

An Approach to Quantifying Narrative Scenarios for Sustainable Consumption and Production Using Participatory Backcasting

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Abstract

More attention has been paid to sustainable consumption and production (SCP) to explore the desirable linkage between consumers and producers for sustainability. To envision SCP, the authors have developed a workshop-based method for designing backcasting scenarios. The idea is to incorporate expertise, opinions and local knowledge that experts and stakeholders have into the scenario design process. While scenarios are generally described in narrative format, it is necessary to quantify described scenarios to examine how to bridge the gap between the current situation and predetermined goals for SCP. However, it is not easy to quantify backcasting scenarios because there are no systematized methods available in existing studies. This paper thus aims to develop a workshop-based process for undertaking a quantitative evaluation of backcasting scenarios in narrative format.

To develop the quantification process, we conducted a literature review and held experimental workshops. Making scenario quantification feasible and efficient during the workshop, the scenario designers deal with the following two things before the workshop – (1) setting tentative input values and the rationales for them and (2) suggesting discussion points in quantification workshops. In a case study, we evaluated one of the described scenarios for Vietnam, inviting experts to discuss it. The SCP goal was assumed to halve CO₂ emissions related to passenger cars in 2050 from the level of the Business-as-Usual (BaU) scenario. Through the workshop, the experts reached a consensus on the quantification results, which showed that the CO₂ emissions were reduced 60% when half of car users shared a car with 10 users.

Key words: backcasting, scenario design, scenario quantification, sustainable consumption and production, workshop

1. Introduction

As stated in Goal 12 of the Sustainable Development Goals (SDGs), much attention has been paid to sustainable consumption and production (SCP), which refers to the use of services and related products to bring a better quality of life while minimizing the use of natural resources (UNEP, 2015). To clarify the desirable linkage between consumers and producers, a five-year research project (2016–2020) called “Policy Design and Evaluation to Ensure Sustainable Consumption and Production Patterns in Asian Region (PECoP-Asia) was established (PECoP-Asia, 2016).” The focus was on

Southeast Asia because resource and energy consumption is projected to increase drastically in response to future economic growth (Bao et al., 2017). Through this project, the authors developed a method for designing scenarios using participatory backcasting to envision SCP, which is far different from our current state of society (Kishita et al., 2019).

Participatory backcasting aims to envisage and explore system innovations and transitions by inviting stakeholders and/or experts to include various knowledge, values, and opinions in backcasting processes, usually to address sustainability problems (Quist et al., 2011). Backcasting first defines a desirable future endpoint (i.e.,

vision) and then looks backwards from the vision to the present to connect the gap between them (Dreborg, 1996; Vergragt & Quist, 2011). In participatory backcasting, workshops are usually used to describe a sustainable vision in a narrative format.

Based on the concept of participatory backcasting, the scenario design process developed in the PECoP-Asia project consists of the following two steps (Kishita et al., 2018):

1. Describe future endpoints (i.e., visions) that achieve SCP and pathways to connect with those visions, presenting them in narrative format taking into account the regional characteristics of Southeast Asia.
2. Quantify narrative scenarios (i.e., stories describing visions and pathways) to test if the scenarios achieve the predetermined goals (e.g., carbon neutrality in 2050) from an environmental viewpoint.

Note that the above steps should be iterative to develop plausible scenarios. These steps are executed at expert workshops to enhance collection of diversified knowledge and views on SCP for Southeast Asia.

In the project, the authors described narrative scenarios at the expert workshops (Step 1) as shown in Table 1 (Kishita et al., 2019). Based on the experts' discussions in the scenario design process, various measures to achieve SCP came to light, such as sharing, remanufacturing and recycling. The focus of this paper is on Step 2, but the problem is that it is not easy to reflect participants' knowledge and opinions sufficiently in the scenario quantification process, particularly when determining plausible values of parameters in a simulation model. This is because no systematized methods for quantifying backcasting scenarios in narrative format are available. Quantification is based on experts' knowledge, which tends to be implicit and not easily transferrable to other cases (e.g., Uwasu et al., 2020; Vita et al., 2019).

