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Board game for co-creating ecosystem based circular economy business models

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Abstract: This study conceptualize and empirically tests a serious board game for co-creating ecosystem based Circular Economy Business Models (CEBMs) in a multi stakeholder setup. The board game targeted to the birth stage of ecosystem development is taking advantage of prior scientific knowledge by utilizing circular economy strategies derived from the CE literature. Theoretical justifications for the game design choices and practical examples of the game are presented. The empirical testing results grounded of the adapted Technology Acceptance Model model verified the user acceptance of the suggested board game. Playfulness and easy to use were significant predictors of the attitude towards using the game, while usefulness was predicting the intention to use the game again. However, teachers and practitioners perceptions towards the game differed and also having good CE knowledge reduced the usefulness perception.

Keywords: circular economy, business model, gamification, serious game, edutainment, board game, strategy game, ecosystem, co-creation

1. Introduction

Circular Economy (later CE) Business Model (later BM) (later CEBM) adopts the reduce, reuse and recycle principles (Kirchherr et al. 2017) and helps companies create value through using resources in multiple cycles and reducing waste and consumption. According to Ellen MacArthur Foundation, “CE it is not about one company changing one product, it’s about all the interconnected companies that form infrastructure and economy, coming together and re-thinking the operating system itself”. Therefore, it is argued that CEBM innovations are by nature ecosystem based (Tsujimoto et al. 2018) since they require collaboration, communication, and coordination within complex networks of interdependent but independent actors/stakeholders.

CE is a relatively novel concept, which development so far has mainly been driven by practitioners, while building a scientific basis for the CE has been scattered and without coherent definition (Korhonen, et al. 2018). Solving complex problems (Murthy, 2000)

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such as developing CEBMs, requires seamless collaboration among diverse set of actors, which have different, complementary, and often controversial knowledge and skills. However, when large group of people having such a diverse background and objectives collaborate, it can easily reduce innovation performance due perceived disagreements among group members relating their opinions and ideas (Simons and Peterson, 2000). Yet, collaboration is compulsory since without it, collective intelligence is not emerging to generate new knowledge that neither of the collaborators previously possessed. As a result, it is argued the ongoing systemic change calls out new and easy to use tools for co-creating CEBMs.

2. Research design

The goal of this study is to conceptualize and empirically test a serious board game for co-creating shared strategic vision for ecosystem based CEBM in multi stakeholder setup. According to Michael & Chen (2005) serious games is a game, which do not have entertainment, enjoyment or fun as their primary purpose whereas “board game” is a game played by placing or moving pieces on a board (The Merriam-Webster.com Dictionary, 2020). Player-centred learning framework proposed by Santonen and Faber (2015) was adopted to describe the key elements of the proposed board game including game players, pedagogy, story, mechanics, aesthetics, and technology (Appendix 1).

A mixed method approach (Leech and Onwuegbuzie, 2009) was utilized in conjunction with an iterative constructive action research process (Kasanen et. al. 1993). Finding effective ways to develop CEBMs is in high demand especially in European Union countries since European Commission has committed to become world’s first climate-neutral continent by 2050. An extensive EU action plan for the Circular Economy has already been implemented (European Commission, 2015) while new action plan is to be publish in the first quarter of 2020. To ensure solid theoretical foundation for the game, a systematic literature review covering business modelling and ecosystems in context of CE was conducted (Becheikh et al., 2006).

On the basis of gained insights from literature, a practical solution (a.k.a. board game) was iteratively constructed as follows. During the first iteration, the game developers (a.k.a. authors of this study) played the game to make sure that the game flow was understandable. The next three iteration phases included two international and one national workshop.

The first workshop (N=16) took place in the Open Living Lab Day 2019, which brings together researchers, public authorities, companies and Living Lab practitioners to exchange knowledge, best practices, methodologies and tools related to Living Labs and user engagement. The proposed board game includes living lab (Bergvall-Kåreborn. et al., 2009) based project-planning feature, which can be used to define end-user and other key stakeholder engagement activities for further co-creating and testing the proposed. Therefore, it was important to collect feedback also from the living lab community. The second workshop consists a group of practitioners and thematic experts (N=16) taking a part to H2020 funded CIRC4Life-project, which is developing and implementing CEBMs for lighting, meat and recycling industries. The third workshop took place during the consortium meeting of “Circular Economy Competence to Universities of Applied Sciences in Finland” – project, which aims to develop novel pedagogical solutions for circular economy teaching (N=17). As a results, the player feedback in total (N=49)

consist industry practitioners, teachers and living lab expert, which covers the key target groups of the board game.

