Using Serious Games for Vision Development in the Participatory Backcasting Process

A Case Study Developing Circular Visions for Business Parks

Master Thesis Industrial Ecology | J.C. Frens (Bsc.)

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II. Executive summary

Due to the ecological consequences and increased resource insecurity caused by the depletion of natural resources of the incumbent linear economy, the Netherlands aims for a fully circular economy in 2050. To guide this transition from a linear to circular economy, strategies need to be made. An approach which enables actors to create these strategies is participatory backcasting. During the process of participatory backcasting, stakeholders develop a shared envisioned future, after which they make a strategy on how this future can become reality.

This process needs to be supported by several tools, including (social) engagement and design tools. The aim of this thesis is to explore how serious games can be used as these tools and what its effects are. By expanding the tools available for participatory backcasting, practitioners can use different tools appropriate for different settings. This has resulted in the research question: *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?* The research was contextualised using the case of the circular economy transition of business parks.

The research took a research-through-design approach. Using this approach, first a design for a serious game was made using the game design process of Peters & van de Westelaken (2014). This approach consists of four iterative steps: (1) design specification, (2) system analysis, (3) game design, and (4) game construction. After the design process, the research process follows. This used the developed game to develop a vision proposal within a workshop setting. For the research, two workshops were conducted. The first workshop was conducted with students of the Master Industrial Ecology, while the second workshop was conducted with stakeholders of business park De Wildeman. Additionally, the participants filled in a questionnaire before and after the workshop. The effect of the game is assessed by analysing the developed vision, using the results off the questionnaires and general observations by the researcher.

II.1. Design Process

During the first step of the design process (design specification), expert interviews, and discussions with supervisors and possible case owners were used to create an overview of the requirements of the game (results in Table II.1). This input was used for the next step of the design process: a system analysis of the envisioning step of the participatory backcasting process.

Table II.1 Design specifications

	Specification	Need or want
1	**Develop a vision**	**Need**
	Not leading	Need
2	**Manage (social) engagement**	**Need**
	Not competitive	Want
3	**Part of participatory backcasting process**	**Need**
	Maximum 4 hours	Need
	Scalable	Want
4	**Other**	-
	Adaptable	Want
	Understandable	Need
	Explains circular business parks	Want

During the system analysis step, the concepts of (social) engagement during workshops, visions and visioning and the circular economy are investigated using interviews and desk research. This system analysis resulted in the system network found in Figure II.1. The results of the design specification and system analysis were then taken to the game design step.
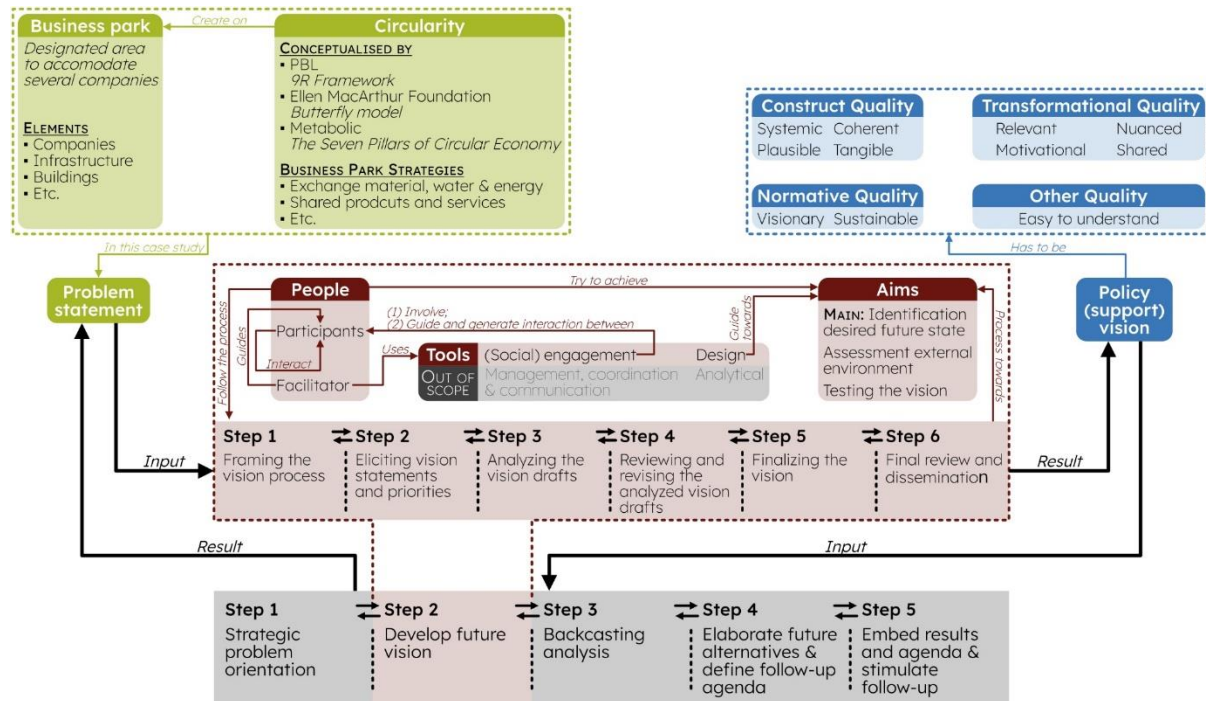

Figure II.1 System analysis of the visioning step during participatory backcasting

During the game design step, a record was made of existing games that served as inspiration for the development of the game. Using this, three concepts based on existing games were created. Of these concepts, one is further developed in the final step of the design phase: game construction.

The selected concept consisted of two phases: idea generation and contextualization. The idea generation phase is a round-based phase. During a round, participants draw two cards. One card with an element that could be present at a business park and one card with a theme relating to the circular economy. Then, the participants throw an economy die to determine the context of the round. Using this input, the participants are asked to write down an idea combining the element and the theme within this economy. They present their ideas, and one person is voted as winner. At the end of this phase, the participants are asked to present their favourite idea generated during any of the rounds.

In the contextualising phase, the participants have a map of their business park and the ideas from the previous phase. They are asked to place and combine ideas to make a future scenario. When the facilitator finds it appropriate, they receive a reflection card with several questions about the vision proposal, which they are challenged to answer. At the end of the phase, the participants are asked to present their vision proposal.

All materials for the game were custom made by the researcher.

II.2. Research Process

To test the effect of the game, two workshops were organized. First, a workshop was conducted with a group of 15 students of the master Industrial Ecology split in three groups. A second workshop was conducted with 3 stakeholders of the business park De Wildeman.

The effect of the game on (social) engagement was tested using three dimensions: (1) experience, (2) learning, and (3) perceived level of influence. The experience was tested using the game experience questionnaire (GEQ; IJsselsteijn et al., 2013) after the workshop. Learning was tested using self reporting by the participants and comparing the answers of the pre- and postquestionnaire. Perceived level of influence was only tested using self reporting in the postquestionnaire.

The results of the GEQ indicate a positive effect on (social) engagement as the components related to high engagement scored relatively high and the results related to low engagement scored relatively low. Furthermore, the results of the learning dimensions showed that almost all participants have learnt about circularity. Finally, most participants indicated that they had a high degree of influence, one student indicated some degree of influence and one stating a little influence. This all showed that the participants were willing to have emotions and thoughts towards the workshop and were willing to affect the results of the final vision. This leads to the conclusion the outcome of this research would indicate that the use of a serious game can have a positive effect on (social) engagement.

The games effect on the vision design was tested using two dimensions: participant satisfaction and a vision evaluation. Participant satisfaction was tested using self reporting in the postquestionnaire. The vision evaluation was conducting using the criteria set by Van den Voorn et al. (2017): (1) presence of transformative elements, and (2) presence of goals and guiding targets.

The results for participant satisfaction with the developed vision range from neutral to high satisfaction. Furthermore, only one (stakeholder) participant indicated they wanted to change the vision developed during the game. However, the change was more incremental rather than disruptive. The vision analysis showed that all four visions contained transformative elements, while clear guiding goals and targets were absent. However, there were clear guiding themes in the stakeholder vision that could result in goals and targets in a follow up session. It is possible that this was due to the game used in the research.

Based on the conclusions of the thesis, several recommendations can be given. First, participatory backcasting practitioners are recommended to embrace serious games as a tool in their toolbox to support the process. Using the results laid out in this report, they can consider the benefits and drawbacks of the tool and decide whether it would be a fit for their case. Furthermore, game and other tool designers are encouraged to develop and test the effect of different tools. The methods used in this research can be used as initial framework to test the effects as to make the tools and their effects more comparable. Thirdly, researchers and policy makers working on the transition towards a circular economy are recommended to use interactive learning and design tools, such as serious games, when interacting and visioning with non-expert stakeholders. Using these tools can enable non-expert stakeholders to give their input without having to learn about the subject first. Finally, business park

researchers and management are recommended to include the stakeholders in the discussion of the future of the business park. Using interactive methods such as serious games could empower them to freely give inputs about their desires and ideas.

While this thesis gives starting insight into the effect of a serious game as (social) engagement and design tool for vision making during the participatory backcasting process, it is not without its limitations. These need to be considered when looking at the results. The research is conducted in a short time scale, which means that it was not possible to incorporate the full participatory backcasting process or any follow-up effects in the results. Furthermore, the data gathered is limited due to a limited number of participants and all research was conducted using one game. Finally, the participants were aware of the workshop being organized for study purposes, and the developed visions would not have direct consequences on their actual future planning.

Future research to overcome these limitations could include more long-term research to investigate the effect on follow-up activities and conducting more workshops with different types of games to compare the effects. Furthermore, the effects should also be tested in a real future planning context.

Besides overcoming the limitations of this research, more observations were made that can be used for future research. Namely, during the stakeholder workshops, they indicated that they were not being 'real' stakeholders. Their reasoning for this was that they 'did not come to the session with an underlying agenda'. Future research could be used to understand if the stakeholders not perceiving themselves as 'real' stakeholders was due to the intervention of using a game or due to other circumstances. Finally, the learning that happened during the student workshop moved the concept of circularity from a technical and strategy-based definition towards more social and practical insights. Future research could be conducted to understand what caused this shift to happen.

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1. Introduction

The current industrial economy is categorised by a linear model following a "take-make-dispose" pattern. The ongoing practise of constant extraction of virgin raw material from the earth without regenerative strategies has led to depletion of the earth's natural resources. At the same time, materials and products are disposed without end-of-life strategy, polluting the ecosystems (Ellen MacArthur Foundation, 2013). Due to the ecological consequences of the incumbent linear economy and increased resource insecurity caused by the depletion of natural resources, the Netherlands aims for a fully circular economy in 2050 (Ministerie van Infrastructuur en Waterstaat, 2016).

To successfully guide this transition from a linear to circular economy, new strategies need to be made. An approach which enables actors to create these strategies is participatory backcasting (Quist et al., 2011; Vergragt & Quist, 2011). During the process of participatory backcasting, stakeholders develop a shared envisioned future, after which they make a strategy on how this future can become reality (Quist, 2007). The process of participatory backcasting is supported using four groups of tools and methods: (1) (social) engagement, (2) design, (3) analytical, and (4) management, coordination, and communication (Quist, 2007, 2013). For more information about these tools, see section 2.1.

The aim of this thesis is to explore how serious games, games with a primary purpose other than entertainment (Michael & Chen, 2006), can be used in these groups of tools and methods and its effects. By expanding the tools available for participatory backcasting, practitioners can use different tools appropriate for different settings. Serious games are explored as possible tool since it can serve as a safe innovation space to explore alternative futures (Flood et al., 2018), while at the same time having the possibility to increase engagement and trust between participants and researchers (den Haan & van der Voort, 2018; Flood et al., 2018). Finally, the addition of game dynamics can result in a wide range of people feeling empowered to influence governance (Kelly & Johnston, 2017). These effects could aid the participatory backcasting process.

In order to scope the thesis, this exploration is limited to one step of the participatory backcasting process and two groups for tools or methods. This has resulted in the research question: *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?*

The research is contextualised using the case of the circular economy transition on business parks. Business parks are important to the Dutch economy as 10.6% of the Dutch companies and 30.2% of jobs were situated on business parks in 2018 (Nordeman, 2019). Furthermore, business parks cover 2.6% of the available land area in the country (CBS StatLine, 2023). As such, in this thesis, a game for vision development on business parks is developed and tested in two workshops. The first workshop was conducted with students of the Master Industrial Ecology. The second workshop was conducted with stakeholder of the business park De Wildeman in Zaltbommel.

1.1. Relevance to Industrial Ecology

This thesis is written as part of the Master Industrial Ecology. Industrial ecology studies the relationship between the technosphere (human society and the industrialised economy) and the biosphere (natural environment). At its core, industrial ecology focusses on how these two can exists sustainably. Currently, the technosphere has great unsustainable environmental impact. Thus, it is important that it changes to reduce this impact.

Large changes to the technosphere, also called transitions, are driven by visions of an alternate future and strategies to achieve them (Loorbach et al., 2017). The research of this thesis can be used for new methods of creating these visions and strategies. Furthermore, the thesis specifically researches new methods for developing visions for a circular economy. The transition from a linear to a circular economy support the aim of industrial ecology. This is because a circular economy should reduce the impact on the biosphere by extracting less raw materials from the environment and creating less pollution and waste (Kirchherr et al., 2017).

1.2. Thesis Outline

The report is split in 8 chapters. After this introductory chapter 1, a literary background is given in chapter 2 to contextualise and scope the research. This includes a literary background on participatory backcasting, serious games and circularity on business parks. Furthermore, using this input, the research question is defined in this chapter as well. Chapter 3 covers the research methodology applied during the thesis which follows a research-through-design approach. After, chapter 4 covers the results of the design process after which the designed game is then presented in chapter 5. Then, the results of the research process are presented in chapter 6. Finally, the discussion of the results and the research are presented in chapter 7 and the conclusions and recommendations are given in chapter 8.

1.3. Participation vs Engagement

The concepts participation and engagement are central. However, both terms have overlapping and differentiating definitions. Participation can refer to concepts as political or citizen participation which is about giving stakeholders control over decisions (Arnstein, 2019; Glicken, 2000) or including stakeholders and guiding interaction within a workshop (Quist, 2007, 2013). Engagement can relate to attitudes, behaviour and intentions towards a subject (a state of being; Schaufeli, 2013) or "the willingness to have emotions, affect, and thoughts directed toward and aroused by the mediated activity in order to achieve a specific objective" (a reaction towards something; Bouvier et al., 2014, p. 496).

To avoid confusion and to make it as apparent as possible what is referred to during this thesis, these words are only used with one definition, which can be found in Table 1.1. These were selected as they are as distinct as possible while still relevant to the context of the thesis.

Table 1.1 Definition of engagement, social engagement, and participation

Term	Definition in this thesis
Engagement	"The willingness to have emotions, affect, and thoughts directed toward and aroused by the mediated activity to achieve a specific objective" (Bouvier et al., 2014, p. 496).
Social Engagement	Social connections and interactions to develop and maintain the participants social network (Bouvier et al., 2014).
Participation	Give stakeholders control over the decisions that affect them (Arnstein, 2019).

The definitions of engagement and social engagement are drawn from gaming literature and are in this context only used for activities in the game. In this thesis, however, they are also used to describe behaviour in the not necessarily gaming related parts of the workshop.

2. Theoretical background

As mentioned in the previous chapter, the aim of this thesis is to understand the effect of using a serious game during the participatory backcasting process. This is tested using the case of the circular economy transition on business parks. To contextualise this goal, the theoretical background is given of participatory backcasting, serious games and the circular economy on business parks. Besides contextualising the research, the aim of this chapter is to give an overview of existing research as identify the research gap and formulate the final research question of this thesis and serve as input for the development of the developed game.

2.1. Participatory Backcasting

First, the concept of participatory backcasting is discussed. In this, participatory backcasting is defined and a brief overview of the value of the approach is given. Furthermore, the process of participatory backcasting is illustrated using the methodological framework of Quist (2007).

Backcasting is an approach for long-term strategy development. It can be defined as "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" (Vergragt & Quist, 2011, p. 747). The principle of backcasting is also visualised in Figure 2.1. It is best used for cases in which there is complex societal problems, where there is a need for major change, but dominant trends contribute to the problem, the effects cannot be solved in markets, and there is a long horizon for the alternative future to develop (Quist, 2013).
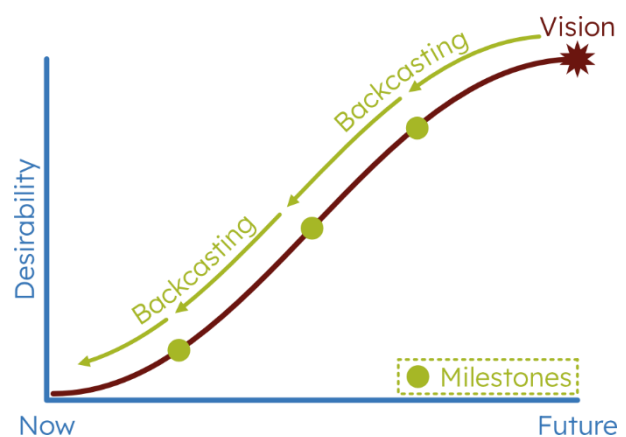
Figure 2.1 The principle of the backcasting process (from Vergragt & Quist, 2011)

The vision-centric approach for strategy building inherent to backcasting differs from other methods of future building. For example, forecasting, in which the business-as-usual scenario is extrapolated into the future to generate a future scenario (what *will* happen), or scenario making, in which the exploration of different possible future scenarios based different variables are made (what *could* happen). As strategies made using backcasting use a desirable future (what *should* happen) as basepoint of the strategy instead of the current situation, backcasting empowers participants to think of more drastic changes, instead of the more incremental changes other tools allow for (Eames & Egmose, 2011).

The 'participatory' part of participatory backcasting refers to the act of doing backcasting with a diverse group of stakeholders. By including different stakeholders during backcasting activities, input from different views, interests and personal visions are included in the process. Besides, the inclusion of stakeholders is important for achieving the endorsement of the proposed vision and strategy and increasing the chances of successful follow-up. Furthermore, it enhances social learning, interactive social research possibilities, and engagement of non-expert users (Quist & Vergragt, 2006). Stakeholders can come from different social domains. For example, business,

research government, and society (wider public and public interest groups; Quist, 2013).

In this thesis, the methodological framework for participatory backcasting of Quist (2007) is used (see Figure 2.2). In this, the participatory backcasting process consists of 5 stages. These are (1) strategic problem orientation, (2) develop future vision, (3) backcasting analysis, (4) elaborate future alternatives and define follow-up agenda, and (5) embed results and agenda and stimulate follow-up and implementation (Quist, 2007).

Types of demands
(1) Normative demands
(2) Process demands
(3) Knowledge demands

Different Goals (examples)
> Involvement of a wide range of stakeholders
> Future visions and follow-up agendas
> Awareness and learning among stakeholders
> Commitment and follow-up by stakeholders
> ...

Five steps

Step 1	Step 2	Step 3	Step 4	Step 5
Strategic problem orientation	Develop future vision	Backcasting analysis	Elaborate future alternatives & define follow-up agenda	Embed results and agenda & stimulate follow-up

Groups of tools and methods
(1) Participatory/interactive tools and methods
(2) Design tools and methods
(3) Analytical tools and methods
(4) Tools and methods for management, coordination and communication

Figure 2.2 Framework participatory backcasting (from Quist, 2007)

Based on this methodological framework, four groups of tools can be used during the different steps of participatory backcasting. Namely, (1) participation and interaction, (2) design, (3) analysis and management, (4) coordination, and communication (Quist, 2007) (see Table 2.1). As can be seen in this table, the goals of participatory/interactive tools and methods more closely relate the definition of engagement (goal 1) and social engagement (goal 2), than participation as defined in section 1.3. Thus, from this point forward, this group of tools and methods are referred to as *(social) engagement tools and methods* in this thesis.

The specific tools used (e.g., interviews or brainstorming) should be appropriate for the setting. A diverse range of tools allows for more suitable selection of tools. Thus, research expanding the range of tools for participatory backcasting is needed to continually improve on the participatory backcasting process in different settings.

Table 2.1 Different types of tools and methods (based on Quist, 2007, 2013)

Type of tool or method	Goal(s)
Participatory/interactive	(1) Involve stakeholders (2) Guide and generate interaction between the stakeholders
Design	(1) Construct visions, scenarios, and strategies (2) Design of the process
Analytical	Assess the designs or stakeholder involvement
Management, coordination, and communication	Management of the project and stakeholder involvement

2.2. Serious Games

In this section, the concept of serious games is explained with an argumentation why serious gaming could be an interesting addition to the range of tools for participatory backcasting. After this, a summary is provided of current research combining gaming and participatory backcasting.

Serious games can be defined as "games that do not have entertainment, enjoyment, or fun as their primary purpose" (Michael & Chen, 2006, p. 21). In a game, it is possible to integrate both the technical and the social parts of a system and let stakeholders play with this complexity (Mayer, 2009). A workshop that contains a serious game, does not solely consist of gameplay. Before the gameplay, there is a briefing phase, in which players are introduced to the game. In this phase, the facilitator explains the rules and purpose of the game. After this, the game is executed. Finally, after the gameplay, there is a debriefing phase, which serves to reflect on the gameplay and make the knowledge gained during gameplay explicit (Kortmann & Peters, 2021).

What could make serious games a good tool for participatory backcasting is, that it can serve as a safe innovation space to explore alternative futures through active engagement (Flood et al., 2018). Furthermore, the addition of game dynamics can be used for engagement through feedback systems. This can result in a wide range of people feeling empowered to influence governance (Kelly & Johnston, 2017). Finally, it could increase engagement and trust between participants and researchers (den Haan & van der Voort, 2018; Flood et al., 2018).

2.2.1. Current research Backcasting and Gaming

Games have long been used in the context of planning and policy making (Mayer, 2009). In recent times, the usage of games in future studies has been rapidly expanding. However, these studies generally either use games to educate its players on future concepts or tools or to make forecasting of the future (Vervoort, 2019). Research that includes games and (participatory) backcasting exists but is limited.

To get an understanding of the prior research combining games and backcasting, papers were found using Scopus with the search query "gam* and backcasting or back-casting" in the title, abstract or keywords. The latest search was conducted on 26-07-2023. This resulted in 14 papers. Five papers were excluded due to language barriers or lack of relevance. These papers are used to identify the research gap when in comes to the use of serious games in participatory backcasting.

In Table 2.2, an overview of these papers is made, including a summary of the research and the game used. In the final column, the papers are assessed in which of the participatory backcasting step (see section 2.1) the game was used or *separate*, if the game was not integrated in the process.

The final column shows if gaming is mainly used during the backcasting analysis step or is separate from the whole participatory backcasting process. Andreotti et al. (2020) differ from this, as a forecasting game is used to orient the problem. Furthermore, Keeler et al. (2022) seem to include both the development of a vision as well as a backcasting analysis. However, the vision development in the game is based on the players drawing two *Transformational Sustainability Goal Cards* and creating a vision and narrative around these randomly selected goals, designed by the game developers. Thus, the spirit of the vision is determined by the game (developers) and not the participants.

Paper	Summary research	Summary game	PB step
(Hickman et al., 2009)	Images of the future of London Transportation were created. Using a simulation (game), different policy packages were tested.	The player selects policy packages and implement them with low, medium, or high intensity. Based on the input of the user, the transportation future of London is decided.	Backcasting analysis
(Ithnin et al., 2018; Tahir Inayatullah et al., 2013)	Exploring the pathway of BRAC and UTeM, respectively, using six different pillars of foresight. These include both backcasting and the Sarkar game, separately.	The Sarkar game is a role-playing game using four types of power (worker, warrior, intellectual and capitalist). It helps organisations understand the structure and style of (future) leadership (Inayatullah, 2013).	Separate
(Mangnus et al., 2019)	Transformation pathways of Kyoto's food system are investigated. Vision statements during individual interviews, then a backcasting analysis is done in groups. Two games are then used to practice and experiment with this future.	1: Let'sKyoto: digital role-playing games with six roles in the food system. During the round all players make different purchases. Then, they vote for possible policies. 2: Food Policy Council: players select roles and food related issues. During the rounds, players draw initiative cards and discuss how to achieve them. They roll a D20 to see if it works.	Separate
(Andreotti et al., 2020)	A game is used to explore possible futures by forecasting for sustainable agroforestry. This frames a participatory backcasting workshop.	During RESTORTES (Speelman & García-Barrios, 2010), players have their own land and there is an area of virgin forest. Players manage their land and discuss the future of the forest.	Strategic problem orientation
(Kahan, 2021)	Introduces bouncecasting; a seminar game where the participants move between forecasting and a backcasting analysis.	The facilitator shows forecasted scenarios. Then, groups meet to plan backwards to find ways to enhance positive and minimize negative aspects. Finally, the groups discuss the results together.	Backcasting analysis
(Guillen Mandujano et al., 2021)	Researched the potential of gamification elements in backcasting using case studies.	N.A. – Developed a framework combining the RECIPE (Reflection, Exposition, Choice, Information, Play, and Engagement; Nicholson, 2015) for meaningful gamification framework and the framework of participatory backcasting (Quist, 2007).	Separate / All
(Bruley et al., 2021)	Stakeholders were invited to co-creation session for a desired vision. Then they were invited to play a game to reflect on different strategies and levers for reaching their goal.	Players must manage the demands of tourists and new residents while maintaining local conditions that are threatened by climate and socio-economic events. The players decisions (individual or collective) can change all conditions.	Backcasting analysis
(Keeler et al., 2022)	A collaborative game was co-designed with city staff. This game was then played in several municipalities in the USA and adapted versions in the Navajo Nation and Germany.	AudaCITY is set in 25 years. The players are told they have won a prestigious sustainability award, but they must construct why. In the first two rounds, a vision is developed, then four rounds are used to develop a strategy and finally scoring is applied.	(Develop future vision) Backcasting analysis

2.2.2. Research Question

Using the prior research summarised above, it is evident that there is little to no research using serious games focussing on the participatory backcasting steps 2 (develop future vision), 4 (elaborate future alternatives & define follow-up agenda), and 5 (embed results and agenda & stimulate follow-up). Thus, the biggest research gap exists for the use of serious games within these three steps. In the context of this thesis, the earlier steps of the participatory backcasting process are more suitable from both a normative and a practical standpoint.

