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Gamification of backcasting for sustainability: The development of the gameful backcasting framework (GAMEBACK)

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ABSTRACT

Considering how wicked problems, such as overconsumption, climate change, or the management of the COVID-19 pandemic rely on multiple stakeholder groups' deliberation, this study investigates gamification's potential in participatory backcasting processes to support the emergence and growth of social innovations towards sustainability. Gameful methodologies have progressively been introduced into strategic planning processes, futures research, and transition studies, offering a powerful input to participatory backcasting processes. As gamification is a novel and impactful way to motivate and engage participants to take action during and after the participatory process, this study develops a framework for practitioners to gamify backcasting processes. Developed through state-of-the-art review of extant corpus as well as two cases of gamified participatory backcasting, the framework elucidates how participatory backcasting processes that include gamification elements designed to address engagement do have an impact on the participants, particularly in terms of the process being a positive, co-creative experience, and offer a good foundation for posterior actions.

1. Introduction

The research related to sustainable consumption, overconsumption and its impact on the environment and the wellbeing of people worldwide, has exponentially increased since the 1990s[1]. The urgency to "do more and better with less" (United Nations, 2016) calls for transitions to Sustainable Consumption and Production (SCP), for example, through circular and sharing economy models (Hamari et al., 2016; Schröder et al., 2019) and other innovations related to consumption and production. SCP is an invitation to tap into the ingenuity of both consumers and producers and to encourage the co-creation of glocal[2] solutions; these are innovations from the local perspective that positively address both local and global wicked problems.

Considering the social dynamics required for transitioning towards more sustainable ways of living, bringing together different stakeholder groups to participate in the co-creation of systemic solutions is required. Two parallel promising processes have emerged during the last decades to combat wicked problems of sustainability; gamification and backcasting. Gamification refers to transforming activities, practices, systems, services and organizational structures towards affording similar experiences and motivations as good as games do (Hamari et al., 2019). Backcasting refers to generating a desirable future, and then looking backwards from that future to the present in order to strategize and to plan how it could be achieved (Quist and Vergragt 2006; Vergragt and Quist 2011). Participatory backcasting (PB) is well equipped to address this challenge as it has the potential to "envisage and explore system innovations and transitions towards sustainability and can be seen as a promising sustainable alternative to traditional planning" (Quist et al., 2011). It requires the application of tools and methods that enable the interactions of different stakeholder groups to guide them through the process from co-creating a vision and building scenarios to depicting the actions and commitments to get there. Backcasting can benefit from participatory tools and methods that intentionally motivate engagement to take the necessary steps towards fulfilling co-created visions, such as gamification. Together, gamification and backcasting have the

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[1] The SCOPUS database shows an increase of about 25 times of publications with the topic of "Sustainable consumption" between the years 2000 (181 publications) and 2019 (4614 publications).

[2] The Oxford dictionary defines glocal as "having features or relating to factors that are both local and global" (Retrieved 19.01.2020).

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potential to inject new paradigms of goal-setting, strategizing and planning for optimally sustainable futures, reminiscent of how successful players reach the winning conditions of a game.

To explore this potential, this study sets out to address the following research question: how can gamification be used in participatory backcasting? The study develops a framework for practitioners for gamification of backcasting processes, introducing the core topics of the study (section 2). The framework is developed through state-of-the-art review of extant corpus as well as two gamified backcasting process cases (participated by 346 individuals; academics, practitioners, CSOs, and policy makers) in China, Colombia, the Philippines, Ghana and Germany (section 3). Section 4 follows a step-by-step approach to present the results obtained. The discussion is presented in section 5, before drawing conclusion in section 6.

2. Background

2.1. Sustainable lifestyles and social innovations

This study departs from the premise that sustainable lifestyles are "a cluster of habits and patterns of behavior embedded in a society and facilitated by institutions, norms, and infrastructures that frame individual choice, in order to minimize the use of natural resources and generation of wastes, while supporting fairness and prosperity for all" (Akenji and Chen, 2016). Lifestyles are interconnected with social norms and values that "enable, support and normalize sustainable everyday practices" (Mont and Heiskanen, 2014). Most of these interconnections happen in the shape of social practices, the smallest analytical unit of human activities and entities that can be studied reconstructing their elements and the links between them (Jaeger-Erben and Offenberger, 2014). These practices reinforce the "distributed agency" or capability to be the source and originator of acts, allowing for "upstream interventions" or interventions addressing the root causes instead of the symptoms of the problem (Kurz et al., 2015).

Social innovations, defined as processes "of changing social relations, involving challenging, altering or replacing the dominant institutions in a specific context" (Wittmayer et al., 2018), are important to shift individual consumption practices towards more sustainable ones, as they reflect narratives of change (concepts, metaphor, story-lines), that, in the case of sustainable consumption, vary in terms of innovativeness, degree of communality, personal engagement, and formality as an alternative process (Jaeger-Erben et al., 2015). Thus, this study assumes social innovation is a phenomenon that can happen from the individual action taken to the societal level and actions that can engage individuals in actions for change that incrementally lead to transformations towards sustainability, starting from the local level leading to changes in global contexts.

2.2. Participatory backcasting for transitions towards sustainable lifestyles

The processes that aim at driving change on the systemic level should involve a broad range of stakeholders from diverse societal groups; use a holistic perspective of sustainability and take into account both production and consumption side (Quist and Vergragt, 2006). As a methodology to envision long-term futures via shared problem definition, long-term goals, and transition pathways, backcasting is a foresight tool for sustainability that "allows participants and users to think beyond incremental changes, and to embrace the more radical and disruptive changes necessary to deliver sustainability" (Eames and Egmose, 2011, p.769). Backcasting has been gradually evolving from a production-systems perspective (Quist and Vergragt, 2006), to a methodology that is also applied to communities (Quist, 2013; Faldi and Macchi, 2017; Guillen-Hanson, 2017; Aitken et al., 2019), lifestyles and consumption (Kuittinen et al., 2012; Doyle and Davies, 2013; Vita et al., 2019), cities (Bibri, 2018), food waste and health (Ryan-Fogarty et al., 2017; Chiabai et al., 2020), mobility (Höltl et al., 2018), all exploring individual and community practices and impacts of consumption in various lifestyles aspects. As part of this development, a wide array of resources to enable co-creative interactions has been accrued, bringing new tools and methods to design, implement and collect information for and through backcasting. Some of these tools (i.e. visioning, one-line-logos, role-playing, etc.) have been used for creative problem-solving processes (Kaner et al., 2007; Gray & Brown and Macanufo, 2010) and point to the relevance of games and gamification for participatory backcasting processes.

2.3. Gamification as an approach to enhance backcasting processes

Gamification is an umbrella concept that broadly refers to "technological, economic, cultural, and societal developments in which reality is becoming more gameful" – i.e. through both intentional and emergent gamification, practically any human activity is becoming like playing a good game which further can enable cognitive, affective, social, and motivational benefits that can further lead to positive shifts on individual and societal levels (Hamari et al., 2019). Under the larger gamification trajectory, there are multiple, more focused developments with differing goals and domains. For example, from the broader sense of ludification or gamification of culture that entails the transformation of societal practices reminiscing these of games and players (Hamari et al., 2019), to more detailed applications, such as serious games (Connolly et al., 2012), defined as "games that do not have entertainment, enjoyment or fun as their primary purpose" (Chen and Michael, 2005); and game-based learning, also known as the process or practice using games to generate and exchange new knowledge (Kiili, 2005; Squire, 2008; Kapp, 2012). Both examples are commonly referred to developments in the education sector. Other sub-concepts include persuasive technology (Oinas-Kukkonen and Harjumaa, 2009), and games-with a purpose. The first one enhances or results from a "game design aiming to create a user experienced game world to change the user behavior in the real world" (Visch et al., 2013) and it is quoted as a tool to design for behavior change (Van Boeijen et al., 2020); the latter is a concept widely applied in human-assisted computational and scientific crowdsourcing purposes (von Ahn and Dabbish, 2008; Morschheuser et al. 2017).

