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Using serious games for (social) engagement in vision development for circular business parks

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Abstract

In order to support transition to a circular economy, visions and strategies need to be developed for which participatory backcasting can be used. This paper reports on the effects of using serious games as a possible supporting (social) engagement and design tool for vision development in participatory backcasting and has been applied to circular business and industry parks. In order to test the effects on (social) engagement, a new framework was developed and used to evaluate engagement by measuring the game experience, perceived influence, and learning, as well as the social connections within these constructs. The effect of the vision design was measured using participant satisfaction and a vision analysis, identifying transformative elements and guiding goals and targets. The results show that a serious game is a suitable tool to support (social) engagement in participatory backcasting. As a design tool, it is suitable for the development of transformative elements, but the used game was not able to create guiding goals and targets.

Keywords

Serious games, participatory backcasting, future vision, circular economy, circular business parks, (social) engagement evaluation

1. Introduction

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 (CE) in 2050 [2]. To guide this transition from a linear to a circular economy, visions and strategies need to be developed. One approach enabling actors to create visions and strategies is participatory backcasting (e.g. [3]), while relevant related approaches include transition management [4] and visioning [5]. During the process of participatory backcasting, stakeholders develop a shared future vision, after which strategies can be defined on how this future can become reality [3].

Within participatory backcasting, the process of vision development can be supported by several tools, including (social) engagement and vision design tools. However, gaming-based tools have been limitedly combined with participatory backcasting, though some examples can be found in the scientific literature [6-13]. By expanding the available tools for vision development in participatory backcasting, both researchers and practitioners will get a broader choice to select an appropriate tool for the vision development stage in the process. Engagement is defined as "the willingness to have emotions, affect,

and thoughts directed toward and aroused by the mediated activity to achieve a specific objective" [1, p. 496].

The aim of this paper is to explore how serious games can be used as a design and (social) engagement tool to support the development of a shared vision. The research question 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?* The research was contextualised for the topic of circular business and industry parks, as their current circularity is very limited while their circularity potential is huge. The paper is organized as follows. It provides theoretical and literature background in Section 2, methodology in Section 3, results in Section 4, discussion in Section 5 and conclusions and recommendations in Section 6.

2. Background

Participatory backcasting is an approach to long-term vision and strategy development. The approach is based on creating a desirable future (vision) and looking back from that future to the present followed by creating a strategy towards the vision [14]. In this research, the methodological framework for participatory backcasting of Quist [15] is used. In this, the participatory backcasting process consists of five

iterative 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 to stimulate follow-up and implementation. Backcasting is a normative approach in futures studies focusing on desirable and sustainable futures. It is different from forecasting focussing on likely futures, and exploratory scenario approaches that focus on possible futures [3,14,15,16].

Participatory backcasting is most useful when applied to complex societal problems, when there is a need for major change, when dominant trends contribute to the problem, when the problem cannot be solved by market-based solutions, and when there is a sufficiently long-time horizon to realise the desirable future [16]. All these points apply to the topic of circular business and industry parks.

In this research, the CE framework of Metabolic is used, called 'The Seven Pillars of the Circular Economy' [17]. This is a vision-based framework that 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" [17]. This framework is holistic, containing seven pillars and three surrounding properties. The pillars are materials, energy, water, biodiversity, society & culture, health & wellbeing, and value. The properties are equity, transparency, and resilience [17]. On business and industry parks, circularity based on the framework can take various shapes and configurations. Options include, but are not limited to, exchange of (waste) materials, energy and/or water between companies (also known as industrial symbiosis), shared products and/or services, and giving more space to nature.