Normatively, using a serious game has been argued to increase engagement and trust between participants and researchers (den Haan & van der Voort, 2018; Flood et al., 2018), which is best established at the beginning of the participatory backcasting process. Furthermore, if the developed game enables the participants to make an ambitious guiding vision, then this can lead to a more ambitious project (Leising et al., 2018). Practically, it is more realistic to include the beginning stages of the participatory backcasting process in the scope of a short-term process like a master thesis. Thus, this thesis focusses on step 2 of the participatory backcasting process: develop future vision.

Besides the step op the participatory backcasting process, what type of tool the developed game is, should be considered. There are four types of supporting tools and methods of participatory backcasting (see section 2.1). Previously, the idea of games being used as safe innovation space for alternative futures (Flood et al., 2018) is discussed. This gives an indication that games could be used as a design tool for future visions. Furthermore, considering games can increase engagement between participants and researchers (den Haan & van der Voort, 2018), it can be used as a (social) engagement tool.

In conclusion, the developed game is used as a design and (social) engagement tool for the development of a future vision in the participatory backcasting process. Using this, the main research question is formulated as: *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?* Within this question, two sub-questions emerge: (1) what is the effect of the use of a serious game during the vision creation process on the (social) engagement of the players? And (2) what is the effect of the use of the serious game on the vision design?

2.3. Circular Economy on Business Parks

The serious game can not be developed or researched without an operating context. Thus, the research is contextualised by the case of the circular economy transition on business parks. This section gives a theoretical background for this contextualising case. This background is used as theoretical input of the design of the developed game and informs the reader to different perspectives surrounding the circular economy and business parks relevant to the development of the game.

Circular economy is a popular concept, which has a high variety of different definitions. Most frequently, it is described as a combination of reduce, reuse, and recycle activities (Kirchherr et al., 2017). These are all strategies to limit the material inflow and outflow of the economic system, while prolonging the (economic) value of materials. Meaning there should be a lower demand of raw materials and less waste.

As there are a high variety in definitions, there are also many different frameworks. In this section, three relevant frameworks and their definition of circular economy are discussed. The frameworks are: (1) the 9R framework (Potting et al., 2017), (2) the butterfly diagram (Ellen MacArthur Foundation, 2019), and (3) the seven pillars of the circular economy (Metabolic, 2017). After these frameworks are discussed, examples are given of how the principle of circular economy is currently implemented in different business parks.

2.3.1. Netherlands Environmental Assessment Agency: The 9R Framework
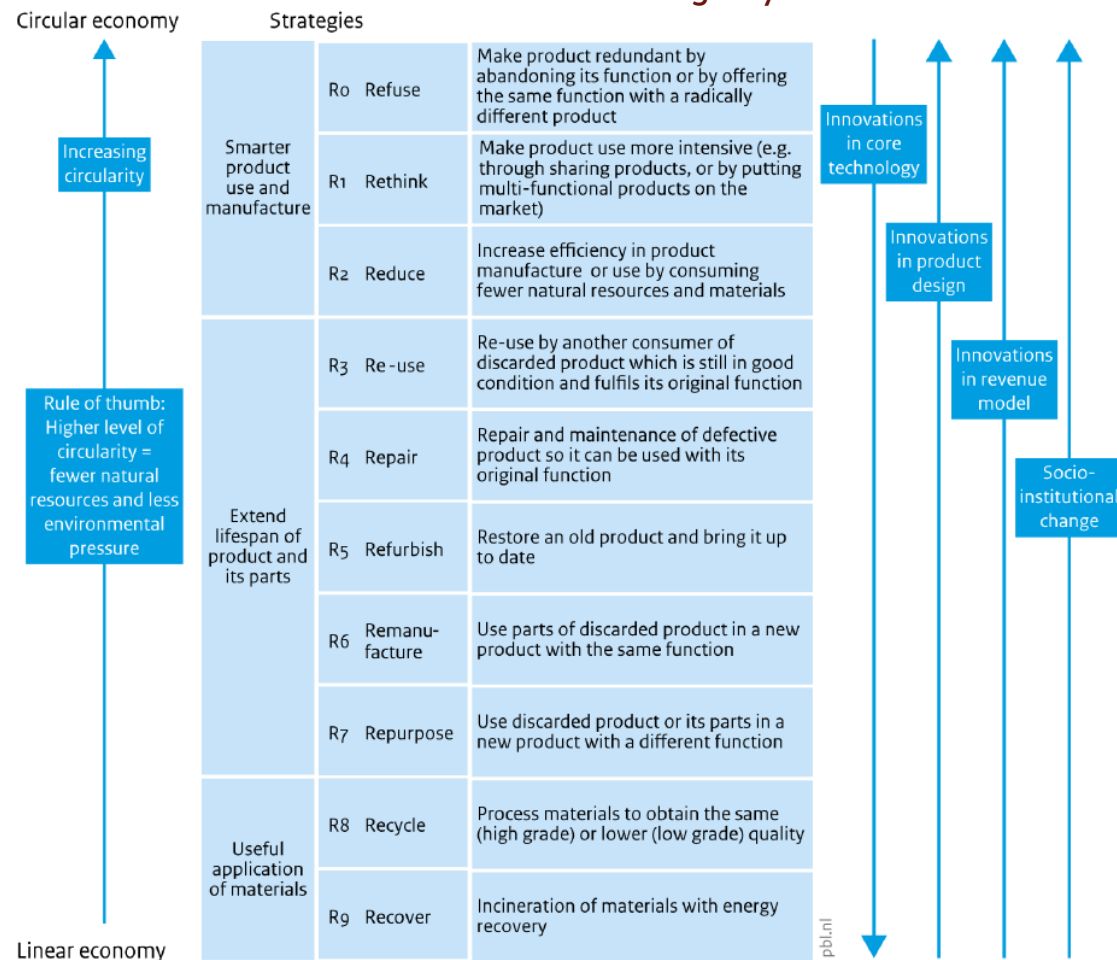
Figure 2.3 9R framework (from Potting et al., 2017, p. 4)

The 9R framework is developed by the Netherlands Environmental Assessment Agency (Dutch: *Planbureau voor de Leefomgeving*; PBL) as an exploration on how to measure the circular economy. It uses the definition for circular economy of the Dutch Ministry of Infrastructure and the Environment. This defines it as: "an economic system based on the reusability of products and product components, recycling of materials, and on conservation of natural resources while pursuing the creation of added value in every link of the system" (Potting et al., 2017, p. 4). In this definition, the recycled materials retain or improve their original quality, so they can be used in the same type of products avoiding so called downcycling. This would ultimately lead to a future where no additional natural resources are needed to support the economy as these tend to have a stronger impact (Potting et al., 2017).

PBL sees the path to a circular economy as the adaption of 10 different circularity strategies, which all lead to a reduced input of natural resources and/or a reduced

output of waste and pollution. The different strategies can be found in the framework in Figure 2.3. However, not al strategies are considered to be equally circular. The smaller the number of the strategy, the more circular it is (Potting et al., 2017).

Furthermore, these more circular strategies require changes in product design, business models and socio-institutional practises. On the other hand, the strategies that align more with our current linear way of thinking, require technological improvements to ensure a high value material or product. This highlights how the transition to a circular economy comes with a mindset change of how society values products, materials, and services (Potting et al., 2017).

2.3.2. Ellen MacArthur Foundation: The Butterfly Diagram

The Ellen MacArthur Foundation has a wider view on what a circular economy entails. It defines circular economy in three principles: (1) elimination of waste and pollution, (2) circulation of products and materials (at their highest value), and (3) regenerating nature. It states that a circular economy can only happen if there is also a transition to renewable energy and materials (Ellen MacArthur Foundation, n.d.-f).

The first principle, elimination of waste and pollution, asks for products to be designed with the end-of-life stage in mind. There should be a mindset shift where waste is seen as a design flaw, instead of a given. After use, the design should allow for the materials to re-enter the economy (Ellen MacArthur Foundation, n.d.-b).

The second principle, circulation of products and materials, deals with how the re-entering of the materials can be done. Here, the Ellan MacArthur Foundation differentiates between the technical cycle (products that are not consumed during use) and the biological cycle (products that are consumed during use and can be biodegraded) (Ellen MacArthur Foundation, n.d.-a).

In the technical cycle, products (and materials) are kept in the economy maintaining the highest value. This is similar to the 9R framework, as priority is given to strategies that require less (virgin) material and energy. For example, when products are shared or reused, more people benefit from its function without using additional energy and materials. If the product cannot be used anymore, relatively little energy and materials are needed to repair or refurbish it. If the product is beyond restoration, it can be recycled, bringing the product back to its raw materials. The embodied time and energy of the product are then lost and new energy most be invested to create new products. Thus, this must be a last resort (Ellen MacArthur Foundation, n.d.-e).

The biological cycle is about how nutrients can return to the soil to regenerate nature. If the materials are already in the economy, they can be used in products (e.g., textiles made from orange peel). After the final use, the materials can be composted or anaerobically digested to create compost and biogas. The compost can be used to give the soil more nutrients and the biogas can produce energy. An important element of this cycle is farming, as most of the product in the biological cycle is food (Ellen MacArthur Foundation, n.d.-d).

The biological cycle also links well into the third principle, regenerating nature. Besides the regenerating nature by returning the nutrients to the soil in the biological cycle, there should also be more space for nature, as less space is required to source virgin raw material. Thus, more land can return to nature and rewilding can happen (Ellen MacArthur Foundation, n.d.-c).

These three principles and the two cycles are visualised in the butterfly diagram (see Figure 2.4). On the bottom, there is the elimination of waste and pollution. The looped arrows represent the circulation of products and materials, with the left side being the technical cycle and right side the biological cycle. Finally, the flow back to the biosphere on the biological cycle represents the principle of regenerating nature (Ellen MacArthur Foundation, 2019).
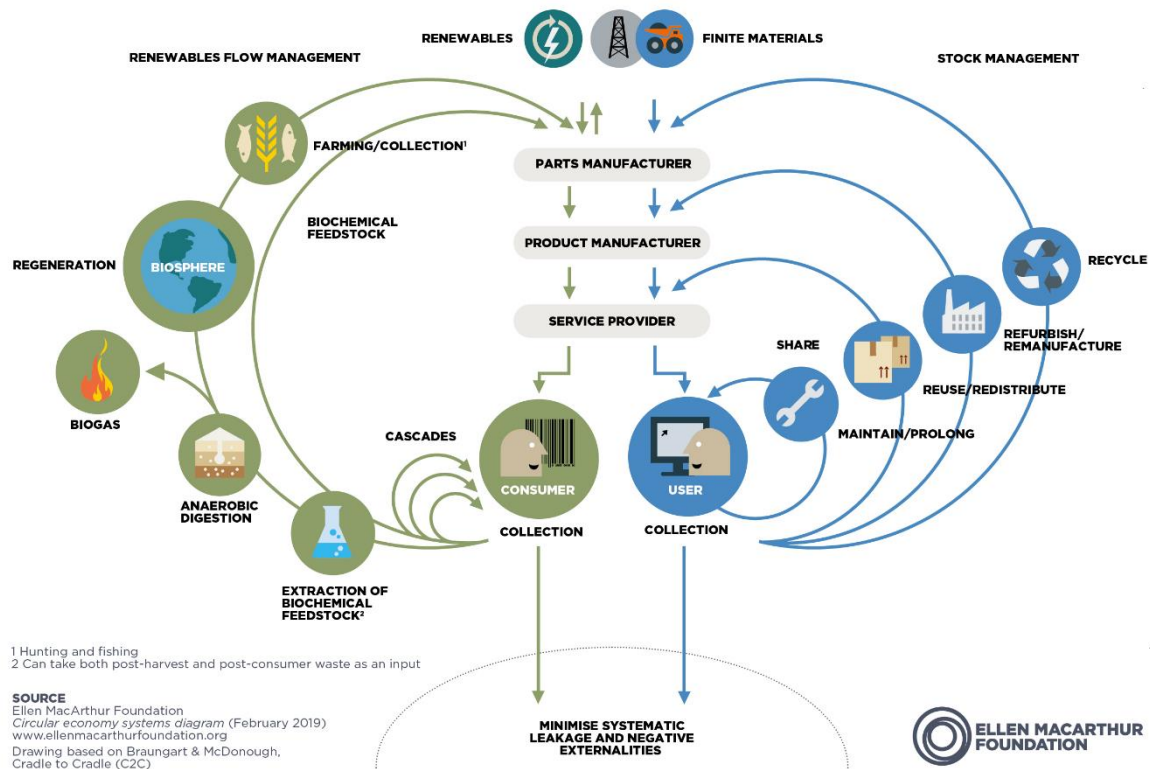
Figure 2.4 The butterfly model (from Ellen MacArthur Foundation, 2019)

2.3.3. Metabolic: The Seven Pillars of the Circular Economy

Rather than defining circular economy by its strategies, Metabolic defines it by what it believes end-state circular economy should look like. It defines a circular economy as "a new economic model for addressing human needs and fairly distributing resources without undermining the functioning of the biosphere or crossing any planetary boundaries" (Metabolic, 2017). This definition results in a more holistic framework, containing seven pillars and three surrounding properties (see Figure 2.5). Below, the seven pillars are discussed, starting at the top, and going clockwise. Finally, the properties are explained.

Materials: Similar to the 9R framework and the butterfly model, the 7 pillars framework requires materials to be cycled at their highest level of complexity. To ensure the possibility of recovery, materials should not be mixed, unless this mix can indefinitely be reused. Additionally, it adds that the length of the cycles must be relevant for human time scales and their connected nature cycle. Thus, a material that takes over a human lifetime to compost, is not part of a circular economy. Thirdly, Metabolic states that the materials should be transported as little as possible, as to reduce energy and materials demand for transportation. Finally, materials may only be used, if necessary, as a dematerialization of the economy is preferred (Metabolic, 2017).
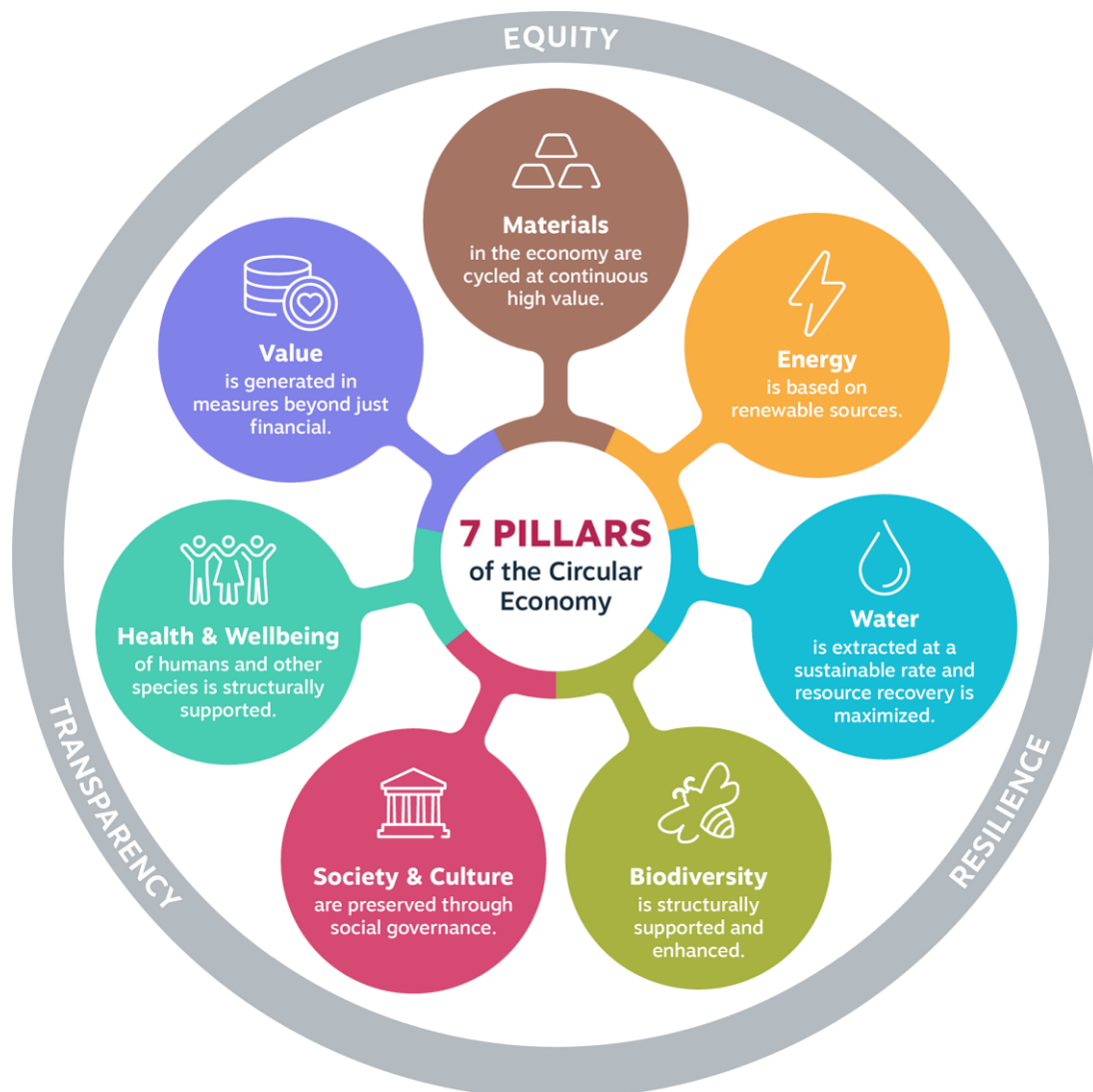
Figure 2.5 Seven Pillars of the Circular Economy (from Metabolic, 2017)

Energy: Just like the butterfly model, this framework states that all energy must come from renewable resources. It also highlights that the material needs for the generation and storage of energy, must also be designed for recovery on the system. Additionally, transportation and conversion of energy is avoided, as to minimise energy losses (Metabolic, 2017).

Water: As water is a vital element of the economic system as well as human survival, the framework requires water quality to be maintained. It should be indefinitely re-used, while recovering resources when possible. This should minimise the freshwater use of water systems and maximise energy and nutrient recovery from wastewater. Finally, it is important that watersheds and harmful emissions to the aquatic ecosystem are avoided (Metabolic, 2017).

Biodiversity: Not only materials should remain high complexity, but also ecosystems. Biodiversity is vital for the resilience of the biosphere. Thus, (rare) habitats should not be fundamentally altered. As this is of such importance to the wellbeing of the planet, material and energy losses are accepted when it is for the purpose of protecting of biodiversity (Metabolic, 2017).

Society & culture: Furthermore, complexity should also be maintained in human cultures. Economic activity should use management models and methods of governance suitable for the needs of affected stakeholders. Activities that harm unique cultures should be avoided (Metabolic, 2017).

Health & wellbeing: The health and wellbeing of people and other organisms should be central in a circular economy. Substances that can harm them should be kept in highly controlled cycles and eventually fully eliminated. Human health and wellbeing should never be damaged by economic activities (Metabolic, 2017).

Value: As there is a limit to resources like materials and energy, these should be used to create meaningful societal value rather than maximising economic gain. These values include, but are not limited to emotional, ecological, and aesthetic value. As these values are inherently different, they cannot be measured as a collective without subjective judgements. Thus, the different value categories must by respected in their own right (Metabolic, 2017).

Properties: The surrounding properties of the seven pillars model represent how the circular solution relates to the world around it. These are: (1) equitable: recognise and adjust based on differences in people's needs and socio-economic situations, (2) transparent: be able to track and trace materials, and (3) resilient: ensure there is knowledge (transmission) on how things work and how they are to be disassembled (Metabolic, 2017).

2.3.4. Circular Activity in Business Parks
The frameworks of circular economy give a systemic view of how the economy should function. However, the case does not cover the full economy, but for solely a business park operating in that economy. To contextualise this, types of circular activity in business parks are explored and related to the different frameworks.

Business parks are "areas designated by local, regional and in some cases national governments to accommodate multiple companies that produce, transfer or store goods or provide services" (Snep et al., 2009, p. 26). They are important to the Dutch economy, as 10.6% of the Dutch companies and 30.2% of jobs were situated on business parks in 2018 (Nordeman, 2019), while only covering 2.6% of the available land (CBS StatLine, 2023).

Considering the economic importance of business parks, they play a considerable role in the transition to the circular economy. However, implementing circular activity on a business park has many barriers. These include but are not limited to lack of trust among actors, lack of information sharing, lack or willingness to collaborate and lack of awareness of the benefits (Valladolid Calderón, 2021). Well executed participatory backcasting processes, could support overcoming these barriers and guide the business parks to implementing circular activities.

A typical example of circular activities on a business park is the exchange of (waste) materials, water, and energy between businesses to use as input, known as industrial symbiosis. The first known example of this happened in Kalundborg, Denmark. In 1972, the leaders of a local refinery and gypsum board plant met and realised that the access gas of the refinery could be used to dry the plasterboards. This later grew in an extensive network in more than 20 streams of resources flow between 14 partners (Kalundborg Symbiosis, 2022; see Figure 2.6).

This exchange of materials, water, and energy relates to the reuse and recycle strategies in the 9R framework and the butterfly model. In the 9 Pillars framework, it relates to the pillars of material, water, and energy.

The second type of circular activities can be described as sharing products and services. This includes activities as businesses sharing utilities such as energy generation and/or freshwater collection technologies and/or utility infrastructure. This differs from the material exchange as this includes the introduction of new energy and water to the business park, in contrast to the waste flows being used as input for other companies as described in material exchange. Furthermore, sharing, for example, waste collection contracts, warehouses, or industrial vehicles are also included.
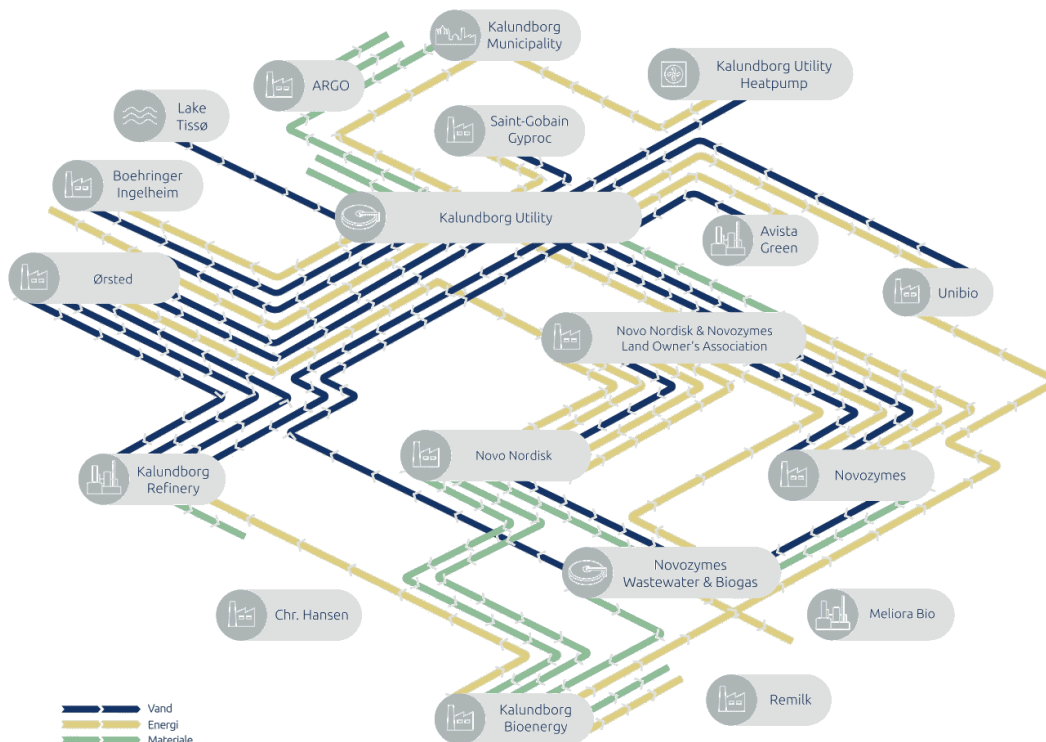
Figure 2.6 Industrial symbiosis Kalundborg (Kalundborg Symbiosis, n.d.)