To make quantitative scenario creation based on predefined narratives more efficient, we formulated the research question of this study as "How should narrative scenario quantification processes using participatory backcasting be developed and facilitated, particularly in an SCP context?" To address this question, we aimed to develop a workshop-based method for undertaking quantitative expression of backcasting scenarios in narrative format. We assumed that workshop participants using our method would be experts such as researchers because diverse expertise is needed in SCP. In this paper,

we develop this method by taking an experimental approach, i.e., prototyping and revising the quantification process using SCP narrative scenarios, which are described by the authors in PECoP-Asia (Kishita et al., 2019).

The rest of this paper is organized as follows: Chapter 2 provides a literature review of participatory backcasting and explains the problems of quantification of narrative scenarios using participatory backcasting. Chapter 3 proposes a method for quantifying narratives in an SCP context. Chapter 4 presents a case study to demonstrate the proposed method using a narrative scenario for Vietnam. Chapter 5 discusses the effectiveness and challenges of the proposed method based on case study results. Chapter 6 concludes this paper.

2. Literature Review

2.1 Participatory Backcasting for Sustainability

Participatory backcasting, which is a normative approach to foresight using desirable or alternative futures involving experts or stakeholders, has grown into an adequate approach to explore system innovations and transitions towards sustainability (Quist et al., 2011). There is an increasing number of scenario projects using participatory backcasting in various domains, such as household heating (Doyle & Davis 2013), SCP (Kishita et al., 2019), and food (Quist & Vergragt 2006). Methodologies for participatory backcasting also have been developed based on such case studies. For example, Quist et al. (2011) proposed a five-step process for participatory backcasting, including strategic problem orientation; future vision development; backcasting analysis; future alternative elaboration and follow-up agenda definition; and embedding of the results and agenda, and follow-up stimulation, (Quist, 2007; Quist et al., 2011). Nikolakins (2020) analyzed how participatory backcasting enabled communities to produce a range of normative scenarios.

As mentioned above, many researchers have paid attention to participatory backcasting. Most of them focus on creating narrative scenarios to describe sustainable visions. On the other hand, narrative scenarios must be quantified for supporting decision-making towards sustainability such as policymaking. This quantification helps to clarify the gap between sustainable visions and

Table 1 Example of SCP narrative scenarios (not exhaustive) (Kishita et al., 2019).

Title	Storyline
A: BICS Society (BICS: Business-Individual-Customer-Sharing)	<ul style="list-style-type: none"> • Because sharing services are already popular, B2B leasing and B2C sharing are widely used. • Some people become prosumers to satisfy individual needs.
B: Beauty is only skin deep	<ul style="list-style-type: none"> • Products are designed by coupling a generalized part and customized part. • Because Vietnamese people like new products, customization services are provided using augmented reality (AR) and virtual reality (VR).
C: Infrastructure innovation 2.0	<ul style="list-style-type: none"> • Sharing and replacement is accelerated by visualizing information for consumers. • An authorization scheme is introduced to improve repair skills in local industry.

the present as well as to discuss how to cross the gap by taking various technological and political measures.

Although research on the quantification of narrative scenarios using participatory backcasting has not been systematized so far, a few relevant studies are available as follows. Vita et al. (2019) created sustainable lifestyle scenarios in European countries with various stakeholders. Based on the described scenarios in narrative format, they evaluated changes in environmental impacts (e.g., CO₂ emissions or water footprints) when various measures assumed in the scenarios were taken using expert and non-expert decisions with Environmentally Extended Multi-Regional Input-Output analysis. In Vita et al. (2019), it should be noted that quantification of narrative scenarios was accomplished after the stakeholder workshops. Uwasu et al., (2020) developed low-carbon energy scenarios with citizen workshops. Attempting to reflect citizens' opinions in the quantification process, they evaluated CO₂ emissions under the various narratives during one citizen workshop using a simplified simulation model.