Participatory backcasting is supported by four groups of tools. These groups are tools for (social) engagement, design, analytical, and management, coordination, and communication. A tool that can be used for social engagement in participatory backcasting is gaming. Serious games can be used as safe innovation space for alternative futures [18]. This gives an indication that games could be used as a design tool for future visions (step 2 develop future visions). However, the literature on games for vision development in participatory backcasting processes is limited, though a few examples could be identified [7]. There is some research combining backcasting and serious games, mainly using the game as tool during the backcasting analysis [6, 8, 12, 19] or separate from the backcasting process [7, 10 ,11,13]. Besides creating a safe innovation space, games can increase interaction between participants and researchers [20] and can therefore be used for (social) engagement. This is especially important during the vision creation step as it is generally when engagement and workshops for participatory vision generation start.

As a (social) engagement tool, the aim of the game is (1) to involve stakeholders, and (2) to guide and generate interaction between the stakeholders [15, 16]. The first goal refers to engagement, defined as "the willingness to have emotions, affect, and thoughts directed toward and aroused by the mediated activity to achieve a specific objective" [1, p. 496]. The second

goal refers to social engagement, defined as social connections and interactions to develop and maintain the participants' social network [1].

3. Methodology

To research the effects of games on (social) engagement and vision design, we extensively evaluated two interventions. The first intervention was a workshop with master students during their Industrial Ecology project course on sustainable and circular Industrial Parks, while the second intervention was conducted at the business park De Wildeman, Zaltbommel. The interventions consisted of a workshop including the game and two questionnaires. The effects of the game were measured using observations, questionnaires, and a vision evaluation.

3.1 Game: CircularPark

The game CircularPark (see Figure 1) is a multiplayer game consisting of two phases in which groups of three to six people make a vision for a circular business park. The first phase consists of several rounds in which the participants are asked to competitively generate ideas based on a semi-random brainstorming prompt. A new brainstorming prompt is created for every round, consisting of three parts: (1) an element card with something that could be present at a business park (e.g., a roof), (2) a theme card relating to the circular economy (e.g., litter), and (3) a die-throw indicating whether the idea should be part of a linear or circular economy (see a,b,c in Figure 1). Both element and theme cards are chosen by the participants from a small selection of the cards, giving them influence in the topics discussed. The ideas are written on an answer sheet (see d in Figure 1), read out loud and voted on by the participants. In the second phase, the participants are asked to collaboratively integrate the ideas generated in the first phase onto a map of the business park under study (see e in Figure 1), followed by adapting and refining the ideas and vision proposal using the questions on the reflection cards (e.g., What does the average day look like at the business park of the vision proposal?; marked as f in Figure 1) [21].

The gaming workshop consists of three steps: (1) briefing, (2) gameplay, and (3) debriefing. During the briefing step, the workshop facilitator gives a short theoretical background on circularity and explains the goal and rules of the game, which is followed by the gameplay. Finally, in the debriefing step, the facilitator asks probing questions for the participants to reflect on the experience. For the evaluation the participants are asked to answer questionnaires before the briefing and after the debriefing step.
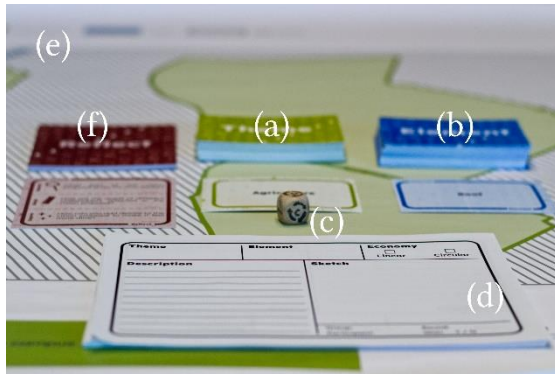
Figure 1: CircularPark game materials: (a) theme cards, (b) element cards, (c) circularity die, (d) answer sheet, (e) map business park, and (f) reflection cards

3.2 Participants

The game was played two times, with different target groups.

3.2.1 Industrial ecology project: industrial systems

The first workshop was played with master students of the Industrial Ecology program, which is a combined MSc program of Leiden University and Delft University of Technology, as part of the 10 ects course Industrial Ecology Project on industrial symbiosis and making industry parks circular and sustainable.

