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Taking a Future Generation's Perspective as a Facilitator of Insight Problem-Solving: Sustainable Water Supply Management

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Abstract: Human societies face various unsustainability problems, often characterized as "wicked" in the sense that they have no single definitive formulation. Thus, the role of creativity or insight in solving such problems has attracted a lot of attention from scholars. Therefore, this study investigated how an emerging methodology, Future Design (and its unique intervention of asking problem solvers to take a future generation's perspective), can facilitate insight problem solving (IPS) and the generation of sustainable solutions. In a municipality in Japan, nine officers from a bureau responsible for water supply management participated in a series of seven Future Design workshops. In two groups, these officers created visions of water supply management 30 years into the future, taking the perspective of a future generation working in the same municipality. On the basis of in-depth transcription analyses of these workshops, we obtained a hypothetical framework demonstrating that four factors mediate the influence of perspective taking on IPS: (a) Discounting the present generation's cost, (b) contrasting the future with the present, (c) deconstructing hierarchy, and (d) intellectual joy. While the first three mediators (a, b, and c) were considered to be contributors to the problem reframing and IPS via constraint relaxation, the fourth (d) was considered to do so via positive interpretation. Further, the reason why taking a future generation's perspective is likely to lead to sustainable solutions, useful for the future—rather than the present—generation, is also discussed.

Keywords: sustainability; Future Design; creative problem solving; insight problem solving

1. Introduction

Human societies face various issues threatening their sustainability, which is ascribed to intergenerational nature of these issues. In fact, sustainability is widely understood to embody "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1] (p. 43). Existing unsustainability problems in various societies are often framed as "wicked" [2–4]. According to Rittel and Webber [5], a wicked problem is complex and messy, characterized by several features: No definitive formulation of the problem exists; its solution is not true or false, but rather better or worse; stakeholders have radically different frames of reference concerning the problem; constraints and resources for solution(s) change over time; and the problem is never solved. While using different terminology, Ackoff [6] also emphasized how the same reality or the same problematic situation can be seen from different viewpoints and noted that these viewpoints do not necessarily offer equal fruitfulness to problem solvers. Problems of unsustainability are wicked partly because no human can live "sustainably" in its exact sense, and thus, "there is no definitive formulation of what sustainability means and how it is achieved" [3] (p. 79).

As resolving unsustainability problems with linear and rational approaches is impossible, the application of creative problem solving (CPS, i.e., searching for a novel and useful solution) has attracted a great deal of scholarly attention. According to Mitchell and Walinga's [7] review of various studies, Guilford [8] was the first to describe CPS as including three distinct components: (1) Understanding the problem, (2) generating ideas, and (3) planning for action. Isaksen et al. [9] expanded the CPS framework into a six-stage model: Mess finding, data finding, problem finding, idea finding, solution finding, and finally, acceptance finding. CPS is increasingly recognized as a promising, integral process of stimulating novel and innovative sustainable solutions [10–12].

While CPS initially appears to be a productive approach to facilitating sustainable practice, Mitchell and Walinga [7] argue that problem solvers are not explicitly helped to discover different ways to frame problems by being aware of entrenched cognitive, social, economic, and institutional barriers that lock onto certain trajectories, while locking out sustainable alternatives. Mitchell and Walinga [7] further argue that the approach of insight problem solving (IPS) overcomes the limitation of CPS; it focuses particularly on the "Aha!" experience [13] that results from sustained effort in which sudden insight breaks the impasse with systemic problem formulation and elegant sustainable solutions. Walinga [14] proposes a cyclic IPS procedure with five stages: (1) Primary appraisal of the problem; (2) secondary appraisal based on prior knowledge; (3) initial focus; (4) problem representation; and (5) solution generation. On this basis, she proposes pathways to overcome the obstacles of insightful problem (re)framing, as detailed below.

With Walinga [14] in mind, the present study investigated how Future Design, emerging from the future studies discipline, contributes to overcoming obstacles of insightful problem (re)framing. According to Saijo [15], Future Design aims to sustainably promote society's transition by stimulating people's sympathy for future generations. To do so, one promising measure is to introduce what he calls "the imaginary future generation." Yahaba town (Iwate Prefecture, Japan) was the first to implement this idea in an actual municipality [16]. In fact, Yahaba's municipal government organized workshops to obtain input during the development of a comprehensive, long-term strategy for 2060. Some citizens were invited to these workshops and were allocated to groups asked to create the town's visions from a 2060 future generation's viewpoint, rather than from current citizens' viewpoint. By observing and analyzing these workshops, Hara et al. [16] concluded that future-generation groups were more creative than other groups and worked to depict the future from values and lifestyles they envisioned for 2060. In fact, they tended to prioritize the resolution of the most complicated and time-consuming problems. Apart from the experience of Yahaba town's in a real setting, Nakagawa et al. [17] and Nakagawa et al. [18] conducted similar laboratory experiments. They invited the general public and consistently found that taking a future generation's perspective significantly changed participants' preferences for policy options in a manner sympathetic to future generations. While this emergent intervention reasonably encourages "disengagement from the present" [19], with intervention participants becoming more sympathetic to a future generation, why participants can manifest such creativity and insightfulness is not immediately evident. Therefore, in brief, this study aims to answer the following research question:

Which pathways to overcome obstacles to insight problem solving are activated by unsustainability problem solvers' taking of the future generations' perspective?