Especially gamification is believed to lead into satisfaction of intrinsic needs (Sailer et al., 2017; Xi and Hamari, 2019). According to the Self-Determination-Theory -SDT- (Ryan and Deci, 2000), intrinsic motivation refers to being motivated by the task and the process itself compared to being motivated by external outcomes. Extrinsic motivation, comes from activities designed to get a specific outcome provided by factors external to the individual, which gives them "personal endorsement and a feeling of choice" (Ryan and Deci, 2000, Pp 71), which can also involve compliance with different types of regulations. These can range from external

controls to rules integrated to the individual's consciousness. This type of motivation lies between non-self-determined behavior and fully self-determined behavior, which is characterized by intrinsic motivation (Ryan and Deci, 2000). Intrinsic motivation is the product of competence, autonomy, and relatedness; elements that enable individuals to experience the sense of achievement and mastery that encourages them to continue with the activity. Moreover, the needs of autonomy and relatedness rely on the possibility to interact with others while personalizing the experience (customization).

Because of the way that certain design elements address specific psychological needs (Sailer et al., 2017), gamification is believed to provide an opportunity for individuals to broaden their understanding and perspective about the environments around them, and also to support backcasting processes for sustainable lifestyles. Gamification can be seen as a way of design for behavioral change, requiring a multidisciplinary process that generally consists of interventions to: (1) to raise awareness, and (2) support individuals in realizing intended new behaviors or maintain existing ones (van Boeijen & Daalhuizen & Zijlstra, 2020). The *gamification of everyday life* presents gamification as a "social innovation which stems from how social dynamics are being shaped and how organizations are being structured" (Koivisto and Hamari, 2019. p 205); it quantifies individual activities and opens the door to an approach that can systematically address and solve some of the most pressing socio-environmental challenges of our times. This study explores the application of gameful approaches to engage citizens in the co-creation or adoption of actions towards sustainable living. Through playfulness, these approaches intend to provide users with experiences to learn, demonstrate mastery, and build intrinsic motivation to act. The proposition known as the RECIPE (Reflection, Exposition, Choice, Information, Play and Engagement) (Nicholson, 2015), intends to provide the context and individual experiences that engage the player to undertake actions for long-term impact in the real world. The RECIPE is a set of "useful design values" (Deterding, 2015) for a user-centered, transparent, and personalized gamified experience; it implies that gamification systems' designers have to offer diverse experiences and affordances for each participant to find something meaningful (rewards) that will empower them to take actions within the system.

The proposed gamified framework for PB, called GAMEBACK, has a practice-oriented approach (Doyle and Davies, 2013; Sahakian and Wilhite, 2014; Kurz et al., 2015; Huber, 2016; Wangel et al., 2019) to endorse sustainable practices and encourage further social innovation. The literature on backcasting and gamification shows that approaches for reflecting, developing, and implementing practice shifts, where dedicated practitioners steadily produce values, habits, and activities (Shove et al., 2012), enhance individuals' motivation and well-being. To this end, the proposed framework takes the methodological approach for participatory backcasting (Quist, 2007; Quist et al., 2011) as a starting point. After reviewing and testing some of the existing tools used for backcasting towards social innovations and sustainable lifestyles (described in section 2), this article further develops the GAMEBACK framework.

3. Methods

This research employs a multimethod design. It comprises four steps of qualitative analysis that build on each other. Steps 1 and 2 consisted of a thematic literature review to analyze the PB toolbox (Step 1), integrating gamification elements into it to draft a prototype of the framework (Step 2). Step 3 is divided into two rounds: the first one consolidated one case study to analyze through the draft framework; the second one, consisted of another case that used the outcomes of the first case in its implementation. This second case was also investigated through the prototyped framework. Lastly, Step 4 consisted of testing the gamified framework in two workshops. The methods used on each step are detailed in this section and summarized in Fig. 1. The results are presented in Section 4.

3.1. Thematic literature review (steps 1 and 2)

The first step comprised a thematic literature review (Paré et al., 2015) to examine the existing information related to this study's main topics. Using SCOPUS database, the first search comprised the keywords "gamif*" to cover all forms of the word gamification, and "backcasting". These terms were searched on three different dates to identify emerging knowledge for both study fields,[3] and up to November 2020, this combination of keywords did not yield any results. This initial observation presents an opportunity to further explore gamification and its value for transition studies, thus contributing to the advancement of knowledge for both research fields. Other keyword combinations of gamification and transition studies were explored, and 22 publications were analyzed. A detailed account of the literature review process features in the Appendix A. With the intention to identify the most used tools for backcasting and how they could be gamified, the thematic search also included non-academic publications related to the design of participatory processes, such as the Facilitator's Guide to Participatory Decision-Making (Kaner et al., 2007); Creative Workshop (Sherwin, 2010); Gamestorming (Gray et al., 2010); and, the Dutch Design Guidelines (van Boeijen & Daalhuizen & Zijlstra, 2020), as well as relevant literature related to gamification design and implementation, such as Reality is Broken (McGonigall, 2011); the Gamification of Learning and Instruction (Kapp, 2012); Gamify (Burke, 2014); Rethinking Gamification (Fuchs et al., 2014); and, Actionable Gamification (Chou, 2015/2019).

The second step of this research consisted of analyzing the Participatory Backcasting framework and its toolbox (Quist and Vergragt, 2006) to first identify what kind of mechanisms exist to motivate individuals to become active participants of the transitions needed to live more sustainably. This analysis (Appendix B) was followed by the study of gamification's elements suggested for motivating individuals to act in the real world (Nicholson, 2015), leading to the creation of the GAMEBACK framework's first draft. The exploration of complementarities between PB tools and gamification motivational attributes that promote participation (aka affordances), shows that:

- Participatory Backcasting involves social actors and guides them through a journey of social learning towards the co-creation of attainable future visions that are both analytical and social constructs (Quist and Vergragt, 2006);
- Gamification refers to societal, cultural, technological, and economic developments that allow accruing skills, motivational benefits, creativity, playfulness, engagement, positive growth, and happiness, and it "can be seen as any practice that aims to afford positive experiences and skills similar to games" (Hamari et al., 2019).

[3] The first research took place when the study started in 2018. The second search happened prior to the submission to the journal on February 2020, the last search took place during the review of the manuscript.