After each iteration, a qualitative and quantitative feedback was collected from the players. During the final two phases, empirical testing was utilized by using a modified Technology Acceptance Model (TAM2) (Venkatesh and Davis, 2000), now including also playfulness dimension associated with serious games (Padilla-MeléNdez, et al 2013).

2. Theoretical foundations of the board game

2.1 Ecosystem development phases covered by the board game

Due the fundamental nature of CE, the proposed board game logic is grounded on an idea of a business ecosystem in which according to Moore (1993) “a company should be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries”. By definition (Tsujimoto et al. 2018) ecosystem objective is “to provide a product/service system, an historically self-organized or managerially designed multilayer social network consists of actors that have different attributes, decision principles, and beliefs”. Moore proposed four evolutionary stages for a business ecosystem including birth, expansion, leadership and self-renewal. The suggested board game is especially target to birth stage when the ecosystem as a system will modularized and the roles of the ecosystem actors will be defined (Moore, 2006; Dedehayir et al. 2018). Moore (1996) itself also acknowledged that the birth phase is a multi-staged experimental learning process, which start with ideating the value-creating relationship with the ecosystem (a.k.a. the main focus area of the board game). Thus, is argued that the serious game based learning approach for developing CEBMs could be justified.

2.2 What is an ecosystem?

Before developing a game, there is a need to understand what is an ecosystem. Scholars have identified four major ecosystem research streams, each having a different theoretical background (Tsujimoto et al. 2018). It is argued that all following four approaches are relevant for CEBM development:

1. **Industrial ecosystem / ecology viewpoin**t focuses on analysing and optimizing energy and/or material flows within the ecosystem is a fundamental feature for all CE based approaches due the aim of eliminating resource input into and leakage out of the system. Thus, board game should include a module for describing the energy and material flows within the system
2. **Business ecosystem viewpoint** highlights the value capture and value creation dynamics as a whole ecosystem, by each ecosystem member and between the ecosystem members. Therefore, the value capture, value creation and value promise for all these actors should be addressed by the game.
3. **Platform viewpoint** focuses on the processes, (technical) support and collaboration mechanisms, which are needed to establish and manage the seamless connections between the diverse ecosystem stakeholders (a.k.a. the operational platform to enable linkages between the ecosystem modules) (adapted from Gawer, A., Cusumano, M.A., 2014)

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4. **Multi-actor network viewpoint** expands the ecosystem actors beyond the business ecosystem by utilizing the Quadruple Helix approach (Arnkil, R., et.al. 2010) –an extension to Triple Helix (Etzkowitz, H. and Leydesdorff, L., 2000) approach – and highlighting the private and public sector as well as academia and civil society as a key stakeholders of CE ecosystems.

3. Main modules of the board game

3.1 Business model innovation development process

Business model innovation process model suggested by Frankenberger et al. (2013) is applied to present the main modules of the game. *The initiation phase* focuses on understanding and monitoring of the surrounding ecosystem of the innovating firm. *Ideation phase* focuses on "the generation of ideas for potential ecosystemic business models. *Integration phase* focuses on the development of a new business model based on promising ideas identified in the ideation phase. Finally, *the implementation phase* as the name state, focuses on the implementation of the developed business model, which often follows pilots, trial-and-error, and experimentation process.