2.2 Problems to be addressed

As described in Section 2.1, quantification of narrative scenarios using participatory backcasting is becoming important. It is not easy, however, to quantify narrative scenarios during workshops for two main reasons. First, the process of quantification using workshops has not been clearly developed in previous research. Although Vita et al. (2019) and Uwasu et al. (2020) presented their quantification results, they did not clearly describe detailed processes such as how to determine input parameter values for quantification. Second, the quantification process is time-consuming because it is not easy to quantify a narrative scenario while securing internal consistency within it. For example, in Uwasu's study (2020), at least 4 hours were spent on quantification.

3. Methodology

In this chapter, we develop a quantification process based on a literature review and experimental workshops.

3.1 Approach

We took an experimental approach to developing the quantification process in the following two steps: performing a literature review to prototype a quantification process and conducting experimental workshops to verify, modify and update the prototyped process. At the workshops, narrative scenarios describing sustainable consumption and production developed by members of PECoP-Asia (Kishita et al., 2019) were quantified by involving several members of the project as workshop participants along with a scenario designer, who determined the quantitative expression of each target

narrative scenario by organizing the opinions of the workshop participants and calculating target indices such as temperature or CO₂ emissions. Here, the predetermined goal of SCP was assumed to halve CO₂ emissions for consumer durables, such as cars, in urban areas compared with the Business-as-Usual (BaU) situation (Bao et al., 2017) in 2050. Such experimental workshops were also used to verify the method proposed in Chapter 5. The details are given below.

3.1.1 Prototyping a Quantification Process

We developed a quantification process based on the literature review presented in Chapter 2. Quantifying backcasting scenarios described in a narrative format at workshops entails three tasks, i.e., (i) selecting or developing a simulation model to enable quantification of narrative scenarios, (ii) determining the input values for the simulation model, and (iii) discussing and validating the simulation results among workshop participants.

3.1.2 Experimental Workshops

We held three experimental workshops online, varying the conditions of the workshops as shown in Table 2.

In the first experiment, we focused on a BICS Society (BICS: Business-Individual-Customer-Sharing) scenario, where sharing services were widely used to reduce CO₂ emissions. The target products were defined by the scenario designers considering the content of the scenario. At the workshops, the participants established input values without referring to any external information. The participants quantified the scenario by changing the input parameters in a trial-and-error manner. For example, the penetration rate of electric vehicles was set at 100%. During the workshop, the participants confirmed a series of input values to achieve the goal of halving CO₂ emissions but the input values were not convincing because of a lack of rationales. For example, participants assumed that all car users no longer owned cars in the scenarios, without a clear rationale. Moreover, in terms of efficiency, the workshop included much repetitive effort because the participants had to check their results each time they changed an input value.

In the second experiment, the scenario designer conducted a sensitivity analysis of two parameters that were most relevant to the content and had a relatively larger impact on quantification results. At the workshop, the scenario designer showed the results of the sensitivity analysis to the workshop participants. The workshop participants could check the quantification results and get a grasp of the situation involving two parameters for halving CO₂ emissions by referring to the results of the sensitivity analysis. Because it had been difficult to determine input values without information in the previous workshop, the scenario designer also collected information relating to the scenario's contents, such as the current state of the target country or results of questionnaire surveys on sharing services. One example

Table 2 List of experimental workshops.