Importantly, this study deals with a phenomenon hardly investigated in the literature, and we conduct qualitative research to investigate a single case deeply. Thus, the study's results are hypothetical. That being said, its significance will not be diminished. In fact, such a study's hypothesis-generation roles are widely recognized [20–23]; therefore, this study provides a hypothetical conceptual framework that explains how taking a future generation's perspective can contribute to IPS. This hypothetical framework serves as a foundation on which to conduct further studies to quantitatively verify or determine the strengths of causal relationships between IPS and its ancestors (Figure 4).

2. Walinga's (2010) Theoretical Framework

After listing several factors hindering insight problem (re)structuring, Walinga [14] lists several pathways to overcome such obstacles. They are: (1) Positive interpretation; (2) divergence training; (3) constraint relaxation; and (4) cognitive readiness. Failure, listed as the fifth item, is omitted in this study because Walinga [14] implies that failure to reframe a problem might encourage problem solvers to overcome obstacles by using some of the first four pathways.

In regards to the first pathway, positive interpretation, Walinga [14] argues that accepting or positively interpreting perceived threats frees the cognitive resources required to focus on the task at hand. She also uses "stressors" synonymously with "threat," and thus, threats are here interpreted as stressors felt during problem solving. Consistent with this, Carmeli et al. [24] argues that psychological safety, defined as people being comfortable with themselves and able to show and employ the self without fear of negative consequences to their image, status, or career, serves as the mediator of creative problem solving.

Divergence training, Walinga's second pathway, is useful in casting a wide attentional net and generating diverse ideas. She cites Munford's [25] meta-analysis, based on 70 studies, of creativity training programs as evidence.

The third pathway, constraint relaxation, is based on the idea that an impasse, which is faced by a problem solver (re)structuring a problem, can be broken if certain constraints can be relaxed. Walinga cites the example that opening a door is normally constrained so that the door is not damaged, but this constraint might be relaxed to break through a locked door in an emergency.

Cognitive readiness, the fourth pathway, refers to problem solvers' preparation for obtaining insight into (re)framing the tackled problem. Ormerod et al. [26] (in Walinga [14]) suggests that a certain level of preparedness is necessary for full insight to occur: Solvers must be ready to see that an impasse has in fact been broken and that a whole new realm of solution possibilities is available. Therefore, cognitive readiness may then be interpreted as the problem solvers' awareness that they are attempting to overcome an impasse and obtain an insight on a meaningful frame for a problem.

With these four pathways to overcome obstacles in obtaining insight for problem (re)framing and solutions, the research question posed in the Introduction can be rewritten as follows:

Research Question 1: Which pathways (i.e., (1) positive interpretation, (2) divergence training, (3) constraint relaxation, and (4) cognitive readiness) are mediated by the intervention requesting that unsustainability problem solvers take a future generation's perspective? Research Question 2: What factors serve as mediators of this intervention's effect on these pathways?

3. Materials and Method

3.1. Research Context

City *X* is in prefecture *Y*, located in mid-Japan. The city has a population of approximately 80,000 and a population density of approximately 4000 people/km^2, typical of urban Japanese cities. Masa (pseudonym; male, aged 35) was chief of the city's waterworks bureau. In the 2018 fiscal year, he participated in a training program organized by prefecture *Y* (supported by this author and other scholars) and experienced a series of three workshops that adopted Future Design. In the workshops, Masa and other participants were divided into groups of four so that each group consisted of officers from neighboring municipalities. They took the perspective of a future generation 30 years from the present and deliberated in groups on the state of water supply management in their regions. After becoming acquainted with Future Design, Masa was then motivated to implement a bureau training program in city *X* to use this method. He was supported by his colleague Yoko (pseudonym; female, aged 47). In the bureau, Masa and Yoko recruited nine young (20–40; M = 30.2; SD = 7.1) volunteer officers (six males; three females) interested in the program and implemented a series of seven workshops from December 2018 to March 2019. The nine participants were divided into two groups (A and B). Groups A and B consisted of five and four participants, respectively, and their membership did not change throughout the seven workshops. Each of the two groups deliberated on and reached a consensus on the state of water supply management 30 years from the present (i.e., 2019 + 30 = 2049). With each workshop lasting 2 hours, Masa and Yoko, respectively, facilitated these two groups' deliberations. All participants' voices were recorded, and the third to sixth workshops were transcribed for each group; the number of transcription pages reached more than 370. Both voices and transcriptions were in the Japanese language.

3.2. Workshop Procedures

Table 1 lists each of the eight workshops' objectives. Workshop 1 was devoted to creating a vision of city *X*'s water supply management 30 years from the present (i.e., 2019 + 30 = 2049). In Workshop 2, participants reviewed the history of water supply management for the last 30 years. As the perspective of future generations was not introduced in these two workshops, these data were not analyzed. In Workshops 3 to 6, participants assumed that they had travelled to 2049, with their own ages unchanged, and were living in city *X* as officers in the same bureau. Then, the two groups were each requested to describe the reality of water supply management at that time. To stimulate their thoughts, additional guidance was provided in Workshops 4 to 6. Specifically, in Workshop 4, they sent queries to the 2019 city *X* and society as a whole. In Workshop 5, they assumed that the 2019 city *X* and society had answered their queries and revised the 2049 reality according to these answers. In Workshop 6, they described the history from 2019 to 2049, specifically in regards to how the reality they described in Workshop 6 was realized. Throughout Workshops 4 to 6, the groups were always encouraged to revise the output of Workshop 3 if they felt it necessary to do so.

