Product Lifetimes And The Environment
2017 - Conference Proceedings
C. Bakker and R. Mugge (Eds.)

DOI: 10.3233/978-1-61499-820-4-422

PLATE conference
Delft University of Technology
8-10 November 2017

PLATE
Product Lifetimes And The Environment

Risk & Race: creation of a finance-focused circular economy serious game

Whalen K.[a,b]

a) International Institute of Industrial Environmental Economics, Lund University, Sweden, katherine.whalen@iiiee.lu.se
b) In the Loop Games, Netherlands

Keywords
Circular economy
Business models
Financing
Serious game
Business game

Abstract
As the topic of circular economy gains increasing popularity, a growing number of serious games and tools have been developed to assist in educating about circular business models. A review of these existing games suggests a lack of emphasis on business operations and financial implications behind circular business model investment decisions. In contrast, recent academic literature suggests the economic implications of adopting circular business models should be stressed, given potential financial differences between circular business models and linear business models. This paper introduces Risk & Race, a serious game developed to assist in bridging this gap between literature and practice by illustrating the financial drivers and barriers to implementing circular business models in practice. Initial findings from testing with students suggest the game succeeds as a support tool for modeling business operations and explaining the financial side of circular business models.

Introduction

Governments, companies, and scholars have expressed concerns about the long-term viability of our current resource production and consumption rates. Many consider moving to a more circular model as a necessary and logical step for today's society. Analysis also suggests this makes sense from an economic standpoint, with estimates that moving to a circular economy could generate €1.8 trillion within Europe by 2030 (Ellen MacArthur Foundation, 2015).

Companies, perhaps intrigued by the promise of cost savings and new business opportunities, have expressed interest in applying this circular way of thinking in the development of new business models. Business models describe how a company creates, delivers, and captures value (Osterwalder et al., 2010) and are viewed as important enablers for circular economy (Bakker et al., 2014b). Circular business models imply that the useful life of products and components is prolonged and/or material flows are closed.

In practice, many types of circular business models are emerging, with Bakker et al. (2014a) distinguishing five types: Classic Long Life Model, Hybrid Model, Gap-Exploiter Model, Access Model, and Performance Model. However, in moving to adopt these models, companies often encounter barriers. Many models encourage retained ownership of physical assets, resulting in capital tie up and increased business risk (Linder & Williander, 2015). Furthermore, a change in business offer (i.e. moving from selling to renting) can disrupt the revenue stream and lengthen return on investment periods. As such, literature has highlighted the need for further understanding about financing circular business models, especially aspects related to investment decisions for physical capital assets (Korse et al., 2016).

To help increase understanding about circular economy and the development of circular business models, a number of serious games have been developed. This is likely due to both games' abilities to model complex systems and assist in reasoning and planning (Sitzmann, 2011; Ke, 2009). However, a review of these existing games reveals a focus on motivating the creation of circular businesses rather than specifically addressing economic aspects of business operations or detailing financial implications behind investment decisions.

Developed to address this gap, the business game *RISK & RACE* has been developed and this paper investigates how such a serious game can assist educators in modeling

Increased return on investment time & cash flow uncertainties
Difficulty and costs associated with arranging reverse logistics
Increased human resources costs
Upfront investment needed for innovation (i.e. adapting products for CBMs)
Changing market demands & assumptions

Table 1. Key Financial Barriers to CBMs.

drivers and barriers of circular business models. Following a brief background section about existing games and previous research, the scope and theory behind *Risk & Race* is presented. Finally, first insights into the applicability of the game in education are summarized from play testing sessions with high school and higher education students.

Background

Circular Business: Drivers & Barriers

Previous research has highlighted the significance of financial drivers and barriers in regards to adopting circular business models.

Proponents of circular business models stress potential gains from reduction of risk (i.e. greater security of resource supply, protection against price volatility) (Peck et al., 2015) and economic growth (i.e. new revenue opportunities, new market potential, and cost savings in manufacturing) (Ellen MacArthur Foundation, 2013). However, as the assumptions that business operations are based upon change over time and with different market demands (Linder & Williander, 2015), macro environment conditions do not always prove certain circular business decisions to be economically beneficial.

