help municipalities describe their policy situations, options, and priorities in a systematic way. This could then promote rationality in political discourse and improve different aspects to get heard and considered before decisions.

The framework developed requires a platform that collects, aggregates, and visualises the contributions and thus facilitates further participation rather than gets exhausted by excessive content. We used the Kausal Platform for content management, as it is specifically designed for describing city-level sustainability actions and causal links to the outcomes of interest. The platform is open source code and is available online (Kausal, 2025a).

4. Theoretical framework

We developed the concepts of open policy practice (Tuomisto et al., 2020) further to make them usable as the information framework on an online platform.

We also had several dedicated discussions with cities' sustainability coordinators between January and April, 2023. These discussions were used to inform the framework development but also to cover value-focused thinking in the context of city-level decision making (Kurkela et al., 2026).

In the framework, a decision situation is described as an insight network, i.e. a network of policy-relevant information objects called nodes, and causal and other connections between them (Table 1).

Insight networks are networks of nodes and edges describing causal relationships between actions and real-life phenomena. In addition, they describe values and priorities of the contributors, who are co-creating these networks. The co-creation process may resemble that of joint fact finding (McCreary et al., 2001), but here the focus is on producing a structured documentation of the information collected. A key output of the process is *shared understanding* (a situation where different facts, values and disagreements related to a decision situation are understood and documented).

The purpose is to have an open description of the main properties of a decision situation, namely a) the action options that are available, b) causal connections from actions to the outcomes of interest (i.e., a *theory of change*), c) priorities by different stakeholders about action options given their impacts, and finally d) priority generalisations that can be used to predict priorities in new situations. These priority generalisations are called value profiles.

Priorities are participants' expressions that they consider an action worth implementing. They can defend their choice by demonstrating that the action has beneficial impacts on some nodes that they consider valuable.

Each node asks a specific question about e.g. energy use (in GWh/a) or CO_2 emissions (kt/a) in a particular context (e.g. building heating energy in a city). The answer of a node is a time series of typically annual values. The answer may be uncertain due to imperfect information.

Therefore, the answer may be described as a collection of hypotheses. Participants may have their own views about the facts, i.e. they believe that one hypothesis is more likely rather than another. This makes it possible to be explicit about the reasons for disagreement. Two participants may disagree on priorities either because they have different values or because they disagree on which hypothesis of a critical node is the most likely. These priority generalisations are called value profiles. The purpose of value profiles is to describe why participants choose as they do and where their priorities come from.

Table 1. Information architecture for a digital tool. It defines the data structures and computational relationships the tool implements. Source: the authors' work.

Concept	Formula	Description
Insight network	G	Insight network is a directed acyclic graph that consists of the objects needed to describe a full decision situation with action options and outcomes, and also including personal views of relevant stakeholders. The objects are connected by causal and other edges.
Action	A_i^j	Action i with one or more options j and a boolean (do: A, don't do: ¬A)
Context	C	Context, i.e. all other assumptions needed to describe a decision situation within the insight network.
Scenario	S	Scenario is a particular situation within the context where a selection of actions are done while others are not. Also, a scenario may assume that some hypotheses are true while the competing hypotheses are not.
Theory of change	$T \subseteq G$	Theory of change is a scenario that describes a user's personal view on how an action affects its outcomes. It includes those nodes, hypotheses and values that the user finds relevant and plausible while ignoring others. It offers a description of the user's personal thinking in such a way that it is closely connected to the other parts of the insight network.
Node (knowledge crystal)	$N \in G$	Node is a variable in the insight network. It typically has quantitative calculations, but it can also consist of qualitative arguments. In open policy practice, nodes are called knowledge crystals.
Output, outcome	N(A, S)	Output of the node calculation given that the set of actions A (A_1, A_2, …, A_n) are done as defined under assumptions S. Outcomes are outputs that have special interest to a decision maker and are therefore used as inputs for value profiles.
Hypothesis	$H_k \in N(A, S)$ with a probability $p_k(A, S) = p(H_k\|A, S)$	Hypotheses about the output of a node. Because outputs are often uncertain, a node may have k hypotheses H_k and each may have an assessed probability of being true. So, the output of node N is $N(A, S) = \{H_k : p_k(A, S)\}$.
Impact	$I(N, A_i^j, S) = N(A_i^j, S) - N(\neg A_i, S)$	Impact of action A_i on node N, i.e., the difference in a node output between the two counterfactual scenarios with doing and not doing the action. All other actions are held constant (incorporated into S).
Decision maker	D	Decision maker is a person who takes the role of prioritising actions.
Priority	$P(A_i, S, D) = p(A_i \succ \neg A_i\|S, D) \rightarrow$ scalar distribution	Priority of *doing* over *not doing* action A_i under assumptions S by decision maker D. It is a probability that A is preferred over ¬A. Priority can be elicited in the decision making process, either through stated preferences or revealed through actual choices.
Value profile	$V(I_i, D) = V_D(\{I_i(N_m, A_i^j, S)\}) \rightarrow$ scalar distribution	Value profile is an aggregation function that combines impacts across multiple outcome nodes for action A_i into a scalar probability distribution. This enables decision-maker-specific comparison between action options. It handles different units through weighting and normalization. Examples include utilities and cost efficiencies. Value profiles and priorities are interconnected, as $P(A_i, S, D) = p(V(I_i, D) > 0)$, where p is probability.

The actual valuation V* of D is a complex mental process inside the decision maker's head and therefore unknowable. However, a key idea is to approximate V* of D with V as precisely as possible and necessary based on what the decision maker says and chooses, so that predictions can be given about action priorities P. A good V is able to predict actual P of D even if data are not available for every P. For example, a multi-attribute utility function with additive independence may be good enough for some practical purposes: $V(I_i, D) = \Sigma\, I(N_m, A_i, S)(W_m|D)$ where W_m are the weights for each node impact, elicited from the decision maker.