Table 1. Objectives of seven Future Design workshops on water supply management.

No.	Objective
1	Visioning the water supply management of *X* city from the present generation's perspective
2	Overviewing the past and present of the water supply management in *X* city
3	Visioning the water supply management of *X* city from the future generation's perspective
4	Continuation of No. 3 (With a special focus on sending requests toward the present generation)
5	Continuation of No. 3 (Updating the vision assuming that the request in No. 4 was accepted)
6	Continuation of No. 3 (With a special focus on the process in which the vision in No. 5 was realized)
7	Continuation of No. 3 (With a special focus on enhancing the robustness of the vision in No. 6)

3.3. Current Status of Water Supply Management in Japan

In order for readers to understand the details of the two groups' discussions (presented below), the summary of the current status of Japanese water supply management is useful. The Waterworks Law of Japan, enacted in 1957, requires that national and local governments take responsibility for necessary actions to support water utilities to provide safe, drinkable water (https://www.mhlw.go.jp/english/policy/health/water_supply/2-1.html). According to Shibuya, Hernandez–Sancho, and Molinos–Senante's [27] summarized overview, most Japanese water utilities have been managed by local governments, under the control of the national government. While the water coverage ratio reached 97.5%, due to the contributions of past generations, these researchers identified at least three challenges for the sustainability of waterworks. First is financial difficulty. Built when Japan rapidly expanded their water utilities, most facilities are now near the renewal period, and their maintenance cost will very likely increase. It is also very likely that the total revenue from the water tariff will decrease in proportion to the population's rapid decrease (since 2008), and this must cause financial problems. Second is the insufficient number of engineers. The vast majority of Japanese water utilities supply water to 50,000 or fewer inhabitants, and 60% of engineers working on these utilities are over 50. As staffing is the major operational cost for Japanese water utilities, hiring younger engineers immediately is difficult, and this causes further difficulties in passing older engineers' expertise to younger ones. Third is the insufficient preparedness for earthquakes. Seismic countermeasures (e.g., seismic upgrade of tanks and water treatment facilities and replacement of older pipelines with seismic resistant ones) have only been insufficiently implemented in water utilities on the scale mentioned above.

As a countermeasure to these sustainability challenges, the national government has strongly recommended that water utilities collaborate with nearby utilities to enhance efficiency (https://www.mhlw.go.jp/content/10900000/000458888.pdf; in Japanese). Collaboration includes the integration of utilities, the sharing of facilities, and integrating water supply management. According to some earlier, successful cases, the government notes that such integration requires a longtime process, so water utilities need to initiate it immediately. Another countermeasure considered is to utilize private sectors, which, in Japan, have developed in parallel to the development of water supply systems and have a high technical level. Magara, Matsui, and Ohno [28] argue that the provision of private sectors expertise and financing is essential to secure an abundant, stable supply of clean water at low cost and to provide service that can greatly satisfy customers. More recently, in 2019, the Waterworks Law was amended so that water utilities can utilize private sectors by introducing concession systems.

3.4. Current Status of Water Supply Management in City X

City *X* began operation of its water supply system in the 1960s, with groundwater as its only source. After that, water demand increased rapidly, along with the population, and excessive groundwater pumping caused a lowering of the groundwater level and ground subsidence. To prevent these problems, in the 2000s, city *X* decided to purchase surface water from *Y* prefecture and to mix it with groundwater, supplying it to inhabitants after purification. Some people were, and still are, against this mixing policy, partly because of the enhanced water tariff and partly because some citizens were, and still are, strongly attached to pure groundwater.

Like most Japanese municipalities, city *X* is fully aware that the sustainability of water supply management is threatened for the same reasons mentioned in Section 3.3. The city acknowledges the importance of the water supply management bureau having a long-term vision. Every decade, in fact, the water management committee creates a 10-year plan. As the last 10-year plan neared completion, Masa and his colleague Yoko decided to conduct the series of Future Design workshops for young (around 30 years old) water management staff, expecting them to use this experience in the future and to be responsible for creating long-term visions one or two decades from the present.

3.5. Visualization of the Group Deliberation Processes

To analyze the two workshop groups' voice transcriptions, this study developed an original technique for visualizing the groups' creative Future Design problem-solving processes by extending the technique of cognitive mapping [29,30]. A cognitive map represents a person's subjective understanding of how she/he makes sense of the world by seeking to manage and control it. Typically drawn, based on information gathered in interview surveys, a cognitive map usually takes the form of nodes representing ideas connected by arrows that represent causal relationships. As Eden and Ackerman [30] stressed, cognitive maps are not simply "word and arrow" diagrams; instead, cognitive mapping is a formal modeling technique with rules for its development. Its basis is derived from personal construct theory [31], on which the present study also relies for its theoretical underpinning. This theory posits that individuals act on their perceptions of the objective world, filtered through their constructive systems, rather than passively perceiving the environment [32]. It also posits that, throughout such a process, bipolar constructs are primary mechanisms that individuals use to organize, simplify, and interpret the objective world. Scholars often adopt the cognitive mapping technique for problem structuring methods, which has been an effective strategy in achieving consensus among diverse groups that addresses a problematic situation with "swamp conditions" [33,34]. Cognitive mapping enables the visualization of each stakeholder's perspective on what the problem is and how it should be formalized.