Furthermore, adopting circular strategies in reality poses financial threats to firms' existing business models and a number of barriers have been identified. Much of the knowledge about circular business is based on existing literature on product service systems as, in contrast to the current linear 'sell more, sell faster' business model, circular business models often move away from one time sale of products.

In addition to impacting company cash flow and lengthening return on investment periods (Mont, 2000), additional firm resources are often required. Products many need to be redesigned in order to make them more durable, repairable, and upgradable (Sauve et al., 2015; Berchicci and Bodewes, 2005), leading to greater upfront investment. Additional costs may also result from arranging take-back and reverse logistics (Kissling et al., 2013) or hiring additional employees to perform skilled tasks such as repair (Kowalkowski et al., 2015). As such, many firms do not implement circular business models. Table 1 summarizes these identified barriers.

CE Game-based Tools

Games for learning, or serious games, often represent reality and present players with a unique dynamic learning situation (Crawford, 1984). In the fields of sustainability and circular economy, such games have received attention as learning objects in both research and practice (DeWulf, 2010, Sadowski et al. 2013, Life cycle game, 2016). Recent games developed within the field of circular economy include *In the Loop* (Whalen & Peck, 2014), *Make it or Break it* (ResCoM, 2016), the *Game of Circularity* (Resource 2015 and the Game of Circularity, 2015), and *Circulab* (Circulab game, n.d.).

While these existing circular economy-focused games have specific and differing learning outcomes, most aim at giving a generalist introduction to various motivations for a circular economy and simplify the financial perspective. For example, although *In the Loop* utilizes a monetary system where players must make strategic investment decisions, purchase resources, and distribute products, players do not track financial records (i.e. fixed and variable cash flow) and human resources are notably absent. As such, players receive surface-level takeaways regarding the financial implications of circular business models.

Risk & Race: Overview & Theory

Risk & Race (Figure 1, Table 2) is a serious game developed to explore the financial side of circular business models. At the beginning of the game, each player 'inherits' a manufacturing company in debt. The aim is to increase company value throughout the game and be the company with the highest value at the end of the game. This company value is expressed by the player's total amount of cash, investments, labor force, and societal impact.

The game is played in ten to fifteen rounds. Each round signifies one year and the game follows a pre-set narrative with various scenarios (i.e. PESTEL forces) unveiled each round that change the game conditions. Using game mechanics similar to other 'worker placement' games[1], players need to carefully choose and plan their actions during each round. They can purchase resources, produce and sell products, train employees and make investments in an effort to increase company value. After each round, players must 'bookkeep' by recording their fixed and variable costs, investments, and revenue from product distribution.

The game environment of *Risk & Race* is a complex system with multiple feedback and feedforward loops which can be divided into two main parts: the external environment (i.e. the game narrative and other players' actions) and the internal environment (i.e. player's decisions and company resources). The game's changing narrative mimics many factors in the current external business environment that are seen as drivers for circular economy. Price volatility

Figure 1. Playing Risk & Race. © S. Manshoven

[1] *Also known as action drafting, this is a game mechanic where players choose action(s) to perform from a set of actions available to all players by placing workers on spaces associated with the desired action.*

Risk & Race	
Funding	EIT Raw Materials
Authors	Claude Nuyts, Saskia Manshoven, Stella Vanassche (VITO, Belgium) David Peck (TU Delft, Netherlands) Henna Sundqvist-Andberg, Mikko Dufva (VTT, Finland) Holger Berg (Wuppertal Institute, Germany) Katherine Whalen (In the Loop Games, Netherlands)
Keywords	Business game, board game, circular business game, Circular Economy
Published	May 2017, Belgium
Language	English
Time	2,5 hours
Players	4 individuals or teams
Contact	saskia.manshoven@vito.be

Table 2. Risk & Race Information Summary.

and uncertain supply of resources is expressed throughout the game through player competition, limited quantities, and, following external events, changing resource prices or availability. Policy mandates and new technologies, such as the phasing out of certain resources due to health concerns or improved recycling abilities, also influence players towards adoption of circular business models.

At the same time, barriers to adopting circular business models are present. Table 3 summarizes how the key financial barriers to adopting circular business models are modeled in *Risk & Race*. Unlike other circular economy games, *human resources* are required to perform activities (i.e. purchasing materials, producing products) and, as such, players must balance employment costs with every action, thus illustrating the limited capacities of firms.