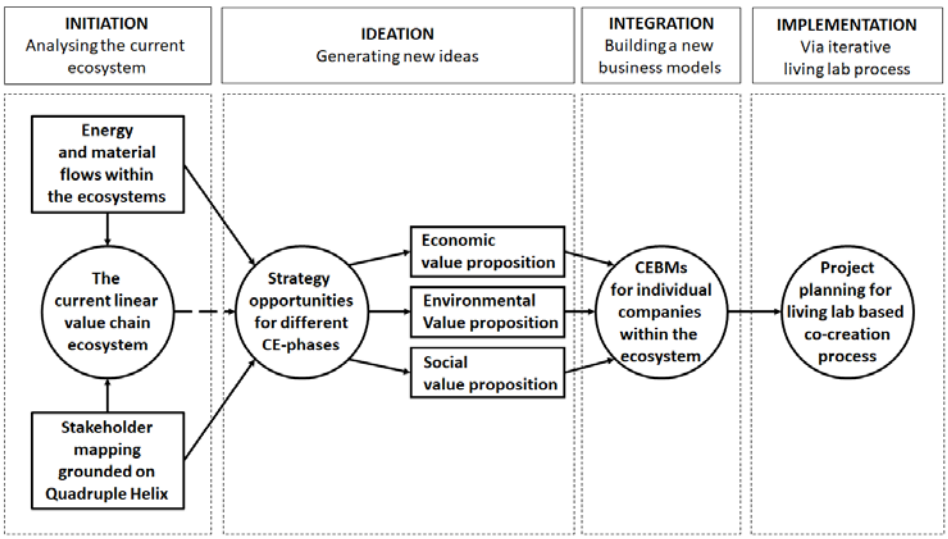

Figure 1 Main modules of the board game

3.2 Module 1. Initiation – Understanding the current business ecosystem

The goal of the first module presented in Figure 2 is to create a shared understanding of the current linear business ecosystem(s).

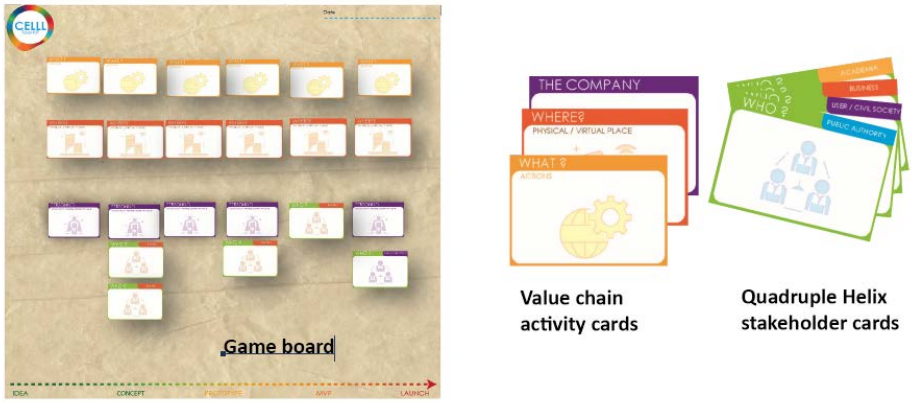

Figure 2 Initiation module for defining the current value chain

Participants aims to create a linear illustration of the current business environment(s) and value stream(s), by using WHAT, WHERE, and WHO cards. Cards includes both predefined term descriptions, which are typically found in business ecosystems, as well as blank cards, which players themselves can fill if the predefined cards do not includes such a term.

WHO cards represent stakeholders in the ecosystem. Identification is grounded on the Quadruple Helix (Carayannis and Campbell, 2009) and Open innovation 2.0 (OI2) principles. (Curley & Salmelin 2013). Quadruple Helix – an extension to Triple Helix approach – describes an innovation system where government, industry, academia and civil society work together to co-create the future and drive structural changes far beyond the scope of what any single organization or person could do alone. WHAT cards help to identify actions and value creating processes within the ecosystem and WHERE cards define physical and virtual places in which actions are taking place by the stakeholders.

During playing, participants place the cards on the board and comment their choices for the rest of the group. The “captain”, a person selected among the players to chair the game, ensures that agreement is reached among the participants, before continuing to the next stage. Outcome is an agreed understanding of a current ecosystem, in other words, value chain of actors and other cooperation partners including the end-users (a.k.a. customers) which often forgotten in value chain mapping.

In conjunction the cards describe all the critical viewpoints as identified in the theoretical foundation section: (1) the energy and material flows (i.e. industrial ecology viewpoint), (2) the value creation, delivery and capture processes within the linear business ecosystem, (3) overview of the processes and collaboration mechanisms, which are needed to manage and operate within the ecosystem, and (4) the key stakeholders OI2 principles.