Because the actual V* is unknown, its approximation should be verified based on the observed values of P in different settings. Effort should be made to elicit the actual valuation V* from the decision maker, but whatever the description of V is, it is important to not take it as an uncontested truth unless its predictions are systematically coherent with observed P. For tactical reasons, some decision makers deliberately express V that does not reflect their P with actual decisions.

Value profile V can be endorsed by several decision makers or other participants. This is an important generalisation, as an insight network would quickly become practically unmanageable if every individual's valuations had to be described separately. For individuals, value profiles are a way to make their own valuations better heard, as – in a democracy – a popular value profile gains weight proportionally to the number of its supporters; and unpopular but clear values are more likely to be found and considered as they are not surmounted by noise. So, a person's interest is to choose a value profile that matches their true values, whether the values are popular or not. In a sense, value profiles have some analogous properties with political parties in a traditional democratic process.

5. Implementing the framework

We use the framework for systematically supporting use cases discussed above. It is built on top of existing frameworks and assessment practices, notably *insight networks* and *open policy practice* (Tuomisto et al, 2020). Open policy practice is a collection of methods and collaborative approaches including e.g. insight networks and value profiles. It was originally developed to support health impact assessments as a part of complex decision situations.

For decision situations, we borrow methods and practices from decision analysis (Keeney and Raiffa, 1993); for causal descriptions, methods from impact assessment (Pearl, 2018); for priorities, from choice experiments (Baranzini et al. 2021); and for priority generalisations, from multi-attribute utility theory (Keeney and Raiffa, 1993).

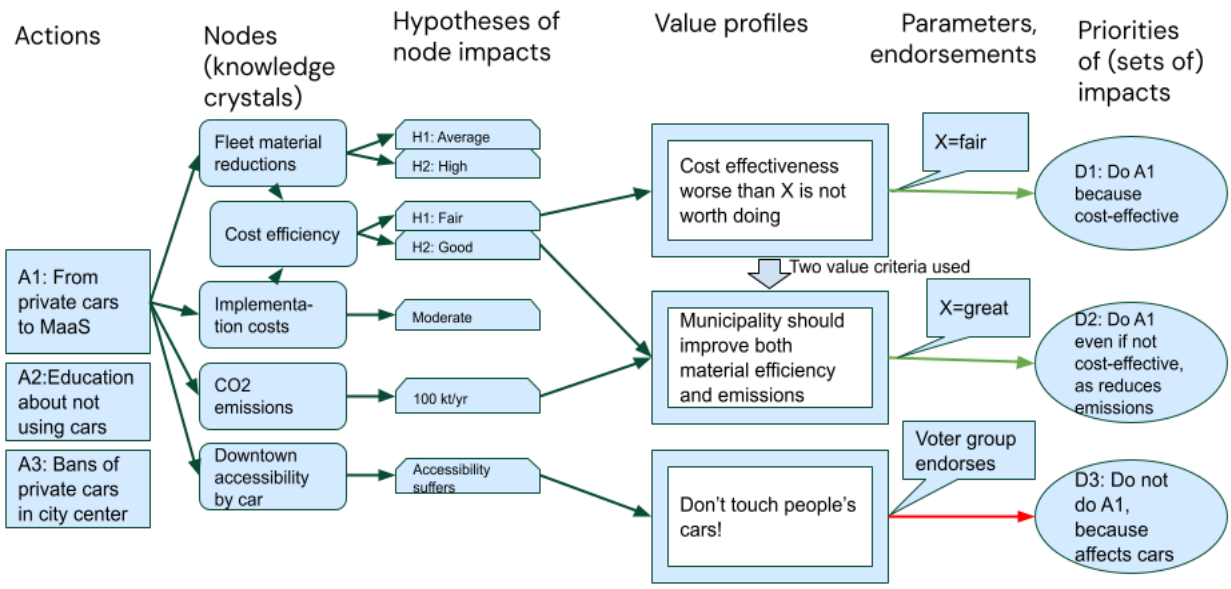

Figure 2. An illustration of the main information objects (actions, hypotheses, value profiles, and priorities) used in the framework as an example of a city-level decision situation. MaaS = Mobility as a service. See text for details. Source: the authors' work.

Each participant has their own mental model about the causal structure under scrutiny. Theory of change is a process and structure of making these explicit and documented (Stein and Walters, 2012). This is a case-specific description about how the participant thinks that things will roll out if an action is implemented. It also helps describe what evidence supports this thinking (Reinholz and Andrews, 2020). A participant's expressed priorities are based on their own theory of change (aka restoration story). Therefore, the framework needs to enable participants to explicate their own theory of change as a causal graph.

The first step is to list actions and outcomes of interest. Then, the participant describes what an action needs to change in order to make the outcomes a reality. These things are then visualised as a causal network of nodes and edges. When possible, the participant uses existing nodes, so that various theories of change are combined into a single description of shared understanding.

Figure 2 has an example of a few possible circular economy actions and values related to them. Many causal chains from actions to outcomes are longer and more complex, but those intermediate nodes are omitted from the figure for simplicity. The figure shows an example of a city-level decision situation with three actions (A1, A2, A3) and three decision makers (D1, D2, D3) to reduce material intensity and CO_2 emissions from traffic, and values and priorities related to the outcomes. The impacts of action A1 are shown in more detail. The content is a compilation of issues raised in different discussions with cities.

Action A1 affects material intensity, CO2 emissions, and downtown accessibility. It also has implementation costs. The impacts on emissions are uncertain, estimates ranging from average to high. Consequently, also the cost efficiency of emission reduction may be fair or good depending on actual emission impacts.