This study develops and adopts the extended cognitive mapping technique to represent each group member's subjective understanding of creative problem-solving, that is, how they make sense of the group's deliberations, as interpreted by an analyst. The maps consist of nodes and arrows. Each node represents a group member's action, for example, the expression of an assumption on the future world's status (i.e., the world assumed by the group) and of an inference on what must have happened before this future world. In the convention of cognitive maps, when possible, each node was represented accompanied by its contrasting ideas [30]. While in the literature original and contrasting ideas were conventionally linked in each node with ellipses marks (...), this study connected them with 'rather than' for the convenience of readers who were unfamiliar with cognitive maps. Nodes were connected by arrows if the analyst interpreted an event that occurred (e.g., a statement of a member) to have triggered another event (e.g., a statement of another member). Other signs (**, †, ††, ‡, & ☆) were also used to identify items referred to by the same members.

After visualization of the group discussion processes, we extracted commonalities between the two groups with respect to: (i) Characteristics of their idea about water supply management's reality in 2049 and (ii) characteristics of the group's discussion process in deriving the idea. Finally, we identified which characteristics of (i) were associated with which characteristics of (ii).

4. Results

Figures 1 and 2 show cognitive mapping of A and B groups' deliberation processes, respectively. In each map, the numbers indicate nodes according to the temporal order in which the group referred to them, so that the cumulative numbers of nodes increased according to the increased number of workshops (Figure 3).

4.1. Solutions of Group A

Kazu (male; aged 27; denoted by * in Figure 1) was Group A's main player. With the scarcity of precious groundwater in mind (nodes 1 and 2) and the facilitator's mention of households possibly collecting and reusing rainwater (node 6), Kazu expressed the idea that, in 2049, treated wastewater must be returned to purification plants rather than released into rivers and the sea, as in 2019 (node 7). However, this idea implies that toilet wastewater would be sent to purification plants, and eventually, would be consumed as drinking water. Only later, during the same workshop, did Kazu and other members realize this (node 12). Paradoxically, among group members, Kazu had the strongest negative emotional reaction to this logical consequence. While the group could have rejected his idea, they decided to accept it and to query those who lived in 2019 about whether brand loyalty to groundwater actually reflected their intrinsic hope (node 14), expecting that the answer would be the same as the group's.

In parallel to this basic line of deliberation, Group A also discussed the collaboration of city *X* with neighboring municipalities to provide water supply services (nodes 3 and 4), with expectations that water resources would be optimally distributed to consumers and that efficiency would result in other ways (e.g., reduced cost of recruiting people; node 18). This idea was merged with the basic line of deliberation on potable water reuse (node 9). Finally, the group was convinced of the inevitability of merging these two ideas because both contributed to the efficient use of precious water resources (nodes 10, 11, and 24).

Group A concluded their deliberation by identifying implications of their ideas on the water tariff. At first, they naively assumed that the tariff would decrease (node 13) according to the enhanced efficiency represented by node 9. However, by pessimistically extrapolating the trend as of 2019, they inferred that the water tariff would inevitably be enhanced in the 2020s (node 19) before the effect of enhanced efficiency emerged and the tariff's reduction in the 2030s (node 20). They optimistically assumed that citizens in the 2020s must have smoothly accepted the tariff's enhancement because the municipality convinced citizens that, sooner or later, the tariff would decrease (node 21).