In the 9R framework this is included in the strategy 'rethink' as it makes the use of products and services more intensive. In the butterfly diagram, this falls under the technical cycle strategy 'share'. For the 7 pillars framework, the main pillar for this type is materials, as less materials are being used. It is also possible to address the energy and water pillar if the shared energy service is generation in a renewable manner and the water is responsibly managed.

This does not cover the full spectrum of possible circular activities, as that also depends on the original definition of the circular economy. As the 7 pillars framework is more holistic, more activities on business parks could be understood as circular activities than with the other frameworks. For example, activities such as (1) giving space to nature (biodiversity), (2) allowing for (temporary) residence (society & culture), (3) bicycle infrastructure and public transport (health & wellbeing), and (4) active regulation on emissions (health & well being) could all be considered circular activities for business parks according to the 7 pillars framework (Metabolic & Creators, 2019).

The theoretical background presented in this chapter has let to the formulation and contextualisation of the research question in this thesis. Using the input of the framework of participatory backcasting introduced in section 2.1 and the opportunities and research gap discussed in section 2.2, the main research question is formulated as *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?* Together with the two sub-questions: (1) what is the effect of the use of a serious game during the vision creation process on the (social) engagement of the players? And (2) what is the effect of the use of the serious game on the vision design? These questions shape the research set-up introduced in the next chapter.

Besides formulating the research question, this chapter also gives input for the development of the serious games designed and used in this thesis. Section 2.1 serves as foundation of the developed game, keeping in mind the full participatory backcasting process as well as its tools and their goals. The prior research in section 2.2 serve as inspiration for the developed game as they showcase games developed within a similar context. Finally, different definitions and frameworks of the circular economy introduced in section 2.3 give input on how the conceptualization on circularity in the game should look. Additionally, the investigation of circular activities in business parks, give tangible examples of elements that could be part of the developed vision and thus the output of the game.

3. Methodology

The main research question of this thesis is *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?* This question is accompanied by the two sub-questions: (1) what is the effect of the use of a serious game during the vision creation process on the (social) engagement of the players? And (2) what is the effect of the use of the serious game on the vision design? These questions explored using a research-through-design approach. This is then contextualised within the boundaries of the case of circular vision creation during the Master course Industrial Ecology Project: Industrial Systems and on the business park De Wildeman.

In this chapter, the methodology of the research is explained in more detail. First, the contextualising case is introduced. Followed by an explanation of the research-through-design approach of this thesis, detailing the research methods in both the design and research process.

3.1. Case Study

To test the effect of the designed game, it needed to be played in the context it was designed for: a business park. The initial acquisition of a business park was done using several channels. Namely, promotion during an event for circularity in business parks in *Zuid Holland*, an advertisement for the project was shared through a LinkedIn post of the first supervisor dr.ir. J.N. Quist, and through the network of the circular economy group of the TU Delft. This acquisition led to several options, that unfortunately did not come to fruition due to lack of commitment from the different business parks.

To still be able to test the effect of the game, a slightly different approach was taken. First, research was conducted with master students during the course Industrial Ecology project: Industrial Systems, then the game was tested on business park *De Wildeman* on a smaller scale than was initially set out. This acquisition of this business park was conducted using the researcher's private network. Both cases are detailed below together with an explanation of their relevance to the thesis.

3.1.1. Industrial Ecology Project: Industrial Systems

Industrial Ecology Project is a 20-week course of the Master Industrial Ecology at the Leiden University and Delft University of Technology. The students are divided into two tracks: Urban and Industrial Systems. This thesis focussed on the Industrial Systems track.

During the course, the students are divided into groups of 6. With this group, they are tasked to analyse and re-design an existing industrial park based on three categories (water, energy, and material flow). There are five existing industrial parks they can choose for their analysis (Botlek Industrial Park Rotterdam, Chemelot Industrial Complex, Industrial Park Höchst, Liuzhou Industrial Park, and Kwinana Industrial Area). These parks were selected as they are discussed in relevant prior literature and have geographical proximity to surface water.

During this thesis, a workshop was held near the end of the course with 15 students working on the Botlek Industrial Park, Industrial Park Höchst, or Kwinana Industrial Area. At this point, the students had made an analysis of the current state of the industrial park, made a redesign based on the three categories, and a stakeholder analysis of the park. During the workshop, the students were experts on the activities

and restrains of the industrial park and were thus seen as suitable participants for a workshop to develop a future vision of this park. Below, a short description is given for the relevant industrial parks.

BOTLEK INDUSTRIAL PARK

Botlek Industrial Park is part of the port of Rotterdam. This is both an important harbour as well as industrial area. In 2021, there are 222 companies registered at the Botlek area, which is only 24.73km^2 (de Haas & van Dril, 2022). Many companies located at Botlek are vital to the (petro)chemical industry of the port of Rotterdam. The area has a large economic importance on a regional national and international level. The area connects and transports liquid bulk to important destinations in the Netherlands, Belgium, and Germany (*Botlek and Vondelingenplaat*, n.d.).

INDUSTRIAL PARK HÖCHST

Industrial Park Höchst is one of Europe's largest chemical and pharmaceutical areas. It is located in Frankfurt/Main, Germany (Kircher & Bayer, 2022). The industrial park is 4.6km^2 and has approximately 90 companies operating at the park. Besides pharmaceuticals, industries represented at the park are biotechnology, basic and specialty chemicals, crop protection, food additives and services (*Industriepark Höchst by the Numbers* , n.d.).

KWINANA INDUSTRIAL AREA

Kwinana Industrial Area is the most significant industrial region of Western Australia. In 2007, its economic output exceeded A$4.3 billion annually. The total surface area of the business park is 120km^2. There is a wide variety of industries present ranging from fabrication and construction facilities through to high technology chemical and biotechnology plants and large resource processing industries. In the industrial area, there are many instances of industrial symbiosis. In 2000, 106 interactions representing either the transfer of product(s), by-products or commercial cooperation was identified (Harris, 2007).

3.1.2. Business Park De Wildeman

De Wildeman is a business park in the municipality of Zaltbommel. It is developed in three phases relating to three adjacent areas. The development of the first phase started in 2005, the second phase in 2017, and the third phase in 2023. Thus, currently there is still a lot of new development ongoing on the business park. The total surface area of the business park is 0.75km^2 ("Burgemeester En Wethouders van Zaltbommel – Ontwerp Beeldkwaliteitplan Zaltbommel, De Wildeman III," 2023; Gemeente Zaltbommel, 2014, 2017).

All development is based on thee core values: sustainability, safety, and accessibility. In 2017, the business park has written a sustainability masterplan. This plan has formed the foundation of a collaboration between the different business parks in Zaltbommel. The aim of this collaboration is to make all business parks in Zaltbommel energy positive before 2025 (*Over De Wildeman*, n.d.).

To ensure the adhering of these core values, all companies on De Wildeman are required to be part of the park management. This park management represents the needs and desires of the different companies. As there is a high diversity of businesses, the board of the park management has representatives of a high variety of companies. The business park contains both smaller and bigger companies. Furthermore, companies on the business park area active in both on transportation,

logistics and distribution as well as industry, production, and peripheral retail (*Bestuur En Adviseur*, n.d.; *De Kavels van De Wildeman*, n.d.; *Parkmanagement De Wildeman*, n.d.).

While the students the Industrial Ecology project: Industrial tracks were experts about their industrial park, they were not stakeholders of the park. Thus, a workshop was conducted on Business Park De Wildeman. This workshop was conducted with 3 different stakeholders of the park: an account manager at municipality Zaltbommel, a general manager of one of the companies on De Wildeman and an office manager at an office on De Wildeman. By conducting this workshop, the perspective of stakeholders of a business park without extensive sustainability knowledge is added to the research.

3.2. Research-through-Design

In a research-through-design approach, design activities play a formative role in the generation of knowledge (Stappers & Giaccardi, 2017). In this thesis specifically, the effect of a design (simulation game) is tested in the context of the vision making process of participatory backcasting. The design is thus used as input for the research process of its effect (see Figure 3.1).
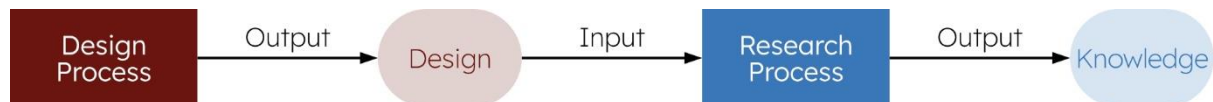
Figure 3.1 Research-through-design approach

For the design process, the game design process of Peters & van de Westelaken (2014) is used. This is an iterative process with four distinguished phases. Namely, design specification, system analysis, game design and game construction. This process is explained in more detail below.

After the detailed explanation of the design process, the research process is explained. This is centred around a workshop using the developed game. The participants are asked to fill in a pre- and postquestionnaire. Finally, the developed vision is analysed using the criteria set by Van der Voorn et al. (2017).

3.2.1. Design Process

As the game design process is iterative, the methods explained below are not necessarily presented in the chronological order of the research. Figure 3.2 shows a summary of the process including the research methods used per phase in the process.

Step 1 Design Specifications	Step 2 System Analysis	Step 3 Games Design	Step 4 Games Construction
• Literature review • Expert interviews • Discussions case owner & supervisors	• Desk research • Prior chapters • Expert interviews • Discussions case owner & supervisors	• Record existing games • Brainstorming • Comparison Matrix	• Formulate rules • Design and construct game elements

Figure 3.2 Design Process

DESIGN SPECIFICATION

This phase aims to have a clear understanding of the purpose of the developed game, what the final product should look like and understand its use scenarios. Usually, this phase consists of a discussion with the client (Peters & van de Westelaken, 2014). However, this project does not have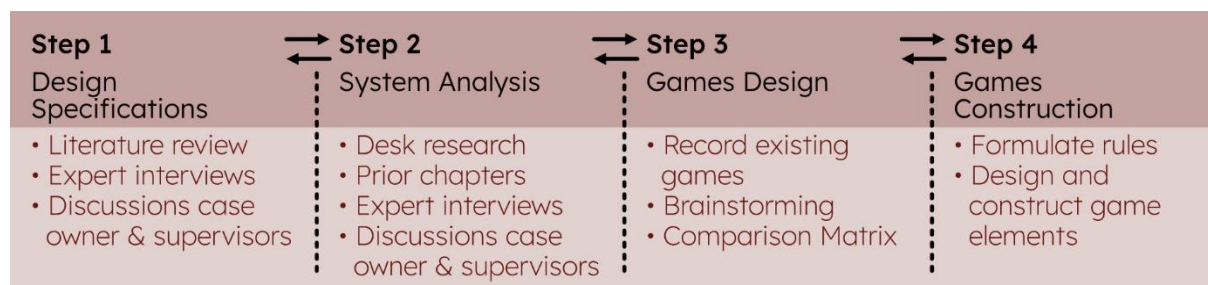 a traditional client, thus the specifications need to be set by the researcher. To inform the decision of the design specification, input is gathered using prior chapters, expert interviews, and discussions with the supervisors and (possible) case owners. The output of this phase is a direction for the design process as well as a checklist of requirements for the game.

The expert interviews are semi-structured interviews and were conducted with several experts with experience in facilitating participatory backcasting processes. For these interviews, 10 experts were contacted, of which 6 were interviewed. Anonymization happened immediately after the experts was first contacted. An anonymised overview of the interviewed experts can be found in Table 3.1.

Table 3.1 Anonymised overview of experts

Expert no.	Anonymised description
1	PhD candidate working with gaming and backcasting
2	Backcasting practitioner who experiments with online tools
4	Future planning practitioner who experiments with engagement tools
6	PhD candidate who works with participatory backcasting and games
8	PhD candidate who worked with strategy making on business parks and games
9	Educator who worked with strategy making on business parks and games

An outline of the semi-structured interview can be found in Appendix A. The interviews were recorded, fully transcribed and anonymised. Then, the statements in the transcript were manually sorted into seven possible groups: (1) participatory backcasting, (2) vision creation process, (3) (good) visions, (4) engagement in a workshop, (5) games/gaming, (6) other, and (7) filler. 'Other' includes statements that can be valuable for the design of the game, but do not fit the other categories. 'Filler' is all statements that are irrelevant to the research, (e.g., small talk). These groups were identified while coding the interviews. After the statements were sorted, they were reviewed to find the important statements to define the criteria of the game.

SYSTEM ANALYSIS

After the design specifications are set up, the next phase is system analysis. In this phase, the important elements of the reference system and their relationship are identified. This phase's purpose is to understand the system on a more fundamental level before making a game (Peters & van de Westelaken, 2014). Two research tools are used in this phase of the design process: (1) desk research, and (2) expert interviews.

The desk research in this phase is used to understand the relevant processes during participatory backcasting. Furthermore, an understanding is made of the current practises and processes used to achieve the goal specified during the game specification phase.

The expert interviews are used to get a first-hand understanding of the strategies currently used to achieve the goal specified during the game specification phase. Due to time and availability restrictions, these interviews were combined with the expert interviews on the design specifications. The structure and method of analysis remain the same.

In the game design phase, the analysed system is used to create the game. During this phase, the most relevant elements of the systems are selected, and game elements are analysed, resulting in a game format. The final output of this phase is the concept of the game (Peters & van de Westelaken, 2014).

Considering the scope of the thesis, the goal is not to design a game from scratch but to adapt an existing game to the analysed system. This results in a deviation from the process as described by Peters & Westelaken (2014). Specifically, instead of making a matrix with different game elements are comparing it to the selected elements, a list of requirements is set up and a record of existing games that follow (most) requirements is made.

This record of possible games is made using desk research and personal experience of the researcher. The games included on the list are based on certain criteria based on the goal of the game as decided in the design specifications and results from the system analysis. Still, this results in an incomplete list due to the vast number of existing games.

This record of games is used as inspiration during the brainstorming of possible games. Using this input, three possible concepts are developed. Finally, one concept is selected based on feasibility and potential.

GAME CONSTRUCTION
During this phase, the game goes from concept to product. The chosen concept of the game design phase is further developed to a playable prototype. This includes formulating the rules, making design choses for the different elements of the game, and constructing them (Peters & van de Westelaken, 2014).

3.2.2. Research Process
The aim of this thesis is to explore the opportunities of gaming in the visioning phase of participatory backcasting as well as understand its effect. To do this, workshops were held with the designed game. Participants are asked to fill in a questionnaire before and after the workshop and a meeting report of the workshop is made. Furthermore, a group interview at the end of the game was used to debrief the participants. The questionnaires, meeting report template and debriefing questions can be found in Appendix B.

As the game is designed as tool for (social) engagement and design, the impact on these two aspects needs to be researched. Below, these two subjects are elaborated on and the method of measuring the impact is explained.

(SOCIAL) ENGAGEMENT
As discussed in section 2.1, the aim of a (social) engagement tool is to involve stakeholders and to guide and generate interaction between the stakeholders. During the research process, both these goals are measured using three categories: (1) game experience, (2) learning, with subcategory of learning from other stakeholders, and (3) perceived level of influence on the design. The rational behind the categories is explained in Table 3.2 together with possible subcategories, variables to measure the (sub)categories and the research methods related to these variables.

Table 3.2 Measuring categories (social) engagement

Main category	Subcategories and variables	Rational	Research methods
Game experience	Core experience during game Variables: competence; sensory & imaginative immersion; flow; tension/annoyance; challenge; negative affect; positive affect	This gives an indication to how the participants felt during the game. This relates to the willingness to have emotions towards and aroused by the activity (see definition of engagement in section 1.3.).	Post-questionnaire using the GEQ (IJsselsteijn et al., 2013)
	Social presence experience Variables: psychological involvement – empathy; psychological involvement – negative feelings; behaviour involvement	Social presence experience related to the experience of and involvement with the other participants. Thus, this gives an indication of the interaction between stakeholders.	
	Post-game experience Variables: positive experience; negative experience; tiredness; returning to reality	This gives an indication to how the participants felt after the game. This relates to the willingness to have emotions towards and aroused by the activity (see definition of engagement in section 1.3.).	
Learning	Learning – general Variables: insights concepts of circularity; insights circularity business park; new ideas for vision of business park; experience of learning goals	If the participants have learnt something during the workshop, it means that they were willing to have thought towards and aroused by the activity (see definition of engagement in section 1.3.).	Post-questionnaire; group interview during debriefing; comparisons pre- and post-questionnaire
	Learning from other participants Variables: insights concepts of circularity from other participants	If the participants were able to learn from each other, it means they were having interactions about the desired subjects.	Post-questionnaire
Perceived level of influence on the design	Variables: self reported degree of influence on design	If the participants feel that they had a high level of influence on the design, it means that they were willing and felt able to affect the activity to achieve the development of the vision (see definition of engagement in section 1.3.).	Post-questionnaire

The construct game experience in this context is used as defined by Poels et al. (2007). In this context game experience is in split three overarching dimensions, each containing several concepts. These dimensions are (1) core experience during game (competence, sensory & imaginative immersion, flow, tension/annoyance, challenge, negative affect, and positive affect), (2) social presence experience (psychological involvement – empathy, psychological involvement – negative feelings, and behaviour involvement), and (3) post-game experience (positive experience, negative experience, tiredness, and returning to reality). Dimensions 1 and 3 relate to the goal of involving

stakeholders and dimension 2 relates to the goal of generating and guiding interaction between stakeholders. These dimensions can be measured using the game experience questionnaire (GEQ; IJsselsteijn et al., 2013). For every participant, the score for each concept is calculated individually following the guidelines of the GEQ. The overall results of the questionnaire are evaluated per component on what the implication are on the (social) engagement.

The construct learning is split into the categories learning – general and learning from other participants. This construct represents the willingness of the participants to have thoughts relating the workshop. Learning – general covers all relevant learning that has happened in the workshop, while learning from other participants covers the social interactions about the desired subjects. The relevant learning both consists of learning about circularity as a concept as well as soft-skill learning goals based on the developed game, identified by the researcher. Using the results of the postquestionnaire, the amount of people having learnt anything is evaluated as well as how this learning came to be (game or other participants). Furthermore, using the change in conceptualisation of circularity before and after the workshop, self reported insights and the discussion during debriefing, the themes of what is learn are uncovered.

The perceived level of influence on the design is measured using self reporting. The results are directly used to interpret how the overall participant felt on their level of influence.

VISION DESIGN

As a design tool, the aim of the game is to help to construct a vision. The affect of the game is measured in two categories: (1) vision evaluation, and (2) participant satisfaction. The rational behind the categories is explained in Table 3.3 together with the research methods related to the categories.

Table 3.3 Measuring categories vision design

Category of vision design	Variables	Rational	Research methods
Vision evaluation	Transformative elements; goals and guiding targets	This category relates to the quality of the vision based on prior work.	Post workshop analysis of developed vision using criteria of Van der Voorn et al. (2017).
Participant satisfaction	Level of satisfaction; desire to change developed vision	This category relates to whether the developed vision accurately portrays the desires of the participants.	Self reporting in postquestionnaire and debriefing

The developed vision is evaluated using the criteria set by Van der Voorn et al. (2017): (1) presence of transformative elements, (2) and presence of goals and guiding targets. The developed visions are written down in a meeting report and send to the participants for verification. After, the transformative elements, and goals and guiding targets are identified in the described vision.

The participants satisfaction design is measured using self reporting. The results are directly used to interpret how the overall participant felt about the vision. If desire to change the vision are expressed, these are evaluated by the researcher on whether they are an incremental or radical change to the developed vision.

4. Results Design Process

The results of the design process are presented following the four steps of the game design process: (1) design specification, (2) system analysis, (3) game design, and (4) game construction (Peters & van de Westelaken, 2014). After each main section, a summary of the overall results of that section is presented. This serves as input for the next sections. As the game design process is iterative, the results are not in presented chronological order, but in order of subject.

4.1. Design Specification

In section 2.2.2, the aim of the game is formulated to be a "design and (social) engagement tool for the development of a future vision in the participatory backcasting process." In this formulation, there are three objectives. Namely, (1) develop a future vision, (2) manage (social) engagement, and (3) be part of the participatory backcasting process. In this section, these objectives are further defined, and possible sub-specifications are introduced based on the expert interviews, discussions with possible case owners, and discussions with this thesis' supervisors. Specifications that were discovered through these methods that do not fit one of the three main objectives are separately discussed. Finally, a summary is given of all specifications.

4.1.1. Develop a Future Vision

The objective to develop a future vision, is the design tool aspect of the developed game. In this context, this means that the output of the game should be the desired future scenario developed by the participants. What this exactly entails can be found in section 4.2.2.

In the expert interviews, it was mentioned that it is important that the vision the participants develop is really their own: *"You want them to make their own vision, but at the same time you can not be part of these visioning process. Like, your input could be to help them back on track but at the same time you cannot really just go brainstorming"* (Interview 1). As the developed game is used as a tool to support the facilitator, this advice should also hold true. Thus, the game should not be leading the participants to a certain direction for the final vision.

4.1.2. Manage (Social) Engagement

The goal of a (social) engagement tool is to involve stakeholders and guide and generate interaction between the stakeholders (Quist, 2007, 2013). Possible challenges and strategies for this can be found in section 4.2.1.

In relation to (social) engagement and games, one of the experts mentioned the following: *"If you put [the participants] in teams to compete, that you put them to compete against each other in the more strategic aspects, then you can lose a little bit of these depth that you need"* (Interview 1). This is explained as the participants will then give input based on the want to win the game, instead of to make the best future vision.

4.1.3. Part of Participatory Backcasting Process

The theoretical framework for the participatory backcasting process has been discussed in section 2.1. However, the developed game is applied in a real-world setting, which means there are practical considerations for the game to be part of the participatory backcasting process.

In the discussion with the thesis' supervisors, it became clear that the participatory backcasting process typically consists of preparation and (at least) two workshops. In the preparation, the strategic problem orientation (step 1) is conducted, the workshops are developed, and stakeholders are identified and invited. In the first workshop, there is a focus on the development of the future vision (Step 2). Finally, in the second workshop, there is a focus on the backcasting analysis (step 3), followed by the elaboration of future alternatives and agenda definition (step 4), and follow-up is stimulated (step 5). Of course, as participatory backcasting is an iterative process, the rules of this set-up are not set in stone. The facilitator and participants can choose to take steps back and forward depending on the needs of the group and the process.

As the step relevant to this thesis (step 2), typically takes one workshop, the developed game must not exceed the time of such a workshop. This includes introductions, briefing, game play and debriefing the game. Based on discussions with both supervisors and case owners, workshops usually take half a workday. Thus, the full game sessions must not exceed 4 hours.

Finally, in the discussions with the thesis' supervisors, it was indicated that it can be hard to predict how many people will show up to a workshop. Furthermore, it would be beneficial if it can be applied in a variety of contexts. For this reason, it would be best if the developed game is easily scalable to different group sizes.

4.1.4. Other
Finally, there were several specifications mentioned that did not fit in one of the three objectives of the goal of the game. These specifications are formulated in this section.

Firstly, several experts mentioned how important it is for a game to fit the case. One person said, *"We were using the cards that we had for Germany for Brazil and the one person called us out and was like: 'we don't use heating in the winter here.' [...] You really need to tailor it to the specific context and it's always good to know about the background as well and who's participating"* (Interview 1). This example shows how important it is that the game is developed for the case at hand. To achieve a higher impact with the game, it can also be developed so it can easily be adapted to a range of comparable cases.

Furthermore, the developed game should match the level of understanding of the participants. One expert mentioned *"If you directly go towards visioning with entrepreneurs who do not see the added value, you have to start on a different level then, maybe city or regional level. The more you zoom in, you have to give a little more input. [...] You can't start with an empty sandbox and say, 'well, go ahead and get started.' You have to help them."* (Interview 9, original interview not in English and translated by researcher). This was also corroborated by possible case owners, who mentioned that for the entrepreneurs on their business park, the game should be easily understandable. If this would not be the case, they thought the entrepreneurs would not interact in the level necessary to develop a future vision.

Finally, as the developed game is used to develop a future vision on a business park to become more circular, possible case owners requested that the game is also explains what this means. Thus, besides developing a future vision, the participants were also education of the circular economy and possible strategies for business parks. Information about this subject can be found in section 2.3.