3.3 Module 2. Ideation– Generating new business ecosystem ideas

Module 2 presented in Figure 3 focuses on collectively generating ideas for CEBMs by using predefined CE-strategy option cards, which are grouped on the basis of CE circle phases including: (1) material sourcing, (2) design, (3) manufacturing, (4)

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distribution and sales, (5) consumption and use, (6) collection and disposal, (7) recycling and recovery, (8) remanufacture and (9) circular inputs.

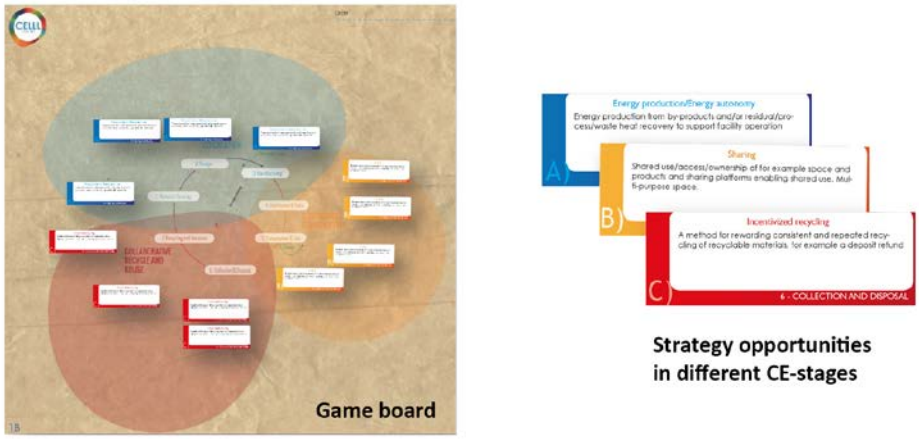

Figure 3 Ideation module for defining business ecosystem ideas

There has been multiple efforts to identify approaches for CEBMs. Among the most prominent studies for our purposes includes the following four each having their own unique viewpoint:

1. **Circular Economy phases approach**: CE Strategies Database, which describes 45 CE strategies that are applicable to different parts of the CE value chain (Kalmykova et al. 2018),
2. **Business model innovation type approaches**: The sustainable business model archetype framework, which includes technological, social and organisational dimensions as main viewpoints each including three main architypes and a total of 53 example approaches (Bocken et al 2014),
3. **Sustainable Business Model Canvas (SBMC) approach:** Morphological box of CEBM design options grounded on value proposition, value delivery, value creation and value capture dimensions as proposed in SBMC (Lüdeke-Freund et al. 2019)

Out of these three excellent options, CE Strategies Database approach (Kalmykova et al. 2018) was adopted as building blocks for the CEBM ideation module. The framework offers structured support to discuss the relationship across the CE phases and identify modularized roles for different ecosystem actors (Moore, 2006). The strategy cards in the game are updated by conducting periodical literature reviews as well as using game outcomes and an input.

During the playing, participants starts by selecting opportunity cards and prioritizing them based on a simple “Yes”, “Maybe” and “No” approach. Next, participants go through their selections of “Yes” and “Maybe” cards, in order to make the final opportunity selection. Simultaneously the connections between the various CE ecosystem modules are discussed to verify that all relevant roles to implement the ecosystem are covered.

The value creation in context of CE business ecosystem is much more complex than in the traditional linear production-consumption systems highlighting mainly the value for the customers and investors. Instead, successful CE ecosystem should contribute to all three pillars of the sustainable development including economic, environmental and social (Korhonen, et al. 2018). To validate that the ideated CE ecosystem is solid, the assumed economic, environmental and social values are defined for the ecosystem. Finally, the selected CE-opportunities are linked to key stakeholders by using the current value chain mapping results and defining new stakeholders by using the Quadruple Helix stakeholder (WHO) cards if needed. An example outcome of the meat product supply chain CE-opportunities from CIRC4Life-project is presented in Figure 4.