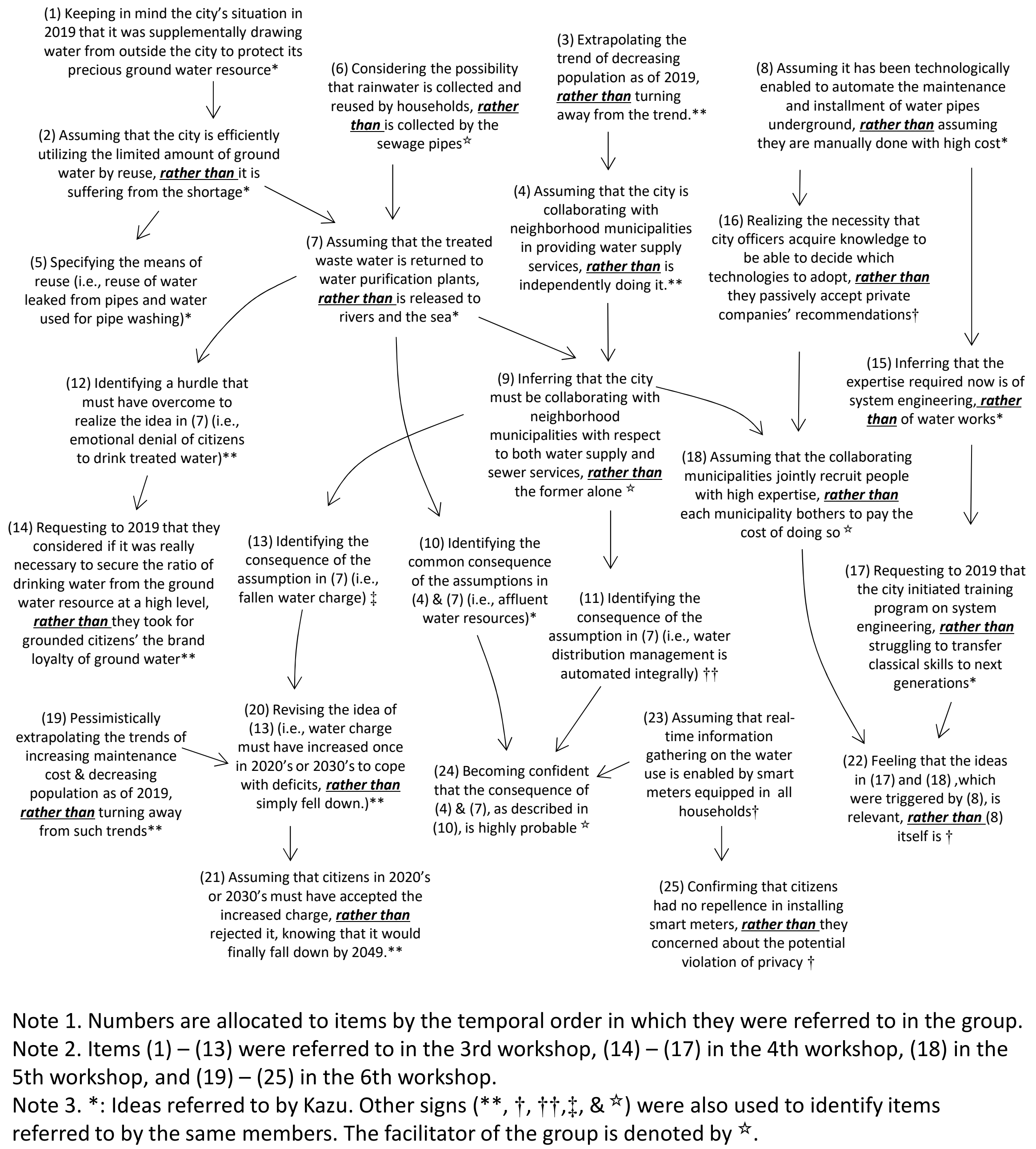

Figure 1. Map of the deliberation process of group A. Arrows from one item to another mean that an event represented in an item triggered the occurrence of another event represented in the other item.

While city *X* had adopted a framework around the extent of introducing *Y* prefecture's surface water to secure resources by sharing the financial burden of the purchase, Group A seemed to have adopted a new framework by questioning how water resources could be secured while also reducing the financial burden, and then arrived at the solution that treated wastewater must be returned to purification plants. Note that, during the last decades, a number of studies were conducted on public responses to potable water reuse (see Hartley [35] and Smith et al. [36] for early and later reviews, respectively). Whether direct or indirect, attempts to secure water resources by potable water reuse schemes have faced challenges worldwide of negative public opinion. In spite of such studies, how public attitudes based on "yuck factor" pre-cognitive affective reactions can be meaningfully shifted remains unknown, as implied by Smith et al. [36]. Despite these past academic and practical attempts, Kazu's idea (node 7, Figure 1) was original in that he embedded a potable water reuse scheme into the context of city *X*, where securing precious groundwater has long been an important political issue. The study's author confirmed, in a post-workshop email survey, that Kazu originated this idea onsite while reacting to other Group A members' statements, rather than having advance knowledge of potable water reuse schemes outside Japan.

4.2. Solutions of Group B

Group B's main player was Koh (male; aged 40; denoted by * in Figure 2), who expressed that, in 2049, city *X*'s water utility must supply households with treated but undrinkable water instead of drinkable water, as in 2019 (node 2). He considered that, in 2019, city *X* (and all Japanese water utilities) supplied high-quality drinkable water despite a large portion being consumed for purposes in which high-quality water was unnecessary. He further contributed to this idea by mentioning that households were responsible for securing drinkable water through high-performance water purifiers developed by 2049.

Since other Group B members contributed little to this idea's development, the group reached no consensus on accepting Koh's idea (nodes 3 and 8) in Workshop 3's first half. Gradually, however, other members began contributing to the deliberation by considering how such a radical societal change had occurred from 2019 to 2049 and/or its implications. Specifically, a member inferred that the national government must have determined the integrity standards of water purifiers for households (node 24). In parallel with the possibly of implementing Koh's idea, another member considered how city *X* and its neighboring municipalities had collaborated and progressed with water management since 2019 (nodes 12, 26, & 27).

In another line of deliberation, Group B discussed water supply management tasks conducted manually in 2019 but automated in 2049 (node 6). The group further inferred that the need for human resources had been greatly reduced compared to 2019 (node 15). This inference served as a cross section between this line of deliberation and the basic line of deliberation originating from Koh's idea (node 2) of supplying undrinkable water, because it eventually inferred that human resources had been reduced (node 14). While Koh played a major role in initiating two lines of deliberation, another member contributed the idea that these two lines crossed (node 16).

To summarize, Koh's idea was to leave the water purification procedure's later steps to households, but only for drinking and cooking purposes. Group B members perceived that, for purposes other than drinking and cooking, the water supply's current quality level is excessive. While city *X* had adopted a framework in which maintaining the existing water supply in the coming age of depopulation and a reduced water tariff was the major problem, Koh seemed to have adopted a new framework by questioning how citizens could consume water for different purposes when maintaining the existing scheme, which is no longer possible. While this idea seems paradoxical and innovative in the context of developed countries technological and financial capacity to supply drinkable water, it might also be regarded as a natural extension of developed countries' worldwide practice of reusing treated wastewater at different levels of quality for different purposes. In a review of technological approaches to gray water (i.e., urban waste water that includes water from baths, showers, hand basins, washing machines, dishwaters and kitchen sinks, but excludes streams from toilets [37–39].) treatment and reuse, Li, Wichmann, and Otterpohl [40] show, in Table 1, that such countries such as Australia, Canada, Germany, Japan, and the United States adopt different water quality criteria for pH, total suspended solids (TSS), total dissolved solids (TDS), turbidity, and biochemical oxygen demand (BOD), among others, and limit their applications according to certain criteria (e.g., toilet flushing, irrigation, washing, restricted and unrestricted impoundments). In an interview with the author after Workshop 3, Koh mentioned that he previously had the idea of only insufficiently supplying treated water to households. He had once shared this idea with a colleague, but it was rejected for a practical reason: Installation of new pipes to supply undrinkable water, while maintaining existing pipes for drinkable water, is financially impractical. Koh thought that receiving questions from group members and providing answers had established links among the facets of his idea. He felt at ease during group deliberations because group members were supposed to imagine themselves as future people; thus, they could discuss less practical ideas so long as the odds of their eventual implementation were not zero.