4.1.5. Overall Results Design Specifications

In Table 4.1, a summary is given of all the specification discussed above. Furthermore, all specifications were categorized whether they are essential for the developed game (a need; N) or it would be nice to have, but the game could work without (a want; W). If the specification was classified as a want, reasoning is given why the developed game could work without this specification.

Table 4.1 Summary results design specifications

	Specification	Source	Need (N) or Want (W)	
1	**Develop a vision**		N	
	Not leading	Interviews	N	
2	**Manage (social) engagement**		N	
	Not competitive	Interviews	W	Competitive elements are possible if it does not interfere with the quality of the input.
3	**Part of participatory backcasting process**		N	
	Maximum 4 hours	Supervisors/Possible case owners	N	
	Scalable	Supervisors	W	Scalability not required in thesis, but good for larger impact.
4	**Other**		-	
	Adaptable	Interviews	W	Adaptability not required in thesis, but good for larger impact.
	Understandable	Possible case owners/ Interviews	N	
	Explains circular business parks	Case owners	W	Education also take place outside the game, during introduction or briefing.

4.2. System Analysis

Based on the results from the design specifications, the system analysis investigates (1) social engagement during (participatory backcasting and visioning) workshops, and (2) vision design and the process of creating a vision. For both subject, after the investigation, a summary is given of how this knowledge can be used for the final game design. Furthermore, overall results are presented at the end of this section.

4.2.1. (Social) Engagement During Workshops

The reason the participatory backcasting framework asks for tools to guide (social) engagement during the workshops, is because there are many difficulties associated with working with diverse stakeholders. This section tries to uncover the most important issues. Additionally, different strategies to overcome the challenges associated with stakeholder engagement are discussed.

The first issue comes from miscommunication due to the different language used by laypeople and experts in the field. When experts use too much jargon, laypeople can feel excluded from the conversation. At the same time, experts might feel that using non-technical terms does not capture the nuance of their statements (Glicken, 2000).

Furthermore, stakeholders of the participatory process may feel discounted when the facilitator does take the participation seriously. For example, if their input is discarded because another decision has already been made (Glicken, 2000). During the interviews, one person mentioned *"You have to be acutely present throughout the entire workshop and be really sensitive to subtle nuances in the room. I actively ask people when you*

see that someone is not active or if you sense a change in the mood in or atmosphere in the room" (interview 4).

Another challenge is that participants should feel safe to share their input. Contributing to this are the interpersonal dynamics of the present stakeholders and feedback giving after giving input (by both facilitator and other participants). On the interpersonal dynamics aspect, (perceived) power dynamics can result in people not feeling safe to give their input. For example, during one of the interviews it was mentioned that students in China were completely silent while their professors were present but give valuable input when separated in a different group (interview 1). Additionally, if the people know each other outside of the workshop, they might have preconceived ideas about each other which can result in giving biased or strategic input in the workshop (interview 8). When someone decides to share their input, it should be reinforced with positive feedback as a vision can never be wrong (interview 8). As facilitator you must make sure everyone is heard and no one is making fun of each other (interview 4).

General strategies mentioned during the interviews to increase and manage (social) engagement were to (1) emphasize the reason the participants were present and added value for them to be heard (interview 1), (2) make the sessions enjoyable and interactive for the participants (interview 1, 2 and 4) and to reward the participants with food or snacks during any part of the workshop (interview 1, 2 and 6)

INPUT FOR GAME
As one of the goals of the game is to support (social) engagement during the workshop, the challenges and strategies are important input to the game. During the design of the game, the challenges were reflected upon and how the game would affect them. The strategies can be used as inspiration and how to deal with the challenges.

4.2.2. Visions and Visioning
A vision is "the more or less explicit claim or expression of a future that is idealised in order to mobilise present potential to move into the direction of this future" (van der Helm, 2009, p. 100). They come in many shapes and sizes. Generally, one can identify seven types of visions (see Table 4.2). The most relevant vision type during participatory backcasting is a policy (support) vision. This describes visions that are made in the context of a network of policy-relevant actors to influence its decision-making process (van der Helm, 2009).

Table 4.2 Vision types (from van der Helm, 2009, p. 99)

Vision type	Distinguishing characteristic
Humanistic	Universal betterment
Religious	Worldly life in relation to the hereafter
Political	Leadership and support
Business/ organisational	Leadership and convergence
Community	Consensual integration of actors and collective action
Policy (support)	Network constitution and decision making
Personal	Personal development project

Wiek & Iwaniec (2014) developed a framework for a good sustainable vision design. A good sustainability vision provides a goal in the development of strategies and motivates people to work towards that goal. To ensure that a sustainability vision is good, it must comply with 10 different criteria, which can be ordered into 3 quality groups (see Figure 4.1). The challenge in creating a good vision is that it balances all criteria (Wiek & Iwaniec, 2014).
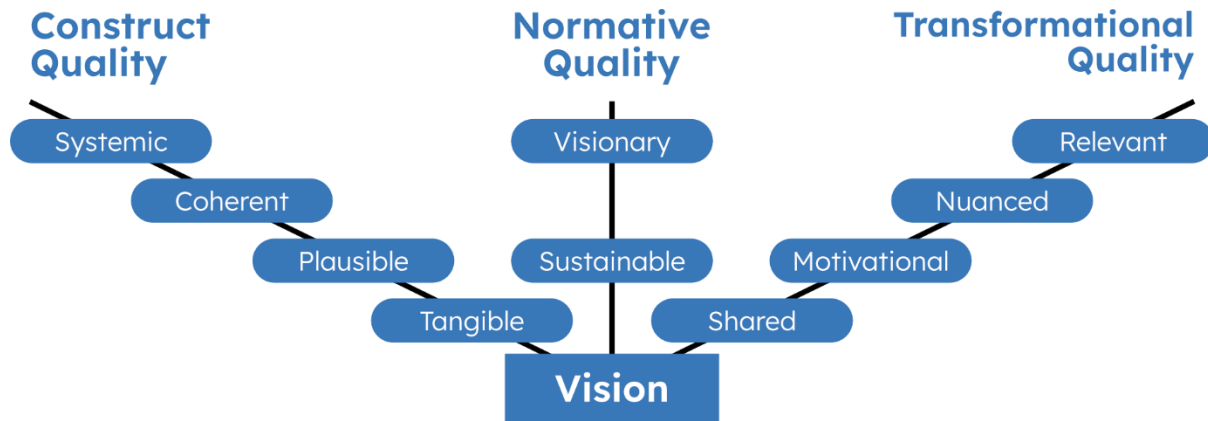

Figure 4.1 Criteria of a good vision (from Wiek & Iwaniec, 2014, p. 501)

In the expert interviews, the participants were asked what makes a well designed vision according to them. Furthermore, they were presented with several visions (see Appendix A) and asked to give feedback. In Table 4.3, criteria discussed in these interviews can be found. The second column shows how these criteria could relate to the criteria of Wiek & Iwaniec (2014). In the final column, a quote from the interviews is given discussing the criterium.

Considering that the criteria uncovered by the interviews closely align the criteria set by the framework of Wiek & Iwaniec (2014), they give a clear indication of what the output of the designed game should be. The only criterium that was not discussed during the interviews was *sustainable*. This can be explained as Wiek & Iwaniec (2014) define criteria for a sustainable vision, whereas the interview focused on visions in general. An additional criterium from the interviews that cannot be found in the framework, is that the vision must be accessible and easy to understand.

VISIONING PROCESS
Besides the outcome of a vision, it is also interesting to know how the visioning process (the designing of the vision) works. O'Brien and Meadows (2001) analysed many different vision methods. While every method was different, they were able to identify five key dimensions in the different visioning processes: (1) analysis of the organization's current situation, (2) assessment of the external environment, (3) identification of the desired future state(s), (4) connection of the future to the present state, and (5) testing the vision.

Important to note is that these dimensions are made about visioning processes that were not necessarily part of a participatory backcasting process. Considering this, some of these key dimensions might take a bigger focus in different parts of the participatory backcasting process and thus take more of a backseat during the develop future vision step. Figure 4.2 shows how the focus on these dimensions is distributed in the participatory backcasting framework.

Table 4.3 Criteria vision form interviews

Criterium interviews	Criterium Wiek & Iwaniec (2014)	Quote from interviews
Concrete	Tangible / coherent	Response to: "For every person to use their unique experiences and backgrounds, together – to spark solutions that create a better, healthier world." *I will just invite the person to, to explain this. Because there are many things that are personal that have a lot of personal values. And so, for instance. What is a better world? What is a healthier? According to whom? And if you are saying that you can explain to us, what do you mean with that. [...] I think it's clear, but I would like to if there is such a generic statement, it's interesting to invite the person to explain their vision.* (Interview 6)
Contains friction	Nuanced / systemic	*I also think that [a good vision] has to has to entail at least some element of friction and this is again to some extent to make it interesting and relevant. Because if you present something that is just a utopia, then it's quite hard to get conversations going and the friction can be about like articulating conflicts.* (Interview 4)
Easy to understand	N.A.	*Preferably as simple as possible and as simple as possible to understand for everyone. [...] But what I experience is that a vision you actually have to be able to [explain] in an elevator pitch and then it has to be clear. What is meant by it and where you want to go and give clear direction.* (Interview 8)
Affects everyday life	Relevant	*I would probably ask so how? Like, could you tell this like future from the perspective of a person who is moving around in the city?* (Interview 4)
Realistic elements	Plausible	*[The vision] has some realistic elements to it. That you don't feel that it's something that someone else has to make happen, but that you could contribute to, you as an organization or even you personally even if you are dead like then. It has something to look forward to for calling it somehow, that's a good vision. [...] It's realistic in terms that you feel there is something that you could do about it or that it could happen. Maybe not that you will do it right away.* (Interview 1)
Positive	Visionary	*Scenarios can be negative; the vision has to be positive.* (Interview 1)
Belongs to the group	Shared	*I also think that vision should be personal in terms that they belong to the group who created them. So even if you as facilitator think, 'I don't really fully understand', if they understand it themselves and they are the ones that want to make it happen. I think that as long as it relates to them, and they feel ownership of the vision. There is no right or wrong vision.* (Interview 1)
Exciting	Motivational	*A good vision should also be big. And you know that we have big courageous goal. So it was, it should be inspiring enough for you to want to get there.* (Interview 1)

As can be seen in Figure 4.2, the focus of the developing future vision step, is to identify the desired future state(s). The assessment of the external environment and the testing of the vision can be done to make the vision more robust but should not be in the forefront and is also tackled later in the process.

Participatory backcasting

	Step 1	Step 2	Step 3	Step 4	Step 5
	Strategic problem orientation	Develop future vision	Backcasting analysis	Elaborate future alternatives & define follow-up agenda	Embed results and agenda & stimulate follow-up

Key Dimensions Visioning Processes

Analysis of the organization's current situation

Assessment of the external environment

Identification of the desired future state(s)

Connection of the future to the present state

Testing the vision

Legend

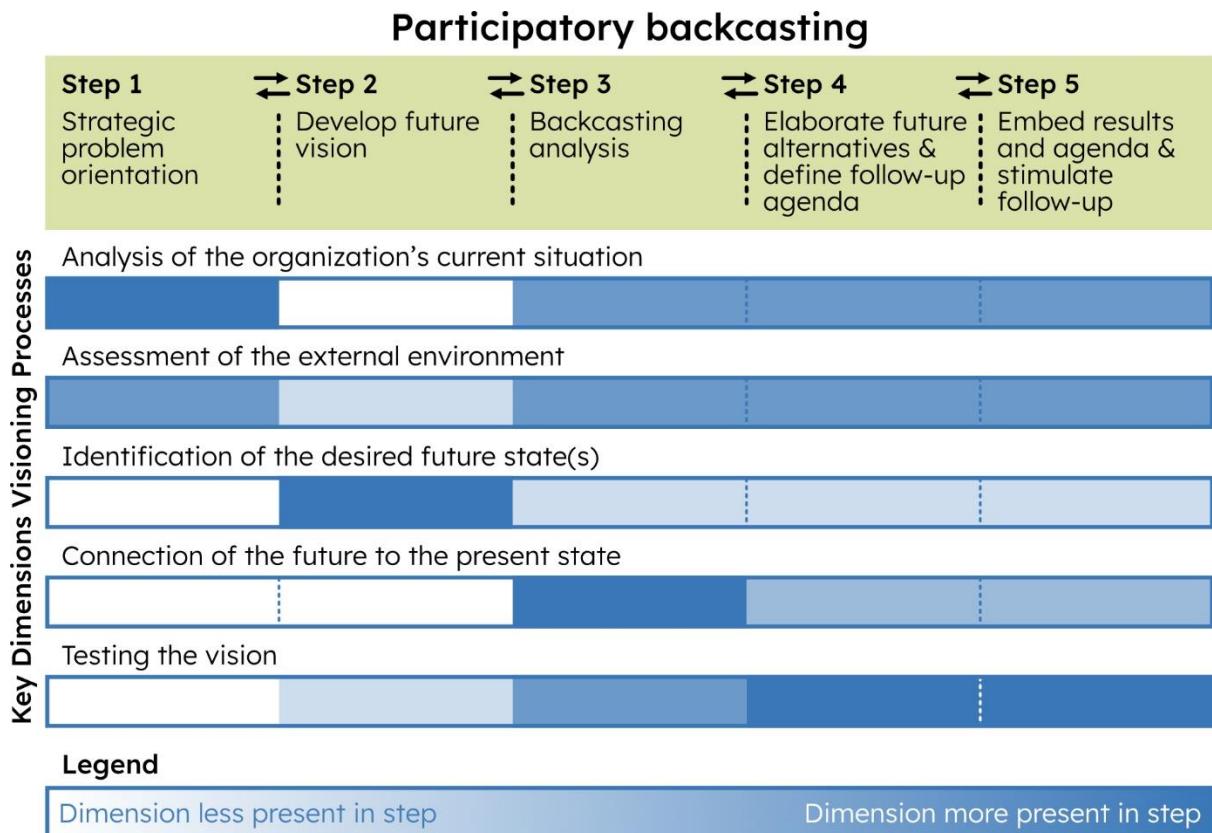Dimension less present in step — Dimension more present in step

Figure 4.2 Relation participatory backcasting and key dimensions vision process.

Thus, an understanding is needed of how to identify a desired future state. A possible process is introduced by Iwaniec & Wiek (2014). In their process, there are 6 main steps (see Figure 4.3). These steps are iterative, and one can move back and forth between those steps.

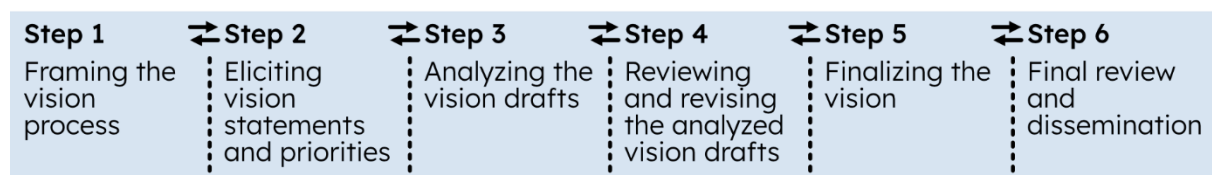| Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Framing the vision process	Eliciting vision statements and priorities	Analyzing the vision drafts	Reviewing and revising the analyzed vision drafts	Finalizing the vision	Final review and dissemination

Figure 4.3 Visioning process (based on Iwaniec & Wiek, 2014)

During the interviews, the experts mentioned several important things to keep in mind while facilitating a visioning workshop. First, it was mentioned that a big challenge for participants can be to put their wishes and desires into words. This can either be because they are not aware of their own desires, or do not know how to formulate this. As facilitator, you are there to help them find what they want (interview 8). However, as second point, the participants must make their own vision. Thus, as facilitator, you should not join the brainstorm on what the vision should look like. Your input is only to put them on track to develop their vision (interview 1). Finally, you must be respectful that it can be painful to think about what you do not have currently. Depending on

your stakeholders, they could live in uncertainty and talking about how they want to world to look, also highlights that their situation is currently not ideal (interview 6).

As the goal of the game is to develop a vision, this section gave input on what the output of the game should be and what process the game is trying to simulate. Namely, the final vision design should have the qualities discussed by Wiek & Iwaniec (2014) and uncovered by the interviews. Furthermore, the interviews highlight important elements on which the game should focus. The visioning process framework (Iwaniec & Wiek, 2014) can be used as a guideline of the flow of the game, as to simulate the process accurately. Additionally, the (relevant) key dimensions (O'Brien & Meadows, 2001) can be used as reflection in or outside the game.

4.2.3. Overall Results System Analysis

In this section, (social) engagement and visions and visioning as separate subjects related to the system developed which the game tried to simulate. Here, the relation between the subjects in the context of the case is presented. A diagram presenting the subjects and their relation can be found in Figure 4.4.

Starting at the green area on the left, the problem statement that contextualises the development of the vision, is wanting to create circularity on a business park. The concept of a circular economy and circularity on business parks are discussed in detail in the theoretical background chapter in section 2.3.

Table 4.4 Issues and strategies (social) engagement

(Social) Engagement
Issues
Miscommunication experts – non-experts
Participants do not fee heard
Not safe to share input due to: - (Perceived) power dynamics;   - History between participants;   - Fear of being ridiculed.
Being afraid to dream and being disappointed
Strategies
Being acutely present
Reward with food
Remind the added value to the participants

This problem statement is then used in the visioning session (red area). The flow of this workshop is determined by the process followed (section 4.2.2). The people present in this session try to achieve the aims based on the key dimensions of the visioning process (section 4.2.2). The interaction between the participants and the involvement with the content is guided by the participants and supported by (social) engagement tools, which are summarised in Table 4.4. and can be found in more detail in section 4.2.1.

Finally, the visioning session results in a policy (support) vision (blue area). The vision is good if it has the different qualities presented. These are explained in more detail in section 4.2.2.
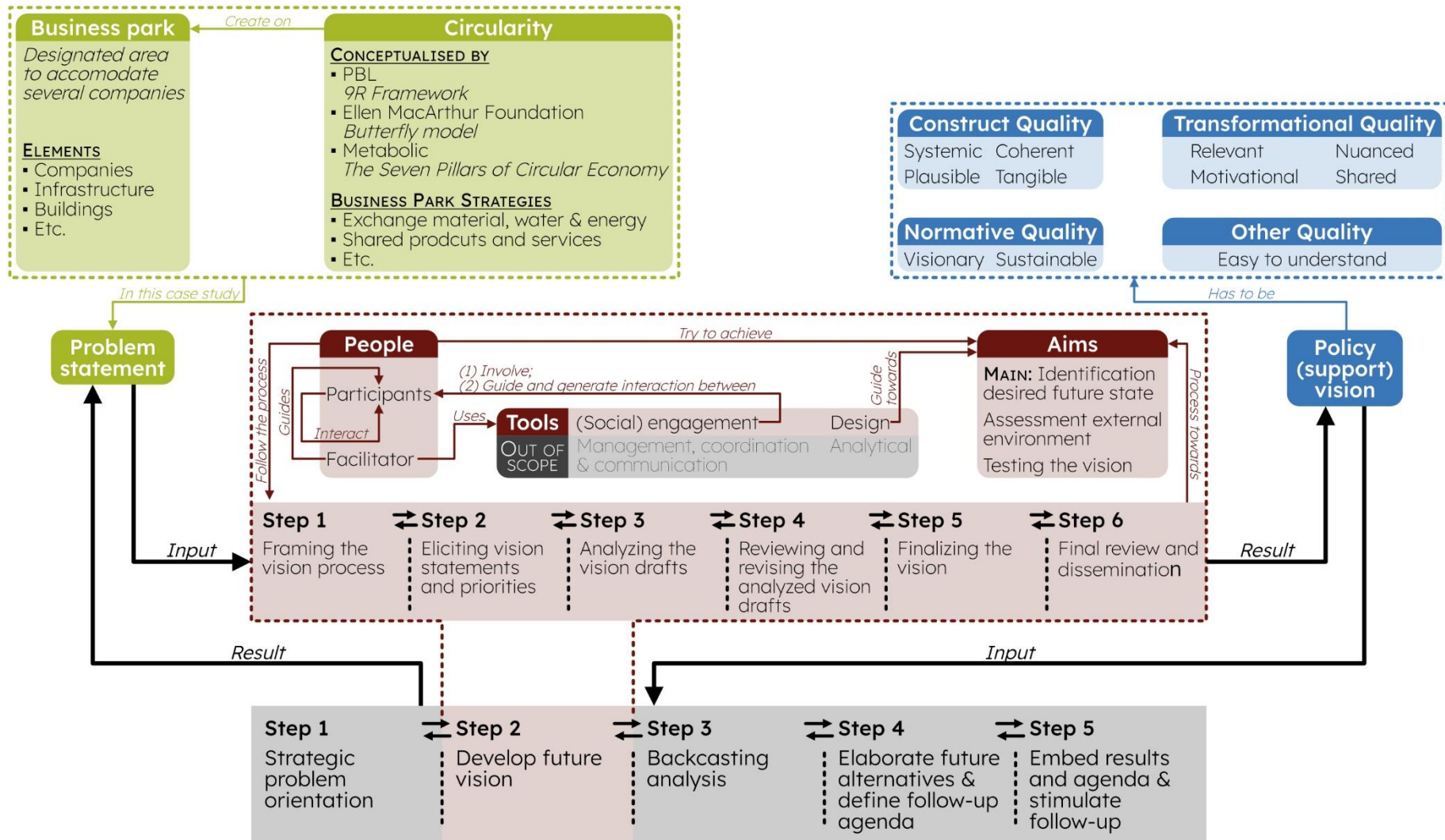
Business park

Designated area to accomodate several companies

ELEMENTS
▪ Companies
▪ Infrastructure
▪ Buildings
▪ Etc.

Create on

Circularity

CONCEPTUALISED BY
▪ PBL
  9R Framework
▪ Ellen MacArthur Foundation
  Butterfly model
▪ Metabolic
  The Seven Pillars of Circular Economy

BUSINESS PARK STRATEGIES
▪ Exchange material, water & energy
▪ Shared prodcuts and services
▪ Etc.

Construct Quality
Systemic Coherent
Plausible Tangible

Transformational Quality
Relevant Nuanced
Motivational Shared

Normative Quality
Visionary Sustainable

Other Quality
Easy to understand

Has to be

In this case study

Problem statement

People

Try to achieve

Aims

Guide towards

Policy (support) vision

Follow the process *Guides*

Participants

(1) Involve;
(2) Guide and generate interaction between

Interact

Uses

Tools
OUT OF SCOPE

(Social) engagement

Management, coordination & communication

Design

Analytical

MAIN: Identification desired future state

Assessment external environment

Testing the vision

Process towards

Facilitator

Input

Step 1
Framing the vision process

Step 2
Eliciting vision statements and priorities

Step 3
Analyzing the vision drafts

Step 4
Reviewing and revising the analyzed vision drafts

Step 5
Finalizing the vision

Step 6
Final review and dissemination

Result

Result

Input

Step 1
Strategic problem orientation

Step 2
Develop future vision

Step 3
Backcasting analysis

Step 4
Elaborate future alternatives & define follow-up agenda

Step 5
Embed results and agenda & stimulate follow-up

Figure 4.4 Final results system

4.3. Game Design

In section 4.1, several specifications for the designed game were set. The main goal of the game is to manage the (social) engagement while developing a vision within the participatory backcasting process. The required elements were that the game is (1) not leading, (2) shorter than 4 hours, and (3) easily understandable. Elements that the game could have but are not required to have, are that the game is (1) not competitive, (2) scalable, (3) adaptable to different cases, and (4) provides education about circular business parks and the circular economy.

Based on these specifications and the system analysis of the previous section, a record of games is made (see Appendix C). This record is not meant to be an inclusive overview of all games fitting the criteria. The goal of this record is to give input to brainstorm for new concepts and use the different games as a base for (elements) of the developed concepts.

Using this record as inspiration, three concepts were developed. Each concept is explained in detail in the sections below. In these sections, the three phases of a workshop with a serious game (briefing, gameplay, and debriefing) are related to the visioning process (Iwaniec & Wiek, 2014), in detail discussed in section 4.2.2. After every introduced concept, a reflection of that concept is given based on a talk-through of the game.

4.3.1. Concept 1

The inspiration game for the concept 1 is *Who's the man?* (Unknown). Like *Who's the man?*, concept 1 uses participant-generated input as the driving factor of the game. Furthermore, the game consists of several rounds using the input and interpreting it on different levels.
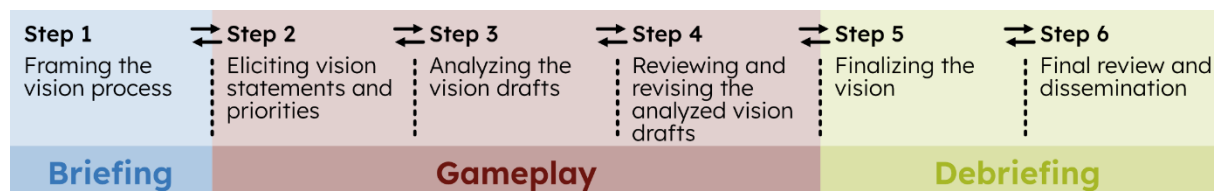
Figure 4.5 Structure game concept 1

In Figure 4.5, the relation between the phases of a game workshop and the different steps of visioning is shown. The content of these three different phases is discussed below.