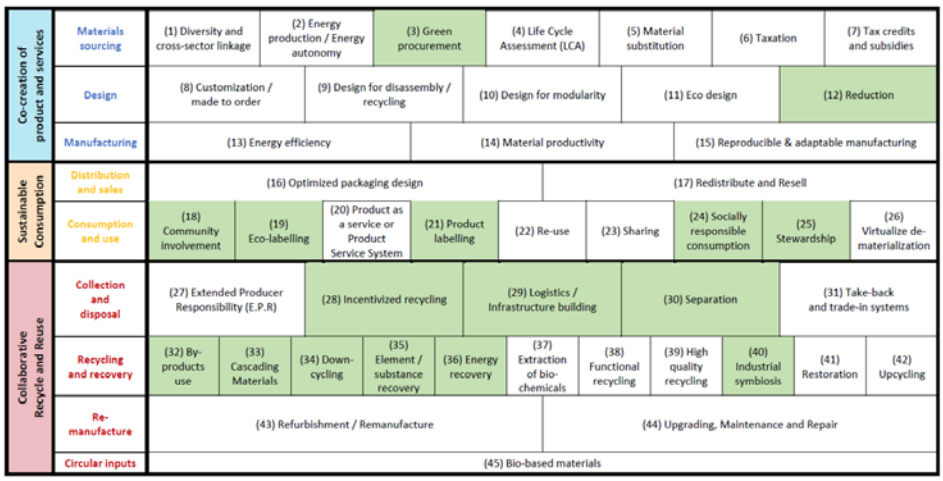

Figure 4 Example from H2020-funded CIRC4Life-project regarding Meat product supply chain

3.4 Module 3. Integration– Building new business models

The Business Model Canvas (BMC) proposed by Osterwalder and Pigneur (2010) is likely the most well recognized framework to develop business models. However, BMC also inherits the limited definition for the value proposition. Therefore, CE compatible Sustainable Business Model Canvas (SBMC) including the three pillars of sustainability proposed by Bocken et al. (2018) was adopted for the board game as such. The SBMC should be defined for the all "modules" a.k.a. organizations in the CE ecosystem.

3.5 Module 4. Implementation planning

As suggested by Frankenberger et al. (2013) *the implementation phase* of the business model innovation often follows iterative trial-and-error process, which includes different types of co-creation and testing phases. Therefore, a living lab approach and design thinking was adopted as the theoretical foundation for the implementation planning module. Bergvall-Kåreborn. et al. (2009) defined living lab as follows:

"A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed

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innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values".

Planning module loosely follows the Double Diamond Model (also known as 4 D), which was initiated by the British Design Council in 2005. The model includes Discover, Define, Develop and Deliver stages, which are overlapping with the previously presented modules. The Discovery phase searches new opportunities by gathering various kinds of information and insights. The Definition stage the aim is to make sense of the identified possibilities while framing the scope for the business challenge and selecting the ideas for further development, rejection or returning in previous stage. The implementation module focuses on the Development stage, in which the suggested solutions are created, prototyped, tested via multiple iterations in the real-life environments. The Deliver stage from the Double Diamond Model is omitted.

Development stage presented in Figure 5 includes a set of predefined cards, which consists a diverse set of service design methods such as workshop, design sprint, observation, minimum viable product (MVP), mock-up, small and large scale pilot tests. The cards are placed in project planning stripes which representing the living lab project progress according to the different innovation process phases from fuzzy front end of innovation to the launch if the new business model innovation. Multiple project planning stripes can be placed on top of each other to visualize the progress of the main development activities and their relationships.

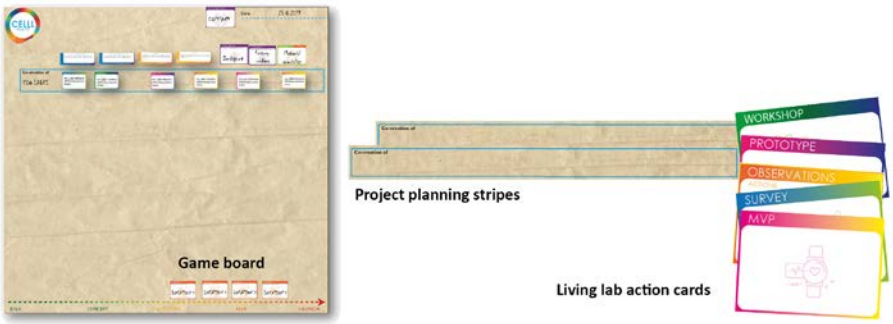

Figure 5 Living lab project planning

4. Findings from the testing of the game

4.1. Pre-testing results with the living lab actors

The first pre-testing results (Appendix 2) from the Open Living Lab Day 2019 workshop revealed following when predefined company cases were used as a starting point for the game playing (i.e. participants were not associated with the companies or ecosystem in question). Mean value 3.29 (on scale 1 to 4) of the overall feeling indicated between good and excellent satisfaction towards the game.