During the course, groups of students analyzed and re-designed an existing industrial park based on three categories (water, energy, and material flows). The two-hour workshop was held in the second part of the course with 15 students working on the Botlek Industrial Park in Rotterdam, Industrial Park Höchst in Germany, or Kwinana Industrial Area in Western Australia. The students had already analyzed the current state and relevant stakeholders and were working on a redesign of the selected park. Therefore, the students could be considered as experts on their industrial park and qualified to develop a circular future vision for their parks.

3.2.3 Business park De Wildeman, Zaltbommel

The second workshop was conducted at the business park De Wildeman, which is a business park under development in the municipality of Zaltbommel in the middle of the Netherlands [22-24]. The park's development is based on three core values: sustainability, safety, and accessibility. To ensure adherence to these core values, all companies on De Wildeman are required to join the park management. In 2017, the business park has written a sustainability masterplan with the aim to make all business parks in Zaltbommel energy-positive before 2025 [25,27].

The three-hour workshop on De Wildeman was conducted with three stakeholders: an account manager from the municipality Zaltbommel, a general manager of one of the companies on De Wildeman, and an office manager at De Wildeman. By conducting this workshop, the perspective of stakeholders of a business park without extensive sustainability knowledge is added to the research. The workshop took place at one of the companies at the business park.

3.3 Data collection

The workshops are evaluated on two different criteria: (1) content of the vision design and (2) the (social) engagement, as these are the two main reasons to apply serious games.

3.3.1 Vision design

The outcome of the game is a vision for a circular business or industry park. It is important that the vision is of good quality and that the participants are satisfied with the outcome. To evaluate the quality of the vision two criteria of Van der Voorn et al. are used [28]: (1) the presence of transformative elements, (2) and presence of goals and guiding targets.

The developed visions were written down in a meeting report and sent to the participants for verification. Next, the transformative elements, and goals and guiding targets were identified in the developed vision. Next, transformative elements were assessed on their circularity using the Seven Pillars of the Circular Economy. The participants' satisfaction design was measured using self-reporting in the post-questionnaire. The results were used to interpret how participants felt about the vision. If a desire to change the vision was expressed, suggestions were evaluated by the researcher whether they were an incremental or radical change to the developed vision.

3.3.2 (Social) engagement

The effects of the game on (social) engagement were tested on three dimensions: (1) game experience, (2) perceived level of influence, and (3) learning. These dimensions relate to different parts of the definition for engagement and include willingness to have emotions, affect, and thoughts directed toward and aroused by the mediated activity to achieve a specific objective, respectively.

The construct game experience is used as defined by Poels et al. [29]. So, the game experience is split into three dimensions, each containing several concepts. The dimensions are: (i) core experience during the game (competence, sensory & imaginative immersion, flow, tension/annoyance, challenge, negative affect, positive affect), (ii) social presence experience (psychological involvement – empathy, psychological involvement – negative feelings, behavior involvement), and (iii) post-game experience (positive experience, negative experience, tiredness, returning to reality). Dimensions 1 and 3 relate to the goal of engagement while dimension 2 relates to the goal of social engagement. The dimensions can be measured using the Game Experience Questionnaire (GEQ) [30]. 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 implications are on the (social) engagement.

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

The construct learning is split into two categories. The first category is general learning, which covers all relevant learning that has happened in the workshop. The second category is learning from other participants, which covers the social interactions about the desired subjects. Using the results of the postquestionnaire, not only the number of people having learned could be evaluated, but also how this learning was induced (through the game or through other participants). Furthermore, changes in conceptualization of circularity before and after the workshop, self-reported insights, and the discussion during debriefing, were used to uncover aspects of what had been learned .

4. Results

The results of the two workshops are described and compared below. Due to a technical error, a few questions were only answered by 5 of the 15 students, regarding participant satisfaction (see Table 2) and perceived degree of influence (see Table 3). Furthermore, participants could leave questions open. The number of participants is reported per variable.