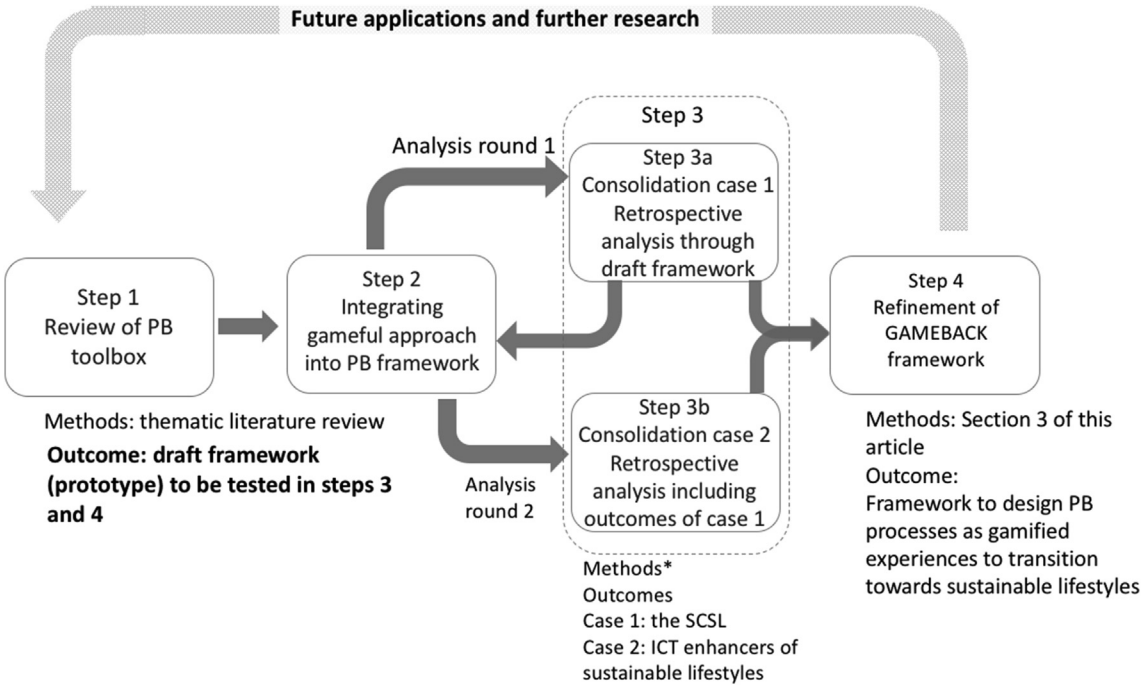

Fig. 1. The multimethod approach of this research.

3.2. Case study analysis (Step 3)

Step 3 applied the proposed GAMEBACK framework to a retrospective case-study analysis, an approach that builds upon existing data recorded for reasons other than research and allows the formulation of ideas about possible associations and potential relationships that can be investigated by looking back over time (Hess, 2004). This step consisted of two cases; the first one comprises five backcasting multisectoral workshops within the Budding Ideas Glocally (BIG 2050) project; the second one represents two backcasting processes with the ICT industry. The gamified activities correspond to different elements of the RECIPE (Appendix C), suggested to motivate participation, both in crafting the visions and their implementation among individuals with often divergent interests and diverse backgrounds. Appendix D presents a systematic account of the data gathered, including details related to the participants and how the outcomes of their discussions were documented. In 2020, 7 and 8 years after the backcasting activities took place, four people were contacted via E-mail/Whastapp the intention is to flesh out what the participants of the backcasting processes recollected from the gamified experiences and what, if any, action was taken after them.

3.2.1. Data collection and analysis

The data produced through the backcasting processes is qualitative, and its collection was possible through inductive approaches: templates and activities resembling games, semi-structured interviews during and shortly after the participatory processes – collected in the form of testimonials-, and ethnography. All the backcasting processes analyzed to create the two cases were carried out as activities organized by the Collaborating Center on Sustainable Consumption and Production (CSCP) between 2012 and 2015. Except for the data about two private projects for which a confidentiality clause applies, the partnering institutions' names and detailed accounts of the data collected and analyzed feature in each of the worksudios' reports. These documents are publicly available at the organization's website (Guillen, 2012; Guillen et al., 2013; Guillen and Spittler, 2012, 2013a,b,c; Guillen-Hanson et al., 2015) and in the references. The confidential projects' data included in this article has been anonymized and pre-approved by the director of the CSCP. These reports and records of the activities served as the primary data sources to be analyzed through the presented framework.

3.3. Validating the framework (Step 4)

The last step tested the proposed framework through two sessions with academic peers, letting them experience a gamified session firsthand. The sessions were designed for the participants to feel like they were part of a game when learning about the process to develop the Strategic Conditions for Sustainable Living (SCSL) and the overall BIG2050 project. Additionally, a short email/Whatsapp exchange with 4 participants of these workshops took place in 2020 to learn about their recollection of the experience. The supplement contains the presentation used at the workshop's presentation, and the details from these sessions.

It is expected that this framework that supports the exploration of playful affordances directly addressing intrinsic motivation answers the question about how gamification can encourage the creation and growth of social innovations to motivate participatory backcasting (PB) partakers to act towards meeting their visions.

4. Results

4.1. The GAMEBACK framework

Steps 1 and 2 were designed to spot the synergies between both approaches and potential outcomes of gamifying tools and methods for PB. This overview allowed the creation of the framework's first draft, tested later through the case analysis. Appendix C shows the alignment of gamification elements according to each of the PB stages (Quist and Vergragt, 2006; Quist, 2013) and suggests activities that can either be applied directly during the PB process or for gamifying the tools to be used. The framework is illustrated in

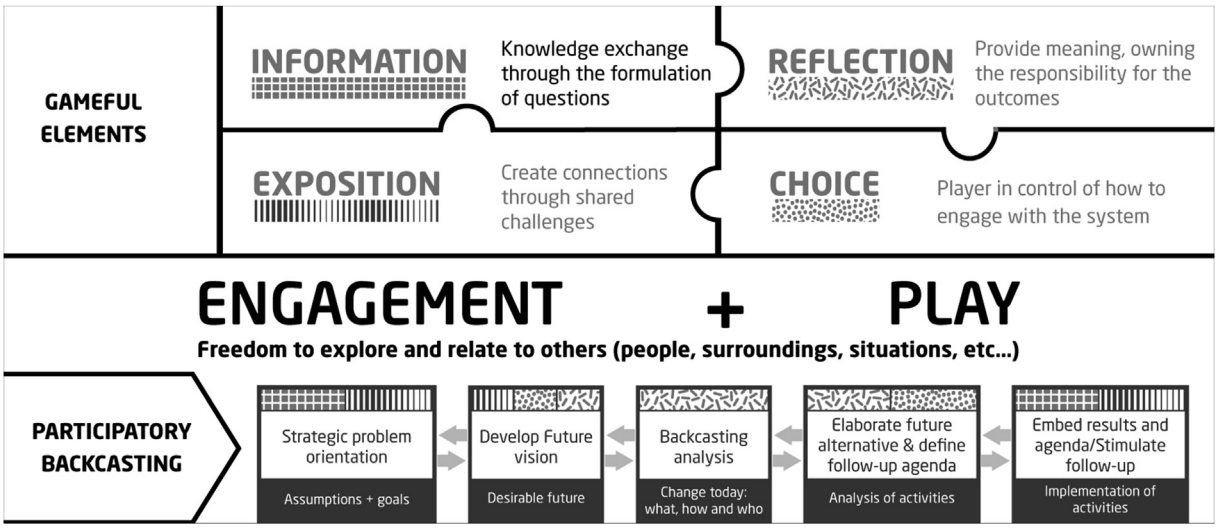

Fig. 2. The GAMEBACK framework draft (visualization) This is the outcome of steps 1 and 2.

Fig. 2. An overview of the potential outcomes of gamifying PB's tools and methods is available in the supplementary information.

The framework's intended application is to enhance the understanding of the long-term impact of gamification activities that have the potential to go beyond co-creating visions of sustainable lifestyles by engaging participants in actions of change.

The RECIPE (Reflection, Exposition, Choice, Information, Play, and Engagement) are the gameful elements that aim to engage the participants in a more personal level of thinking; intrinsically motivating them to generate connections with their daily lives and the world outside the game (Nicholson, 2015). Although all the RECIPE's elements are applicable throughout the PB process, the suggested framework emphasizes the elements that can enable the co-creation of results to facilitate the next step. The elements of PLAY and ENGAGEMENT happen throughout the entire process because Play is an exploratory activity that enables exposition and reflection; unlike games, it does not have goals or rules, allowing to discover situations that include failure and other situations from which participants can learn without risking consequences in real life (Nicholson, 2015). Engagement throughout the entire process is necessary to transition from reflections to actions. Thus, the framework suggests the RECIPE in relation to the PB process (Fig. 2) so that the elements of gamification let the participants start the gamified backcasting experience based on access to information. As the diagram demonstrates, these elements iterate among themselves, as they consider choices to be made and ways to get engaged in both the activity taking place and what is meant to happen afterward. The PB framework steps are connected to the gameful elements to allow a playful experience throughout the entire process.