These answers are then used by three decision makers, D1, D2, and D3. D1 has cost-efficiency as their sole criterion for decision making with a view that only fair or better cost-efficiency is worth paying. They believe that average emission reduction is the most plausible, resulting in fair cost-efficiency. Thus, they consider action A1 as a useful enough action and support it.

In contrast, D2 has a different approach. They also think that cost-efficiency is a key criterion but they also find the emission reductions of the traffic system as an important impact of A1. D2 has a stricter limit for cost-efficiency than D1 and expects great cost efficiency, so they would be less willing to accept actions than D1. Interestingly, D2 is more optimistic about the material intensity reduction potential of A1 and believes that it will have good but not great cost efficiency. They would vote against such an action unless it had important emission side-benefits, which finally tilts the balance in favour of doing A1.

D3 may also find cost-efficiency estimates useful, but they have another, more important valuation criteria that overrides any other. It is about people's right to drive their cars downtown rather than having to rely on a mobility service. This is a showstopper for them related to A1. Also, they are aware that this valuation is endorsed by a key voter group.

The nodes in such an insight network are described as knowledge crystals (Tuomisto et al., 2020). This means that the topic of a node is described as a question, and the node contains plausible answers to the question and its rationale (i.e. any data and reasoning that is needed to convince a rational and critical reader about the answer).

In summary, actions, nodes, hypotheses, value profiles, and priorities as information objects intend to describe all of the valuations, disagreements, and uncertainties relevant for a decision, and how and why decision makers choose in the way they do. In this work, we studied how this approach succeeds in describing real-life policy discussions. We used data from a voting advice application and demonstrated that parliamentary candidates' priorities and reasonings can be meaningfully synthesised into an insight network that explains their rationale for their priorities.

6. Materials and Methods

Finland has a rich culture of voting advice applications. There are dozens of media houses and organisations that invite candidates of Parliament elections to answer questions related to policies and values. Voters can answer the same questions and find candidates and political parties that have the most or least similar opinions to their own. These applications are popular in Finland, as 35 % of voters say that it is a major source of information for making voting decisions. In the group of young voters (between 18 and 30 years) the value is

53 %, and these applications are the most important source of voting information for them (Borg and Koljonen, 2020).

For our purposes it is useful that the answers reveal clear priorities from the candidates, and these can then be used as input data for our framework. It is also crucial that the candidates can give rationale for their priorities in a free-text form. These texts can be used to understand the mental models of the candidates, and thus they help build the theories of change from actions to impacts.

We used the voting advice application of the largest Finnish newspaper, Helsingin Sanomat (2023), and searched candidates from three voting districts and from every party. We selected in total 18 candidates that were actively giving rationales for their choices. The candidates were selected from Uusimaa (a mostly urban region near Helsinki) and Eastern Finland (a mostly rural region) and from each of the nine political parties that had members in the Parliament. This way, we hoped to get a wide variety of arguments and priorities that are explained in writing.

We then used their Likert scale answers to two environmental questions to document their priorities. We also described their causal reasoning of the priority based on their free-text answers. The Likert data and the causal reasoning were documented on Kausal Platform, which was used both for content management and construction of the insight networks and value profiles. Whenever possible, we used the same causal chains and nodes for several candidates.

The data were analyzed with R statistical software. The code used to analyse the insight network is available at Github (Tuomisto, 2025).

We transcribed the priorities and arguments expressed in these materials into the information structure described above. We paid special attention to ensuring that the intention of the arguments was maintained as far as it could be understood from the written material. Ideally, the participants would contribute directly to the platform by adding their priorities, values, and understanding of relevant nodes. In this proof-of-concept stage, the focus was on testing the capabilities of the method and the tool in a) capturing the reasoning and values; b) converting the content into the specified information objects, notably insight networks and value profiles; and c) testing how the resulting network system could reproduce the priorities expressed in the original content in the voting advice application.

The focus of this work was on methodological issues, rather than the actual content and arguments presented by the candidates and the parties. This gave us freedom in the study design. We did not need a sample that could produce an unbiased summary of each party's reasoning or values. Also, for each argument, it was critical to see whether it could be expressed in the network in a meaningful way, while it was not essential that the content was understood in the exact way that the candidates had meant it to be. For these reasons, we focused on finding very different views from different parties and different parts of the country. We estimated that 18 candidates and the two questions that were most closely related to circular economy would produce enough material to test for the method. Because reasoning was critical for our analyses, we specifically chose candidates that had verbose answers for the two questions.

7. Results

7.1. Several contributions resulted in a single insight network

The content was described on and can be found from Kausal Platform (Kausal, 2024). Key parts of the Finnish content were translated into English.

At the voting advice application, most candidates did not give rationale for their priorities, or the rationale was too superficial to help a reader to understand their mental model. Consequently, we had to choose a subset of verbose candidates and therefore cannot know whether our insight network is a representative description of how the candidates overall think about the issues at hand. Other methods such as surveys are needed to find out how popular each priority or theory of change actually is.

Some arguments were very common, strengthening the view that individual mental models can indeed be described as a compiled insight network where several contributors share common causal chains. For example, the node about greenhouse gas emissions from Finland appeared in most causal chains related to a question to the candidates about postponing climate goals (Figure 3). Typically, left and green parties saw this as the critical outcome and a sufficient reason to keep up ambitious climate policies and not postpone the goal, while

right wing parties were more likely to consider a healthy economy and energy prices as even more important outcomes, thus leaning toward postponing the climate goal (Figure 4). Figure 3 and 4 share a part of the network, but the conservative candidate considers a wider range of impacts and thus a combination of two value profiles are used to describe his argumentation.