BRIEFING

The goal of the briefing for concept 1 is to frame the visioning process. This introduces the participants to what is going to happen, as well as bring them in an appropriate state of mind. During the briefing, the facilitator explains the goal of the session (develop circular vision for business parks) and gives a short presentation to provide the participants with background knowledge on the circular economy. Furthermore, the participants get the opportunity to ask questions. Finally, the rules of the game are explained, and the gameplay can start.

GAMEPLAY

The gameplay covers three phases of the visioning process (from *Eliciting vision statements and priorities* to *Reviewing and revising the analysed vision drafts*). The full game consists of four rounds.

Generating Input: The first round of the game is to create the vision pool. For this game, the participants are split into groups of 4 to 6 people. All groups are giving a different set of question cards to which they need to write down coherent answer statements on a separate piece of paper. The questions are based on the system analysis from section 4.2. Every group is asked to assign a leader that is tasked to make sure everyone is heard.

Swapping the Narrative: In the second round, the statements generated in round 1 are swapped between the groups. The groups are asked to make a coherent story with the received input. At the end of this round, the leaders are asked to present the narrative. All groups will have received markers and a big paper to support the story.

Decomposing into Themes: After making the narratives, the groups are asked to make different groupings of the received input in one theme. Additionally, they should add one answer that does not fit the theme. When the themes are made, the leaders alternate in presenting the groups without including the name they had given the theme. The other groups must guess the odd one out and name the presented theme.

Analysing the Differences: In the final round, the participants are asked to find the difference in themes and narrative details between the groups. The challenge is to find a unique element and present it to the other groups. After a unique element is found, the group can highlight it on their paper. The aim of this round is to find the most unique elements.

DEBRIEFING

The debriefing covers finalising the vision and final review and dissemination steps of making a vision. The goal of these steps is to formulate the final vision and reflect on the vision and see how this fits the participants world view. Besides, the participants are asked to reflect on the whole process and their take aways of the workshop.

To formulate the final vision, an overview is made with all unique elements. The participants can anonymously vote which elements they find most important. Then, the facilitator is tasked to formulate a draft vision including the elements in which the narratives overlapped and the most important unique elements. This draft is then discussed and adapted with the participants until a satisfactory vision is achieved.

After the final vision is developed, the reflection on the vision and the process occurs. This is done using conversation starter questions together with a central discussion.

REFLECTION CONCEPT 1

At the core of concept 1, is that stakeholders are able to shape the topics of the discussion during the game from the first possible moment. Then, at every next step, they can use their topics at deeper levels. This means that the vision would truly come from the participants and not from the game. However, this would only be the case if the questions used in the first round is actively designed to be as neutral as possible.

Furthermore, a positive aspect to this concept is that the game can easily be adapted by the facilitator. If the game was to be used in a different case, only the cueing material of round 1 would need to be adapted. Additionally, during the game, the facilitator can decide to focus more and less time during the different rounds, depending on what an appropriate focus is for the case at hand.

While on the one hand, the separate, semi-detached rounds can be used as tool of the facilitator to guide the focus. On the other hand, the separate, semi-detached rounds

could also mean the structure of the game and workshop could become chaotic and confusing for the participants.

Additionally, during the game, the participants make 2 or more separate desired future scenarios and finally summarising them in one final vision. This bringing together could lead to inconsistencies. In order to circumvent this, the facilitator needs to be acutely aware of the nuances of all developed scenarios. Furthermore, if this is successful, there is still the risk that people hold on to the scenario their group has developed instead of the shared vision. Having multiple visions in a backcasting experiment has been found to lead a less significant degree of follow-up and spin-off compared to experiments with a single vision (Quist, 2007).

Besides, as a serious game, there should be a proper balance between the reality, its goal, and enjoyment while playing (Harteveld et al., 2010). For concept 1, the reality can be properly implemented with the cueing cards. The goal of developing a vision can be achieved by the flow of the game. However, it is unlikely this concept increases the enjoyment of the workshop significantly compared to more traditional (social) engagement tools. Thus, this could reduce the added value of using a game in the participatory backcasting process.

Finally, besides the quality of the game, the goal of the game development should be considered. These goals are stated as managing (social) engagement and develop a vision. Whereas concept 1 does provide guidance for the (social) engagement during the exploration and analysis of the game, the final development is a more traditional format. In the end, the vision is developed by sitting together and discussion the trade-off between the vision prototypes and come to a compromise.

4.3.2. Concept 2

In section 2.2.1, the vision development process in the game *AudaCITY* (Keeler et al., 2022) was criticized, as the goals of the vision were determined by drawing cards. Thus, the game and its designers decide the essence of the goal instead of the participants. Concept 2 takes the same setting - the participants having won a sustainability price and creating a story how they did that - but only focusses on the vision development instead of the backcasting analysis.

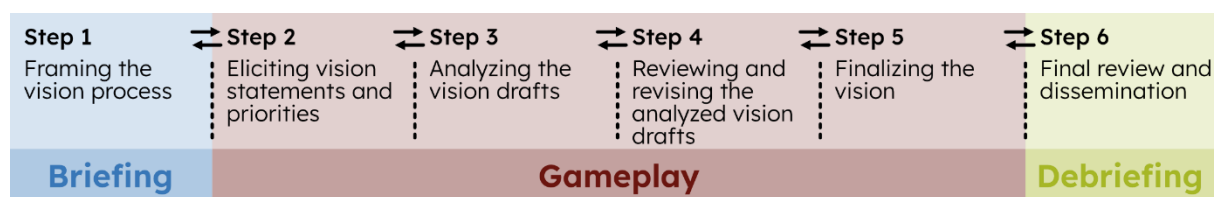| Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Framing the vision process	Eliciting vision statements and priorities	Analyzing the vision drafts	Reviewing and revising the analyzed vision drafts	Finalizing the vision	Final review and dissemination
Briefing	**Gameplay**				**Debriefing**

Figure 4.6 Structure game concept 2

In Figure 4.6, the relation between the phases of a game workshop and the different steps of visioning is shown. The content of these three different phases is discussed below.

BRIEFING

Again, the goal of the briefing is to frame the visioning process. Similar to concept 1, it is used to explain the content of the workshop and prepare the participants for the game. The facilitator explains the goal of the session (develop circular vision for business parks) and provides the participants with background knowledge on the

circular economy. Furthermore, the participants get the opportunity to ask questions. Finally, the rules of the game are explained, and the gameplay can start.

GAMEPLAY

The gameplay consists of some preparation and 3 playing rounds. As the game is a role-playing game, these rounds are further progressions in the storyline.

Preparation: All players receive a role sheet with partially completed information. The players are asked to finish the role sheet using either their own convictions, or the role they want to play. The roles include 6 stakeholders of a circular future (e.g., minister of circular economic affairs, CEO of *9R waste stream management*, worker manufacturing industry, etc.).

The facilitator welcomes all roles to the game and congratulates them on winning the price of being the most circular business park of the Netherlands. They are then asked to describe their park in an article, as to inspire all other business parks to create a situation as good as theirs.

Vision Pool: The facilitator explains that since the transition to circular business park was done together and in a participatory manner, the idea is to write this article together as well. Making sure all perspectives and ideas are heard. Groups of 4 to 6 players are made in which every role is represented at the most once. In the group, players are asked to think about the reality of their circular business park from their roles (e.g., day in a life, work environment, etc.) and how these roles interact with each other. If the players need it, they can use inspiring questions based on the input of section 4.2.

Analysing the Vision Drafts and Review: Players are asked to sit together with all other players with the same base role. Players with the same base role are asked to find elements of their generated scenario that compliment each other and that conflict with each other and how to solve this. Then, the original groups come together again, and the players present each other the changed input and discuss any new conflicts and the implication.

Finalize the Vision: Finally, the article needs to come together. Players are asked to show a final walk through of the business park, highlighting the circular elements. This is one using a template in which (part of) sentences need to be filled in. This template is centrally displayed, and the groups take turns on what needs to be filled in the blanks. If a group has a better way of filling the blank, they can steal a blank spot, to have their answer included. Furthermore, a map needs to be drawn up of the full park incorporating the important elements.

DEBRIEFING

During the debriefing, the participants are asked to reflect on the developed vision. During this time outside the game, they can still voice their concerns and communicate what they might change. Furthermore, the debriefing acts as a moment to reflect on the experience and to end the gameplay and learn from their experiences and how to use it in everyday life. This debriefing session can be facilitated using conversation starter questions together with a central discussion.

REFLECTION CONCEPT 2

As concept 2 is a role-playing game set in the future, the participants are forced to think about what this ideal future would look like from different perspectives. This can be beneficial for the vision, as personal opinions become less central to the discussion.

However, the participants would have to be willing to commit to the role playing for this to be effective.

Another positive aspect is that in this concept, the finalization of the vision is embedded in the gameplay. This provides a clear end state for the gameplay and gives the participants with a goal to work towards during the game.

Moreover, this game allows for a natural follow-up during the backcasting analysis phase. As the result of this game is an article describing the circular business park, a follow-up game for the backcasting analysis could be an article in the same media about the journey towards this vision.

However, this concept also has an important downside. During the game, there is little structure and guidance given to the participants. Given that they are not experts about circularity or vision making, it could be difficult to envision such a future with this little guidance. Furthermore, the immersion in the game could decrease by confusion about what should happen. This means that the goal of managing (social) engagement could suffer, as to much of the participants focus is delegated to understanding what is happening instead of making the vision.

Additionally, during the game there is little opportunity for education on a circular economy. Instead, the participants are left to figure out what this means for themselves and their roles. It could become very difficult for someone who is not well versed in the concept of circularity to contribute to the discussion. As the goal is to have all perspectives heard, this would be unacceptable.

4.3.3. Concept 3

The games that inspired concept 3 are *The Thing from the Future* (Candy & Watson, 2014), *Make A World* (Gray, 2011) and *The Extraordinaires Design Studio* (O'Connor, 2013). Like *The Thing from the Future*, concept 3 asked the participants to create elements in different types of futures, based on randomized element and theme cards. Then, like *Make A World*, they are asked to visualise their ideas from accessible materials to communicate their plans. Finally, the Think Cards from *The Extraordinaires Design Studio* are used for inspiration, as after the participants have made a vision prototype, they are asked to reflect using similar questions cards.

Step 1	⇄ **Step 2**	⇄ **Step 3**	⇄ **Step 4**	⇄ **Step 5**	⇄ **Step 6**
Framing the vision process	Eliciting vision statements and priorities	Analyzing the vision drafts	Reviewing and revising the analyzed vision drafts	Finalizing the vision	Final review and dissemination
Briefing	**Gameplay**			**Debriefing**	
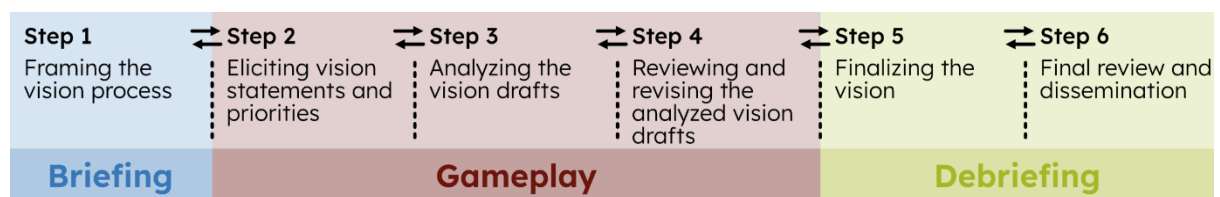
Figure 4.7 Structure game concept 3

In Figure 4.7, the relation between the phases of a game workshop and the different steps of visioning is shown. The content of these three different phases is discussed below.

BRIEFING

Again, the goal of the briefing is to frame the visioning process. This introduces the participants to what is going to happen, as well as bring them in an appropriate state of mind. During the briefing, the facilitator explains the goal of the session (develop circular vision for business parks) and gives a short presentation to provide the participants with background knowledge on the circular economy. Furthermore, the

participants get the opportunity to ask questions. Finally, the rules of the game are explained, and the gameplay can start.

GAMEPLAY

The gameplay of this concept consists of two phases. In the first phase, participants are asked to generate small parts of a possible future. Then, in the second phase, the elements should be placed in a real-world environment and trade-offs are discussed.

Vision pool and determining priorities: The participants are split-up in groups of 3 to 6 people. Each group receives of a six sided economy die, deck of theme cards based on the Seven Pillars of Circular Economy framework (Metabolic, 2017) and a deck of cards with elements that could be present at business park.

This part of concept 3 is played in several rounds. Per round, the groups select a theme card, an element card and roll the die to determine the context. Once the theme, elements and type of future are determined, all players take one minute to write down their idea of an element in this theme that could exist in this future. Afterwards, all players explain their thoughts to each other, and a vote is made what the best execution is of this element.

Constructing coherent scenario: With the elements gathered, all groups are asked to place the elements on a map of their business park and how these would interact and support each other. If the group is satisfied with the prototype vision, they receive a *Reflection* card from the facilitator. This card has three questions about the vision and the group is asked to reflect using these questions. If needed, they are allowed to change their prototype vision. Finally, the new circular business parks are presented between the groups.

DEBRIEFING

The goal of the debriefing session is two-fold. First, the aim of the debriefing is to finalize the vision and reflect on it. Furthermore, the debriefing acts to wrap up the experience, understanding people's experiences and a moment to reflect on the process.

(Most likely) the different presentations of the future are not the same and have incompatible differences. During the debriefing, these differences are discussed, and the participants are asked to make trade-offs and comparisons between the different vision proposals.

After this discussion is concluded, there is a reflection on the vision and the process. This is done using probing questions together with a central discussion.

REFLECTION CONCEPT 3

This is a relatively simple game that gives the participants a subject and a topic relating to circular economy. This results in unplanned combinations, which encourages creative thinking. Furthermore, by alternating thinking about a circular future and a linear future, the participants are forced to reflect on the differences and explore the extremes in the situation.

As the input for the idea creation is relatively limited, the changes of the game influencing the participants ideas is slim. On the contrary, it gives them the opportunity to form their own ideas within the topic. In this way, concept 3 allows for a lot of input of the participants.

Furthermore, the concept allows for easy adaption. During gameplay, the facilitator can adapt and highlight focus, by choosing an appropriate *Reflection* card. Moreover, if the game is implemented in a different case, the facilitators would need to change the cards. However, the structure can remain the same. Additionally, depending on the group size of the workshop, the number of groups can be changed.

In this concept, similar to concept 1, the final vision formulation is during the debriefing of the game. However, in this concept, there is a less traditional situation of discussing the different options. Instead, there are multiple vision prototypes with physical representation that provide input for the discussion.

The beginning of concept 3 has a slight competitive element. However, this is in the phase where strategy is made and could boost the creative thinking. Considering this, the competition is harmless for the greater goal of the game.

An element that needs to be paid attention to in the further development is the integration of the two phases. While the phases are less detached then in concept 1, as the elements brainstormed in the first phase are central to the discussion of the second phase. However, the transition between the two phases needs to be designed properly as to avoid unnecessary chaos.

4.3.4. Comparison and Selection

Based on the reflections at the end of the sections introducing the concepts, a comparison was made which is used to select a concept to create the final design. The most important points of three reflections are summarised in Table 4.5.

Table 4.5 Comparison Concepts

Concept 1	Concept 2	Concept 3
Positive elements		
High level of input from participants	High level of input from participants	High level of input from participants
Easily adapted to different case	Role playing lets participants think from different perspective	Encourages creative thinking
Easily adapted to different focus	Final vision development embedded in gameplay	Easily adapted to different case
	Natural follow-up to backcasting analysis phase	Easily adapted to different focus
Negative elements		
Cueing material could be leading	Only works if participants commit to role playing	Transition between phases could be chaotic
Chaotic structure due to semi-detached rounds	Little guidance to how to make a circular vision	
Risk of inconsistent vision due to the merging of multiple scenarios	Due to limited explanation, participants who are not well versed in circularity could have difficulty in contributing	
Risk of competing visions if people hold on to their original concept	Complexity could negatively affect management of (social) engagement	
Not enough focus on the entertainment of the game		
Tradition final vision development		

Based on the comparison of the three concepts, concept 3 seems to be most promising. The game has the most potential of being an enjoyable game that fits the target audience, as well as properly meets the goals of the game development. Thus, this concept is used to design and develop the game further in the next step: game construction.

4.4. Game Construction

In this section, the construction and design of the different materials of the game are explained. Chapter 5 is used to explain the rules and flow of the game. Thus, this is not included in this section.

4.4.1. Card Decks - Elements and Themes

There are two card decks used during the first phase of the game: Element cards and Theme cards. Theme cards contain different themes related to the circular economy using the three frameworks described in section 2.3. Element cards contain elements that could be present at the business park. These elements are based on things that are present in an urban environment (e.g., buildings and infrastructure), a corporate setting (e.g., job and office), and a governance setting (e.g., network and rule). An overview of the content printed on the different cards can be found in Appendix D. The final designs can be found in Figure 4.8.

For these card decks, it is important that the cards are not too leading. The participants are supposed to give their own interpretation to the subject at hand. Furthermore, as the cards are used together and are meant to have the same importance during the first phase, this should also be reflected in the design.

Figure 4.8 Examples of the element and theme cards and their backsides

As the cards should not be to not leading, they only contain the word that is meant for inspiration. Any visual representation of the element or theme is left out, as this could influence how the participants understand the element or theme. However, a pattern with illustration relating the pillars of the *Seven Pillars of Circular Economy* is added to the background and the back of the cards to serve as a reminder as what types of content could be included in circular designs.

To ensure the two decks have the same importance, they are made the same size: the size of a standard deck of cards. However, it is useful that they are easily differentiated playing and cleaning up the game. First, both decks are given a different colour for quick card type recognition. To not be fully reliant on colour, the name of the type of card is added to the front of the card in a border around the word. This allows the participants to see what type of card it is while selecting the cards of the rounds. Furthermore, the back of the card has the type of card in a bigger font to differentiate the decks.

4.4.2. Economy Die
During the first phase, a die is used to determine whether the groups brainstorm about an element in a circular or linear future. However, as the main goal is to brainstorm about a circular business park, the chances of the die giving circular should be higher. This can be achieved by making four sides represent a circular future and two sides a linear future.

Figure 4.9 Economy die   Figure 4.10 Stamps for economy die

The construction of the die proved to be more challenging. Ordering a custom die, came with a minimum amount of 50 dice, which is not the scale needed for this thesis. Thus, they needed to be manually constructed. This is done by using a blank wooden die and using a stamp on the sides to represent the different futures. For the final design of the economy die, see Figure 4.9. The stamp was made by carving the mirror image of the desired die front in linoleum (see Figure 4.10) and using ink from an existing stamp set.

4.4.3. Answer Card

Finally, the participants need a space to write down their idea during the brainstorm. For this, it is important that the cards are consumed during the game. It is thus valuable if additional sheets are easily created when needed. Furthermore, as a reference for the next phase and the debriefing, the input of the brainstorm should be included.

The design is similar to the answer sheet of the *The Thing from the Future*. The top provides a space for the input of the brainstorm. Below there is a space to explain and/or draw the idea. The answer card is the size of an A5 and fully black-and-white (see Figure 4.11). This means that any printer can easily print two on an A4.

Figure 4.11 Answer card

4.4.4. Map

In phase two of the game, the participants need to place the generated ideas in the context of their own business park. This is done by giving them a map of their business park and placing the different elements brainstormed during phase 1. To allow for brainstorming freedom, the map shows three different areas: (1) the business park, (2) water, and (3) land surrounding the business park. To help with placing the elements, some reference sizes are given next to the map, with building footprints that the participants should recognise (e.g., the building of the workshop or a famous building close to the location of the participants). Additionally, it is possible to add the existing road network to allow participants to better place themselves on the map.
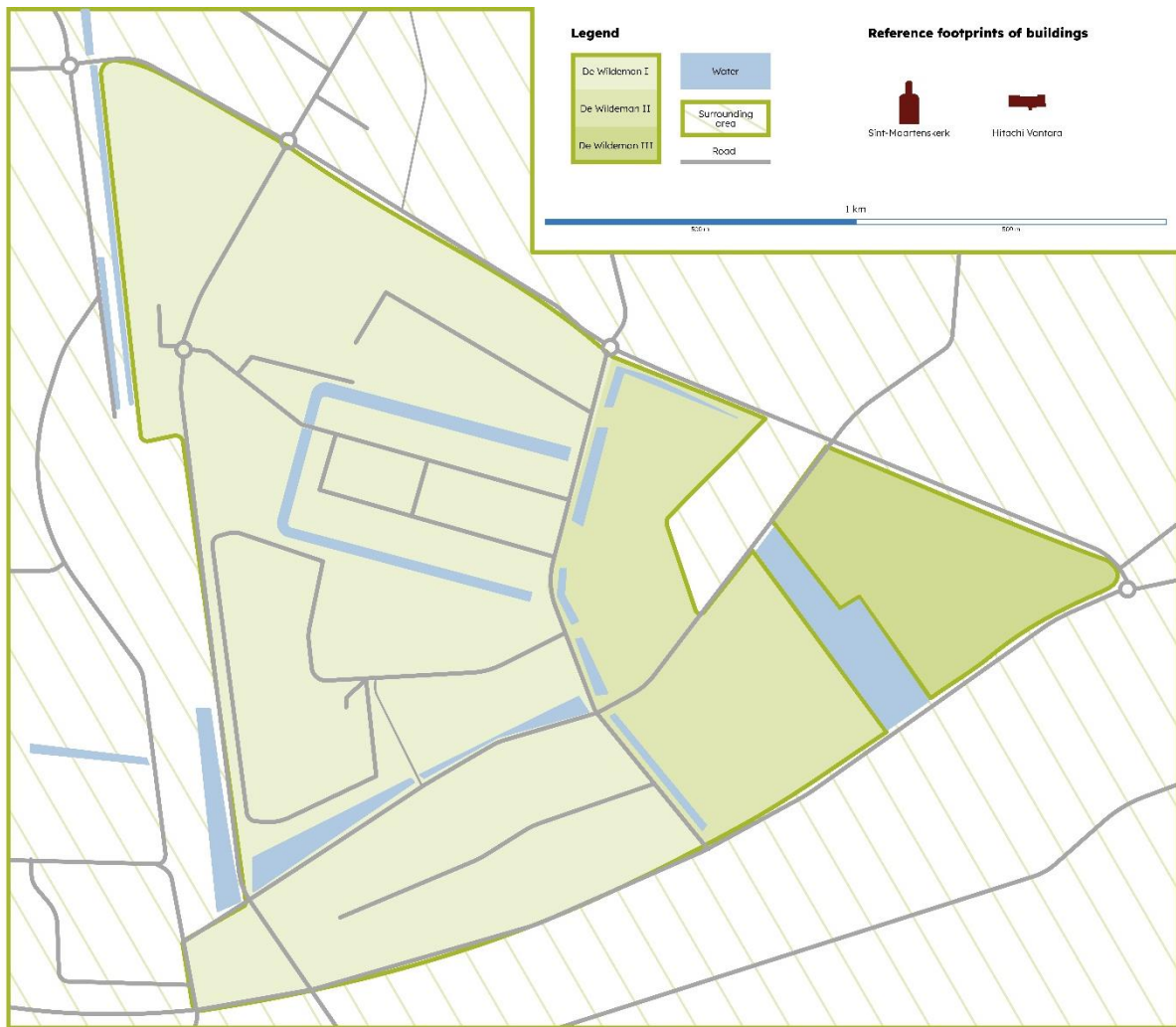
Figure 4.12 Example map of business park

4.4.5. Card Deck – Reflection

The reflection cards are added inspired by the *Think* cards of *The Extraordinaires Design Studio* (O'Connor, 2013). During this game, the player draws a card after having finished their initial concept. The card states three different questions; a research question, a design question and an improve question. All questions have a different subject, mentioned in the corner (see Figure 4.13).