As a normative process, the application of the GAMEBACK framework is described as follows:

1. Backcasting's strategic problem orientation provides the necessary information for the gamification experiences to be designed and implemented. This information exposes the user to the play environment and triggers a reflection process that happens throughout the entire backcasting (i.e. during play and choice-making) and helps for further action afterward (engagement during and after the process).
2. By being exposed to the current reality, the participants acknowledge the problematic they want to address and can look into the future as well. The participants are also exposed to their visions, which helps them to carry out the necessary analyses for making choices and engaging in follow-up actions.
3. The future vision can be developed through a game or by applying gamification affordances that appeal to the participants personally and socially. In consequence, more reflection occurs.
4. The backcasting analysis results from these reflections leading to choices that enable the elaboration of future alternatives and the definition of follow up agendas. For this study, these choices are the ones that lead to the engagement for developing, strengthening, and multiplying social innovations towards sustainable lifestyles.

Each of these gamification activities needs to be designed and implemented according to the participating target groups, time, and resources. The gamification elements must be part of the backcasting process design and not brought in later as an "add on," as doing the latter may fail to connect the participants with the process or convey a confusing message. It is also relevant to bear in mind how the data will be collected and interpreted. If applied to transitions towards sustainable lifestyles, these actions are the steps that can drive the creation of sustainable social innovations to start the change processes.

4.2. Analysis of the cases through the GAMEBACK framework

4.2.1. Consolidating the cases

To test the proposed framework, two cases featuring seven backcasting sessions with gamified elements were retrospectively analyzed, identifying if and how all the elements of the framework were addressed; and, if possible, pinpoint what type of gamification affordances had the strongest impact among the participants.

Case 1. the co −creation of the strategic Conditions for Sustainable Lifestyles - This case comprises a two-year-long project called "Budding Ideas Glocally for 2050″ that was financed by the German Ministry for Economic Cooperation and Development (BMZ). The project kicked off at the United Nations Rio +20 summit in Brazil on June 20th, 2012. The backcasting processes took place in China, Colombia, Germany, Ghana and the Philippines between 2012 and 2013. This project had middle-class consumers as its target group. Its objectives were: (1) to identify key conditions that

could support the strategic development of sustainable social innovations; (2) to encourage the development and uptake of existing social innovations (such as farm-to-fork initiatives) and sustainable business models (like upcycling and repurposing workshops); and, (3) to elaborate recommendations for international donor organizations to support the processes to lead more sustainable lifestyles in the countries of the study. Five "Strategic Conditions for Sustainable Lifestyles" (SCSL) were identified as they are consistent across all contexts, presenting a clear scope of action for different drivers of change to emerge. They help to crystalize situations, institutions, and even actors that would otherwise be perceived as too abstract or distant; moreover, they motivate participants to express autonomy, strengthen or build mastery within familiar contexts, which generates the necessary relatedness to craft visions that trigger innovative solutions. These conditions are: i) brand (design) sustainable living as an aspirational and affordable purpose; ii) decentralize decisions and actions and enable local empowerment via participatory governance; iii) make the business case for Sustainable Consumption and Production (SCP); iv) build knowledge, capacity and skills for future consumers; and, v) facilitate transparency for trust-building. The conditions are far-reaching and flexible, allowing to systematically address societal well-being, environmental impacts, and economic prosperity. A more detailed account of the conditions and their creation process is summarized in the supplement and in Guillen-Hanson (2017). To share the results with the participants and stimulate the follow up that backcasting calls for, the project created an online platform named the "Global Network on Sustainable Lifestyles (GNSL)" that featured gamification elements (voting and quizzes) for dialogue and knowledge exchange. The platform (www.vision2050.net) was online between 2012 and 2017. It had over 600 members worldwide.

Case 2. Gamified backcasting for ICT solutions towards sustainable lifestyles - This case encompasses two PB processes with international stakeholders of the Information and Communication Technologies (ICT). Building upon previous experiences with the sector,[4] the backcasting activities analyzed here were carried out as part of a private project between 2014 and 2016. These activities were designed to zoom in on the industry's existing solutions, consolidate visions for sustainable living in a 20–40 year horizon, and discuss processes that would lead to sustainable production and consumption. Both cases used the same type of gamification affordances and had a common co-creative approach for crafting visions of sustainable lifestyles, depicting pathways for different production and consumption practices. Only the last two sessions of the entire ICT series were analyzed because they already contain the outcomes of the first two sessions and, by the time they took place, the SCSL were already formulated and served as a guideline for designing the participatory backcasting activities. Because the participants of these sessions comprised mainly competing organizations (representatives of the same industry) with representatives of other sectors (CSOs, academia, and policymakers), the backcasting process focused on the industry's problems and solutions while showcasing success stories from the participating companies. The format provided a neutral ground for discussion and collaborative action development. Content-wise, these sessions featured the same glocal impact areas of the BIG 2050 project: education and employment, leisure and culture, food systems, transportation, and the household. The cross-cutting themes were: energy, communication, and health. Having these in common facilitated the application of the SCSL for the discussion in terms of sustainable lifestyles as a goal as shown in Fig. 3.

[4] Backcasting sessions with Nokia and Deutsche Telekom/T-Systems do Brasil (CSCP, 2012) and with the Global e-Sustainability Initiative (Guillen, 2012).

4.2.2. Analysis of the cases through the GAMEBACK framework

Following the structure of the draft framework, this section presents the results of the case analysis according to each of the framework's steps as proposed in Appendix C, illustrated in Fig. 2. The elements of Play and Engagement are applied throughout the entire process. The supplement contains additional information about the material and execution of each of the steps described in this section.

STEP 1 – Strategic problem orientation. Gamification elements emphasized: Information and exposition

The current reality assessment was introduced through megatrends highlighting facts and figures to provide information and expose the participants to futures-research insights that directly impacted individual lifestyles. Case 1 featured keynote speeches delivered by the local partners and experts. Case 2 was designed as a "Gallery walk" featuring megatrends across three stations. A facilitator introduced the "station host", a cardboard cut of a consumer from the future showing her/his lifestyle values and presenting some of the social innovations and emerging trends in products and services (Fig. 4). The station visitors left "thought cards" with questions about how these lifestyles were possible on the cardboard persons as in the "brainwriting" method. Case 2 required a larger amount of material and time than Case 1, while the playful way to present the information in Case 2 enabled to create higher levels of relatedness with the participants.

Studies about consumption trends and lifestyle hotspots for each of the countries (Case 1) and technological developments (Case 2) were carried out during the project's research stages. A set of fictitious consumers were defined to explore possible ways in which future trends intersect with individual needs, actions, and aspirations. Each character represents different demographics. For Case 1, the characters were adapted to the national contexts and local habits; for Case 2, two characters represented consumers from industrialized nations and two from developing nations. The visioning sessions were developed in two parts. Each of them featured different gamified elements to help the participants work together in the choice-making, challenge-facing discussions to co-create the scenarios of lifestyles in 2030 (Case 2 only) and 2050 (both cases). The first part consisted of a roleplay. This activity required to get acquainted with the consumers from the future and understand their values and consumption choices. Afterward, the participants assumed their personalities, pretending to be in the year where the vision was meant to take place.