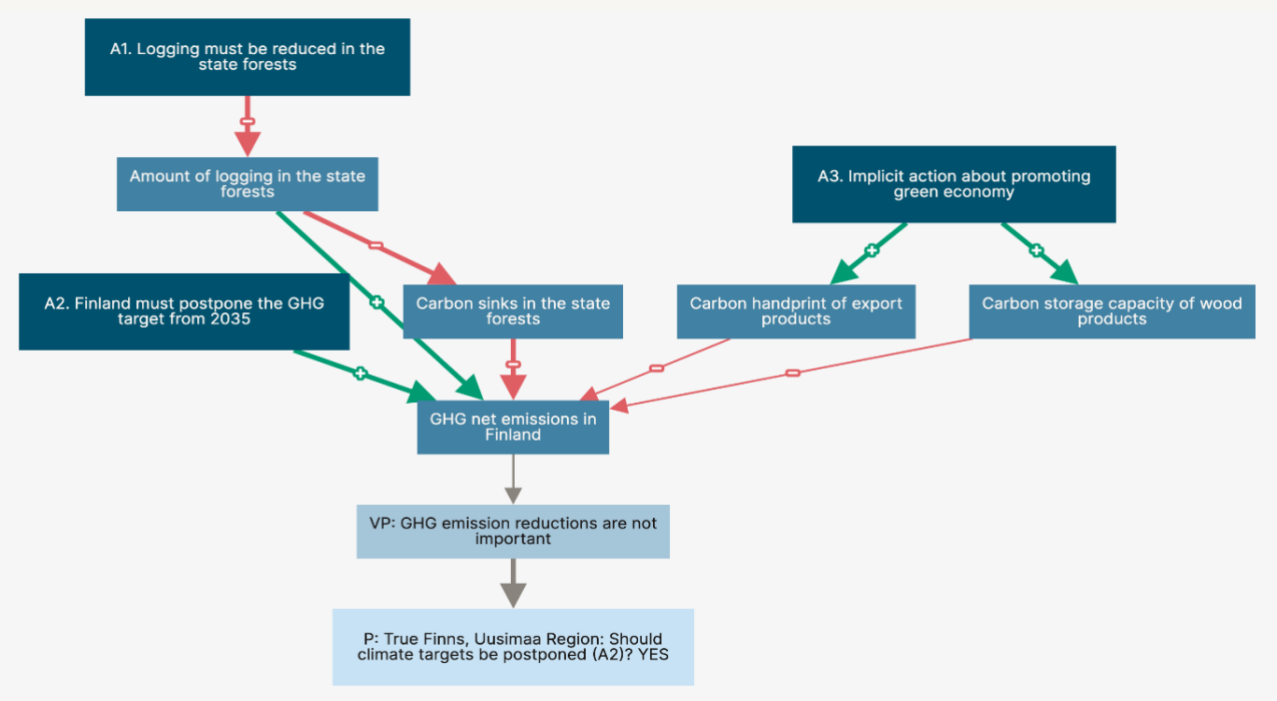

Figure 3. Insight network part that is relevant for a candidate from the populist True Finns party. Dark blue: action options. Blue: nodes in a causal chain. Greyish blue: value profiles. Light blue: priorities expressed by the candidates about a particular action option, in this case A2. Green and red arrows depict an increasing and decreasing impact on the target node, respectively. Grey arrows represent reasoning rather than causal connections. Source: the authors' work.