The types of questions (research, design and improve) are kept for the design of the developed game. The subjects are changed to the criteria of a good sustainability vision of Wiek & Iwaniec (2014). On overview of the questions on the cards can be found in Appendix D. Like the Think cards of *The Extraordinaires Design Studio* (O'Connor, 2013), there is an illustration added per question type and the subject is added in the corner. The headings per question that are present on these Think cards are removed due to the limited space available on the card, as they do not have a significant added value.
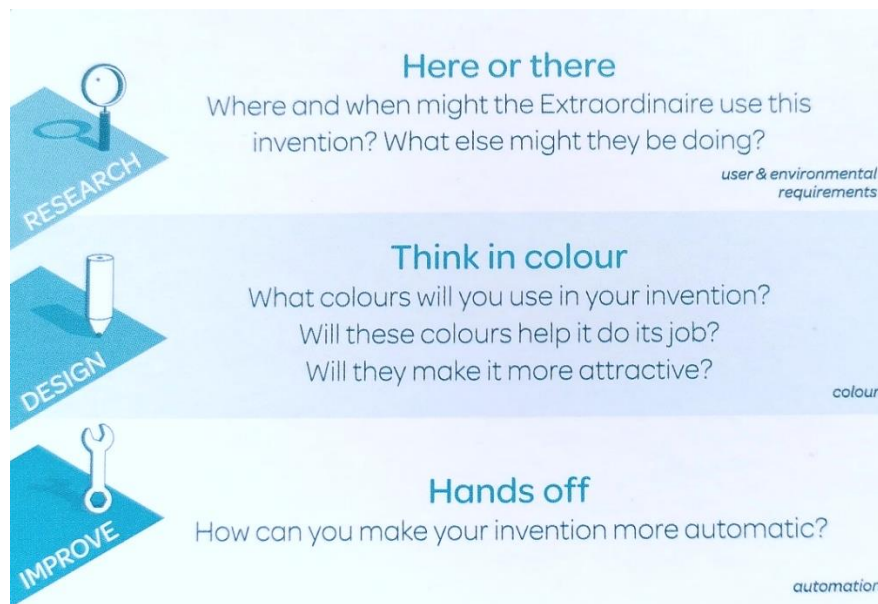
Figure 4.13 Think card from The Extraordinaires Design Studio (O'Connor, 2013)

The Reflection cards are the same width as the Theme and Element cards and double the height. This means that the three decks can be stacked up nicely together. The design is similar to the Theme and Element cards with the bold border and type of card in the border and on the back. Furthermore, the pattern on the cards is the same as the Theme and Elements card. The cards are made in a red colour that complements the rest of the design. The final design can be found in Figure 4.14.
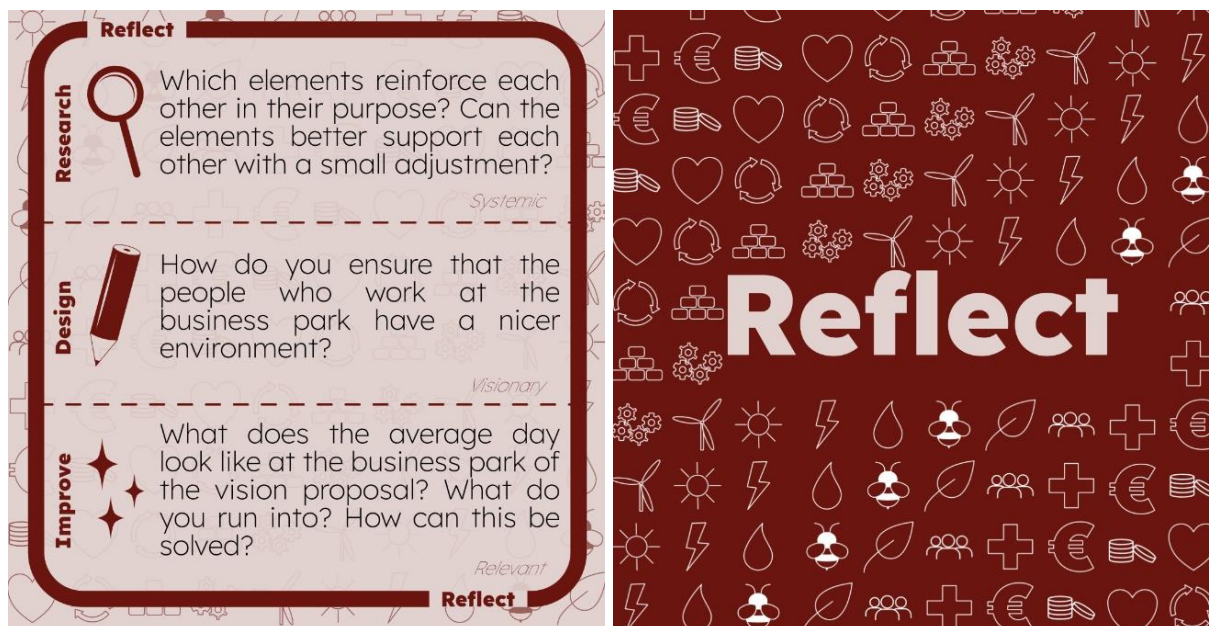
Figure 4.14 Example of the reflection cards and its backside

5. The Design

This section gives an overview of the design of the developed game. It gives the game rules and shows the materials used during gameplay. Furthermore, at the end of the section, alternative rule sets are presented that can be used if the workshop groups are different from the base design.

The developed game consists of two phases that are played in groups of 3 to 6 people. In the first phase, the participants are asked to generate ideas, while the second phase focuses on the contextualisation of these ideas on their business park. After both phases, there is a short moment in which the participants present their results to the other groups.

5.1. Phase 1: Generating Ideas

The first phase is a competitive round-based method to idea generation. The materials used in this phase are 2 decks of cards, an economy die and answer cards. The first deck of cards contains elements that *could* be present at a business park. The second deck has themes relating to the circular economy. The die has 4 faces indicating a circular economy and 2 faces indicating a linear economy. The answer cards are used to write down the generated ideas.

Every round during this phase has the same structure. One player starts as dealer. They put down as many cards from the two decks, so the total number of cards is the number of players in the group + 1 (see Figure 5.1 as example with four players). Then, all other players place 1 card to the discard pile, until there is 1 theme card and 1 element card left. Finally, the dealer rolls the economy die to determine the context. The remaining theme, element and economy combination serves as brainstorm prompt of all players for that round (for an example, see Figure 5.2).

Figure 5.1 Example start of round with four players

Figure 5.2 Example brainstorm prompt

After the prompt is determined, all players are asked to write down something they come up with on their answer card within 90 seconds. The answers are collected by the dealer, who reads them out loud. Together, the players vote on the best answer relating to the prompt and this player wins 1 point. If needed, the dealer serves as tiebreaker. The dealer role moves one spot clockwise and the next round starts. The rounds are repeated for a predetermined amount of time.

After all rounds are played, the groups are asked to come together. The winner of each group is asked to present their top 3 to 5 most insightful ideas. Every group is allowed to copy one idea per other group to take to the next phase.

5.2. Phase 2: Contextualizing Ideas

The aim of the second phase is to collaboratively build the future vision using the ideas of phase 1. The materials used in this phase are a map of the business park, a deck of card with reflection cards, scrap paper and pens (see Figure 5.3).

Figure 5.3 Starting materials in phase 2

During this phase, the participants are asked to place the 3 to 5 ideas they presented after phase 1 (or their circular counterpart in case of a linear idea) and the copied ideas on the map of their business park. After, they can add any of the other ideas they generated during phase 1 or add new ideas that emerge during the discussion.

After a set amount of time, or when the facilitator seems fit, they draw a reflection card. These cards contain 3 questions: a research question, a design question and an improve questions. Every question also has a theme that relates to criteria of good visions. For an example, see Figure 5.4.

Figure 5.4 Example of a reflection card

After the groups have created their vision proposals, they are asked to present the results to the other groups. Every group can ask questions to the other groups. After all the groups have presented, all participants are asked to come together to discuss how to bring the separate vision proposals together into one final vision.

5.3. Alternative Rule Sets

The rules described above assume a workshop of 6 or more participants from the same business park. While this is the preferred context of the game, this is not always possible. Thus, three alterations are made, so the game can be adapted to different contexts: (1) four or five participants from one business park, (2) three participants from one business park, and (3) six or more participants from different business parks.

5.3.1. Four or Five Participants from One Business Park

If there are four or five participants, all participants form one group in phase one, which is played normally. After, instead of the presentation, every participant is asked to name which idea they would like to see on the business park.

For phase two, the group is split in two. As starting situation, the groups must include the ideas that were named during the end of the first phase. From here, the normal rules are followed with the smaller groups.

5.3.2. Three Participants from One Business Park

The phase one adaption with two or three participants, is the same as for four or five participants. All participants form one group, which follows the normal rules. Then, at the end of this phase, every participant picks their favourite idea that was generated which idea they would like to see on the business park.

For phase two, the participants remain in a single group. They must include the ideas that were named during the end of phase one. Since this means that there is only one vision proposal generated, the visions cannot be compared. Instead, the group is asked to answer two reflection cards. At the end of the phase, the group has to describe a day-in-the life of someone working on the business park.

5.3.3. Six or More Participants from Different Business Parks

If there are six or more participants, but they are not from the same business park, there is a slight change in the rules. During phase 1, groups of participants are made with as many people as possible from the same business park. Then, the normal rules can be used. The generated ideas are still shared in a presentation and people are allowed to copy ideas from the other groups.

Phase two is again played in the same groups with as many people of the same business parks together. After this phase, the groups are asked to share their vision and ask questions. However, since the vision proposals are not for the same park, there will not be a moment of comparison and integration.

6. Results Research Process

As described in section 3.2.2, the effect of the game is tested by conducting a workshop for two different groups. First, the workshop was conducted with a group of 15 students of the master Industrial Ecology. Secondly, the workshop was conducted with 3 stakeholders of the business park De Wildeman. The results of these two workshops are described and compared below. Due to a technical error, some questions were only answered by 5 students. Furthermore, participants were allowed to leave any questions open. The number of participants is reported per variable. The results are split into three sections: (social) engagement, vision design and other.

6.1. Results (Social) Engagement

The results of (social) engagement are split in the three categories that there were measured. Per category, the results of the student workshop and stakeholder workshop are presented and compared.

6.1.1. Game Experience

The results of the game experience questionnaire (GEQ) can be found in Figure 6.1. The results of the student workshop were plotted on one boxplot per component. Based on the interquartile range method, six outliers were detected. Since these are natural outliers, the data is not removed from the discussion. However, they are plotted separately from the boxplot to give a more accurate presentation of division of the data. On top of the student boxplots, the results of the three stakeholders are plotted.

For all components of the GEQ, the results of the stakeholder workshop fell within the total range of the results of student workshop. For 6 of the 14 components (43%) all stakeholder results fell within the middle 50% of the student results. For the other 8 components, at least one of the results was located within this 50% middle range. In total, 11 of the 42 (26%) stakeholder results were outside the 50% middle range of the student results.

The results of the GEQ core module of the student and stakeholder workshop are similar and thus are discussed together. Results of two components that indicate high (social) engagement (sensory & imaginative immersion and positive affect on mood) scored relatively high, with most results scoring above the centre value. Results for the component flow, which would also indicate high (social) engagement, head a broad spread in results. The results of two components that would have a negative affect on (social) engagement (tensions/annoyance and negative affect on mood) scored relatively low with all participants scoring below the centre value.

For the GEQ post-game module, the student and stakeholder workshop are also similar, however, the stakeholder results do trend towards a more positive experience compared to the student results. Components that indicate low (social) engagement (negative experience and tiredness) score low. The component that indicates high (social) engagement (positive experience) scored spread results for the student workshop. For the stakeholder workshop, the scoring is neutral to high.

Finally, the results of the social presence module of the GEQ of the student and stakeholder workshop are also similar. The component indicating low (social) engagement (negative feelings) scored low. The components indicated high (social) engagement (empathy and behavioural involvement) score high and spread results, respectively.
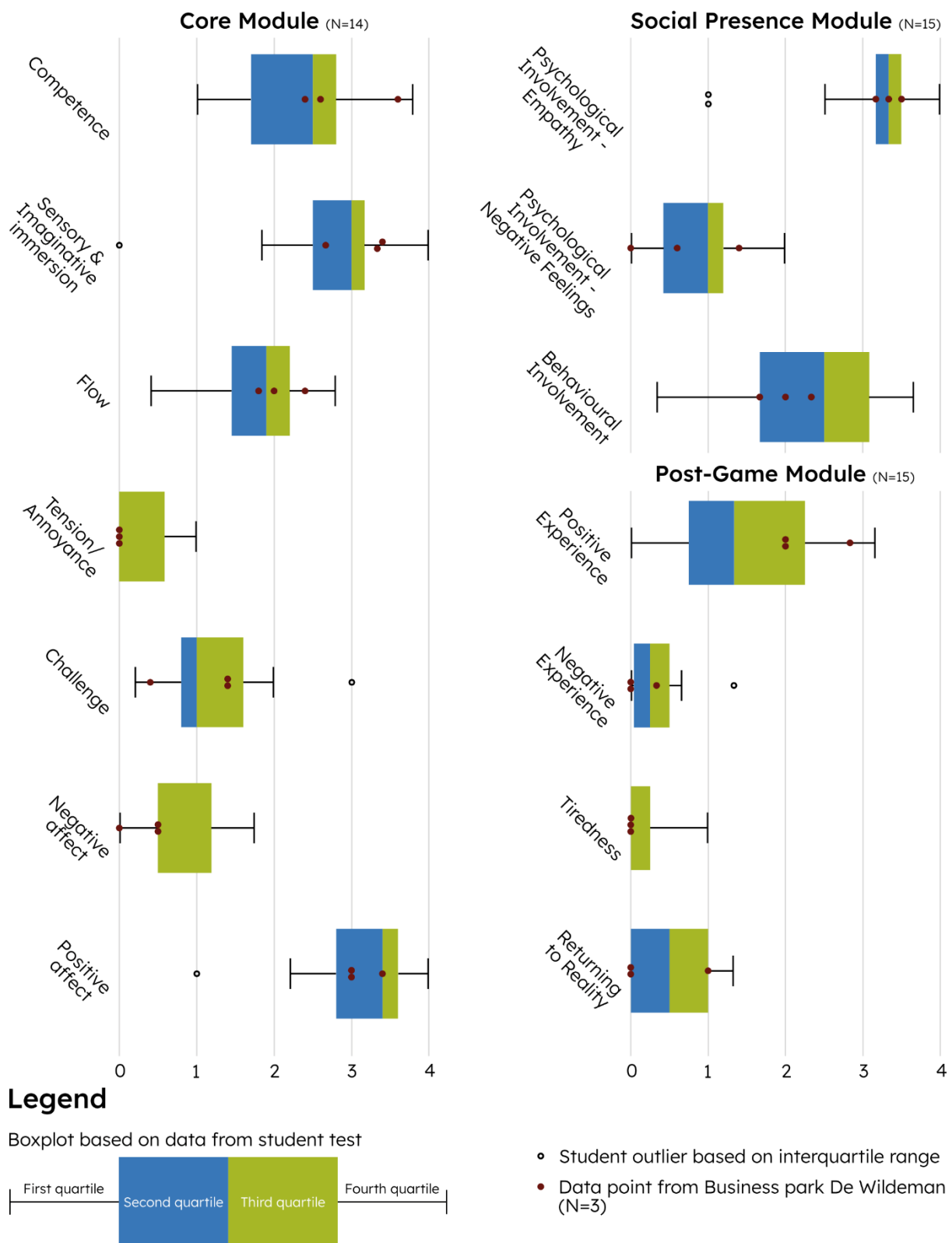
Core Module (N=14)

- Competence
- Sensory & Imaginative immersion
- Flow
- Tension/ Annoyance
- Challenge
- Negative affect
- Positive affect

Social Presence Module (N=15)

- Psychological Involvement - Empathy
- Psychological Involvement - Negative Feelings
- Behavioural Involvement

Post-Game Module (N=15)

- Positive Experience
- Negative Experience
- Tiredness
- Returning to Reality

Legend

Boxplot based on data from student test

| First quartile | Second quartile | Third quartile | Fourth quartile |

- Student outlier based on interquartile range
- Data point from Business park De Wildeman (N=3)

Figure 6.1 results GEQ

6.1.2. Learning

In the postquestionnaire, participants were asked to self report whether they found they had any insights about the concept circularity due to the game or other participants and if they had any insights for circularity on their business park. Furthermore, they were also asked whether there is a part of the vision proposal that they had not thought about before the workshop. The results can be found in Table 6.1.

Table 6.1 Self reported insights

	Results students	Results stakeholders
Any insights	13 (N=15; 87%)	3 (N=3; 100%)
Insights concepts of circularity from - other participants and/or the game - other participants - the game	 12 (N=15; 80%) 10 (N=15; 67%) 7 (N=15; 47%)	 3 (N=3; 100%) 3 (N=3; 100%) 2 (N=3; 67%)
Insights circularity business park	10 (N=15; 67%)	3 (N=3; 100%)
Part of vision proposal they had not thought about before workshop	3 (N=5; 60%)	2 (N=3; 67%)

The large majority of student (13/15) and all stakeholder (3/3) participants have indicated to have had insights surrounding circularity. This indicates that they were willing to have thoughts directed towards and aroused by the workshop. Furthermore, most participants (12/15 students and 3/3 stakeholders) also answered having learnt from other participants, which indicates the presence of relevant interaction between stakeholders.

During the pre-questionnaire, the participants were asked to give their definition of circularity. Most participants – students and stakeholders – answered this with a technical and strategy-based approach. Furthermore, more participants focussed on minimizing waste over minimizing virgin materials. 11/12 students and 3/3 stakeholders mentioned using waste as resource. 9/12 students and 2/3 stakeholders included the goal of minimizing waste, and 5/12 students and 0/3 stakeholders included the goal of minimizing the use of virgin materials. One student explicitly stated that circularity does not include downscaling production. One other student explicitly mentioned that the products need to create a positive impact. Other participants did not report about these topics.

During the post-questionnaire, the participants were asked about their insights about circularity in general and on the business park. In general, the insights described by the students are a more social and organizational approach to circularity compared to their answers before the workshop. Of the 13 students that reported to have any insights about circularity, 12 shared their insights. 7 mention that new methods of management are needed to improve circularity. 4/12 students with insights explicitly mentioned circularity includes a redistribution of wealth and 3/12 explicitly mention that the well being of people should also be included.

Besides learning about circularity, the participants were also asked whether they experienced (1) making trade-offs, (2) formulating argumentation, (3) approaching a subject from several perspectives, (4) making compromises, and (5) out-of-the-box thinking on a 4 step Likert-scale. The results of this part of the questionnaire can be found in Table 6.2. In this table, every column represents one participant.

Most students (4/5) and stakeholders (2/3) indicated to have had a lot of experience with at least one of the learning goals. One student indicated not experiencing the goals or experiencing them a little for all goals. One stakeholder indicated experiencing the goals a little or experienced one of the goals a fair amount for all goals. Considering that most participants had thoughts aroused by the game to experiencing these underlying themes, it indicates they were engaged by the game.

Table 6.2 Self reported experienced

	Students (N=5)					Stakeholders (N=3)		
Participant number	1	6	7	12	15	1	2	3
Making trade-offs*	3	2	2	0	1	2	1	1
Formulating argumentation*	3	3	3	1	3	3	1	1
Approaching a subject from several perspectives*	3	2	2	1	2	3	2	1
Making compromises during teamwork*	0	1	3	0	2	2	1	1
Out-of-the-box thinking*	-	3	3	1	2	3	3	2

* 0=did not experience, 1=experienced a little, 2=experienced it a fair amount, 3=experienced it a lot, -=no answer

Finally, during the debriefing of the workshop, the participants were asked about their insights and how they could use the experience of the workshop for vision making in the future. The response during the student workshop was that they would be able to use a vision-based approach to circular thinking rather than a strategy-based approach. During the stakeholder workshop, the main response was that they were reminded by the value of coming to a brainstorm with an open mind, rather than a goal that needs to be achieved. In both workshops, the participants were able to have a valuable and insightful discussion about how they could use the experience of the workshop to future settings. This indicates they willing to have thoughts directed towards or aroused by the game to learn and understand how to apply their new knowledge in a different context.

6.1.3. Perceived level of influence on the design

During the postquestionnaire, the participants were asked to what degree they felt that they personally had influence on the vision proposal using a 5-point Likert-scale. The results of this question are found in Table 6.3.

After, they were also asked to explain their answer. The student participant stating little influence explained that the vision was not targeted toward the main areas of interest for the proposal. The student participants stating high influence said they were *"considerably very involved throughout the game and [they] felt like [their] voice and opinion matter"* (Translated from Dutch by the researcher). One of the stakeholders said that they had high influence as they were with a small group with similar world views, which led to similar ideas.

Table 6.3 Perceived level of influence

	Students (N=5)					Stakeholders (N=3)		
Participant number	1	6	7	12	15	1	2	3
Self reported degree of influence on design *	1	3	2	3	3	3	3	3

* 0= No influence, 1=little degree of influence, 2=some degree of influence, 3=high degree of influence, 4=very high degree of influence

6.2. Results vision design

The results of the designed vision are presented in two sections. First, participant satisfaction of the vision is presented and than the developed vision proposals are checked for the criteria set by Van der Voorn et al. (2017): (1) presence of transformative elements, and (2) presence of goals and guiding targets. In both sections, both the results of the student workshop as the stakeholder workshop are presented.

6.2.1. Participant satisfaction

During the postquestionnaire, the participants were asked if they were satisfied with the developed vision proposal on a five-point Likert-scale and whether they would still like to adapt a part of the vision proposal. The results can be found in Table 6.4.

Table 6.4 Participant satisfaction

	Students (N=5)					Stakeholders (N=3)		
Participant number	1	6	7	12	15	1	2	3
Satisfied with developed vision proposal*	2	2	3	2	4	3	4	3
Would like to adapt developed vision proposal**	N	N	N	N	N	Y	N	N

* 0=No, very unsatisfied, 1=No, somewhat unsatisfied, 2=Neither satisfied nor unsatisfied, 3=Yes, somewhat satisfied, 4=Yes, very satisfied; ** N = No, Y = Yes

Most (3/5) student participants indicated being neutral towards the developed vision. One indicated some satisfaction and one indicated being very satisfied with the developed vision. The stakeholder participants were more positive about their developed vision. Most (2/3) were somewhat satisfied, and one was very satisfied. Overall, the results only indicate neutral to high satisfaction with the developed vision. Furthermore, only one (stakeholder) participant indicated wanted to change the vision. The proposed change was an incremental change, rather than a change of the essence of the vision. The change suggested change was that they would *"separate the warehouses and office spaces: one big building for 'technologies' and more smaller buildings for offices, allowing for self-expression"* (Translated from Dutch by the researcher).

6.2.2. Vision Evaluation

Van den Voorn et al. (2017) formulated two evaluation criteria for assessment and comparisons of future visions. These criteria are (1) presence of transformative elements, and (2) presence of goals and guiding targets. The three visions developed in the student workshops and the vision developed in the stakeholder workshop presented together below. The full visions of the four groups can be found in Table 6.5.

Table 6.5 Developed visions

Business park	Vision

Students: Botlek
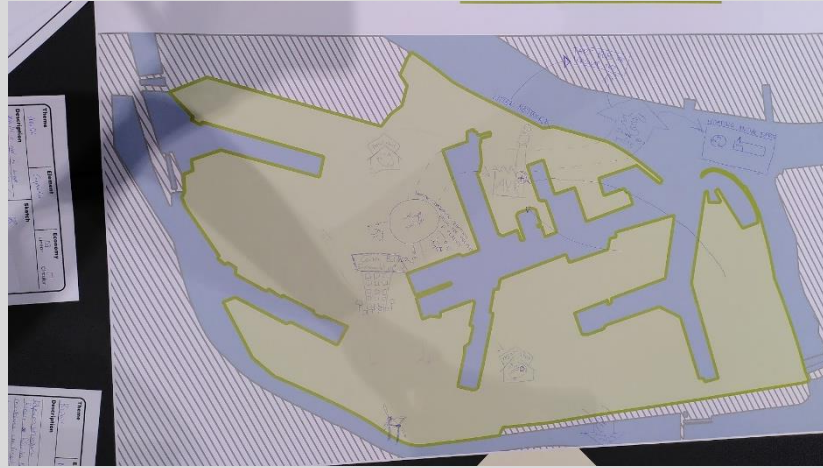
There is a central Botlek Environment office that manages and oversees al actions of the park concerning the environment. Things it oversees include on park windmills, a repair shop for small tools of the companies and stuff from the employees (material input is company waste), a litter network for cleaning litter (which is redistributed to art projects), and a floating animal farm. Furthermore, there is a wealth cooperation for creating value for people and planet. This cooperation ensures that the profits of the park are shared with the local community.

Students: Kwinana

A new distribution centre is placed in Kwinana. This collects materials, water, salt, and metals from the sea close by, while generating energy for the pump needed for this. Furthermore, a waste collection agency is set up to collect plastic from the local shore. This plastic is also shared with the new distribution centre, and what is not usable, is given to a local toy shop that makes children's toys from waste materials. In the buffer zone of the park, a recreational park is realised with a lot of green nature. In this park, there are also energy generating fitness equipment for the employees of the park to use.