The second part included playing boards and downvoting. The board presented a visualization of the scenario, including the area of impact and the description for downvoting activities that enabled identifying the "hotspots" – lifestyle impact areas to be addressed today, and the consolidation of visions for the future. A way to show the future vision is by finding patterns and relationships between the categories considered in the scenario and developing a statement that focuses on value drivers (van Boeijen & Daalhuizen & Zijlstra, 2020). Having these visualized (the graphic record of the scenarios were in full view) helped keep the playfulness while engaging the participants (as themselves) in discussing how and why these future visions represented their aspirations for the future. For both cases, the downvoting took place through "dotomocracy", a widely-used facilitation technique that consists of casting votes using round stickers. The facilitators observed that some of the additional gamification features (ranking using different color codes to determine the "hot-spots"; and the

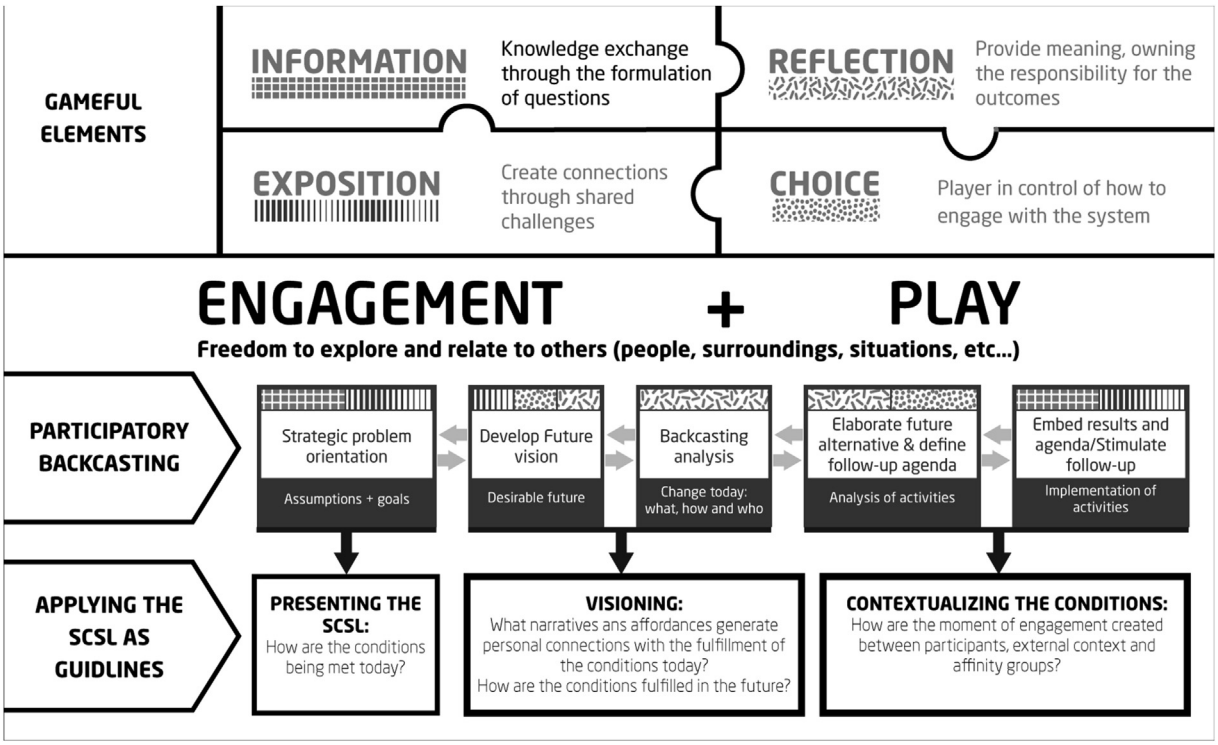

Fig. 3. Application of the SCSL as discussion guidelines. Case 2.

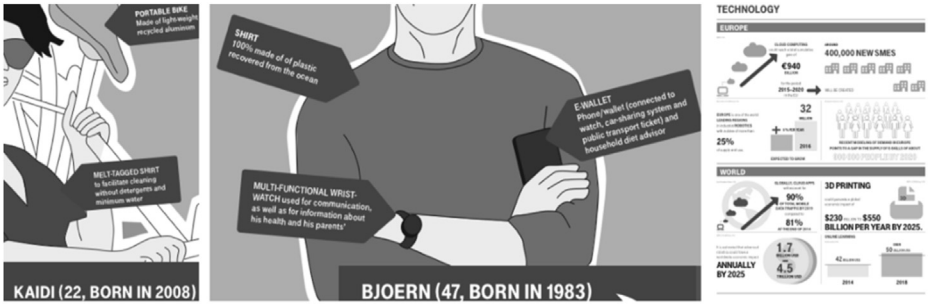

Fig. 4. Example of the megatrends posters (facts and figures) and future innovations (Case 2).

STEP 2 – Develop Future Visions. Gameful elements emphasized: Exposition, Choice and Reflection

Table 1
Participants' quotes about the visioning step.
STEP 3 - Backcasting. Gameful element emphasized: reflection

Nr.	Quotes from participants	Timeline
1	*"Through the 'visioning' I learned a new way of thinking which I believe is crucial for the future. At the same it challenged me […] The variety of different stakeholders and initiatives broadened the perspective and made it even more exciting to develop a 'common' vision without any limitations." Quote from the Berlin Workstudio Report (Guillen et al. 2013)*	Directly after the PB process
2	*"What I liked was that there was visual support for what was discussed and the persona approach helped participants to take the discussion into a more experienced based direction than solely fact based. I took away quite a bit for myself regarding the methods and process and I liked the scenario part". Nathalie S. Participant Case 1. 2020.*	Seven years after the process

level of priority for being addressed in the short-mid-long terms) were creating confusion or distracting the participants from the discussion topic. Nevertheless, this activity provided a lively atmosphere where constructive discussions emerged for making group decisions in the subsequent activities, as illustrated by the quotes in Table 1.

Considering structural, technological, and cultural drivers (Quist, 2013), this step answers the questions "WHAT changes are needed to bring about the vision"? , "HOW can the changes be brought about?" and "WHO could or should contribute to realizing the vision and what activities they should do? – including who would oppose these changes" (Quist, 2013). The gamification

Table 2
Participants' quotes about the backcasting step.
STEP 5 - Embed results and agenda. Stimulate follow up. Gameful element emphasized: Choice.

Nr.	Quotes from participants	Timeline
1	*"The Big2050 Workstudio in China […] gathered domestic stakeholders to discuss the most important drivers and impacts for the shift from current lifestyles to a low carbon future […]it is a good opportunity to share with the international experts and networks the most promising ideas. The practices in China that were identified […] can have a long term impact on global sustainable development, and China will also benefit from the contribution from other continents." Excerpt from Wuxi's workstudio report (Guillen and Spittler, 2012)*	Directly after the PB process
2	*"The event appeared to contribute well to breaking down 'silo' approaches of different stakeholder groups, such as public and civil society actors. Participants seemed pleased they could bring their own professional insights, an also showed genuine interest in hearing new perspectives outside of their usual circles. While some priorities were discussed, the brevity of the event meant the outcomes probably did not provide an agreed pathway or strong roadmap for later action or reference, rather some inspiration for further actions". Neil C. Participant Case 1. 2020.*	Eight years after the process

element of reflection is characterized by the description, or what the participant thinks about why s/he engaged in the activity, followed by the analysis, where the participants connect their playful experience with their daily life, "pushing them outside of the gamification system and make connections" (Nicholson, 2015). The third element of this reflective process is application, which encourages the participants to take action. A topic expert hosted the sectoral roundtables. To help with the discussion, reflection, and collection of data, the "tablecloths" were designed like a checkered board (what – how – who as the column heads; technological, cultural, structural changes as the rows).