Strongly disagree/agree 5-point Likert scale was used for follow-up measures. Game can clearly also provide new insight/knowledge (mean 4.00) for the participants and it

was considered as a useful for the player or his/hers organization (3.93) as well as beneficial for CEBM development (4.40) and project planning (4.50) purposes in general. The co-creative element of the game was also validated (4.56). However, as it could be expected, at this stage the game still had some issues relating the objectives of the game (3.25), duration of the game (2.88, note: due the having the workshop in the conference, the time was limited) and the game logic (3.37). Nevertheless, participant would like to play the game again (4.44) and enjoyed playing the game (4.27).

Open-ended responses were also collected. The improvement suggestion proposed more structure for the game playing and reducing the number of the available cards at the certain point of the playing. There was some confusion among the players right after starting the game. An introduction to the core terms used in the game was also proposed. There is also a need to simplify the strategy options cards descriptions and increase the font size. The potential user suggestions for the game included decision/policy makers, companies, SMEs, education (students and teachers), innovation managers, EU-funded projects.

4.2 Testing results with the practitioners from industry experts and teachers

The results from the adjusted TAM analysis based on the workshops (1) among H2020 funded CIRC4Life-project members developing their own business models and (2) with university of applied sciences teachers using predefined company cases are presented in Figure 6.

As a result, the adjusted TAM model presented in Figure 6 was working as expected. Significant correlations (** sig, 0.01 level, 2-tailed, * sig, 0.05 level, 2-tailed) were observed between all other summary variables ranging from weak 0.368* to strong 0.728**.

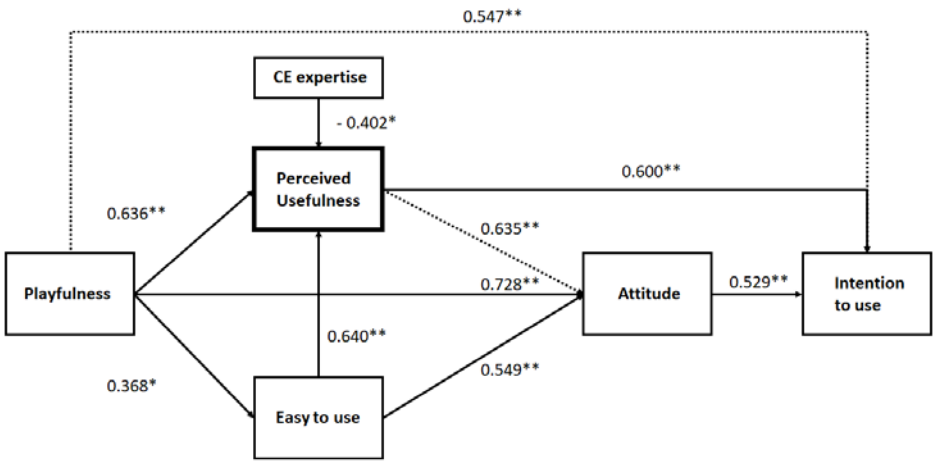

Figure 6. Adjusted TAM analysis results

In order to evaluate the interaction between the key variables, multiple linear regression analysis was calculated to predict attitude towards using based on playfulness, easy to use and usefulness. A significant regression equation was found ($F(2, 28) = 22.99, 0.00$) with R^2 of 0.622. Playfulness and easy to use were significant predictors of

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the attitude towards using. Furthermore, second multiple linear regression analysis was calculated to predict intention to use using based on playfulness, easy to use, usefulness and attitude. A significant regression equation was found ($F(1, 29) = 16.31, 0.00$) with R^2 of 0.360. Usefulness was a significant predictor of the using again.