Table 1
Vision analysis

	Transformative elements Principle & CE pillar(s)	Goals and guiding targets
Student 1 (Botlek)	Restructure management to repurchase for the environment or society. Pillar: Value Local resource collection/ generation. Pillars: Materials and energy Recycling of waste materials. Pillar: Materials Repairing existing products. Pillar: Materials	NA
Student 2 (Kwinana)	Local resource collection. Pillar: Materials Recycling post-consumer waste. Pillar: Materials More space for nature. Pillar: Biodiversity Space for not-work needs. Pillars: Value, health & wellbeing, and society & culture	NA
Student 3	Repurchase for the environment or society. Pillars: Value, biodiversity, and society & culture Local resource generation. Pillar: Materials More space for nature. Pillar: Biodiversity Space for not-work needs. Pillars: Value, health & wellbeing, and society & culture Collaboration between companies on the park grounds. Pillar: Society & culture	NA
Stakeholder (De Wildeman)	Shared facilities. Pillars: Materials and society & culture Local energy and resource production/ collection. Pillars: Energy, materials, and water Space for not-work needs. Pillars: Value, health & wellbeing, and society & culture More room for nature. Pillar: Biodiversity	NA

4.1 Vision design

During the game, the participants made a visual representation of their proposed vision (see Figure 2 for an example). The vision analysis showed that all the visions contain transformative elements. Per vision, transformative elements were identified and grouped using circular economy principles and the related pillar(s) of the Circular Economy framework [17]. 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. All CE pillars were addressed at least once. The pillar *materials* was addressed most often (8x), followed by *society & culture* (6x), *value* (5x), *biodiversity* (4x), *health & wellbeing* (3x), *energy* (2x), and finally, *water* (1x). However, none of the visions contain any explicit goals or guiding targets. The results of the vision analyses can be found in Table 1. The detailed visions can be found in Frens [21].

Figure 2: Example output game

The results from the post survey show that five participants were (very) satisfied with the vision design. Three students were somewhat neutral by being neither satisfied nor unsatisfied. On the question if the participants would like to change the developed visions, only one out of eight respondents said they would like to adapt the plan. The results can be found in Table 2.

The answers to the questions about the insights of circularity in general and on the business park, students reported social and organizational insights, while seven students especially mentioned that new management methods are needed. This was also present in the design of group 1. Four students explicitly mentioned redistribution of health and three students said that the wellbeing of people should also be included. This is also in line with the designs of the students, where many elements of broader social values were added to the design.

Table 2
Frequency table Participant satisfaction

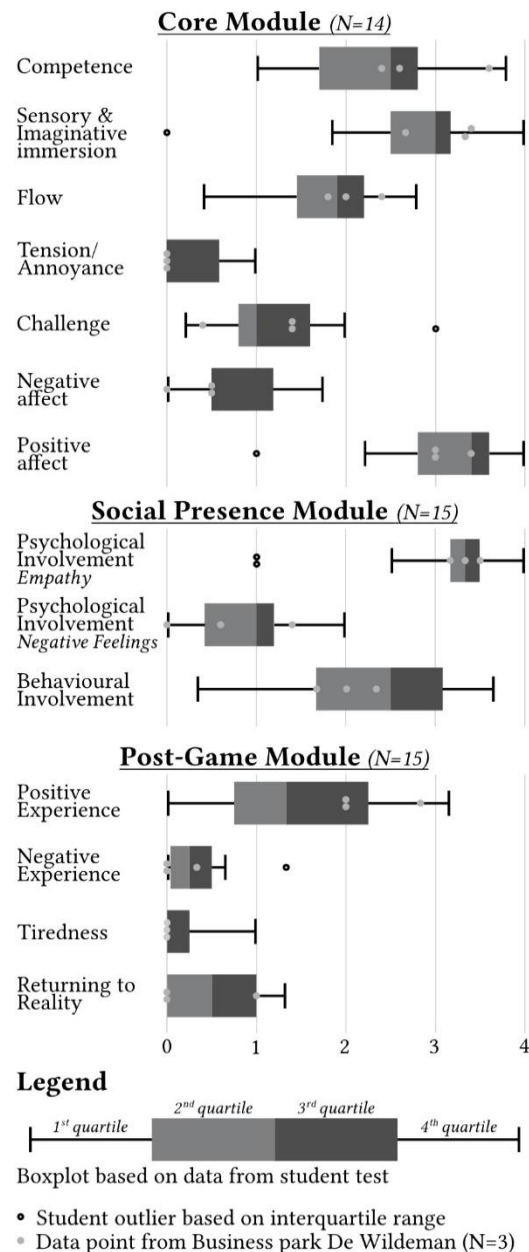|	Students (n=5)	Stakeholders (n=3)
Very unsatisfied		
Somewhat unsatisfied		
Neither satisfied nor unsatisfied	3	
Somewhat satisfied	1	2
Very satisfied	1	1
Wants to change the developed vision		1