	Experimental workshop 1	Experimental workshop 2	Experimental workshop 3
Narrative scenario quantified (see Table 1)	A: BICS Society (BICS: Business-Individual-Customer-Sharing)		B: Beauty is only skin deep
Goal to be achieved	To halve CO ₂ emissions relating to passenger cars in 2050 compared with those in the BaU scenario		To halve CO ₂ emissions relating to refrigerators
Overview of the quantification process	Participants determined input parameter values without any additional information and checked their results	Participants determined two input parameter values proposed by the scenario designer by checking the results of sensitivity analyses	Participants determined two input parameter values by checking the results of sensitivity analyses
Persons involved in the process	One scenario designer and four participants		
Information provided to workshop participants by scenario designers	Scenario storyline	Scenario storyline, information on current situations, future forecasts and the results of sensitivity analyses	
Discussion points	Participants chose discussion points by themselves	Scenario designers chose discussion points	Scenario designers proposed discussion points and participants selected from them
Examples of changed parameters (discussion points) (not exhaustive)	Penetration rate of electric vehicles, How many people share a car	Penetration rate of car sharing services, Lifetime of shared cars	Electricity consumption of a refrigerator
Outcomes	Confirmed a series of values for realizing SCP but without clear rationales	Confirmed the state of two parameters needed to achieve SCP	Quantification unfinished because the participants determined the values
Feedback from the participants	(+) Participants could discuss whatever they wanted to (-) Too much repetition during the process	(+) Fewer reiterations in the process because it was easy to understand how the results changed when the two values were changed (-) Participants could not propose other discussion points	(+) Participants could choose discussion points (+) Fewer reiterations in the process because it was easy to understand how the results changed when the two values were changed (-) The discussion stopped when the scenario designer operated the simulation model or searched for information on the model
(-) Difficult to determine the values and rationales			

* (+) indicates positive feedback from the workshop participants and (-) indicates negative or constructive criticisms.

of a determined input value is the lifetime of shared cars, which was set at longer than seven years (Onozuka et al., 2021). In terms of the workshop's efficiency, the number of iterative processes was lower because the participants were able to get a grasp of the situation to achieve that goal easily. However, the participants could not propose other discussion points during the workshop because the scenario designer did not present the results of sensitivity analyses of other parameters. Although the workshop participants could see related information, they felt that it was still difficult to establish plausible input values for what might occur in 2050.

In the third experiment, the target product was changed from automobiles to refrigerators because the content of the target narrative scenario changed to sharing an electric appliance among many people. To address the challenges found in the second workshop, the scenario designer prepared results of sensitivity analyses of ten parameters in advance, considering the content of the narrative scenario. At this workshop, the participants chose discussion points from candidate discussion points proposed by the scenario designer such as the electricity consumption of a refrigerator. Nevertheless, the participants could not determine the input values within the workshop for two reasons. One was a lack of information for determining plausible input parameter

values. This time, we quantified narrative scenarios in terms of CO₂ emissions relating to refrigerators. There was less information about refrigerators in Vietnam than about passenger cars. The other reason lay in the workshop's facilitation. During the workshop, if the scenario designer could not recall information, he would try to find it in the simulation model or on the Internet, leaving him unavailable to facilitate the discussion, so the discussion would stop. This may have led to insufficient discussion.

3.1.3 Problems Identified from the Experimental Workshops

Through the experimental workshops, we identified the following three problems:

- The rationales behind the input parameter values are important to consider for reasonably determining the future parameter values described in the target narrative scenarios, e.g., for 2050. For this purpose, sufficient information should be provided to the participants of quantification workshops.
- It is more efficient and effective to limit the number of discussion points, because not all parameters need to be discussed and determined precisely at the workshop.
- It is difficult for scenario designers to facilitate the workshop while operating the simulation model, particularly in a virtual environment.

3.2 Quantification Method for Pre-defined Narrative Scenarios

We developed a quantification method to address the problems found in the experimental workshops (see Section 3.1.3).

To deal with the first problem, we presume that, when setting input parameter values for scenarios, scenario designers need to prepare tentative parameter values and the rationales for them in advance of workshop. Here, rationales are developed mainly based on external information, such as future forecasting reports or statistical reports gathered by the scenario designers. The scenario designers explain these parameter values and their rationales at the workshop to the participants.

To deal with the second and third problems, the scenario designers prepare key discussion points considering storylines of the scenario and sensitivity analyses of input parameters. They also divide the role of scenario designer at quantification workshops between a facilitator and a technical assistant, who is responsible for running the model. Therefore, it is preferable to involve at least two scenario designers.

Fig. 1 gives an overview of the proposed quantification process. A workshop is combined with back-office work done by the scenario designers to make quantification during the workshop more effective and efficient. The process is composed of three phases and each phase includes one or more steps.