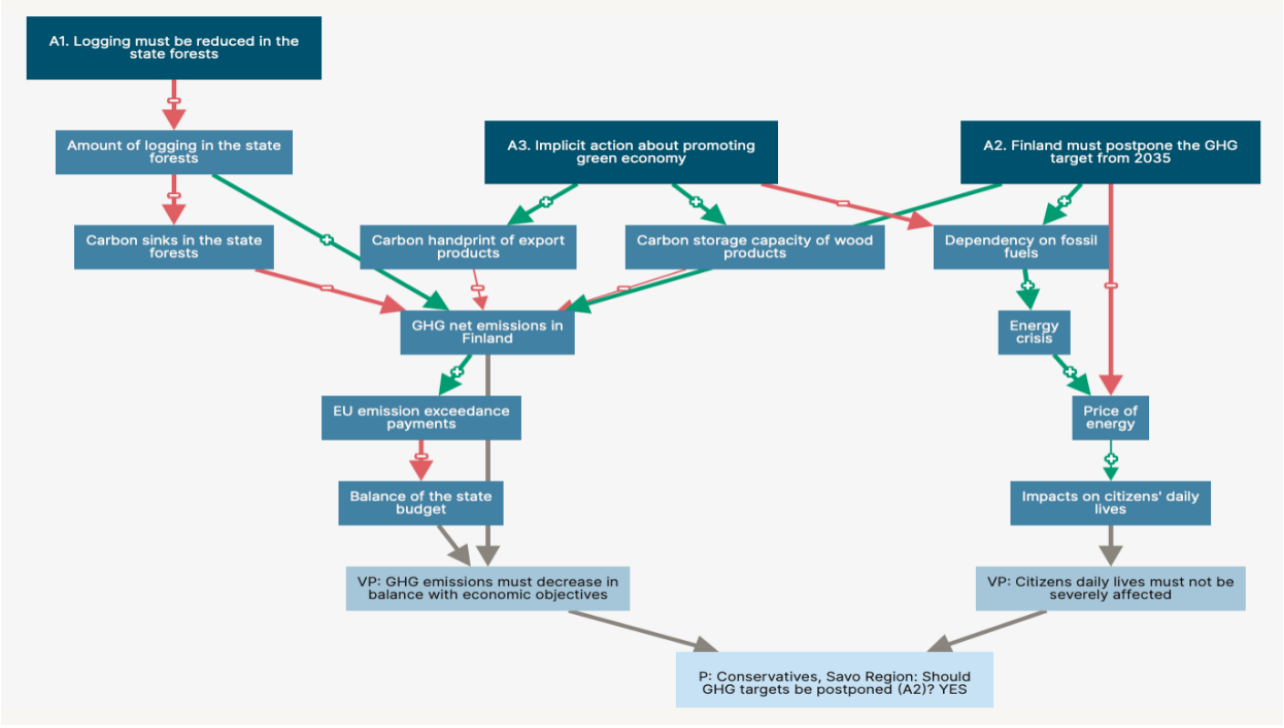

Figure 4. Insight network part that is relevant for a candidate from the Conservative party. Notation as in Figure 3. Source: the authors' work.

7.2. Insight network identified some implicit assumptions

Expressions of priorities were common in the free-text rationales of candidates, but the actual outcomes of interest were not always clear. This was seen in e.g. comments that the climate goal should be postponed to ensure the competitiveness of Finnish industry. The comment may mean that maintaining the existing industry is a goal itself, or the speaker may instead have thought about the income and prosperity as the ultimate goal, while the industry is merely one means to the end. Thus, we cannot conclude from the written material how he would prioritise new green industry, which, according to some, only gains speed if climate goals are more ambitious than elsewhere. By explicating the outcomes that are used for prioritisation, insight networks may help identify such implicit assumptions and thus focus the work to better understand participants' priorities and mental models, like some other methods (Van Mechelen et al., 2017).

In the beginning of the content analysis, a straightforward way was to link priorities to the outcome nodes that the candidates mentioned. However, this quickly made the insight network messy as the number of contributions increased. Therefore, we started to use value profiles for connecting outcome nodes and priorities. In practice, already a few priorities were enough to draft a meaningful value profile for them. Decision maker's value descriptions can then be iteratively improved based on both observations about priorities and decision maker's own value statements.

Interestingly, the priorities in the material were not always about actions given some outcome nodes. Sometimes priorities did not specify any action, just impacts. One such example was a discussion about how to reduce car emissions downtown, also mentioned in Figure 2. In one case, politicians had raised great concern about how the downtown economy will suffer if there are less cars. Here, there was a clear priority (opposition) against an impact, while the actions that actually would lead to such an outcome were left implicit. In a sense, this value-based prioritisation of an impact was used as a generic argumentation tool to oppose any and all actions that might reduce car traffic downtown. This is in line with the framework, as long as implicit actions are allowed in priority descriptions. In the material, we identified two implicit actions that were such a strong part of argumentation that it was worth describing them in the network.

An implicit action also occurs in a priority statement "The Finnish greenhouse gas emissions are so small that our actions don't save the world anyway." This statement was common and was often used as a tool to oppose climate actions in general, implying that any climate action has too small an impact to be worth supporting.

Sometimes the outcomes of interest, rather than actions, were vague: "Finland has the best skills in forestry, we need to trust that." In this case, the priority about the action was clear (do not reduce forestry in the state-owned forests), but the candidate was willing to delegate the decision making power to those in the business. Apparently the implicit assumption was that the outcomes are likely to be good enough without further examination or intervention.

7.3. Differences in priorities may be due to values but also due to facts

Differences in priorities may be due to values but also due to facts. An example of this was the economic impact of the forest industry. Two candidates agreed that this industry sector is important but disagreed on whether logging should be reduced. One assumed that the status quo will continue, while the other expected to see new high-value lignin products in the future, thus enabling to reduce logging and increase sales at the same time. Thus, describing the two different hypotheses of a causal node made these fact-related differences explicit. It was then possible to pinpoint that the differences were not in value judgements. This approach also makes it possible to apply value profiles on top of different belief systems of factual issues.

In addition to the forest industry node, five other nodes showed several hypotheses, as the contributors expressed conflicting views on the topics. Thus, hypotheses appeared to be an important tool for explicating such situations. The hypotheses were documented side by side as a part of a single node. This is useful for a proponent, who can strengthen their case by adding favourable hypotheses to their causal chain. However, if the proponent proposes overly optimistic hypotheses that are not backed up by evidence, they open a door for an opponent, who can challenge the hypotheses and offer other hypotheses with stronger data support.

Explicit hypotheses offer an opportunity to launch a discussion where the disagreeing candidates are asked a) whether they have evidence for their own opinion or against the other one, and b) whether they would change their conclusion in case that it turns out that they are wrong and the other candidate is right.

The hypothesis approach clarifies whether a decision maker has expressed priorities given all hypotheses, or only given the one that they themself believe in. Thus, the approach nudges decision makers to express their priorities also for situations they find unlikely, because otherwise they would appear ignorant or indifferent in those situations. An alternative approach to promote one's own view is to seek data that shows the other hypotheses to be so unlikely that they can safely be ignored. At this stage of the method development, we do not have experience about what decision makers actually do in such situations.

We analysed 36 contributions from 18 individual contributors from the voting advice application data (Figure 5). Each contributor expressed priorities about two environmentally relevant questions in the voting advice application. Each contribution consisted of a priority statement about an action and argumentation to support the statement. We created the nodes and value profiles as needed to explicate the mental model of the contributor. In total, 23 nodes and 4 actions were needed to describe the mental models of the contributors in a single insight network. Two actions were directly from the application, presented as prioritisation questions, and two were implied in the responses of the contributors. Twelve value profiles were created to describe how the contributors d'efended their priorities. One of the value profiles was a compilation of several other value profiles and described a set of commonly shared priorities among the left wing and green parties: ambitious climate goals with high priority; emphasis on biodiversity protection; importance of just solutions; and a moderate interest in the Finnish economy. This value profile was used to argue for seven distinct priority statements.