Students: Höchst

The infrastructure services of Höchst will become a cooperation where to local community is also a shareholder. This will ensure that the needs of the community are also considered in the activities of the park. Traffic infrastructure is reimagined by only allowing electric vehicles and bikes on the park area to reduce pollution and noise. Companies on the park are only allowed o produce essential products and not luxury products to reduce its material impact. Energy for the park is generated on the park grounds, using windmills and solar panels. Community on the park grounds is prioritised by placing a community garden on the park to create food for the employees and the local community. Furthermore, around the river, a park is realised for recreation to support the local biodiversity. This park also has a fitness area to where employees can workout for free while generating energy. Finally, the park organises a monthly rave for all employees to increase trust between companies and for people too meet each other to make cooperation between companies easier. On the floor of the rave space, energy generating plates are located on the floor, so the dancing people also contribute to the energy generation of the park.

Stakeholders: De Wildeman (cont. next page)

The full park is reimagined from the ground up. Everything placed on the business park will be tracked in a material passport, so materials can be recycled after use.

As the west side of the park is facing the highway, the activities with the highest nuisance for neighbourhoods around the park are placed there. A large high-rise building is placed to cover the warehouse and office needs of the companies placed at the park. The basement floors to a few floors above ground are reserved for warehousing and the top floors for office and meetings spaces. The spaces in the warehouse and office area can be reserved for the companies on a month-to-month basis, so the space needed can fluctuate based on seasonal needs. The lower office floors are built to be modular and are easy to change to warehouse space for smaller pallets if the demand arises.

As the core infrastructure for most companies will be present in this building, companies new to De Wildeman can start with minimal start up time as they only need to buy in into the existing facilities.

On the roof of this building, the rainwater is collected for a separate grey-water network for flushing the toilets and cooling machinery or spaces in the building. Besides the rainwater collection there is a 3-way energy generation system based on the roof (only 2 methods present on the drawing). Firstly, the roof is covered in solar panels to create solar energy during the day. Possibly the solar panels can also be integrated onto the façade of the building. Furthermore, the roof offers space for urban-based wind turbines as the hight of the building allows for capturing higher wind speeds. Finally, water turbines are placed in the grey water network, using the force of the water coming down from the roof to generate a little extra energy.

As the warehouse of the full business park is centralised, it is the only area that trucks must reach. To make this more efficient, a new access road is made from the highway to the south of the central building that is only accessible for trucks. This way people transport does not hold up the trucks and vice versa. Next to the access road, there is an area for the truck drivers to park and use services to sleep, stretch and clean themselves. At the north side of the warehouse, a new exit road is placed that is also only used by trucks.

Next to the central building and the truck stop, there will be a restaurant and small supermarket for the workers of the park and truck drivers. This way, the people of the park can enjoy a nice fresh lunch, surrounded by the people working alongside them. Here, contact between the different companies will be able to form in a more casual setting.

To create a nicer environment for the people on the business park and to decrease the nuisance to the surrounding neighbourhoods, the periphery of the business park has a buffer zone filled with princess trees and a companion planted picking garden. The food collected in the picking garden is used and sold in the restaurant and supermarket.

The princess trees are maintained and harvested by a new party attracted to the business park. This new company will plant and process the trees to make resources for the other companies. These could be thinks like planks for production or wood curls for shipment. This company is located on the northeast side of the park building.

In the middle north of the park a facility for childcare and schooling is located. This will enable parents to have a more flexible work schedule and decide to spend more times with their kids during breaks. As the school/childcare is located next to the wood working place and an area of princess tree forest/picking garden, these elements can in incorporated in the curriculum. In this same building as the childcare, a sporting facility will be located, so employees can choose to have a workout after or in between work time.

The remaining area of the business park can be used for a campus style area with specialty buildings and outdoor area for walks, lunch spaces (outdoor tables) and outdoor meeting areas. The solar power pond on the east of the business park will remain to generate extra energy.

All the student visions contain transformative elements. Per vision, the transformative elements are identified. Then, the underlaying principles related to the circular economy of the different elements are presented, to understand the reasoning behind the vision. For these principles, the related pillar(s) of the Seven Pillars of Circular Economy framework (see section 2.3.3) are given.

The students group working on the Botlek case, six transformative elements can be identified: (1) central environmental office to oversee actions concerning the environment, (2) wealth cooperation to redistribute profits to local community, (3) local windmill park for renewable energy production, (4) repair shop using waste of local companies, (5) collect litter as resource for local art projects, and (6) a floating animal farm for local food production. Elements 1 and 2, relate to a restructure of management to repurchase for the environment or society (pillar: value). The principle of local resource collection/generation (pillars: materials and energy) in present in elements 3 to 6. Furthermore, elements 4 and 5 also refer to the recycling of waste materials (pillar: materials). Finally, element 4 also represents the principle of repairing existing products (pillar: materials).

In the vision of the student group working on the Kwinana case, four transformative elements are identified: (1) collect water, minerals, and metals from the local sea to use for production, (2) collect and reuse litter in and around the park as materials, (3) recreational nature area in the buffer zone of the park, and (4) energy generating fitness equipment for employees. Elements 1 and 2 follow the principle of local resource collection (pillar: materials) and element 2 also refers to the principle of recycling post-consumer waste (pillar: materials). Element 3 refers to the principle of more space for nature (pillar: biodiversity). Elements 3 and 4 share the principle of allowing space for not-work needs of the employees 7 (pillars: value, health & wellbeing, and society & culture).

In the vision of the last student group, working on the Höchst case, seven transformative elements are identified: (1) infrastructure services becomes a cooperation in which the local community is a shareholder, (2) companies are only allowed to produce essential products and no luxury products, (3) only electric vehicles and bicycles are allowed on the park grounds, (4) energy in locally generated using solar power, windmills, and fitness equipment for employees, (5) a park is realised for recreation and biodiversity, (6) a shared vegetable garden is used for local food production, and (7) there is a monthly community rave for all employees to generate trust between companies. The first two elements refer to the principles to repurchase for the environment or society (pillars: value, biodiversity, and society & culture). Elements 4 and 6 relate to local resource generation (pillar: materials). Elements 3 and 5 share the principle of more space for nature (pillar: biodiversity). Allowing space for not-work needs of the employees is present in element 4, 5, 6, and 7 (pillars: value, health & wellbeing, and society & culture). Finally, elements 1 and 7 increase the collaboration between companies on the park grounds (pillar: society & culture).

The vision developed for De Wildeman during the stakeholder workshop contains 15 transformative elements. To give a clear overview, the elements are presented in four principles. These principles are based on the identified elements and the pillars of the

Seven Pillars of Circular Economy framework. For every principle, the relevant pillars are also indicated. When elements fit within multiple principles, this is also indicated.

The first principle is *shared facilities*. This principle encompasses five elements and relates to the circular economy pillars materials and society & culture. During the workshop for De Wildeman, the stakeholders envisioned several facilities that they wanted on the park grounds, that could be shared by all companies. These include (1) warehouses, (2) offices, (3) a restaurant, (4) a supermarket, and (5) childcare facilities. Elements 3 to 5 are also represented in the principle *space for not-work needs*.

The second principle is *local energy and resource production/collection*. Seven elements of the vision can be placed in this principle. The related circular economy pillars are energy, materials and water. Several opportunities were uncovered to use the space of De Wildeman to generate energy and resources. The energy is generated using (1) solar panels, (2) urban wind turbines, and (3) generators in waterpipes. Resources are produced/collected on park grounds by (4) collecting grey water, (5) growing princess trees, (6) having a food garden, and (7) efficient urban mining by requiring all building to have a material passport. Elements 5 and 6 are also represented in the principle *more room for nature*.

The third principle is *space for not-work needs*. During the workshop, the stakeholders desired several elements on the business park that could fulfil the needs that are not directly related to work. This principle relates to the circular economy pillars society & culture, health & wellbeing, and value. In this principle, five elements can be placed. This included (1) recreational outdoor area, (2) childcare facilities, (3) a supermarket, (4) a restaurant, and (5) sport facilities for employees. Element 1 is also included in *more room for nature* and elements 2 to 4 are included in *shared facilities*.

Finally, the last principle is *more room for nature*. By using the space available for De Wildeman more efficiently using the shared facilities, they aimed to create more space for nature. This principle relates to circular economy pillars biodiversity and value. Four relevant elements in this principle are (1) growing princess trees, (2) having a food garden, (3) recreational outdoor area, and (4) separating the aera that need to be accessible for heavy vehicles to reduce (noise) pollution. Elements 1 and 2 are also present in the principle *local energy and resource production/collection* and element 3 is also present in the principle *space for not-work needs*.

GOALS AND GUIDING TARGETS

Both the visions proposals of the student workshops as well as the vision proposals developed during the stakeholder workshop do not contain any explicit goals or guiding targets. However, all vision proposals do contain clear principles relating to the circular economy that could be used to formulate goals or guiding targets in a follow-up workshop.

A summary of the vision analysis can be found in Table 6.6.

Table 6.6 Vision analysis

	Student group 2 (Botlek)	Student group 1 (Kwinana)	Student group 3 (Höchst)	Stakeholders (De Wildeman)
Transformative elements	Yes (6 elements in 5 principles)	Yes (4 elements in 4 principles)	Yes (7 elements in 5 principles)	Yes (15 elements in 4 principles)
Goals and guiding targets	No	No	No	No

6.3. Other Results

Due to the exploratory nature of the research, observations were made that were not in the original research design. Even though these results do not directly answer the research question, they do contextualize the results and give insights for future research.

6.3.1. Not a Stakeholder?

During both the student workshop and the stakeholder workshop, participants made the comment that they had fun and were satisfied with their results. However, they wondered what would happen if *real stakeholders* would play the game. During the student workshop, this was explained by how they had already developed a vision to work with and the workshop mainly gave them the opportunity to explore and be creative, while not necessarily impacting their course work.

When asked to elaborate on the statement during the stakeholder workshop, the stakeholder who made the original comment explained that they did not show up to the workshop as a stakeholder, but as a person. They went to the workshop with the understanding that they would play a game and see what would happen. They did not enter the workshop with any underlying objectives to achieve during the discussion. The two other stakeholders agreed with this statement.

6.3.2. Similarities Visions

Besides the analysis of the developed vision proposals individually, they are also compared to find similarities. When looking at these similarities, important context to keep in mind is that the vision proposals of the student groups were developed during one workshop in which they were allowed to copy ideas from the other groups if this would fit their proposed vision.

The only similarity between all four developed visions proposals is that all have at least one method of renewable energy generation present in the vision. The method of generating this energy different in every proposal, but overlap is present. Windmills are used in the Botlek, Höchst and Wildeman proposal, solar panels are used in the Höchst and Wildeman proposal and energy generating fitness equipment is used in the Kwinana, Höchst and Wildeman proposal.

Besides the renewable energy generation, three vision proposals contain recreational green spaces on the park (Kwinana, Höchst and Wildeman). Two vision proposals mention the collection of low value materials such as company waste and/or litter to be collected and used for outside projects (Botlek and Kwinana). Implementing a new governance structure in the park is mentioned in two vision proposals (Botlek and Höchst). Finally, two vision proposals include local food production (Botlek and Wildeman).

Overall, 5 similarities have been found between the four vision proposals. One major similarity was present between all four proposals, one similarity was present between three proposals and the other 3 similarities were present in only 2 of the four proposals.

7. Discussion

In this chapter, the results presented in the previous chapter are discussed. First, the results about the (social) engagement and then the results about vision design are discussed. During this, possible explanations for the results are considered. Them, the research setup used in this thesis are reflected upon. After this, the limitations and future research recommendations are reviewed. Finally, this chapter dives into the contribution of this thesis to the academic discussion.

7.1. (Social) Engagement

The effect of the serious games on (social) engagement was tested using three dimensions: game experience, participants learning and perceived influence. The three dimensions are discussed below.

7.1.1. Game Experience

In the core module of the GEQ, *sensory & imaginative immersion* scores high. A possible explanation for why the participants would experience this could be the explorative nature of the developed game. The game aimed to trigger them to think creatively and imagine different solutions and futures. This explanation is supported by the observation that that most participants would write down their ideas in most rounds in the first phase of the game for both workshops.

An additional hypothesis that could explain both this result as well as the high *positive affect on mood* and low *negative affect on mood* is that for both the students and stakeholders, playing the game was an entertaining intermission for an otherwise normal workday. This is corroborated by that during the workshops, it was observed many times that the participants would laugh out loud. For the student workshop, one student stressed that they had a lot of fun during the debriefing and a different student stated they want to play the game again as 'further remark' of the questionnaire.

The relatively *low tensions/annoyance* could be explained due to the seemingly low stake start of the game. As the conditions of the game reset after every round, the players were able to set at ease in the first rounds and collaborate once they were friendly. This explanation would also be supported by the relatively low results on the dimension *challenge*.

Similar to the dimensions *positive affect on mood* and *negative affect on mood* in the core questionnaire, the *positive experience* and not *negative experience* of the participants in the post-game module could be explained due to the entertaining intermission in an otherwise normal day. Additionally, it is possible that they felt satisfied as all groups were able to complete the task in the game, which could feel as a sense of achievement.

Finally, the high *psychological involvement – empathy* of the social presence module could be explained by that the participants were first challenged with low-stake competitive brainstorming and then had to work together. Since they were able to voice their own ideas in a playful manner and later delve deeper into the concepts, the interactions start positively. During the workshop it was also observed that the participants would show interest in the ideas developed by other participants and ask questions to understand their point better. This resulted in a healthy dialogue rather than a harsh competition.

Overall, the results of the GEQ would indicate that the use of this serious game has a positive effect on (social) engagement.

7.1.2. Participant Learning

Most students and all stakeholders have indicated that they have learnt something about circularity during the workshop. During the first phase of the game, people were challenged to give their own ideas of the linear and circular economy in different context. As mentioned above, it was observed that participants would discuss the ideas generated during the first phase of the game. As the participants hear all the different ideas, it is likely that new perspectives arise.

The results that the insights of the students were more social and organizational could be caused by the design of the game. This explanation would be two-fold. First, in the second phase the participants were asked to envision the new future on their park. By framing the vision in the real world, the social and managerial implication were more likely to arise. Furthermore, the game design is based on a circular economy framework which includes the social and organizational elements. As this impacted the ideas discussed in the first phase, the students would think about this perspective during the game. This can also be found in the developed vision proposals, in which two of the four proposals include a change in management to benefit society and the environment.

The results that most participants experienced the formulated learning goals and were able to formulate how they could use the workshop experience in future work is in line with the other results. It thus underlines that the participants for the most were willing to have thoughts directed towards and aroused by the workshop enough to learn during the workshop. This would be a positive indication for the (social) engagement during the workshop.

7.1.3. Perceived Influence

Finally, the participants were asked whether they believed to have influence on the vision. Overall, the most participants felt involved in the design of the vision, which is stated as one of the goals of (social) engagement.

The perceived influence could be explained by the design of the game. Namely, the participants are given many opportunities to influence the vision. During the first phase, every participant has agency to influence the brainstorming prompt and in the second phase, they are given more freedom to change the ideas. Due to this agency, people can feel able to influence the vision. However, the initial pickings of the brainstorming prompt are randomized and cannot be majorly impacted by the participants. It is possible that this is why some participants felt a lower level of influence.

During the first phase, it was observed that most participants wrote down an idea for most rounds. Thus, during this phase they used their agency to influence the final proposal. During the second phase, vision proposals from both workshops have ideas from the first phase as well as adaptions and new ideas implemented in this phase. The brainstormed ideas of the first phase were more closely implemented in the vision proposals by the students than the stakeholders. Thus, in this phase the stakeholders were more willing to affect the vision proposal to fit their ideal future.

Additionally, the comparison between the four vision proposals showed that there was little overlap between them. This would also indicate that the game did not lead the participants towards a certain vision and that the participants influenced the result of the vision proposal.

7.2. Vision Design

The effect of the serious game on the design of the vision was tested using two dimensions: participant satisfaction and a vision evaluation. These dimensions are discussed below.

7.2.1. Participant Satisfaction

The neutral to high satisfaction of the developed vision proposals could be explained due to the participants being encouraged to adapt and change the initial ideas to better fit the context of the business park. Furthermore, as part of the vision development, they are encouraged to reflect on the vision. During this reflection, all participants were encouraged to voice their thoughts. Given the constant opportunities to both influence and adapt the vision, all participants were able to voice and argue their values in the vision. It was observed that especially these moments of reflection allowed all participants to voice their thoughts and concerns.

7.2.2. Vision Evaluation

The vision evaluation was done using two indicators: (1) the presence of transformative elements and (2) the presence of goals and guiding targets. All four developed visions contained clear transformative elements and non of the visions did not contain clear goals and guiding targets. However, all visions do contain strong guiding principles that can be used to make goals and guiding targets in follow-up sessions.

The presence of transformative elements can be explained due to the semi-random brainstorming prompts that are not related to the current state of the business park. This means that the participants have to think about ideas and possibilities that are not necessarily present or developed in the current day. By allowing the participants to think freely and creatively in the first phase, they can bring the ideas that are not embedded in present-day to the developed vision.

At the same time, the participants thinking freely and creatively can also be the reason that there were no targets and goals set during the game. It is possible they were thinking about these concepts for the first time and were not able to quantify and formulate target. Allowing some time for a follow-up session to make these goals and guiding targets would allow the participants to reevaluate and solidify the main themes of the vision.

Furthermore, the absence of goals and guiding targets could also be a result of the game design. The participants were not explicitly asked to set these targets within the workshop. It is possible that a change in the game design would result in guiding goals and targets in the vision proposals.

7.3. Research Setup

In this thesis, a research-through design approach was used. Within this approach, a single iteration was completed. This means that one design was developed and then used for the generation of knowledge, but this knowledge was not used to further develop the design. While more iterations would benefit the robustness of the results,

one iteration is a realistic amount for the context of a master thesis. However, there were also choices made within the design and research processes that need to be reflected upon.

In the design process, the game design process of Peters & Westelaken (2014) is used. While other design frameworks are available, this framework allowed for an organised and repeatable approach to the game design and proved to be suitable for the thesis. During this design process, the decision was made to focus on the system of a vision development workshop within participatory backcasting rather than the system of a business park. This has resulted in a game that follows the visioning process with the context of a business park added to it. If the decision was made to focus on the system of a business park, it is possible that the resulting game would focus more on this context, while the visioning process would be more in the background. Due to this decision, the resulting game is easier to adapt to a different context and more effectively adds to the available tools for participatory backcasting.

In the research process, both the (social) engagement and vision design is measured on multiple dimensions. While the dimensions of the vision design are based on prior research, the dimensions for measuring the (social) engagement were constructed for this research. This was done, as there were no known existing methods for measuring (social) engagement. While the different components of the game experience questionnaire, participants learning and perceived influence does approximate what (social) engagement entails, it is possible that better research methods are available.

7.4. Limitation & Future Research

While this thesis gives a starting insight into the effect of a serious game as (social) engagement and design tool for vision making during the participatory backcasting process, it is not without its limitations that need to be considered when looking at the results.

The first important limitation of the research is the time scale. As the research was conducted in a short period of time, it was not possible to incorporate the full participatory backcasting process from strategic problem orientation to making a strategic agenda. This means that the thesis only covers the effect on (social) engagement and vision design during the visioning workshop. However, no effect on the full process could be discussed. Additionally, if the research was to be spread over an even longer timeframe, the effect on future impact and follow-up activities could also be included. Future research should be conducted to understand the effect of games on the full process as well as its impact on follow-up activities.

Next, it is important to discuss the scale of the research. The results are based on two workshops with a total of 18 participants (15 student and 3 stakeholder). This is even less for part of the learning of participants, perceived level of influence, and participant satisfaction as a technical error reduced the number of participants to 8 (5 students and 3 stakeholders) for these sections. While this gives preliminary insights into the effect of the game, more and repeated workshops would be able to give more robust conclusions.

Additionally, all research is conducted using the same game and there was no control group conducting a workshop without a game. Thus, the measured effect could be a result of the workshop more than the game. Furthermore, the conclusions of the effect of this game may not transfer to other games. Future research could be conducted on

a bigger scale, so different (types of) games could be tested for its effects as well as a control workshop without a game.

A final limitation is that during both workshops, the participants were aware that it was organized for this study. This means that they knew that the developed visions would not necessarily be used for future development of the business park. Due to this, it could be possible that the participants acted differently than if they had been under the impression that the workshop was to make the vision for the business park. Additional research in which the developed vision would be implemented should be conducted to understand if this changes the effect.

Besides the limitations described above, two other interesting observation occurred that provide opportunities for future research. Namely, that the participants in the research did not feel as they were stakeholders, even though the were discussing the future of the business park they worked at, and an interesting trend in what was learnt by the student participants.

First, during the workshop with stakeholders, it was said that they showed up as "a person and not a stakeholder to play the game" (translated from Dutch by researcher). Future research could be conducted to understand why the stakeholders did not feel like such in the context of the research. Possible explanations could include the research setting or the use of a game that reduces the need for strategic contributions. If the implementation of a game as (social) engagement and/or vision design tool makes the participants be involved as themselves rather than their role, it could open-up interesting opportunities for future participatory backcasting work.

Finally, during the student workshop, there was a very clear trend in the types of learning about circularity. Before the workshop, most students described circularity in technical and strategic terms, while their after-workshop insights were more social and practical. While possible explanations were given in this report, follow-up research should be conducted to be sure on why this trend emerged.

7.5. Academic Contribution

This thesis contributes to the academic discussion in several aspects. Firstly, the exploration of the use of serious games as tool for participatory backcasting aims to inform future participatory backcasting research about the benefits and drawbacks of this tool. Additionally, this exploration hopes to encourage others to develop and research tools and methods that could be used within the participatory backcasting process. Historic participatory backcasting was conducted using different tools and methods. However, the focus of this research were the results of the process rather than the methods utilised. By developing and researching tools for participatory backcasting, practitioners can make more informed decisions what they use. In the same vein, the thesis proposes and uses methodology for researching tools developed for vision design and (social) engagement.

8. Conclusion

The aim of this thesis is to answer the question *What is the effect of using a serious game as a (social) engagement and design tool during the development of the future vision step of participatory backcasting on (social) engagement and vision design?* In this chapter, this question is answered by answering the two sub-questions (1) *what is the effect of the use of a serious game during the vision creation process on the (social) engagement of the players?* And (2) *what is the effect of the use of the serious game on the vision design?* Finally, recommendations are given how this knowledge can be used.

8.1. Effect (Social) Engagement

The aim of (social) engagement tools is to (1) involve stakeholders and (2) guide and generate interaction between stakeholders. The results of the GEQ score and post game modules indicate a positive effect of participants being involved (goal 1) and the social presence module indicates a positive effect interaction being generated (goal 2). Furthermore, most participants were willing to have thoughts directed towards and aroused by the workshop enough to learn something during the workshop (goal 1) and have learnt about the relevant topics from other stakeholders (goal 2). Finally, the participants overall felt that they were able to influence the design of the vision (goal 1). In conclusion, the outcome of this research would indicate that the use of a serious game can have a positive effect on (social) engagement.

8.2. Effect Vision Design

What is the effect of the use of the serious game on the vision design?
The game helped to create visions that the participants were neutral to very satisfied with. It proved to be suitable for creating transformative ideas but lacked the ability to generate clear goals and targets. It is possible that another serious game would not have this problem. Within this game, it could be overcome by a follow-up session for target setting as there are clear themes identified after the first workshop.

8.3. Recommendations

The results of the research lead to recommendations for several groups of people. Specifically, recommendations are formulated for participatory backcasting practitioners, game/tool designers, circular economy researchers and policy makers, and business park researchers and management. Below, the recommendations for these groups are discussed separately.

First, participatory backcasting practitioners are recommended to embrace serious games as part of their supporting toolbox. Based on the challenges presented by the case, they should consider the benefits and drawbacks of using games as tool for (social) engagement and/or vision design.

When considering it as tool for (social) engagement, the implementation of the game resulted in a relaxed environment in which the participants quickly felt at ease to share their ideas. As everyone was prompted to share their concepts, it became likely for people to hear new perspectives. Using a similar game can thus be used in a context where stakeholders are closed off and have trouble sharing their personal vision.

Furthermore, the stakeholders indicated that they did not come to the workshop with a predetermined agenda. Since they were aware of the game setting, they were more curious about what would happen. Both the game setting, but also the semi-random selection of the brainstorm prompts in the first phase could prove useful in a context

when the stakeholders have clear underlying agendas which they do not want to let go.

Additionally, when considering it as a tool for the vision design, the practitioners should critically consider the needs and criteria of the to be developed vision. The game allowed the participants to think freely and creatively, generating many transformative elements for the developed vision. Thus, if the generation of ideas for a future vision is difficult, a game to increase the creativeness can help. However, if the stakeholders have trouble making more concrete decisions to set targets, using a game may prove to be unhelpful. It is possible that alternative design choices could result in a game that is able to set clear guiding targets.