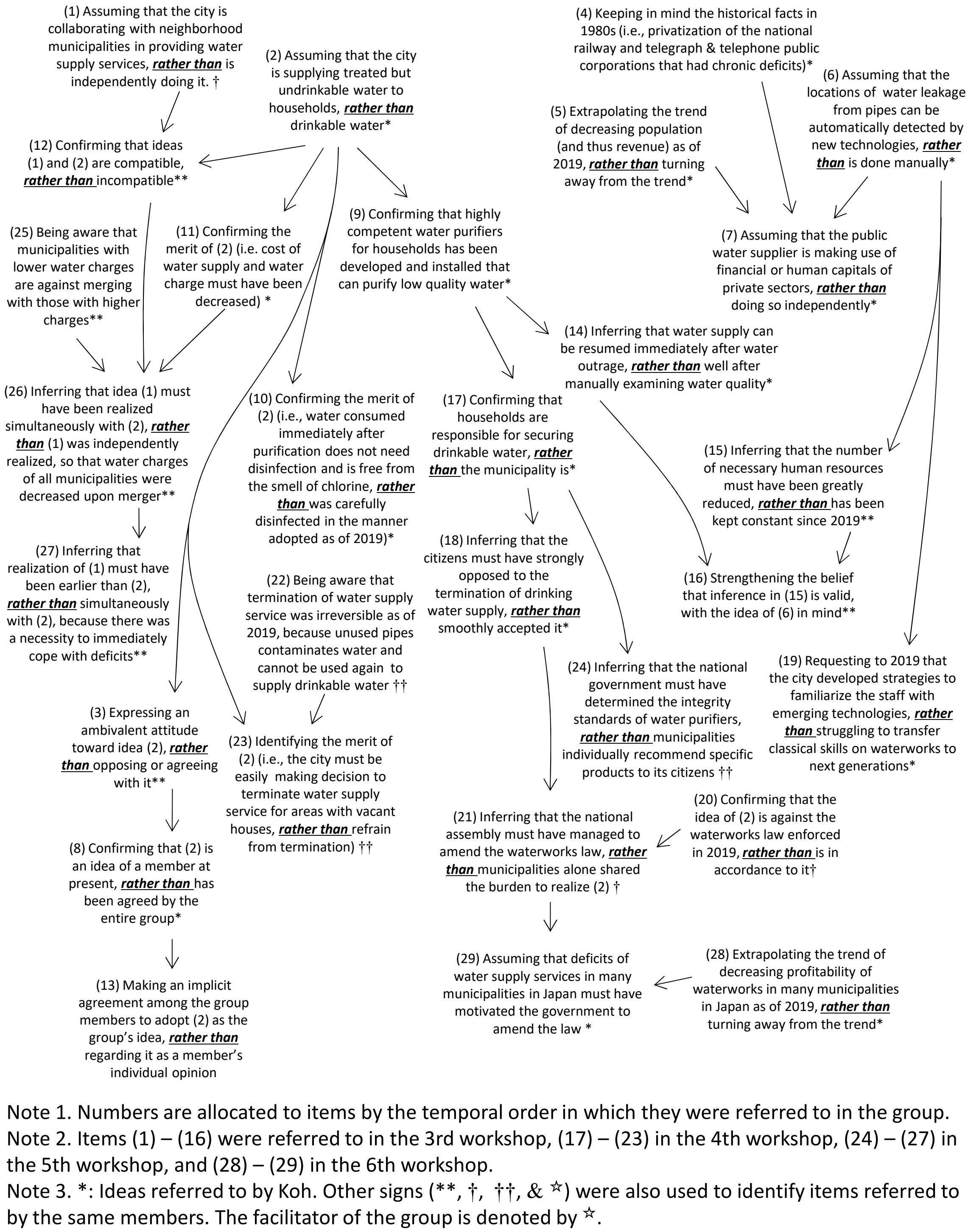

Figure 2. Map of the deliberation process of group B. Arrows from one item to another mean that an event represented in an item triggered the occurrence of another event represented in the other item.

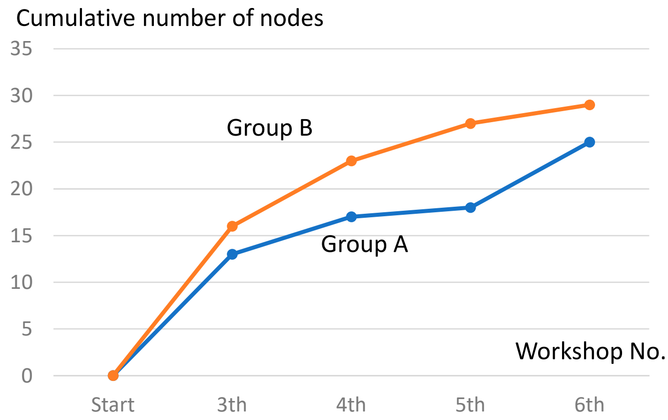

Figure 3. Increase in the two groups' numbers of nodes. The Future Design method was only adopted after Workshop 3; thus, no numbers are shown for Workshops 1 and 2.