STEP 4 - Elaborate future alternative and define follow-up agenda. Gameful element emphasized: Reflection

Translating the outcomes of the roundtable discussions into step-by-step actions required the development of selection criteria consistent with the vision of sustainable lifestyles and the intentions of supporting the emergence and spread of social innovations. To make these discussions more related to their daily activities, the participants created promising practice maps, including competencies, needs, and offers. The boards' design for collecting these discussions was meant to drive cooperation and provide matchmaking opportunities for follow up. This activity was the one that emphasized the most in the analysis and application aspects of the reflection, as illustrated in the quotes of Table 2.

Because of its systemic nature, backcasting offers a perspective for transition processes to support the definition of feasible, short-term change actions (Quist and Vergragt, 2006). Hence, making choices towards a common goal implies finding synergies and opportunities for all the stakeholders involved, and some gamification affordances can make this process playful yet consistent and useful for the consolidation of action roadmaps. When designing a gamification strategy, two types of player engagement ought to be considered: engagement between players through game mechanisms and engagement between players in a social manner (Nicholson, 2015). During PB activities, the set up itself facilitates personal social engagement as the agenda allows people to interact and exchange ideas and information. The engagement through game mechanics considers interaction through game elements, creating challenges for each other or working together toward a shared goal (Nicholson, 2015). The GAMEBACK framework seeks to enable the latter type of engagement, recognizing that sometimes competitively challenging each other may work to drive cooperation for a common, higher goal such as living sustainably as a society. The action roadmaps' consolidation applied different gamification elements and group dynamics for each case because of time restrictions. Communication and interactions with all the stakeholders took place throughout the design and implementation of the projects that constitute both cases. For the activities of Case 1, the main communication channel (the GNSL) remained open for three years after the project's end.

4.2.2.1. Reflection about the cases' analysis. Since the participants of Case 2 were mainly competitors, the outcomes of Case 1, the SCSL served as a guideline to provide a neutral discussion ground to support the industry's efforts in identifying ways that their solutions, which are driving technological innovation, could enable social innovations as well. This proved to be an effective way to talk about burning topics for sustainable consumption, the opportunities for enabling transformations in other sectors, and social disruption issues. For example, in 2014, crowdsourcing was named an opportunity for ICT to drive sustainable lifestyles; nowadays, gamified crowdsourcing systems are among the topics some gamification scholars are researching (Morschheuser, 2017). On the same line e-participation (related to condition #2), is a subject of gamification studies that some governments are currently exploring (Hassan and Hamari, 2019). When designing the PB activities, the gameful elements, which influence the player's journey and how they exchange knowledge, were chosen to enable immersive, appealing experiences that led to fruitful discussions about the future, reflection, choice, and engagement while disconnecting the participants from their daily life environments. These interactions were highly appraised, reinforcing the notion that the engagement with affinity groups is crucial for engaging individuals in "the real world," even if these groups do not seem to be obvious at the first instance (Nicholson, 2015). Table 3 presents some of the participants' reflections on this regard.

4.3. Results from the testing workshops

The gamified workshops developed to test the framework took place within two academic conferences on sustainable consumption and production.[5] Most of the feedback collected relates to the elements of gamification. One year after the activities, the participants recalled the sessions being "fun and interactive." The respondents also mentioned not having used any of the methods in their activities, mainly because of a lack of familiarity with the approach. This is an opportunity for collaboration between gamification and backcasting designers, researchers, and social innovators. The quotes in Table 4 illustrate some of these findings.

5. Discussion

This section contains the discussion with reflections about some of the identified shortcomings and possibilities for further

[5] Global Research Forum 2019 (GRF) and the European Roundtable on Sustainable Consumption and Production 2019 (ERSCP).

Table 3
Participants' quotes about the overall backcasting experience.

Nr.	Quotes from participants	Timeline
1	*"I enjoyed the every minute of the workstudio; the range of participants, their background and variety of visions to social innovation made this event remarkable, and just right. The event allowed me to share examples […] learn from other participants working in different areas but with the same objective. The methodologies suggested were fresh and innovative – allowing participants to interact, collaborate and develop a common vision. I especially appreciated the approach when one had to put himself in ones shoes and imagine living in 2050. It has really put the way of thinking in a different way and helped us to come up with concrete examples for a new vision." (Quote from* Guillen, et al 2013b*)*	Directly after the PB process
2	*"The workshop had a strong input of trends, technologies and best practices. Some, such as urban/rural development challenges or traditions clearly enabled participants to identify with shared identity and culture. Others were clearly new and enabled identifying brainstorming around potential solutions. […]many stakeholders were comfortable/familiar with the idea of finding successful ideas from elsewhere and adopting and adapting them […] The discussion of lifestyles in a holistic sense seemed novel and comfortable with changes to behaviours (i.e. beyond just technological or legislative actions). Neil C. Participant* Case 1*. 2020.*	Eight years after the process

Table 4
Quotes from test workshops participants.

Nr.	Quotes from participants	Timeline
1	*"I realized something was strange when you asked us to start doing some math with the points we collected. This is a great way to present a project, we all were smiling at the end"* (ERSCP participant)	Directly after the test workshop
2	*"I don't think a lot of people can pull-off a session like that. I certainly would not feel capable to do so" (GRF email interview)*	One year after the test workshop
	"[…]it requires time and perhaps skills that not many of us have. It is an interesting approach and it would be nice to have a couple of sessions like this in our conferences." (ERSCP email interview)	One year after the test workshop

implementation, acknowledging the limitations of the current research and bringing about the study's broader relevance, such as integrating gamification through immersive technologies in participatory backcasting processes. As this research is not inferential, an in-depth analysis of gamification's impacts beyond the recollection of having made all the sessions interesting and fun was not possible. This situation partially answered the research question as it was not possible to monitor how many of the actions discussed in Case 1 were taken forward. For Case 2, the participants did integrate some of the outcomes into their activities and portfolios.

Reflections: The framework proposed intends to support backcasting practitioners to identify gamified activities that allow participants to discuss serious matters in a playful, encouraging way. Many backcasting practitioners may already use some gamified tools; this framework enables learning about the elements of gamification for enhancing the tools and methods they are already familiar with or acquiring new ones, potentially developing more robust motivation mechanisms for implementation of the planned actions. To facilitate the GAMEBACK framework application, the Appendix C.1. offers a practical template for the process designers and faciliators. Further research about the long-term impact of these activities and how they translated into actions is still needed.

Limitations – the methodology presented here is context-dependent and requires to identify the right affordances according to the expected impacts. Recognizing the fine line between gamification and game-based activities to choose the tools that make the experience more impactful is one of the limitations that the processes' designers must be aware of and plan upon. While some games already exist as part of the backcasting toolkit, this does not mean they should be applied without previously analyzing if the game is suitable for the session, the audience and the objectives to be achieved. Moreover, implementing a game as part of the agenda does not mean that the process is gamified, only that some parts of it feature a game. Other contextual factors are related to the participants and the location. In both cases analyzed, the participating individuals were already interested in sustainable lifestyles. Most of them were invited to participate via organizations established in the intervention countries and represented people who can shift consumption practices without sacrificing their livelihoods. It is a supposition that the usage of gamified solutions can potentially attract individuals who are not interested in the topic. However, proving this hypothesis is beyond the scope of this research. Asserting the long-term impact of the gamified process has also proven to be difficult and so far inconclusive. This could be due to reasons that range from confusing games with gamification, lack of awareness about existing gamified tools, how to design gamified environments, enabling the possibilities for follow-up and measurement, to costs in terms of time and resources needed to follow up the actions after the interventions took place. The latter are needed to measure the impact of both the participatory process and the actions undertaken afterward. Unless designed as interventions with means to be monitored in a relatively large time-span (5–10 years), it may be challenging to achieve conclusive evidence about the success of applying the methodology here proposed.