Three value profiles needed a scale or scope parameter, meaning that several contributors had the same line of thinking but with some important differences. For example, a group of contributors said that actions must not cause unreasonable harm to a particular group, but the group in mind varied between contributors. Another value profile talked about postponing the climate target, and the parameter defined the suitable target year for that contributor.

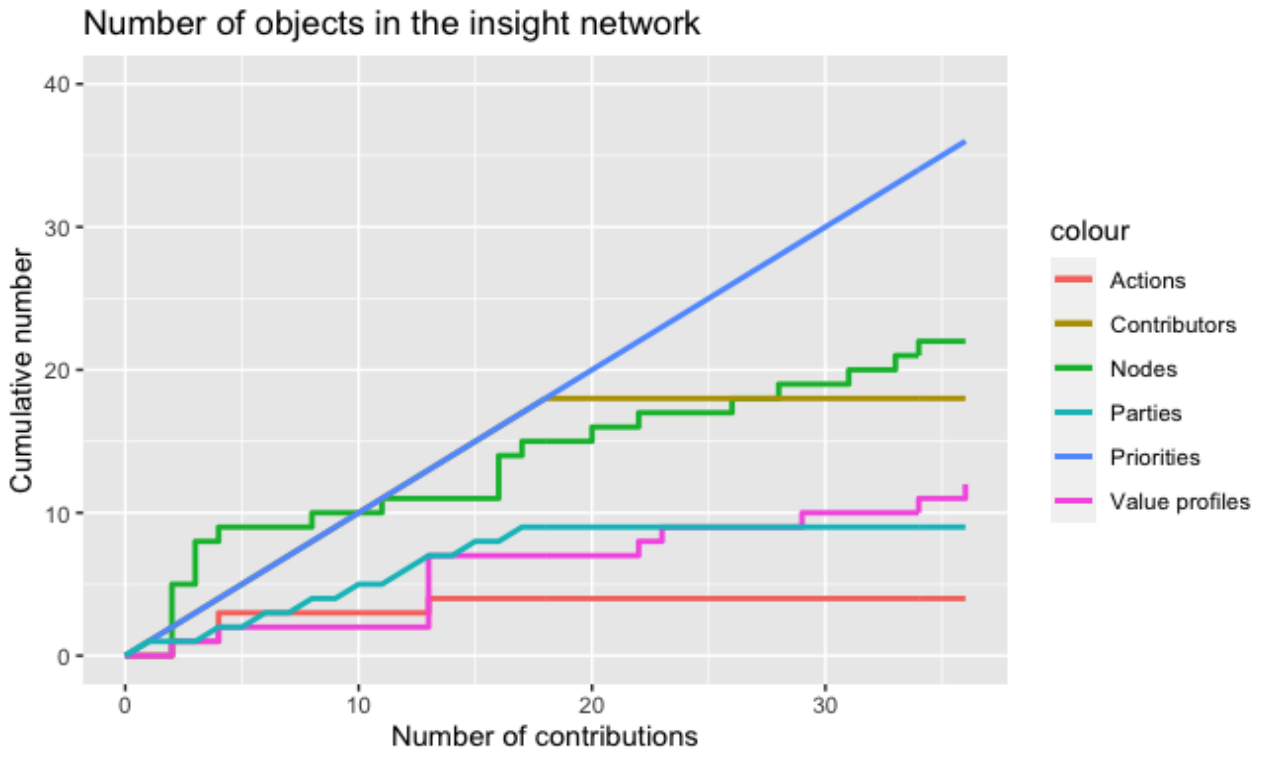

Figure 5. Number of objects needed to describe the rationale of every contribution in an insight network. Source: the authors' work.

Table 2. Key results and related future research questions of the study categorised by the three research objectives. Source: the authors' work.

Key findings	Related future research questions
RO1: Information framework combining causal inferences with values	Is the quality of decisions improved when using the framework?
Framework successfully integrates actions, nodes (with hypotheses), value profiles, and priorities.	Can explicated priorities be generalised effectively into value profiles that enable knowledge transfer between different cities and decision situations?
The framework is mathematically consistent: theories of change as simulation models, value profiles and priorities as probabilities	How to develop insight networks in practice into quantitative impact models and sets of hypotheses into mathematical distributions?
36 contributions synthesized into a single insight network (23 nodes, 4 actions, 12 value profiles). Multiple stakeholders' theories of change combined systematically.	Do the current information objects cover all use cases of decision support?
RO2a: Opportunities in implementation	How applicable and credible do citizens perceive the framework?
Reveals implicit assumptions in argumentation.	How precisely can the framework describe the nuances of participants' views that they themselves find important?
Separates factual disagreements from value differences using hypotheses.	How do people react when challenged to see their own hypotheses described side by side with conflicting hypotheses?
Value profiles aggregate similar reasoning patterns (one profile used by 7 contributors).	How do participants react when nudged out of their comfort zone by using their own arguments to defend positions they oppose?
Sub-linear growth: repeated arguments reuse existing network components	What improvements are needed so that the content stays manageable and informative even when scaled to thousands of contributions?
RO2b: Challenges in implementation	What framework improvements would increase stakeholders' confidence in the framework and platform?
Contributions cover different topics widely but not in proportion to their popularity.	How to estimate the popularity of each priority or theory of change among broader populations?
Some outcomes/actions remain implicit in argumentation. Need for stakeholder validation of explicated assumptions.	How to explicate implicit assumptions and confirm them with stakeholders?
Selection bias: only verbose candidates could be analysed	How can the framework include priorities of all relevant actors, particularly those difficult to reach through conventional engagement?
RO3: Development needs for online tool	What platform maintenance and governance structures would support wide trust and enable continuous collective learning in the long term?
Practical user interface for collecting, synthesising, and visualising the information.	What further functionalities are needed to support stakeholder contributions?
Methods to elicit priorities under alternative hypotheses (not just own beliefs)	How to elicit preferences given shared understanding, even if the respondent finds some premises unlikely?
Scalability testing with larger stakeholder groups	How useful do decision makers see the framework and what use cases do they have?
Integration with actual participatory processes (not just secondary analysis)	Would disinformation campaigns be less effective if decision-specific and context-relevant reasonings were openly available?