4.2 (Social) engagement

4.2.1 Game experience

The results of the game experience questionnaire (GEQ) can be found in Figure 3. The results of the student workshop are plotted on one boxplot per component. Based on the interquartile range method, six outliers were detected. Since these are natural outliers, the data has not been removed from the results. 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 fall within the total range of the results of student workshop. For 6 of the 14 components (43%) all stakeholder results fall within the middle 50% of the student results. For the other 8 components, at least one of the results is located within this 50% middle range. In total, 11 of the 42 (26%) stakeholder results are 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 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 center value. Results for the component flow, which would also indicate high (social) engagement, have a broad spread in results. The results of two components that would have a negative effect on (social) engagement (tensions/annoyance and negative affect on mood) scored relatively low with all participants scoring below the center value.

Figure 3: Results GEQ

For the GEQ post-game module, the student and stakeholder workshop results are also rather similar. However, the stakeholder results suggest 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) shows a broader range of 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) scores low. The components indicated high (social) engagement (empathy and behavioural involvement) score high and spread results, respectively.

Table 3
Frequency table perceived degree of influence

	Students (N=5)	Stakeholders (N=3)
No influence	0	0
Low degree of influence	1	0
Some degree of influence	1	0
High degree of influence	3	3
Very high degree of influence	0	0

4.2.2 Perceived influence

Apart from the engagement in the post survey, we asked the participants to what degree they felt that they personally had influence on the vision proposal using a 5-point Likert-scale. The results can be found in Table 3. Six out of 8 participants said they perceived a high degree of influence; one person experienced a low degree of influence and another person some degree of influence. The student participant experiencing low 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 felt like [their] voice and opinion matter" (Translated from Dutch by the researcher). One of the stakeholders experienced high influence but the participants were with a small group with similar world views, which may led to similar ideas.

4.2.3 Learning

In the postquestionnaire, participants were asked to self-report whether they obtained any new insights about the concept of circularity due to the game or other participants and if they had obtained any insights for circularity at their business park. Furthermore, they were asked whether any part of the vision proposal had not been thought about before the workshop. The results are shown in Table 4.

In the debriefing, participants were asked to share their insights and how they could use their learning at the workshop for vision-making in the future. The students indicated that they would be able to use a vision-based approach to circular thinking rather than a strategy-based approach. The main response of the stakeholders was that they were reminded of 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 learning and insights of the workshop in future settings.