4.3. Identification of Mediators

Next, the research question is answered through the identification of four factors (each described below) mediating the effect of taking a future generation's perspective on IPS.

The first mediator is to discount the present generation's cost. As explained in Section 3.1, Group A optimistically assumed that group ideas' emotional rejections, which must have occurred in 2019 and afterward, were resolved. Additionally, the group optimistically assumed that citizens in the 2020s had accepted the increased water tariff with the expectation that it would finally decrease in the 2040s. Considering that group members assumed that they were living in 2049, distinct from their 2019 selves, this optimism can be paraphrased as discounting the present generation's cost of accepting the imagined future generation's solution. Similarly, Group B assumed that 2019 citizens must have accepted the strong belief that the government is responsible for securing safe drinkable water. Group B was also optimistic in assuming that the 2019 government had amended the Waterworks Law to support the realization of the group's idea. This discount of the cost is associated with what Walinga [14] called constraint relaxation, because the cost perceived by the group serves as a constraint on the feasibility of the group's idea.

The second mediator is contrasting the future with the present. Using the cognitive mapping technique, this study visualized group members' ideas with their contrasting ideas whenever possible. Consequently, Group A imagined 2049's reality in contrast to that of 2019 in six nodes (2, 4, 7, 8, 15, and 17) among the 25 nodes in Figure 1. Group B did so in six nodes (1, 2, 6, 10, 17, and 19). These nodes suggest that group members reversed what was taken for granted in 2019 and thus removed putative constraints before acquiring the future generation's perspective.

The third mediator is deconstructing hierarchy. In general, administrative organizations have a rigidly hierarchical structure. Thus, city *X*'s water supply activities are always based on the Waterworks Law enacted by the parliament. Usually then, officers would not freely consider what the parliament should do to implement the municipality's future vision, but participants in this study did so while taking the future generation's perspective (see Group B's nodes 21 and 23, Figure 2). In short, group members succeeded in relaxing constraints in acting according to the hierarchy by which they were bound previously to acquiring the future generation's perspective.

The fourth mediator is intellectual joy. Eight of the nine participants responded to a post-workshop questionnaire, and two of these eight appreciated their intellectual experiences in the workshops. For example, a Group B member (denoted by ** in Figure 1) responded, "The technique of taking the perspective of the future broadened my view. I understand that different techniques lead to different consequences. It was interesting, and I learned a lot from it." A Group A member (denoted by ‡ in Figure 1) responded "It was great to be a future person and acquire a perspective different from the one I usually have as a present person because we obtained new ideas by doing so. Nobody can understand the goodness without experiencing it by themselves." Two participants (one in Group A, denoted by ** in Figure 1 and the other in Group B, denoted by † in Figure 2) responded that it was interesting to observe other participants expressing ideas while they took the future generation's perspective. This joy seems to have relaxed the stress of describing the future (three of the eight participants referred to this difficulty, i.e., Group A members denoted by *, **, †, and ‡ in Figure 1 and a Group B member denoted by † in Figure 2); thus, joy seems to have facilitated insight [14].

5. Discussion

This study aimed to identify mediators of the effect of taking a future generation's perspective on IPS. Through an in-depth analysis of two groups' transcribed voices from a series of Future Design workshops in a Japanese municipality, four factors mediating the influence of perspective taking on IPS were identified: (a) Discounting the present generation's cost, (b) contrasting the future with the present, (c) deconstructing hierarchy, and (d) intellectual joy. While the first three mediators contributed to problem reframing and IPS via "constraint relaxation" [14], (d) intellectual joy was considered to do so via "positive interpretation" [14]. These findings can be summarized as a conceptual framework (Figure 4), but since the study is hypothetical, we do not demonstrate that the causal relationships shown in the figure are always valid in workshops adopting the future generation's perspective. Even so, this result has significance because the creativity or insight of workshop participants taking the future generation's perspective is a scarcely investigated phenomenon. Thus, an in-depth qualitative case study is a promising strategy to understand such a phenomenon and to obtain a hypothetical conceptual framework with the potential to generalize outside the investigated case.