8. Discussion

8.1. Framework overview and key contributions

In this work, we further developed a framework and a platform for describing and analysing decision situations based on the causal chains from actions to impacts to valuations to priorities of decision makers and stakeholders. The framework borrows from several decision support methods, notably from open policy practice (Tuomisto et al., 2020). A key idea is that the framework should support co-creation of knowledge and openly document the information for further scrutiny by using a web platform. The established decision support methods do not systematically utilise openness and participation as methods for producing information, quality control, and communication; our work especially attempts to enable such an approach.

The main outputs of this work were the information objects (actions, nodes, hypotheses, priorities, and value profiles) that are able to describe the essential parts of a decision situation. Then we applied these information objects to actual semi-structured content (voting advice application statements, priorities, and rationales) and produced an insight network that captures the differing views and opinions of the contributors. Overall, these information objects did capture the arguments and priorities of the candidates and formed a meaningful insight network that described their shared understanding of the decision situation. (Table 2).

Kausal Platform, which was used in this study, is based on openness and collaborative data collection. It is currently used in municipalities for collecting, synthesising, and communicating information relevant for climate and sustainability actions. It enables quantitative modelling of actions and their impacts, but so far it has not been used for explicitly collecting data about stakeholders' values and priorities. This study is a proof of concept about how it could be done.

The current information objects were versatile enough to describe what the candidates had written to the voting advice application. With some facilitation, the same should be doable with citizen groups in sustainability workshops. Thus, it could be used as a supporting method for common facilitation methods (Schuman, 2005) and knowledge co-production approaches (Korhonen-Kurki et al., 2022). Therefore, it seems plausible that the approach could work in the use case of a city with an ambitious climate target.

The challenge to offer useful guidance for a policy process is not new. Indeed, one of the first recommendations for value-based policy to support the public's welfare was written down by Mencius, a Confucian philosopher, more than 2000 years ago (Bloom, 2009). The novelty of the presented framework is in the combination of various methods covering different aspects of policy making on an open platform. These include stakeholder-specific theories of change, the use of specialised nodes to describe causalities between actions and outcomes, probabilistic handling of factual and value disputes, and systematic methods to compare the expressed values with revealed priorities from actions. The framework offers a suite of approaches to participate in a policy discussion as a citizen, expert, civil servant, or politician.

There are three branches of decision theory (MacCrimmon, 1968), and we attempt to borrow aspects from all of them. The approach compares a) what a rational decision maker should choose according to the analysis (normative decision analysis), b) what priorities the decision maker actually expresses with their choices (descriptive decision analysis) and c) whether the analysis is able to predict their mental model successfully (prescriptive decision analysis). Thus, in our approach the decision maker is an active subject but also a part of the analysis as an object.

The framework and the platform attempt to systematically solve actual user needs by borrowing established methods and building a new coherent constellation that enables organized use of citizen input and encourages better argumentation. Also, it enables the work to start from different levels: it can start from scratch based on participant discussions like in this work, but it can also take existing insight networks, quantitative impact models, contingent valuations, choice experiments results, or expressed value profiles, and then further co-create and adapt content to the local needs. A city can also take a ready-made assessment from another city and check if the premises and conclusions apply to their own situation with little adjustments. The framework aims to offer an overview on the decision situation and then enable different pieces of knowledge and data to be added to and utilised in relevant places.

The framework was designed to offer scalability. In practice, when the number of contributions increase, more and more of the content has already been described and the size and complexity of the network grows sub-linearly. Some support for this phenomenon was observed, as most of the rationale mentioned were

presented by many candidates in similar ways (Figure 5). Scalability may also be improved by using the same framework in various cities so that they can see each other's contributions and learn from them.

This scalability is demonstrated by NetZeroPlanner, an impact assessment tool for cities to estimate emission reductions and costs of their climate action plans (NetZeroCities, 2025). This tool is running on Kausal Platform and it offers a ready-made causal network and model, which a city can adjust to their own circumstances by entering city-specific input data. However, NetZeroPlanner does not contain explicit value profiles.

We tested an approach where hypotheses are treated as stories that people tell when they try to understand issues. A set of story-like hypotheses is closer to a participant's own experience and easier to grasp than, e.g., a probability distribution. An additional benefit is that contributors can easily see, if their stories have already been included or not.

Everyone has many false premises about things that are known with a reasonable certainty. With better information each one of us might choose differently. Therefore, the framework was designed to be able to elicit preferences given a shared understanding, not just given the respondent's own beliefs.

Shared understanding exposes people to each other's points of view, and the documentation forms a basis for further discussions, thus possibly increasing learning from previous mistakes (Taylor et al., 2022). It offers tools for criticizing decisions that are based on unlikely premises.

The analysis is used to iteratively improve the insight network to more truthfully represent the decision maker's premises and values. If situations are found where a decision maker's opinions and/or choices are inconsistent, there is an opportunity to study whether this is due to hidden agenda, differing opinion about facts, ambiguity of facts, an honest mistake, or something else.