Table 4
Self-reported insights (learning)

	Results students	Results stakeholders
Any insights	13 (N=15)	3 (N=3)
Insights concept of circularity from		
- other participants and/or the game	12 (N=15)	3 (N=3)
- other participants	10 (N=15)	3 (N=3)
- the game	7 (N=15)	2 (N=3)
Insights circularity business park	10 (N=15)	3 (N=3)
Part of vision proposal not thought about before workshop	3 (N=5)	2 (N=3)

5. Discussion

The vision evaluation shows that all visions included transformative elements, while none had guiding goals or targets. The presence of transformative elements can be explained by using semi-random brainstorming prompts that are not related to the current state of the business park. By allowing the participants to think freely and creatively in the first phase, they can propose ideas for a circular future beyond the presence. The absence of goals and guiding targets could be due to the game design. However, the vision design process usually consists of more than one workshop. In case of a follow up workshop, guiding goals and targets can be added. So, if there is a need to generate or define the goals and guiding targets earlier in the process, the game can easily be adapted for this.

In the survey, participants indicated that they learned about circularity, which is in line with the observations in the first round, when players were challenged to give their own ideas of the linear and circular economy and discuss these. So the game gives an explorative space to experiment with different types of circularities and to become creative in the vision design. This was further supported by the observation that most participants proposed an idea in most rounds and could influence the vision proposal. The final vision proposals not only included ideas from the first phase, but also adjustments and new ideas implemented in later phases. Examples of such creativity include the social, organizational, and managerial changes in the park to become more circular. Although such input was part of the CE framework applied in the game design, it also facilitated the discussion. In this way the game has value in the vision design stage of participatory backcasting. Additionally, the creativity and discussion showed that the participants were willing to have thoughts directed towards the development of the vision using the game, which would indicate a positive effect on the (social) engagement.

The results of the GEQ show that the participants experienced emotions toward the mediated activity. The results of the social presence module indicate that these emotions were also directed toward other

participants, and suggest a positive effect on (social) engagement.

Finally, the participants were asked whether they believed to have influenced the developed vision. Overall, most participants felt involved in the design of the vision, in line with the goals of (social) engagement for the game.

This research contributes to the benefits and drawbacks of using games as tool for participatory backcasting, which is complementary to prior research on games in backcasting focusing on the output of workshops [6, 8-13]. This explorative study could also encourage others to develop tools and methods that could be used within the participatory backcasting process and evaluate their effects. By developing and evaluating tools for participatory backcasting on their effects and conditions for achieving these effects, practitioners can make more informed decisions on what methods to use and with what purpose, and under what conditions and settings.

6. Conclusion and recommendations

The aim of this paper was to explore effect of a serious game on vision design and (social) engagement in participatory backcasting. From the results of playing the games with four teams in two different settings we can conclude that the game was useful and supportive to create visions that the participants were on average (very) satisfied with. The game proved to be useful for generating transformative ideas but did not lead to clear goals and targets. This could be overcome by adding a follow-up session for target setting.

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 (engagement) and the social presence module indicates a positive effect on interaction and social engagement during the game. Finally, the participants on average perceived that they were able to influence the design of the vision (through their engagement). In conclusion, our research suggests that the use of a serious game can have a positive effect on (social) engagement.

While our research provides first insights into the effects of a serious game as (social) engagement and design tool for vision making during the participatory backcasting process, it is not without limitations. For instance, the research is conducted in a short time period, so it was not possible to incorporate the full participatory backcasting process or any later effects in the results. Furthermore, the data gathered have limitations due to a small number of participants and all research was conducted using one game. It should also be mentioned that the participants were aware of the workshop being organized for study purposes, and that the developed visions would not have direct consequences on their actual future planning.

Finally, several recommendations can be given. First, participatory backcasting practitioners are recommended to make use of serious games as a tool in their toolbox to support the backcasting process.

Taking advantage of our results, they can consider the benefits and drawbacks of the tool and decide whether it would be beneficial for their case. Future research about the use of gaming could include research on the effects on follow-up activities. It is also suggested to organize and study more workshops using different types of games to compare their effects. Furthermore, the effects should also be tested in a real future planning context. In addition, other designers could develop and test the effect of different tools. The methods used in this research can be used as initial framework to test the effects to make the tools and their effects more comparable.

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