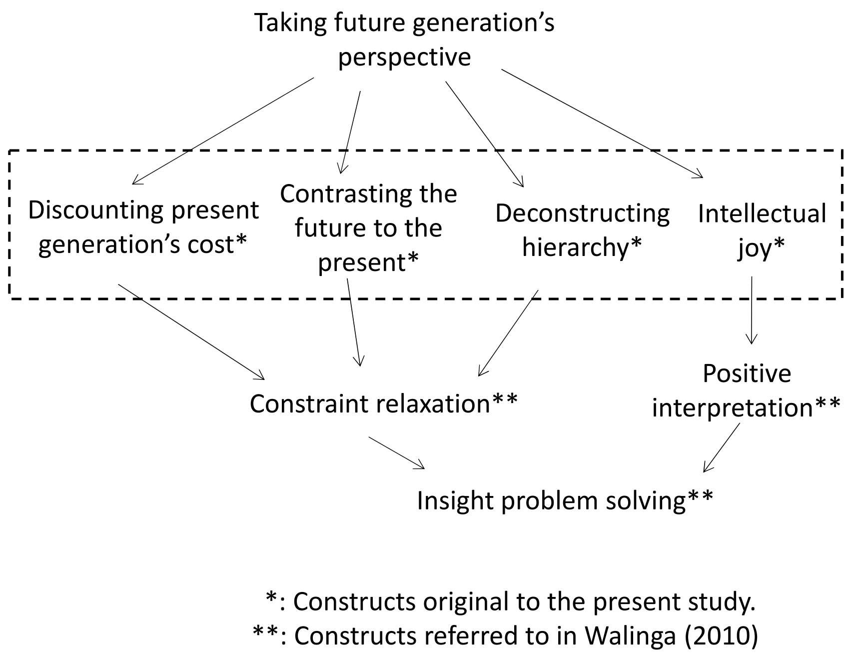

Figure 4. Hypothetical conceptual framework of taking a future generation's perspective in insight problem solving.

Two things should be noted about this conceptual framework. The first is the mediator (a) discounting the present generation's cost. As mentioned in the Introduction, the role of creativity or insight in attaining sustainability has attracted a great deal of scholarly attention [7,10–12]. Few studies, however, have explicitly discussed the mechanisms by which sustainability is secured in reframing and devising creative solutions obtained from procedures proposed in the general literature of creative problem solving (CPS) or insight problem solving (IPS). This is problematic because, in general, procedures for creativity or insight can produce creative solutions that are beneficial for the present rather than the future generation, especially considering the tradeoffs between present and future generations [41–44], since the present generation must share the burden when implementing a solution. This provides strong evidence that taking the future generation's perspective is a promising strategy for sustainable problem-solving or sustainable insight problem-solving.

In regards to the second mediator, we identified (b) the process of contrasting the future with the present. This suggests that taking the future generation's perspective facilitates paradoxical thinking. According to Westenholz [45], paradoxical thinking occurs when a problem solver's previous frame of reference is "deframed" and devoid of meaning, thus enabling the pursuit of new ways of understanding the surrounding environment. According to his example, in a situation where people want equal wages because they are equally important to an organization's production, paradoxical thinkers might assume that people want differentiated wages because some, more than others, can easily be done without or be replaced in production. This study's finding suggests that taking the future generation's perspective facilitates paradoxical thinking by reversing the frame of reference binding the present generation's thinking in a manner beneficial to the future generation's perspective takers. This should serve as a promising strategy for relaxing the constraints binding problem solvers.

The third mediator identified is (c) deconstructing hierarchy. Such deconstruction is a logical consequence of group members' imagined attempts as future people who can succeed in disengaging from their present selves. The difficulty and importance of disengagement have been highly recognized in practices of participatory scenario development [19], because, to disengage, participants must put aside the fact that they are daily bound by norms valid in the hierarchical structure. Note that speculation about the relation between the deconstruction of hierarchy and insight problem solving seems to be consistent in the literature [46,47], with high power distance among the group members hiding group creativity: Individuals are more likely to fear expressing ideas contrary to those of someone with a higher status.

Apart from these points about the conceptual framework in Figure 1, several things should be noted about the visualization of the group deliberation processes. First, this study extended the cognitive mapping technique [29,30], which is theoretically based on Kelly's [31] personal construct theory; that is, the study's maps represent problem solvers' ideas along with their contrasting ideas. The study's findings indicate the validity of applying this technique in visualizing the deliberation for insight problem solving to attain sustainability because sustainable solutions are often obtained by reversing prevailing thoughts binding the present generation. The cognitive mapping technique is expected to make explicit the prevailing, implicit thoughts and to facilitate the present generation's adoption of what Westenholz [45] calls paradoxical thinking.

Second, the present study visualized the group deliberation processes, ex post, according to the transcription of the groups' recorded voices rather than in real time, unlike the countless numbers of computer-supported argumentation visualization techniques that could be used onsite (see Scheuer et al. [48] for a review). Our technique cannot be adopted for real-time use because contrasting ideas are quite often implicit and can only be identified by carefully interpreting them within a certain context. In spite of this, the technique seems to have practical significance when a series of group deliberation workshops occur with an interval of several weeks or longer without changing the groups' membership. This technique can thus visualize the deliberations from past workshops to provide explicit feedback [49,50] about the group's performance, to remind group members about what paradoxical thoughts have already been obtained, and to facilitate further paradoxical thinking.

Third, this visualization technique is useful to realize the convergence of divergent ideas that are partly generated by paradoxical thinking. (Note that Mitchell and Walinga [7] list divergence and convergence as typical examples of creative-problem solving characteristics essential at all organizational levels in creating a sustainable future.) Convergence is especially important in the context of problem solving for sustainability because problem solvers must address interconnected social, environmental, and financial concerns [51–53]. The technique adopted here aids group members' deliberation processes in the visualization of how various lines of deliberation occur due to divergent thinking, how these lines cross, and how, then, the group's solution can have both comprehensiveness and unity.

As in most studies, this one has several important limitations. First, its conceptual framework remains hypothetical, so it should be verified in a range of cases other than sustainable water supply management. Second, the study's participants were municipality officers with expertise in water supply management even though some were novices and in their 20s. Thus, future studies should verify how the conceptual framework must be adjusted for participants' characteristics, for instance, their level of expertise.

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