Additional analysis were conducted to evaluate the possible perceived differences between the teachers and practitioners. As a result significant mean difference between teachers and practitioners were identified in the case of playfulness (mean 4.02 vs. 3.42) indicating teacher considered the game more playful than practitioners (Table 1). A significant regression equation was found for teachers ($F(1, 17) = 7.24, 0.015$) with R^2 of 0.299 in which usefulness was significant predictor of predicting intention to use. On the contrary, playfulness was significant predictor of intention to use for practitioners ($F(1, 8) = 7.78, 0.024$) with R^2 of 0.493. There was also weak negative correlation between CE expertise and perceived usefulness, indicating those having good CE knowledge, do not found the game as useful as the others.

Table 1. Adjusted TAM analysis results

Variables	*Mean All*	*Mean Academic*	*Mean Practitioners*
V1: Playfulness	3.80	4.03**	3.41**
V2: Usefulness	3.84	3.89	3.76
V3: Easy to use	3.72	3.67	3.84
V4: Attitude towards using	4.06	4.16	3.84
V5: Intention to use	4.06	4.16	3.90

** sig. 0.01 level

5. Conclusions

A facilitated board game for co-creating ecosystem based CEBMs was theoretically justified and empirically tested. The approach utilizing predefined circular economy strategies derived from prior CE studies as a foundation for the game appeared to be a good design choice. The user acceptance of the suggested board game was verified by utilizing Technology Acceptance Model. Playfulness and easy to use were significant predictors of the attitude towards using the game, while usefulness was a significant predictor of the using the game again. However, it appeared that the teachers considered the game more playful than practitioners and for them usefulness was significant predictor of using the game again. Instead, for the practitioner the playfulness was the predictor of the intention to use the game again.

As a result, it is argued that both “usefulness” and “playfulness” are critical pre-requirements for the game. It appears that if the game is useful and provides enjoyment, the users were willing accept the limitations relating “easy to use”. The open responses indicated that the CE strategy descriptions and the related terms were somewhat confusing and those should be clarified. The game logic is understandable, but since the topics is challenging, it clearly requires mental efforts from the participants especially when the game is played in serious goal-oriented mode (e.g. companies developing genuine ecosystem). The tested working prototype still need further developed to become full-scale product, which will have the capacity for supporting organizations on the way

to CE. In the further development phases, game developers should considered if different versions for the practitioners (e.g. SMEs) and educational purposes are needed.

It was also identified that the players having more extensive CE experience did not find the game as useful as the others. For them it should be highlighted that the tool is designed to be used as a team exercise, which facilitates teamwork, social communication skills and enabling a dialog between actors who has different CE skills. Open and rich dialogue with diverse set of actors can later on reduce conflicts due the common and structured understanding of the shared vision.

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Appendix 1: Table1: Evaluating the board game by using the Player-centred Learning Framework (Santonen and Faber, 2015)

Analysis framework factors	*Description*
Player -	**DEFINITION: a person(s) who is taking a part to game activities in order to learn a specific and predefined learning goals, while enjoying him/herself during this process**
Target group: intended players of the game	*Main target group*: Employees and managers in organizations, which are interested to make a transformation towards circular economy *Secondary target group*. University students
Learning goal: what learners need to learn in the game	Understanding the opportunities for the Circular Economy Business Models (CEBM), defining CEBMs and planning the implementation project
Motivation: intrinsic and external motivation to play the game	*Intrinsic motivation:* Learning more about CE *External motivation*: Developing new business opportunities and networks (companies), gaining study credits (students)
Prior knowledge and skills: knowledge and skills on the game topic before playing the game	A basic understanding about CE strategies, business model canvas, design thinking methods is preferred but not required if the game is used for learning purposes.
Player composition: the organisation of players in a game	One team of multiple stakeholders having preferable a diverse background (e.g. see Santonen, 2016)
Pedagogy	**DEFINITION: The learning approach used to educate players of the game**
Assessment/Feedback: within game feedback on player actions	Players receive direct in-game feedback by discussing each other while playing the game,
Debriefing/Evaluation: capturing of the lessons learned after playing the game	Group de-briefing (social learning) and illustartions summarizing the outcomes of the game
Safety: the lack of real world consequences	Risk free experimentation
Action-domain link: transferability of actions in the game to the real world	Actions (decision making) can be linked to actions in real world and in best case scenario, the game will results further development actions (e.g. establishing a development project).