Phase 1. Workshop preparation by the scenario designers (Steps 1–3 in Fig. 1)

Before running workshops, the scenario designers do some preparatory work for quantifying the narrative scenarios, which includes:

- Clarifying the problem definition for quantifying narrative scenarios (e.g., scenario to be quantified, goals to be achieved, time horizon, target region, and target products) to share with the workshop participants.
- Developing or selecting a simulation model for quantifying the narrative scenario to make quantification results more convincing.
- Providing tentative input values and their rationales for the simulation model to stimulate discussion among the participants.
- Providing key discussion points to focus on to facilitate

workshop efficiency.

Here, we presume that the storyline of the narrative scenario to be quantified has already been developed in advance of quantification.

Phase 2. Discussion by workshop participants (Steps 5 and 6 in Fig. 1)

The workshop participants first check the results of quantification with tentative input parameter values suggested by the scenario designers. The participants then discuss the validity of the suggested input parameter values and the results to modify and determine new input values and their rationales. In this phase, the participants mainly focus on the discussion points suggested by the scenario designers, but the participants can add more discussion points as they need.

Phase 3. Review and modification (Step 7 in Fig. 1)

After the workshop in Phase 2, the scenario designers set the input values and quantify the narrative scenario. The scenario designers may share the quantification results with the participants to have them review the quantification results. Steps 5–7 are reiterated until the participants are satisfied with the quantification results. In cases where the participants suggest modifying the simulation model or request additional information to make quantification convincing, the scenario designers need to conduct part of the preparatory work for Phase 1 again.

4. Case Study

4.1 Overview

To demonstrate the proposed method, we organized two online workshops. The first one was for quantification of narrative scenarios (around 1.5 hours) and the second one was for the workshop participants to review the quantification (around half an hour). Three experts from engineering and economics were invited to the workshop as participants. Two scenario designers were assigned to the first workshop, one to act as a facilitator and the other as a model operator. A scenario in Vietnam developed by members of the PECoP-Asia Project was quantified. The scenario assumed that the key measure to attain SCP would be sharing services to mitigate environmental impacts, while the predetermined goal was to halve CO₂ emissions in 2050 compared with

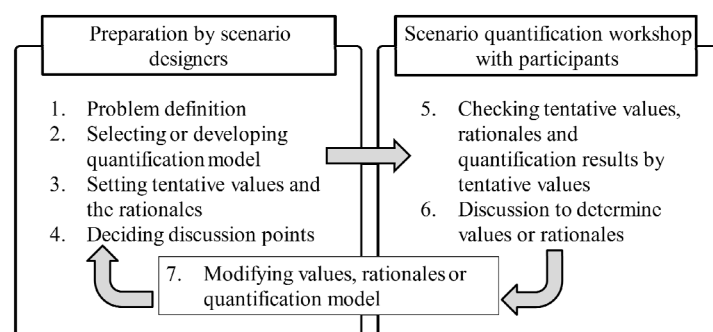


Fig. 1 Scenario quantification procedure using participatory backcasting (updated from Onozuka et al. (2021)).

Table 3 Examples of parameter values and their rationales established in the quantification workshop.

Parameter	Value (2020)	Value (BaU)	Tentative value set by scenario designers	After workshop	Unit	Rationales
Penetration rate of car sharing services	0%	0%	50%	50%	-	The same level as in Thailand. Reference: 45% in Bangkok, Thailand at 2050 (Sekine et al., 2020).
Users of car sharing services per shared car	-	-	50	10	-	The same level as in Japan (assumed by the scenario designers). Reference: Internet questionnaire. Considering time required, 50 is not realistic (comment by participants).
Annual car mileage	10000	10000	10000	5000	km/year	Reduced because of lifestyle change caused by COVID-19 (comment from workshop). In 2020, mileage was almost halved in Vietnam.

the BaU situation. In this case study, we assumed that the target product and region of concern were consumer cars in urban areas of Vietnam. This is because cars have not become widespread in Vietnam and controlling the production volume of cars could have a big influence on the country's CO₂ emissions.