Broader relevance and contribution - the proposed methodology offers a flexible framework for integrating more immersive approaches, most of them related to gamification and the action of playing for advancing the agenda of sustainable development, particularly in the areas of consumption, decision-making processes, and their impacts. Although the proposed framework is meant for personal interactions, immersive technologies, such as Augmented Reality (AR) – a real environment enhanced by computer-generated perceptual information (Schueffel, 2017), Virtual Reality (VR) – simulated experiences using technology, and Mixed Realities (MR) – a hybrid between virtual and real worlds-, are increasing their presence in the context of everyday actions, offering an opportunity to enable different types of participation and interactions between people, while making visions more tangible in sensorial terms. Applying these technologies as gamification approaches for backcasting may help create mechanisms that can evaluate the immediate results and the participants' follow-up actions. Besides enriching the literature of backcasting to drive transitions towards sustainable consumption, this study offers a relatively unexplored approach to engaging and motivating

participants to act towards the change they want to happen after the backcasting experience occurs. Another advantage of the proposed framework is that it provides the opportunity to identify affinity groups (communities of practice) by offering a broad space where different actions to make sustainable lifestyles possible can coexist and complement each other.

Researchers are invited to contextualize the findings here presented and explore other methods and solutions to introduce gamification into different domains, particularly those where gamification is still relatively unknown. In the same fashion, research is encouraged to strengthen existing successful gamification applications for sustainable consumption by addressing issues that have not been explored so far, such as rebound and spillover effects. This framework can also serve as a starting point for embedding gamification to other design processes, like circular design and other solutions that can drive transitions towards more sustainable ways of living.

6. Conclusion

Exploring the question how can gamification be used in participatory backcasting? intends to provide researchers and social innovators with a gamification framework that uses intrinsic motivation elements to design and implement backcasting activities (Section 2). After presenting the four-step approach of the research (section 3), it was showed how, despite many of these activities that have long featured as part of the PB toolbox, it is necessary to plan the gamification strategy as part of the backcasting design process itself (Section 4). Therefore, this study presents a draft framework that integrates the PB steps with the elements of gamification and two testing approaches: the analysis of two cases and a validation workshop.

To enhance co-creation and motivate action towards the crafted visions, gamification can be used as a strategy that must be properly designed in order to be successful. This means that the affordances (what people will use) are suitable to the implementation context and the desired experiences that the PB is aiming to bring about. Play is a motivating activity that enables attention and concentration during a long time and makes individuals feel safe, aware that mistakes will not be judged, leading to bravery to offer the best of oneself (Nicholson, 2015; Marin, 2016). This research shed several lights on issues related to the role of individuals as consumers and as representatives of different interest groups (stakeholders), reinforcing the need to appeal to the person as an individual who makes choices based on factors that range from self-motivation to awareness and capability. While the majority of publications among the extensive literature on game-based learning and gamified products and services tend to present gamification in a positive light (Stansbury and Earnest, 2017; Hassan and Hamari, 2019), the lack of research specifically addressing gamification in and for backcasting processes is a shortcoming for identifying if these experiences contributed to the implementation of actions after the process ended and what kind of impacts they generated, leaving a wide, open floor for more experimentation and research. Regarding the specific case of using gamification to design participatory backcasting activities, or potentially other approaches for transition studies, the results of this study and various others analyzed (Huang & Yeh, 2017; Stansbury & Earnest, 2017; Severengiz et al., 2018) showed that participants do enjoy the gameful experiences for delving into difficult topics. Moreover, gamification seems to generate an even deeper memory of the discussion than the reports produced as outcomes. This could be because gamification has proven to level up the discussion field, enabling participants to connect on a different level, independent of the stakeholder group they represent.

When designing participatory backcasting activities, besides being very conscious about the specific context of the community/location where activities will take place, it is necessary to choose the right gamification affordances, so the process is an enjoyable co-creative experience. If providing rewards such as points, badges, monetary compensation, etc, there is a need to observe: what are these rewards symbolizing? How will they benefit the process and contribute to engaging the participants to act after the PB? How will these elements be maintained post-PB sessions? Exposing the participants to backcasting processes that contain elements of play and reflection can lead them to make more informed and responsible choices. The process here proposed can generate solutions that resonate with the values and aspirations of the participants; when these solutions are translated into actions, individuals would be making a step forward in the creation of new transformational social innovations, that within the context of sustainability, supports systemic transitions towards more sustainable ways of living.

CRediT authorship contribution statement

Georgina Guillen Mandujano: Conceptualization, Methodology, Validation, Investigation, Data curation, Writing – original draft, writing - review and editing, Visualization, Funding acquisition. **Jaco Quist:** Supervision, Writing – original draft, Writing – review & editing. **Juho Hamari:** Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDICES

Appendix A. Literature review process (From Section 3.1)

Last date of search in SCOPUS: October 12, 2020.
Search string.
Gamification and transitions = 63 articles.
Gamif* and social and innovation = 119 articles.
Forecast and gamification = 56 articles.

Table 5
Thematic literature review inclusion criteria for academic publications

Criterion	Inclusion criteria	Exclusion criteria
Document type	• Book/book chapter • Conference paper • Journal article • Online database • Reviews in academic journals	• Other document types
Presentation	• Abstract	• Lack of abstract
Scientific content	• Documents that present literature reviews, models, experiments and techniques addressing gamification for sustainability, social innovations and transitions studies. • Documents that describe socio-environmental impacts of gamified interventions/games on consumption practices, lifestyles, social innovations and transition studies. • Documents that relate to practices and policies towards sustainable social innovations and transitions.	• Documents related solely to gamification that do not analyze impacts on sustainability or transitions. • Documents that do not relate to gamification or games. • Documents unrelated to gamification, games, sustainability or social innovation.
Language	• English	• All other languages
Availability	• Accessible via academic search databases and the university's library	• Not available online • Additional access costs

Appendix B. Aligning the tools and methods for PB with outcomes from gamification design (STEP 2 of the research method)

Table 6
Potential outcomes of gamifying PB's tools and methods

Type of tools and methods for PB	What is the tool used for	Outcomes of gamifying the tools and methods
Group 1. Participatory	Involve stakeholders, generate and guide interactions among them.	Strong connection with the process and its outcomes due to the enhanced intrinsic motivation (competence, autonomy and relatedness) in a personal and even emotional levels.
Group 2. Design	Scenario construction and detailing future systems Stakeholder involvement processes	Playful approach to future-oriented thinking that helps visualizing and discussing the linkages, cross-dependencies of practices for and within lifestyle choices As gamification is also the result of a design process, developing both simultaneously enables the development and implementation of activities that are flexible and normative enough to support a human-centered design process.
Group 3. Analytical	Assessment of scenarios and designs, process analysis and evaluation, stakeholder identification and analysis.	Facilitate the access to different types of qualitative and quantitative metrics, depending of the type of solution and its use.
Group 4. Management, coordination & communication	Manage the process and subsequent actions from it originated.	Interactive approach to keep participants motivated and involved. Gamification can strengthen communication efforts, maintain stakeholder networks, and invite further interactions.