Secondly, designers of serious games or other supporting tools are recommended to develop and research the effects of the different tools. In this report, an initial framework is given to possibly measure the effect of a tool on (social) engagement and vision design. By expanding the available tools and reporting on their effects, more suitable tools can be used.

Thirdly, researchers and policy makers working on the transition towards a circular economy are recommended to use interactive learning and design tools, such as serious games, when interacting and visioning with non-expert stakeholders. Even though the stakeholders had an elementary understanding of circularity, they were able to formulate many transformative elements related to the circular economy. The use of the game made it possible that the workshop mainly focussed on developing the vision proposal using input of the participants rather than presenting possible opportunities by the facilitator.

Finally, business park researchers and management are recommended to include the stakeholders in the discussion of the future of the business park. Using interactive methods such as serious games could empower them to freely give inputs about their desires and ideas. The vision proposal developed by the stakeholders of De Wildeman have shown that this method can results in transformative and relevant results.

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Appendices

Appendix A. Outline semi-structured expert interviews

Information: *I am currently doing my master thesis. The aim of my thesis is to develop and test the impact of participatory tool during the participatory backcasting process. To make sure the tool is suitable, I am currently gaining expert feedback from experienced practitioners to understand the real practise of the tool as well as the desired outcomes of the specific phase I am developing for.*

PARTICIPATORY BACKCASTING

Information: *We will start quite general with a few questions about your experience in PB. Please keep in mind that there are no wrong or right answers, and these questions are made for me to get a better understanding of the use scenario of the tool.*

1. Who are you and why do you work with PB?
2. Could you describe in your own words what participatory backcasting is?
3. When would you use participatory backcasting and why?
4. Who would be the key actors involved in a PB workshop?
5. Could you describe how a typical workshop for PB facilitated by you would look like?
6. What would you say are the essential milestones during the PB process? What do you do to come to these milestones?
7. What do you use to enhance engagement during your workshops?
8. What is, in your opinion, the role of supporting tools in the PB process?

ENVISIONING PHASE

Information: *Like a mentioned, my aim is to develop a participatory tool for PB. Specifically, I want to develop a tool for the 'creating envisioned futures phase', as it is one of the earlier phases of the process. The next few questions will be about this phase.*

9. Could you describe in your own words what the role is of this phase during PB?
10. *(If not enough information is given in Q5)* Could you describe how this phase in the PB process would typically look like for you? *(Always)* Do you use specific vision methods and how do you get the visions developed?
11. How much attentions do you typically give to this phase during your workshops or in between workshops?
12. Are there any challenges that you might think of while conducting this phase? These can be specific to this phase or the PB process in general.
13. *Do you have any experience with working with gamification or serious games in this phase or other phases of PB?*
    a. *If yes: could you tell me about this experience?*
    b. *If no: Would you be interested in it? Why (not)?*

GOOD VISIONS

Information: What is important to me, is that the outcome of the participatory tool is useful for the rest of the process. In this final part, we will talk a little about good visions.

14. What are the most important elements of a good vision for Participatory Backcasting?
15. I will give you a few examples of visions (maybe screen share). Please indicate whether you would be satisfied with this result after the 'creating an envisioned future'. Please highlight the good parts as well as how this vision might be improved.

a. "For every person to use their unique experiences and backgrounds, together – to spark solutions that create a better, healthier world." (Johnsen & Johnsen; Wright, 2022)
b. "Imagine always being in a five-minute walking distance from your bike, no matter where you are and how you got there. Not because your bike is following you, no, because every bike in the city is yours. But not just yours, it's mine as well, and theirs. All bikes are shared and instead of owning a bike, biking has become a service that you can use anywhere at any time." (Shared bicycle case: course 0SV40)
c. "To give everyone the power to create and share ideas and information instantly, without barriers." (Twitter; Wright, 2022)
d. "Create better everyday lives for as many people as possible." (IKEA; Wright, 2022)
e. "To accelerate the energy transition by bringing together the right partners from the academic and business world to integrate and innovate in the construction environment. We will set a new, higher standard for all homes regarding sustainability, health and cost that can be achieved with technologies available today." (Team CASA, 2016)

GAMING/CASE

16. How did you go about designing the game?
17. How did you reach the relevant people for conducting a case study at a business park?
18. Do you have any other take aways for me when designing a game in the business park context?

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Appendix B. Measuring tools workshop

B1. Questionnaire pre-workshop

INFORMATION

You are invited to participate in a study titled *Gaming for Circular visions on business parks*. This research is being conducted by J.C. Frens under the supervision of dr. ir. J.N. Quist and Dr. G. Bekebrede of TU Delft.

The aim of this research is to gain insight into the prior knowledge of the possibilities of circularity at your business park, and it will take you about 5-10 minutes to complete. The data will be used for graduation research of the Master Industrial Ecology. We will ask you to answer several open and closed questions as completely as possible.

As with any online activity, the risk of a breach is always possible. To the best of our ability, your responses to this survey will remain confidential. We will minimize any risks by keeping the non- anonymised data only within the aforementioned research team. In the questions you will be asked for your name. This is used to link the answers from this questionnaire to the answers to the post-workshop questionnaire. This information will be deleted one week after linking. You are also free to use a pseudonym here, as long as it matches in both questionnaires.

Your participation in this study is completely voluntary and you can withdraw at any time. You are free to omit any questions. If you later want to delete your data, please contact j.c.frens@student.tudelft.nl and state your name (or pseudonym). Deletion of the data is no longer possible after linking the questionnaires. This means that you can delete your answers up to a week after completing the second questionnaire.

For further questions, please contact the researcher responsible: J.C. Frens (j.c.frens@student.tudelft.nl) or for complaints you can contact my supervisor, dr. ir. J.N. Quist (j.n.quist@tudelft.nl).

1. Informed consent
   o I have read the above information and agree to this study
   o I **do not** agree to this study

2. If you agree, the aggregated and anonymised data will be stored in the 4TU.ResearchData database at the end of the research.
   If you *do not* agree to this, your data can never be completely anonymized during the project, because it must be kept separate.
   o I give permission for the aggregated and anonymised data to be shared on 4TU.ResearchData after this project
   o I **do not** give permission for the aggregated and anonymised data to be shared on 4TU.ResearchData after this project

NAME

3. What is your name?
   This information is used to link the pre-workshop questionnaire to the post-workshop questionnaire. Feel free to use a pseudonym **but put down the same for in both questionnaires.**

4. What business park are you doing the project on? (Only for student questionnaire)
   From this point forward, this will be referred to as 'your business park'.
   o The Netherlands: Rotterdam Industrial Park (Botlek)
   o The Netherlands: Chemelot Industrial Complex
   o Germany: Industrial Park Höchst
   o China: Liuzhou industrial park
   o Australia: Kwinana Industrial Area
   o Other, namely: _____

CIRCULARITY – CONCEPTUALISATION & AT BUSINESS PARKS
This part focuses on your idea of circularity. All answers are correct.

5. Briefly give your understanding of the concept of circularity.
   Use 1 to 5 sentences.

   _____

   _____

   _____

6. Do you know what *your business* park is **currently** doing to increase its circularity?
   o Yes
   o No

7. If yes: Could you give a short description what *your business park* is doing to increase their circularity?
   Use 1 to 5 sentences.

   _____

   _____

   _____

8. Do you have additional ideas of what *your business park* **could do** to increase its circularity?
   o Yes
   o No

9. If yes: Could you give a short description what *your business park* could do increase its circularity?
   Use 1 to 5 sentences.

   _____

   _____

   _____

   _____

10. Please indicate to what extent you agree with the statements below.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know / Don't want to answer
It is in *my personal* interest that the economy becomes circular	O	O	O	O	O	O
I think circularity is nonsense	O	O	O	O	O	O
I think circularity should be more important than profit	O	O	O	O	O	O
I think it is important that the place I (will) work is involved in circularity	O	O	O	O	O	O
I think the business park I am working on does enough for circularity	O	O	O	O	O	O

COMMENTS

11. Do you have any further remarks?

_____

_____

_____

B2. Questionnaire post-workshop

INFORMATION

You are invited to participate in a study titled *Gaming for Circular visions on business parks*. This research is being conducted by J.C. Frens under the supervision of Dr. ir. J.N. Quist and Dr. ir. G. Bekebrede of TU Delft.

The aim of this survey is to gain insight into your experience during the workshop and what you took away from it, and it will take you approximately 5-10 minutes to complete. The data will be used for graduation research of the Master Industrial Ecology. We will ask you to answer several open and closed questions as completely as possible.

As with any online activity, the risk of a breach is always possible. To the best of our ability, your answers to this survey will remain confidential. We will minimize any risks

by keeping the non- anonymised data only within the aforementioned research team. In the questions you will be asked for your name. This is used to link the answers of this questionnaire to the answers to the questionnaire after the workshop. This information will be deleted one week after linking. You are also free to use a pseudonym here, as long as it matches in both questionnaires.

Your participation in this research is completely voluntary and you can withdraw at any time. You are free to omit any questions. If you later want to delete your data, please contact j.c.frens@student.tudelft.nl and state your name (or pseudonym). Deletion of the data is no longer necessary after linking the questionnaires. This means that you can delete your answers one week after completing the second questionnaire.

For further questions, please contact the responsible researcher: J.C. Frens (j.c.frens@student.tudelft.nl) or for complaints you can contact my supervisor, Dr. ir. J.N. Quist (j.n.quist@tudelft.nl)

1. Informed consent
   o I have read the above information and agree to this study
   o I **do not** agree to this study

2. If you agree, the aggregated and anonymised data will be stored in the 4TU.ResearchData database at the end of the research.
- If you *do not* agree to this, your data can never be completely anonymized during the project, because it must be kept separate.
   o I give permission for the aggregated and anonymised data to be shared on 4TU.ResearchData after this project
   o I **do not** give permission for the aggregated and anonymised data to be shared on 4TU.ResearchData after this project

NAME
3. What is your name?
   This information is used to link the pre-workshop questionnaire to the post-workshop questionnaire. Feel free to use a pseudonym **but put down the same for in both questionnaires.**

---

4. What business park are you doing the project on (only for student questionnaire)
   From this point forward, this will be referred to as 'your business park'.
   o The Netherlands: Rotterdam Industrial Park (Botlek)
   o The Netherlands: Chemelot Industrial Complex
   o Germany: Industrial Park Höchst
   o China: Liuzhou industrial park
   o Australia: Kwinana Industrial Area
   o Other, namely: _____

OUTCOME OF THE WORKSHOP
5. Are you satisfied with the resulting vision proposal developed during the game?
   o Yes, very satisfied.
   o Yes, somewhat satisfied.

o   Neither satisfied nor unsatisfied.
o   No, somewhat unsatisfied.
o   No, very satisfied.

6. Could you shortly explain your answer above?

    _____

    _____

    _____

7. To what degree did you personally have influence on the resulting vision proposal?
    o   Very high degree of influence
    o   High degree of influence
    o   Some degree of influence
    o   Little degree of influence
    o   No influence

8. Could you shortly explain your answer above?

    _____

    _____

    _____

9. Is there a part of the vision proposal that you would still like to adapt?
    o   Yes
    o   No

10. If yes: what would you like to change?

    _____

    _____

    _____

11. Is there a part of the vision proposal that you had not thought about before the workshop?
    o   Yes
    o   No

12. If yes: what had you not thought about before the workshop?

    _____

    _____

    _____

13. For the following subject, indicate if you experienced it during the workshop.

	Did not experience	Experienced a little	Experienced it a fair amount	Experienced it a lot	I don't know / Don't want to answer
Making trade-offs	O	O	O	O	O
Formulating argumentation	O	O	O	O	O
Approaching a subject from several perspectives	O	O	O	O	O
Making compromises during teamwork	O	O	O	O	O
Out-of-the-box thinking	O	O	O	O	O

CIRCULARITY – CONCEPTUALISATION & AT BUSINESS PARKS

This part focuses on your idea of circularity. All answers are correct.

14. Did **the other participants of the workshop** you get any new insights on the concept of circularity during the workshop?
    o Yes
    o No

15. If yes: what insights did they give you about circularity?
    Use 1 to 5 sentences.

    _____

    _____

    _____

16. Did **the game** you get any new insights on the concept of circularity during the workshop?
    o Yes
    o No

17. If yes: what insights did it give you about circularity?
    Use 1 to 5 sentences.

    _____

    _____

    _____

18. Did you get any new insights for circularity on *your business park* during the workshop?
    o Yes
    o No

19. If yes: what insights did it give you about circularity on *your business park*?
    Use 1 to 5 sentences.

20. Please indicate to what extent you agree with the statements below.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know / Don't want to answer
It is in *my personal* interest that the economy becomes circular	O	O	O	O	O	O
I think circularity is nonsense	O	O	O	O	O	O
I think circularity should be more important than profit	O	O	O	O	O	O
I think it is important that the place I (will) work is involved in circularity	O	O	O	O	O	O
I think the business park I am working on does enough for circularity	O	O	O	O	O	O

GAME EXPERIENCE - CORE QUESTIONS

21. Please indicate how you felt **while** playing the game for each of the items.

	Not at all	Slightly	Moderately	Fairly	Extremely	I don't know / Don't want to answer
I felt content	O	O	O	O	O	O
I felt skilful	O	O	O	O	O	O
I was interested in the game's story	O	O	O	O	O	O
I thought it was fun	O	O	O	O	O	O
I was fully occupied with the game	O	O	O	O	O	O
I felt happy	O	O	O	O	O	O
It gave me a bad mood	O	O	O	O	O	O
I thought about other things	O	O	O	O	O	O
I found it tiresome	O	O	O	O	O	O
I felt competent	O	O	O	O	O	O
I thought it was hard	O	O	O	O	O	O
It was aesthetically pleasing	O	O	O	O	O	O

	Not at all	Slightly	Moderately	Fairly	Extremely	I don't know / Don't want to answer
I forgot everything around me	O	O	O	O	O	O
I felt good	O	O	O	O	O	O
I was good at it	O	O	O	O	O	O
I felt bored	O	O	O	O	O	O
I felt successful	O	O	O	O	O	O
I felt imaginative	O	O	O	O	O	O
I felt that I could explore things	O	O	O	O	O	O

22. Please indicate how you felt **while** playing the game for each of the items (cont.)

	Not at all	Slightly	Moderately	Fairly	Extremely	I don't know / Don't want to answer
I was fast at reaching the game's targets	O	O	O	O	O	O
I felt annoyed	O	O	O	O	O	O
I felt pressured	O	O	O	O	O	O
I felt irritable	O	O	O	O	O	O
I lost track of time	O	O	O	O	O	O
I felt challenged	O	O	O	O	O	O
I found it impressive	O	O	O	O	O	O
I was deeply concentrated in the game	O	O	O	O	O	O
I felt frustrated	O	O	O	O	O	O
It felt like a rich experience	O	O	O	O	O	O
I lost connection with the outside world	O	O	O	O	O	O
I felt time pressure	O	O	O	O	O	O
I had to put a lot of effort into it	O	O	O	O	O	O

GAME EXPERIENCE – SOCIAL PRESENCE QUESTIONS
23. Please indicate how you felt **while** playing the game for each of the items.

	Not at all	Slightly	Moderately	Fairly	Extremely	I don't know / Don't want to answer
I empathized with the other(s)	O	O	O	O	O	O
My actions depended on the other(s) actions	O	O	O	O	O	O
The other's actions were dependent on my actions	O	O	O	O	O	O
I felt connected to the other(s)	O	O	O	O	O	O

The other(s) paid close attention to me	O	O	O	O	O	O
I paid close attention to the other(s)	O	O	O	O	O	O
I felt jealous about the other(s)	O	O	O	O	O	O
I found it enjoyable to be with the other(s)	O	O	O	O	O	O
When I was happy, the other(s) was(were) happy	O	O	O	O	O	O
When the other(s) was(were) happy, I was happy	O	O	O	O	O	O
I influenced the mood of the other(s)	O	O	O	O	O	O
I was influenced by the other(s) moods	O	O	O	O	O	O
I admired the other(s)	O	O	O	O	O	O
What the other(s) did affected what I did	O	O	O	O	O	O
What I did affected what the other(s) did	O	O	O	O	O	O
I felt revengeful	O	O	O	O	O	O
I felt schadenfreude (malicious delight)	O	O	O	O	O	O

GAME EXPERIENCE - POST-GAME QUESTION

24. Please indicate how you felt **after** you finished playing the game for each of the items.

	Not at all	Slightly	Moderately	Fairly	Extremely	I don't know / Don't want to answer
I felt revived	O	O	O	O	O	O
I felt bad	O	O	O	O	O	O
I found it hard to get back to reality	O	O	O	O	O	O
I felt guilty	O	O	O	O	O	O
It felt like a victory	O	O	O	O	O	O
I found it a waste of time	O	O	O	O	O	O
I felt energised	O	O	O	O	O	O
I felt satisfied	O	O	O	O	O	O
I felt disoriented	O	O	O	O	O	O
I felt exhausted	O	O	O	O	O	O
I felt that I could have done more useful things	O	O	O	O	O	O
I felt powerful	O	O	O	O	O	O
I felt weary	O	O	O	O	O	O
I felt regret	O	O	O	O	O	O
I felt ashamed	O	O	O	O	O	O

I felt proud	O	O	O	O	O	O
I had a sense that I had returned from a journey	O	O	O	O	O	O

25. Do you have any further remarks?

_____

_____

B3. Debriefing questions

Question 1: How do you feel about the results of the game?

Question 2: What were the most challenging and easiest part during the game?

Question 3: Did you have any interesting insights that you would like to share?

Question 4: How can you use this experience while make visions in the future? (students) // How can you the experience of the workshop when thinking about the future of both De Wildeman, but also your own company? (stakeholders)

B4. Meeting report template

PHASE 1

Round 1
Input

Theme	Element	Economy

Ideas

Person	Idea	Won?
1		
2		
…		

Comments:

Round 2
Input

Theme	Element	Economy

Ideas

Person	Idea	Won?
1		
2		
…		

Comments:

Summary

Score

Person	Final score
1	
2	
..	

Winning idea's

Round	Theme	Element	Economy	Idea
1				
2				
...				

IN BETWEEN

Based on rule variant: give presented ideas per group/person

PHASE 2

Reflection card(s)

Research question	
Answer	
Design question	
Answer	
Improve question	
Answer	

Final vision proposal

[Picture map of business park]

[Summary vision]

DEBRIEFING

Initial response

Question 1: How do you feel about the results of the game?

Question 2: What were the most challenging and easiest part during the game?

Question 3: Did you have any interesting insights that you would like to share?

Question 4: How can you use this experience while make visions in the future? (students) // How can you the experience of the workshop when thinking about the future of both De Wildeman, but also your own company? (stakeholders)

Appendix C. Roster of inspiration games

Game	Short Description	The goal of the game
The Extraordinaires Design Studio (O'Connor, 2013)	Single-person game. Players pick a larger-than-life client and an object to the design. After the design is complete, the player draws a Think card to highlight a different aspect of the design and investigate the client's life.	Amusement, brainstorming
Dilemmarama the Game (van de Ven & Toonen, 2016)	Multi-player game. Pick two situations that are both undesirable. Discuss with the group which one you would pick. Highlights different trade-offs and priorities of the players.	Amusement, conversation starter
Who's The Man? (Unknown)	Team-based game. Every team writes down different words and puts those folded in a bowl. In the first round, someone gets a minute to try to describe the words and the team must guess until there are no words left. In the second round, the describer can only use one word and in the third round, the describer cannot talk and must mime the word.	Amusement
Make A World (Gray, 2011)	Create a prompt and use different materials (e.g., scraps, stamps, markers, or craft supplies) to make a visualisation of your solution.	Amusement, brainstorming
The Thing from the Future (Candy & Watson, 2014)	Multiplayer game. Draw cards about how long away, what type of future, what terrain, what object and what mood the thing is. The players need to explain how this object would look in this future.	Amusement, conversation starter
Dungeons and Dragons (Tweet et al., 2004)	Open-world role-playing game. Every player makes their character based on a playing sheet. A facilitator tells the story, and the players respond to the story about what actions their characters are taking. Dice are used to determine the success of those actions.	Amusement
The Empathy Game (Herrmann & Elferink, 2019)	Multiplayer. Pick one of three cards (who is…? imagine or memory), this gives a story prompt, which the player needs to answer based on their loved experience. The other players listen and engage with the story by throwing dice and basing questions on the outcome of the throw.	Amusement
Dixit (Roubira & Cardouat, 2008)	Multiplayer. Players have six cards with images, one player picks a card from their hand and gives a single-word hint and puts it upside down. All other players put down a card that would also fit the hint. After, all players try to guess the original card.	Amusement
AudaCITY (Keeler et al., 2022)	Multiplayer. The game AudaCITY is set in 25 years and the players are told they have won a prestigious award for sustainability. They must construct why in 7 rounds. In the first two rounds, a vision is developed based on two random goal cards, then four rounds are used to develop a strategy and finally scoring is applied.	Strategy making

Appendix D. Content cards

D1. Element and theme cards

Element	Amount	Theme	Amount
Job	2	Waste streams	1
Infrastructure	2	Raw materials	1
Building	2	Non-organic materials	1
Company	2	Organic materials	1
Network	2	Electronic waste	1
Rule	2	Litter	1
Product	2	Reuse	1
Mobility	2	Repair	1
Cooperation	2	Refresh	1
Roof	2	Recycle	1
Art	2	Financial value	1
Factory	2	Aesthetic value	1
Outdoor area	2	Ecological value	1
Business plan	2	Emotional value	1
Subsidy	2	Social value	1
Management	2	Wealth	1
Event	2	Shared value	1
Governance	2	Triple value creation	1
Employee	2	Pollution	1
Education	2	Pesticides	1
Tool	2	Sport	1
Machine	2	Recreation	1
Vehicle	2	Work	1
Recreation	2	Safety	1
Traffic	2	Sound	1
Parking facility	2	Biodiversity	1
Office	2	Diversity	1
		Inclusion	1
		Equality	1
		Identity	1
		Communication	1
		Animals	1
		Agriculture	1
		Climate	1
		Environment	1
		Plants	1
		Water use	1
		Water quality	1
		Surface water	1
		Electricity	1
		Heat	1
		Power generation	1
		Energy	1
		Refrigeration	1
		Health	1
		Profit	1

D2. Reflection Cards

Research – Subject	Research – Question	Design – Subject	Design – Question	Improve – Subject	Improve – Question
Systemic	Which elements reinforce each other in their purpose? Can the elements better support each other with a small adjustment?	Visionary	How do you ensure that the people who work at the business park have a nicer environment?	Relevant	What does the average day look like at the business park of the vision proposal? What do you run into? How can this be solved?
Visionary	In what way is the vision proposal an improvement on the current situation?	Relevant	How will the people in the business park notice the change to the vision proposal? How do you prepare them for this?	Coherent	What could be added or removed from the vision proposal so that the elements work better together?
Relevant	What kind of people are needed in this vision proposal who are not yet present at the business park?	Coherent	What conflicts can arise between the elements? How can you prevent them?	Sustainable	Is it possible to adapt the elements modularly so that new findings can be implemented in the future?
Coherent	What is the common thread of the vision proposal? How do you ensure that it stays relevant in future decision?	Sustainable	How does the vision proposal affect the natural ecosystem? Is it possible to make room for native nature?	Nuanced	If the current vision proposal is 100% ideal, what would 80% ideal look like?
Sustainable	What new materials are needed to realize the different elements?	Nuanced	What would the vision proposal look like if 1 element less could be realized?	Plausible	Does the vision proposal correspond to the current developments in the business park? How can these developments be considered?
Nuanced	Which element(s) are the most important to realize?	Plausible	What do currently existing examples of element(s) of this vision proposal look like?	Visionary	How can the vision proposal differentiate itself from alternative proposals?
Plausible	What is the biggest risk in developing the vision proposal? How can this be dealt with?	Visionary	How do you ensure that the vision proposal is an improvement for the surroundings?	Shared	How could you accommodate opponents of this vision proposal?
Visionary	What part of the vision proposal gives the wow-factor?	Shared	How are the needs of different stakeholders reflected in the vision proposal?	Tangible	How can you add details to the vision proposal to make it feel more alive?

Shared	Which elements could be taken up by several companies together?	Tangible	What does someone immediately notice when they enter the business park of the vision proposal?	Sustainable	How can the business park influence the actions of the established companies to become more sustainable?
Tangible	What goal(s) do you hope to achieve with this vision proposal?	Sustainable	How can the companies in the business park help each other with sustainability?	Motivating	How can you put a surprising spin on the vision proposal?
Sustainable	What is the balance between society, nature and economy in the vision proposal?	Motivating	How do you ensure that the vision proposal lives with the different companies?	Systemic	How do you ensure that different elements fit well together?
Motivating	Why would you as a company want to contribute to the vision proposal? How could you make this (even) more attractive?	Systemic	How should the infrastructure be adapted to achieve the vision proposal?	Visionary	Are there any negative elements in the vision proposal? How can these be adjusted to make the full proposal positive?