8.2. Addressing key challenges

Many citizens dislike political disputes and want to delegate decision making power to experts who decide efficiently and avoid political messiness (Hibbing and Theiss-Morse, 2002). This phenomenon is called stealth democracy. This creates a tension between the need for participatory processes to legitimize complex transitions and public preference for streamlined decision-making. Our framework addresses this challenge by combining expert-driven causal modeling with participatory value elicitation. It also helps people focus on those parts where they have the most to contribute. This might please both supporters of stealth democracy and those of direct democracy. However, this is not obvious as these two groups tend to be on opposite sides of the political spectrum, namely on populist right and on the left, respectively (Bengtsson and Mattila, 2009).

Circular economy transitions are inherently normative processes and require valuations about e.g. equity and justice (Köhler et al. 2019). The framework answers to this need by making values an essential and explicit part of the description of decision situations. This may also help reveal vested interests of existing industries, which sometimes motivate to hinder the progress (Köhler et al., 2019),

The framework aims to produce a systematic and rational view on controversial issues. The benefits come from the possibility to look at the big picture and the details in the same system and compare different theories of change. The framework does not directly solve the key barriers of the circular economy, e.g. uninterested consumers and hesitant companies (Kirchherr et al., 2018) but it helps explicate if those indeed are blockers in practical situations.

The framework is particularly relevant for circular economy transitions, where multiple stakeholders must coordinate across value chains; complex trade-offs exist between environmental, economic, and social impacts; local actions have global implications; and system-wide changes require broad stakeholder support.

As mentioned in Introduction, 80 % of global citizens want a more ambitious climate policy (UNDP, 2024), yet lack of consumer interest is listed as a major blocker of the circular economy (Kirchherr, 2018). The framework could be used to challenge consumers about their role and discrepancy between their expressed values and revealed priorities. This could clarify whether the inactivity is due to actual indifference or, rather, lack of belief in one's own potential for influence.

The framework follows the idea of representative democracy, as it enables influencing decisions without directly participating in the actual decision making. But it offers richer opportunities for participation than just voting for a single candidate. The guidance produced for a decision maker can possibly be very detailed, thus offering a new channel of influence.

Due to the participatory nature, the framework is not a traditional decision support system. Rather, it could be called a "citizen support system" to reflect its focus on increasing understanding among all stakeholders.

The framework was developed to enable self-organised groups to collect data about decision situations and decision makers' values, priorities and hypotheses based on what they do and say publicly. It does not require that decision makers participate personally, nor that they approve the process. Thus, the system may work even if the decision makers use eristic tactics (Schopenhauser, 1830) and are hostile against careful and knowledge-based scrutiny.

Decision making is not a strictly rational process. There is scientific evidence that people often choose in an irrational manner (Slovic et al., 1977) and sometimes even deliberately against what they know to be the best option, a phenomenon called acquiescence (Walco and Risen, 2017). Yet, when different beliefs are made explicit by using hypotheses, it makes it clearer what the common knowledge base is. It also gives opportunities to challenge theories of change and makes it harder to promote actions without rational support.

The framework offers insights to participants about the weak points of their own argumentation and what more is needed to convince a rational audience.

The actual collaboration and how it should be organised was outside the scope of this study. Therefore the actual network construction was done by the authors based on existing material from the voting advice application. There are both practical and technical development needs for applying the framework with actual stakeholders in a decision situation (see Table 2).

9. Conclusions

In this study, we presented a framework for combining stakeholder value judgements to causal chains connecting policy actions with outcomes of interest. The framework was tested with written material of political reasoning by Finnish Parliament candidates on an online platform. Both the framework and the platform showed capability to reflect the priorities and rationales of the candidates. They seem promising tools for organising information about circulatory economy decisions especially with multiple stakeholders and multiple outcomes. The study was limited by the size of material and lack of actual interaction with stakeholders. Scalability and participation are the critical research topics for further development of the framework and platform.

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Authors' Contributions JT developed the idea, analysed the material and wrote the first manuscript version. SI developed the idea. MF contributed to the iteration of the idea and analysis approach. TT designed the user experience of potential contributions. JY, JT and BB developed the information structure needed to describe the content. All authors participated in several meetings with city representatives, and co-wrote the manuscript and read and accepted the final manuscript.

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Data Availability The full insight network is available at Kausal Watch platform https://greentransition.watch-test.kausal.tech/en-GB/. The code used to analyse the network is available at Github https://github.com/jtuomist/value-profile/. The original response data of all candidates is available at the website of Helsingin Sanomat https://www.hs.fi/politiikka/art-2000009392020.html.

Ethics Approval and Consent to Participate The study used information that is publicly available from the Helsingin Sanomat voting advice application. The priorities and other information were given by the candidates for the Parliament of Finland in the 2023 elections. Each candidate voluntarily revealed information about their own thinking and opinions for the purpose that citizens can learn and study it. No other information was collected about the candidates.

Consent for Publication All content was anonymised, and only the party and voting district were used in the analysis. In Finland, most parties have at least 14 candidates in each district. Therefore, no consent was required from the candidates whose comments were used.

Declarations

Competing interests Kausal Ltd is a company that produces software as a service (SaaS) platforms for municipalities and local governments to turn climate goals into actions. Therefore, Kausal clearly has a commercial interest in the questions presented in this article. On the other hand, the methods developed and tested cannot be commercially successful unless they reflect real problems and offer truthful and useful solutions. Also, Kausal's platforms have an open core licence, which enables anyone to start using and further developing the software that may be developed based on the results of this article. Publishing methodological results in open access journals is the policy of Kausal.
Finnish Environment Institute has participated as a public research organization without any commercial interests. The authors/organisations do not have any financial, commercial or legal relationships.

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