4.2 Case Study of Narrative Scenario Quantification

The case study results are summarized as follows:

Phase 1. Workshop preparation by the scenario designers

1. The scenario designers decided to use a simple simulation model called “product circulation model,” which was developed to evaluate the environmental impact of product lifecycles, considering consumer behaviors (Onozuka et al., 2021). This model was able to estimate environmental impact changes when various measures (e.g., sharing and remanufacturing) were considered.
2. The scenario designers set tentative input values and their rationales for the product circulation model. For example, the penetration rate of car-sharing services was set at 50% assuming that circumstances relating to car-sharing services would be similar to those in Bangkok, Thailand, referring to previous research done by other scholars. Table 3 gives some examples of input values and the rationales for them set by the scenario designers.
3. The scenario designers suggested a few discussion points, which focused mainly how parameter values would change from those in BaU scenarios. For example, they raised a discussion point about how to set the value of the parameter “Users of car-sharing services per shared car” because it was strongly related with the main measure (sharing services) of the narrative scenario.

Phase 2. Discussion by the workshop participants

The workshop participants discussed how to modify the input values based mainly on the discussion points proposed by the scenario designers. For example, “Users of car-sharing services per shared car” was modified from 50 to 10 through discussion by participants: “It is assumed in the narrative scenario that people will stop owning cars and use sharing services instead. However, this input parameter value refers to the current situation in a developed country, where people already own cars.

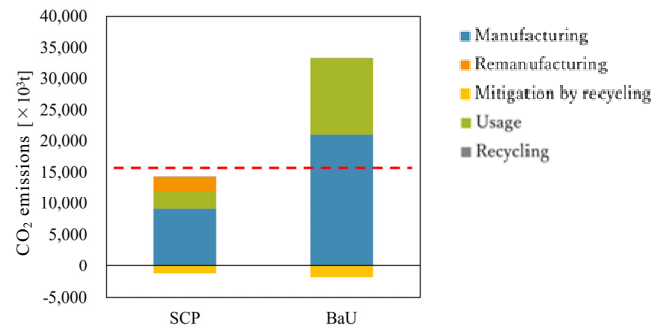


Fig. 2 Quantification result of case study.

Considering the time a sharing-service user would use the car in a day, 10 would be more appropriate than 50 to make the value more consistent with the storylines.” Two other qualitative statements were also discussed. One was on lifestyle changes due to COVID-19 - “we can assume that the demand for mobility will decrease because remote work is being promoted to address the COVID-19 situation.” This value was halved after considering a mobility report (Apple, 2020). The other was on renewable energy. One participant said “Renewable energy should also be taken into consideration because it has huge potential for reducing CO₂ emissions.” In this narrative scenario, we assumed that renewable energy would be used at the level of the Sustainable Development scenario in the World Energy Outlook 2020 (International Energy Agency, 2020). Table 3 presents some of the input parameter values and rationales discussed at the workshop.

Phase 3. Review and modification

Based on the discussion by the participants, the scenario designers set input parameter values to estimate the CO₂ emissions and shared them with the workshop participants. Figure 2 shows the quantification results, which showed that CO₂ emissions would be reduced by 60% compared with the BaU scenario in 2050. Note that all the workshop participants agreed on the final quantification results in the second workshop.

5. Discussion

We have proposed a quantification method for narrative scenarios using participatory backcasting. Judging from the results of the case study, the proposed method worked well in obtaining quantitative scenarios

that achieve the predefined SCP goal (i.e., halving CO₂ emissions in 2050 from the BaU scenario). Although the focus of this paper was on SCP, the proposed method could be applied to any discussion on sustainability. We obtained some important insights into the quantification process when comparing the results of the experimental workshops.