Appendix C. Overview of the framework according to the PB process – gameful elements

Table 7
Applying gameful elements to PB processes. An overview of the framework

PB stage	Objectives	Gameful elements	Description of the element	Suggested activities
Strategic problem orientation and definition	Identify and set the normative assumptions and goals to be agreed upon.	Information/Play	Exchange knowledge and formulate the questions to be answered together.	Graphic Jam[b] Speed dating[c]
Develop Future vision	Craft normative scenarios (with attainable goals) through the use of creativity for moving beyond present mindsets and paradigms.	Exposition/Play/ Engagement	Narratives that allow social interaction, connecting participants through shared challenges.	Fishbowl[b] Pecha-Kucha[b]Participatory infographic[c] Creature Feature [b]
		Play/Engagement	Freedom to explore boundaries without the threat of real-life consequences.	Role-playing [c] Excuse me, I'm lost[a]
		Choice/Play/Engagement	Put the player in control of how to engage with the system (including the choice not to engage at all).	Dotomocracy[c] Trading cards[b]
		Reflection/Play/ Engagement	Identify how and why the visions relate to oneself –	Headline-making[b] Memory Wall[b]

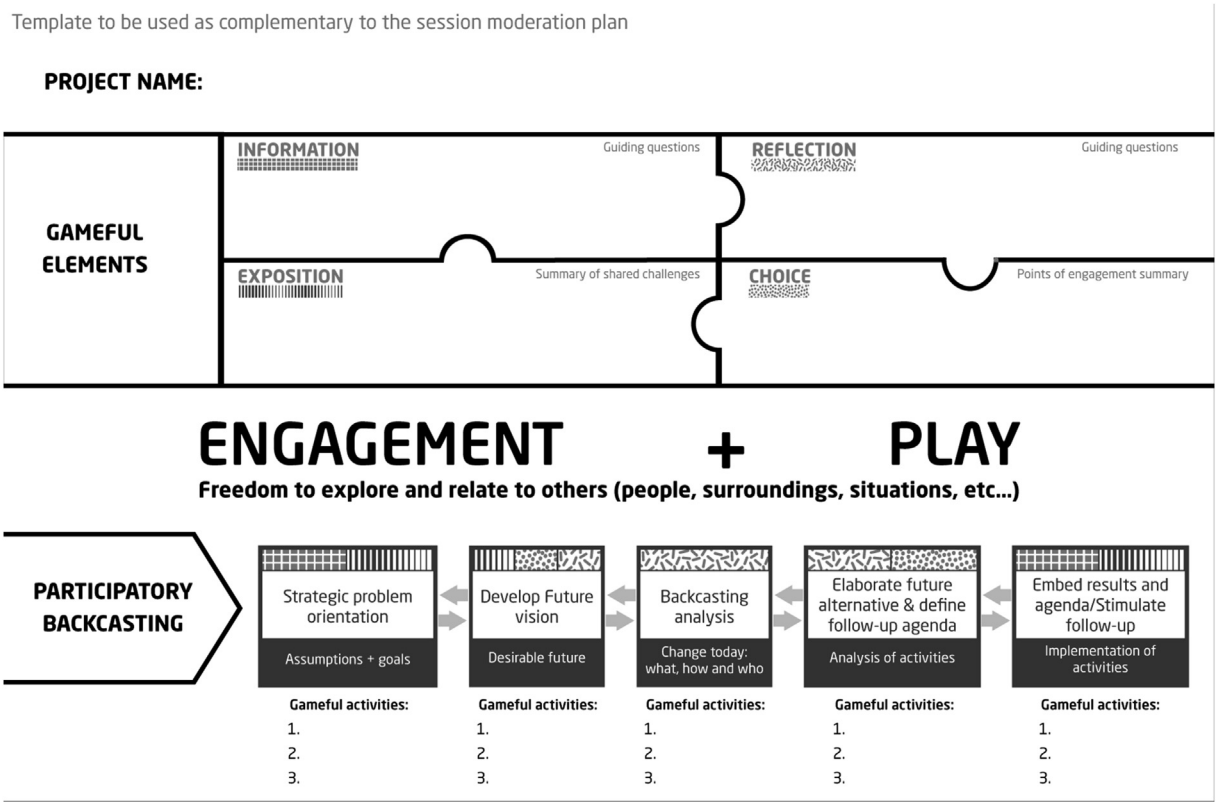
(*continued on next page*)

Table 7 (*continued*)

PB stage	Objectives	Gameful elements	Description of the element	Suggested activities
			enable autonomy and mastery to reach the goals.	
Backcasting Analysis	From the perspective of the created vision, this is to look into the needed technological, cultural and behavioral, and structural changes needed to address today the questions of: what changes are needed, how to bring them about, and who is could/should contribute (and in what capacity) as well as who could oppose the realization of the vision.		Creating opportunities for the participants to recount past game- experiences and connect them with happenings in their lives. Allows participants to provide meaning to the activities performed and to be carried out, owning the responsibility for their outcomes.	3-12-3 Brainstorm[b] NUF (New, useful, feasible) test[b] Affinity Diagram[b] Empathy maps[b]
Elaborate future alternative & define follow-up agenda	Assessment of the scenarios designs and stakeholder learning to translate the outcomes of the backcasting analysis into the activities for different stakeholder groups contributing to bring about the desirable future.		Group reflection entails learning from the insights of the others, creating personal, purposed-based connections among the players.	Forced analogy[b] History maps[b] Heatboard[c]
Embed results and agenda/ Stimulate follow-up	Articulate the learning from the experience, include consequences and opinions.	Choice/Play/Engagement	Give autonomy to empower exploration and engagement.	Pain-Gain maps[b] Ethos-Logos-Pathos[b]
	Enable the possibilities for implementing the activities planned and their progress, including iterations and learning from each step of the process.	Engagement/Play	Relatedness: connect with other players and people involved in the real-world setting. Enable achieving a state of flow.	Letter to future us[c] Postmortem[b] Graphic Jam[b]

These activities are suggestions from the Creative Workshop[a] (Sherwin, 2010); Gamestorming[b] (Gray et al., 2010); and Guillen-Hanson, 2017

Appendix C.1. GAMEBACK framework template for practitioners



Appendix D. Data collection for the cases

Table 8
Overview of participants and data collected for Case 1

Location	Dates and length	Participants						Data Collected/outcomes						
		Participants	Academia	Business	CSO	Policymakers	other	2050 scenario with participants' votes (each impact area in a A3-size paper sheet)	Playing boards for action roadmaps (A1-size paper each)	Panel discussion output (A3-size paper sheets)	Sectoral roundtable discussion outcomes (A1-size paper sheets)	Promising practices "needs-offers" (A1-size paper sheets)	C−O world café (A1-size paper sheets)	Graphic records (A1-size paper sheets)
Wuxi, China	24.10.12 (4 h)	42	12	17	7	4	2	8 impact areas	5	n.a.	12	8	n.a.	n.a.
Bogota, Colombia	3.12.12 (8 h)	50	8	16	13	8	5	12 impact areas	12	12	12	18	8	3
Manila, the Philippines	21.03.13 (8 h)	51	7	21	14	6	3	12 impact areas	12	10	12	21	11	4
Accra, Ghana	13.06.13 (8 h)	50	10	17	11	7	5	12 impact areas	12	n.a.	10	20	n.a.	4
Berlin, Germany	4-5.11.13 (12 h)	74	21	15	15	9	14	12 impact areas	12	22	16	40	14	8

Table 9
Overview of participants and data collected for Case 2

Location	Dates and length	Participants						Data Collected/outcomes					
		Participants	Academia	Business	CSO	Policymakers	other	2050 scenario with participants' votes (each impact area in a A1-size paper sheet)	Playing boards for action roadmaps (A1-size paper each)	Sectoral roundtable discussion outcomes (A1-size paper sheets)	Competency map and promising practices	Scale-up strategies discussion output (A1-size paper sheets)	Graphic records (A1-size paper sheets)
Germany	3rd quarter 2014 (12 h)	33	5	20	5	1	2	5 strategic conditions	5	8	15	6	8
Germany	2nd quarter 2015 (8 h)	46	8	25	9	3	2	5 strategic conditions	8	10	18	7	n.a.

Appendix E. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2021.126609.

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