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Analysis framework factors	*Description*
Story	**DEFINITION: The information that needs to be made accessible to players to be able to play the game**
Problem-learner link: the way by which the game is made relevant to the player	Co-defining the current ecosystem, presenting known opportunities from already applied real strategies, utilizing prior scientific knowledge
Instruction, Help and Hints: the support that is provided to get the player started quickly	Instruction on game rules before playing game. If needed the introduction of the key terms can be provided for those who are novice in CE or living lab based project planning. Facilitators keep track of time and progress and help players.
Fantasy: the make belief aspect of the game	Plausible future scenario: Developing CEBM for real or sample organizations
Mystery: the gap between available and unknown information	The selection of the opportunities is not predefined, but based on the collective effort of the participants.

Analysis framework factors	*Description*
Mechanics	**DEFINITION: Procedures and rules of a game**
Goals/ Objectives: win conditions of the game	Collective goals are given: 1) define current ecosystem, 2) identify CE strategy opportunities, 3) identify key stakeholder, 3) define CEBM, 4) make a plan for implementation
Rules: structure, limitations and affordances which guide players' actions in the game´	The game is time-limited process with rounds forcing participants make agreement regarding the collective goals. Players have to do all steps themselves.
Adaptation: adjustment of the difficulty of the game to the skill level of the player	Facilitator can provide examples, give more in-depth definitions for the key terms, keep introductory lecture before playing the game.
Sensory Stimuli: the incentives build in to allow players' (temporary) acceptance of the game reality	Relevant and realistic (enough) model of reality
Progress: the measure of how the player progresses in achieving goals	Rounds left, collectively created illustrations on the board based on the cards.
Challenge: difficulty of realising goals within a game	CE ecosystem is complex phenomenon, which requires contributions from many experts having a diverse knowledge background. It may be difficult to get all the relevant players to play the game. Also transforming CE opportunities into tangible business model could be challenging.
Conflict: solvable problems a player is confronted within the game	A need to define current and future ecosystem and make an implementation plan for the further steps.
Control: player's possibilities for active and direct manipulation of the game state	Player can add open content by using blank cards.

Table continues in the next page.

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Analysis framework factors	*Description*
Aesthetics	**DEFINITION: The graphic design of game**
Representation: player's perception of the game's reality	Simplified visualisation of the CE circle consisting (1) material sourcing, (2) design, (3) manufacturing, (4) distribution and sales, (5) consumption and use, (6) collection and disposal, (7) recycling and recovery, (8) remanufacture and (9) circular inputs phases. Value chain and living lab process illustrations.
Theme: the setting or context of the game	Ideation and decision making.
Technology	**DEFINITION: The medium in which the aesthetics take place, the mechanics will occur and through which the story will be told**
Interaction: how a player interacts with the game and with other players (combination of equipment, inter-personal and social interaction)	Analogue board game in which the players discuss the different options and make selections (i.e. Social interaction)..
Pieces or players: the game objects and people that are included in the game scenario	Board game consisting two game boards, packs of predefined and blank cards, timeline stripes and markers to modify and add needed elements. All the elements are reusable, and could be cleaned after usage. Players represent a role (e.g. engineer, sales persons, recycling company, policy maker, end-user)

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Appendix 2:

Table 1: Testing results with the living lab actors (N=13-16)

Variables	*Mean*	*V2*	*V3*	*V4*	*V5*	*V6*	*V7*	*V8*	*V9*	*V10*	*V11*
V1: Overall feeling	3.29										
V2: Enjoyable	4.27	0.563*									
V3: Duration	2.88	0.562*									
V4: Understandable objectives	3.25										
V5: Game logic	3.37		0.503*								
V6: Useful for me / my organization	3.93										
V7: New insights, knowledge and ideas	4.00										
V8: Beneficial for BM development	4.40						0.530*				
V9: Beneficial for project planning	4.50										
V10: Useful as co-creation tool	4.56					0.650**			0.513*		
V11: Play again	4.44		0.578*			0.545*				0.789**	

Note: The scale for variable V1 was from 1 to 4 (scale: Poor, Fair, Good, Excellent) and for V2 to V11 from 1 to 5 (scale: strongly disagree to strongly agree).