First, the scenario designers' preparation of tentative input parameter values and rationales helped the experts determine the input parameter values for 2050. This is because it was smoother to start a discussion on whether suggested values were convincing or not, rather than determining input parameter values from scratch. Before running workshops, it is important to gather a sufficient amount of information related to various SCP measures described in the target scenario in a local context (e.g., in Southeast Asia) to facilitate discussions among the participants. The gathered information can be used in formulating rationales to decide input parameter values. Second, having the scenario designers raise the discussion points leads to reduced time required for quantification by guiding the discussion among the participants. Third, separating the roles of the scenario designers into facilitator and model operator (technical support staff) is helpful toward efficiently quantifying the narrative scenarios during two-hour workshops based on experts' discussions.

Table 4 compares three methods for quantifying narrative scenarios using a participatory backcasting approach. The originality of the proposed method is to provide a formal process for conducting workshop-based quantification aiming to obtain plausible sets of parameter values. When compared with the quantification processes by Vita et al. (2019) and Uwasu et al. (2020), our method focuses more on interactions with workshop participants to obtain direct feedback by asking them to give rationales for determining parameter values. One characteristic of the proposed method is to quantify narrative scenarios based on participants' discussions under workshops' strict time constraints (e.g., two hours per workshop).

In the proposed method, however, some problems remain to be further addressed. One problem is that the

possible range of quantification (e.g., which parameters are considered at a workshop) is limited because the scenario designers choose the discussion points and pre-developed simulation models in advance of the workshops. To deal with this limitation, in Phase 1, the scenario designers need to choose discussion points carefully that are critical to achieving the predetermined goals. Another problem of how the proposed method would support policy design for SCP has not yet been examined. Therefore, engaging more real-world stakeholders (e.g., policy makers) in the scenario design process, including the quantification process, will be needed in further research. For example, combining participatory backcasting with a gamification approach shows a potential to motivate workshop participants' action towards visions created in a participatory backcasting process (Mandujano et al., 2021). The case study shown in this paper invited experts only, but it would be ideal to involve local stakeholders as well. One future task will be to have both researchers and stakeholders involved in testing the proposed methods.

6. Conclusions

We proposed a workshop-based method for quantifying narrative scenarios based on the concept of participatory backcasting. To develop the method, we conducted a literature review and held experimental workshops. To verify the effectiveness of our method, we quantified a narrative scenario in Vietnam using expert workshops. Through the experimental workshops and the case study, we gained the following insights:

- To reduce time spent on quantification workshops, it is important to establish discussion points in advance.
- Tentative input parameter values and rationales prepared by the scenario designers facilitate discussion during the workshop.
- Separating the role of scenario designer into facilitator and model operator assists smooth discussion.

Future work will include applying this process to other scenarios involving real-world stakeholders to further test the method.

Table 4 Comparison of quantification methods in participatory backcasting.

	Proposed method	Vita et al. (2019)	Uwasu et al. (2020)
Scenario title	Sustainable consumption and production in Southeast Asian countries in 2050	Sustainable lifestyles in European countries in 2030	Sustainable energy vision for a city in Japan in 2050
Goals to be achieved	To halve energy and resource consumption compared with that in the BaU scenario	To reduce footprints such as water or land.	To reduce CO ₂ emissions by 70% in 2050 compared with those in 1990
Purpose of using workshops	To determine a plausible set of parameter values to achieve predefined goals based on narrative scenarios	To develop visions in narrative format	To develop visions and pathways in narrative format, To determine plausible input parameters to achieve predefined goals based on narrative scenarios
Quantification process	The quantification process was formalized as illustrated in Fig. 1. While the scenario designers chose discussion points and simulation models used, workshop participants (experts) determined the parameter values to achieve predefined goals based on their discussions.	With an input-output model, the research team performed quantification based on narrative visions which were developed at stakeholder workshops. No feedback was provided by the workshop participants to the quantification results.	Workshop participants (citizens) performed quantification, but the plausibility of the chosen parameter values was not discussed or confirmed during the workshop.
Participants	Scenario designers and experts	Scenario designers, experts, and stakeholders	Scenario designers and stakeholders

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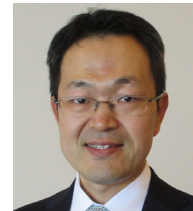
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