The external business environment also impacts each company as, following certain market trends, *market demand* changes each round with the game narrative. Also, resource costs can change due to price volatility on the market, or geopolitical tensions, changing the company's profit margin. Players can react to these evolutions by investing in new or more efficient product design and in new (circular) strategies to assure their resource supply.

Other financial implications of certain internal business decisions related to circular business models also become apparent as the game progresses. As players may choose to distribute products either through direct sales (ownership) or pay-per-use contracts, i*ncreased return on investment periods* are modeled. While the latter distribution method reduces the effect from certain external environmental influences (i.e. resource competition), the longer pay-back time is clearly modeled.

Finally, adoption of above-mentioned policies and new technologies require *significant upfront investments* and do not have clear rates of return. In some cases, players must first invest in multiple strategies before being able to see long-term financial benefits. As such, circular business decisions usually make more economic sense as play progresses rather than in the beginning of the game.

Initial Testing Insights

After an initial iterative design process, playtesting sessions were conducted in Finland, Germany, the Netherlands, and Belgium with a variety of potential target groups including business professionals, entrepreneurs, high school students, and university students. To provide some insight into the game's potential as a tool in education, this paper briefly reflects on only the latter two types of sessions, specifically three sessions with students that took place during the second half of 2016. One session was held with high school students in Germany [n= 12], while two sessions were held with master's students in the Netherlands [n=26] and Finland [n=66].

While all sessions emphasized the need for a moderator to guide each round, clarify concepts, and ensure the game runs smoothly, results indicate *Risk & Race* could provide valuable contributions to educational programs, especially for master's students. Most participants used a combination of distribution types and purchased strategies, enabling them to compare the effects that various circular (and linear) actions had on their company financials. Surprisingly, participants also did not find the bookkeeping aspect of the game tedious, as there was some concern from the designers that this part would be seen as distracting from gameplay.

After playing the game, master's students reported greater knowledge about resource management, business continuity, and company finances due to the game's emphasis on resource purchasing and cash flow. While a comparison of pre and post surveys taken by students in the Netherlands reported an emphasis on smart investment after playing, surveys from both master's

Key CBMs Financial Barriers from Literature	Embodiment in *Risk & Race*
Increased return on investment time & cash flow uncertainties	Visible by comparing the two types of distribution: Direct sales (player gains revenue immediately); Product-Service (player receives slightly more revenue, distributed over three rounds)
Difficulty and costs associated with arranging reverse logistics	Economic costs and uncertainty of take-back volume associated with operating reverse logistics
Increased human resources costs	Human resources required to operate circular strategies; players must make trade-offs between hiring new workers or smartly allocating current employees.
Upfront investment needed for innovation (i.e. adapting products from CBMs)	Significant investment required for circular strategies; some are also conditional (i.e. you must invest in 'Circular Design' before you can remanufacture products).
Changing market demands & assumptions	Game is dynamic system with external influences: Market demand and resource prices fluctuate during the game; External events reveal new conditions; Players compete over the same resources.

Table 3. Embodiment of key financial implications of CBMs within Risk & Race.

student groups indicated increased familiarity with a variety of business-related and circular economy-related terms and concepts including variable cash flow, fixed cost, product service systems, remanufacturing, and reverse logistics.

In contrast, some additional modifications could be necessary if the game is to be used more widely with high school students. The high school students appeared to have more difficulty than the master's students in understanding and playing the game. Furthermore, some language issues were also encountered. While the master's students were familiar with working in English, the German high school students were not.

Conclusions

This paper introduced *Risk & Race,* a game developed to increase understanding of circular business models. While financial differences between linear business models and circular business models are often stated to exist, when educating about circular economy concepts through the use of game-based learning, such differences are not often explicitly illustrated. This paper provides a first overview of how main financial drivers and barriers to adoption of circular business models from literature have been translated and embodied in a serious game.

Risk & Race appears to make a valuable contribution to the growing field of circular economy serious games as the game provides insight into company finance and illustrates resource management, company cash flow, and the influence of external factors (PESTEL). However, elaboration on current findings and additional playtesting must be carried out. Reflection of the game development process and specific mechanics could also be interesting from a serious game design perspective.

Acknowledgments

The author thanks the *Risk & Race* development team as well as the playtesting participants for their valuable support and feedback. *Risk & Race* was developed in partnership with VITO, TU Delft, In the Loop Games, VTT, and Wuppertal Institute and funded by EIT Raw Materials. This paper is also supported by the Mistra REES program, which is funded by Mistra (The Swedish Foundation for Strategic Environmental Research).

References

Bakker, C., Den Hollander, M., van Hinte, E., & Zijlstra, Y. (2014a). *Products that Last: Product Design for Circular Business Models*. TU Delft, The Netherlands.

Bakker, C., Wang, F., Huisman, J., & Hollander, M. D. (2014b). Products that go round: exploring product life extension through design. *Journal of Cleaner Production, 69*, 10-16.

Berchicci, L., & Bodewes. W. (2005). Bridging environmental issues with new product development. *Business Strategy and the Environment, 14*(5): 272–285.

Crawford, C. (1984). *The Art of Computer Game Design*. Los Angeles, California: Osborne/McGraw-Hill.

Circulab game. (n.d.). Retrieved January 24, 2017, from http://circulab.eu/en/

Dewulf, K. (2010). Play it forward, A game-based tool for Sustainable Product and Business Model Innovation in the Fuzzy Front End. Paper presented at the Knowledge Collaboration & Learning for Sustainable Innovation, ERSCP-EMSU conference, Delft.

Ellen MacArthur Foundation. (2013). *Towards the Circular Economy Economic and Business Rationale for an Accelerated Transition*.

Ellen MacArthur Foundation. (2015). *Growth Within: a circular economy vision for a competitive Europe.* Retrieved from www.ellenmacarthurfoundation.org/publications

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production, 143*, 757-768.

Ke, F. (2009) 'A Qualitative Meta-Analysis of Computer Games as Learning Tools', In *R. E. Ferdig (Ed.), Handbook of research on Effective Electronic Gaming in Education*, New York: IGI Global, pp. 1–32.

Kowalkowski, C., Windahl, C., Kindström, D., & Gebauer, H. (2015). What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies. *Industrial Marketing Management, 45*, 59-69.

Kissling, R., Coughlan, D., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S., & Dickenson, J. (2013). Success factors and barriers in re-use of electrical and electronic equipment. *Resources, Conservation and Recycling, 80*, 21-31.

Korse, M., Ruitenburg, R., Toxopeus, M., & Braaksma, A. (2016). Embedding the Circular Economy in Investment Decision-making for Capital Assets – A Business Case Framework. *Procedia CIRP,48*, 425-430.

Life cycle game. (2016). Retrieved January 24, 2017, from https://www.circular.academy/portfolio_page/lifecyclegame/

Linder, M., & Williander, M. (2015). Circular Business Model Innovation: Inherent Uncertainties. *Business Strategy and the Environment*, *26*(2), 182-196.

Mont, O. (2000). Product-service systems: final report. Naturvårdsverket.

Osterwalder, A., Pigneur, Y., Clark, T., & Smith, A. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. Hoboken, NJ: Wiley.

Peck, D. P., Kandachar, P. V., & Tempelman, E. (2015). Critical materials from a product design perspective. *Material Design, 65*, 147-159.

ResCoM. (2016). Retrieved January 24, 2017, from http://www.rescoms.eu/news/ellen-macarthur-foundation-test-out-rescom-serious-game

Resource 2015 and the Game of Circularity. (2015). Retrieved January 24, 2017, from http://www.greatrecovery.org.uk/resources/resource-2015-and-the-great-game-of-circularity/

Sadowski, J., Seager, T.P., Selinger, E.Susan G. Spierre Kyle P. Whyte. (2013). An Experiential, Game-Theoretic Pedagogy for Sustainability Ethics. *Science and Engineering Ethics*, 19(3), 1323-39.

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and CE: Alternative concepts for trans-disciplinary research. *Environmental Development, 17*, 48-56.

Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psychology, 64*, 489-528.

Whalen, K., & Peck, D. (2014). In the loop — sustainable, circular product design and critical materials. *International Journal of Automation Technology, 8*(5), 664-676.