Ticket to Sustainability: A Board Game About Sustainable Software Engineering

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Abstract

Software becomes ever larger and more complex. The IT sector already significantly contributes to global greenhouse gas emissions, and will keep growing. As such, it is important that software developers consider environmental sustainability when creating their IT solutions. The first step towards more environmentally sustainable software is establishing awareness of the problem, as well as presenting greener solutions to developers. To this aim, we have developed an extension to a popular board game, *Ticket to Ride*, that can be used by companies and schools to teach (future) developers about environmentally sustainable practices in software engineering and prompt discussion about these topics. The extension modifies some game mechanics to fit the theme, but mostly integrates a new *discussion* element. The game cards, divided in 6 categories, now contain information on sustainability issues in IT in 6 categories. Additionally, each card includes a discussion prompt that is addressed upon playing it. We expect the discussion element incorporated in a game format to provide a valuable learning experience. Due to time limitations, we were unable to conduct a survey and have the game play-tested by groups within our target audience. We have, however, provided suggestions for how the impact of the game could be validated in future research.

Keywords: sustainable software, gamification, serious games, games with a purpose, game-based learning

1 Introduction

According to a report by Ericsson [7], as of 2020, ICT equipment is responsible for 1.4% of the global carbon emissions. Belkhir and Elmeligi [3] report an estimated 2.6-3.1% of global greenhouse gas (GHG) emissions as of 2018, which they predict will have increased to over 14% by 2040. Given the growth of the IT sector, it is of utmost importance to make this sector more sustainable; to achieve this, we should make developers aware of the carbon footprint of their IT solutions. As such, we believe the first step to making software more environmentally sustainable is by increasing awareness of sustainability issues in software engineering and teaching good practices with regard to making software engineering more sustainable.

Another trend is the booming market for board games: in 2020 alone (during the COVID19-pandemic), the global market increased by 20%[1]. As such, board games may also provide a good starting point for having people interact with more serious topics. To this aim, we have developed a board game extension centered around sustainable software engineering practices in order to let developers interact with these concepts in an engaging way. Most of all, we aim for it to foster discussion on the topics addressed by the game, and establish within the developers an overall awareness of and willingness to critically think about sustainability issues pertaining to their software. We believe playing a serious game and fostering discussion in this way can appeal to our audience in ways that simply lecturing them about good software engineering practices cannot.

The target audience includes software engineers working in companies who are relatively unfamiliar with the concept of sustainable software engineering, regardless of their overall experience in software engineering. It would be equally suitable for (senior) computer science students as long as they have a basic familiarity with the IT concepts being used (e.g., design patterns). It is ideal to play this game in groups of four (minimum two) to get the most out of the discussion element of the game.

In the literature, the act of educating, training or informing someone using a game is called Serious Gaming [15]; synonyms include Game-Based Learning and Gaming With A Purpose. Our game falls into this same category. There are quite some examples of researchers studying whether these types of games are effective tools for teaching. The authors of [16] show that the interactive nature of games can lead to better learning outcomes. We are, however, more interested in the research surrounding serious games specifically geared towards sustainable software engineering practices, which is a more specific topic.

We start by taking a look at research around games that try to teach software engineering practices. Kosa et al. [10] present a literature review on serious games and found that over 90% of software education games are digital. The authors emphasize that most of these games focused on teaching practical or applied software skills. Since out game is more focused on discussion and interaction, physical face-to-face experience makes more sense. [10] also mentions that educational games can make it easier to "involve social aspects", which aligns with our own goals. Furthermore, the authors highlight that there is evidence gamification can make the learning process more effective and enjoyable. It is noted in this paper that gamification is hard to formalize; however, there is not one set of rules that you can follow to create a successful game. We have the advantage of extending an existing well-known and well-liked game, so we have

less to worry about in this regard. Miller et al. [12] do emphasize that more technical and/or complicated concepts are better taught in a different manner. The abstraction needed to make a game enjoyable is not well suited to teaching very complex topics, which is why we chose to focus more on discussion rather than teaching players about technical concepts in sustainable software engineering.

In general researchers highlight that the inherent collaboration in multi-player games enhances player-to-player interactions, making it a good method to introduce people to a novel concepts to discuss [2, 5, 8, 12, 15]. Stanitsas et al. [15] even points out specifically that there were no studies in 2018 that combined social and environmental sustainability into serious games. Although, [5, 12] ended up filling this gap partly by exploring how to teach about the United Nations Sustainabable Development Goals, neither specifically targets sustainable *software engineering* practices. Our board game, *Ticket to Sustainability* aims to fill this gap.

2 The Game

Creating a fun and engaging, yet simple game from scratch is a long process, so we base our game off the existing game *Ticket to Ride: San Francisco*. Because we want our game to facilitate casual discussion, the game must have a short playtime to not become tedious. The game should also be easy to learn so that players can focus on the topic of sustainability issues in software engineering, rather than game rules. *Ticket to Ride: San Francisco* fits all these requirements, as it boasts "3 minutes to learn, 15 minutes to play" [6]. The *Ticket to Ride* series already contains >20 variations on the same base game with their own map and theme [14], so it feels appropriate to extend the game once more. The game also fits thematically with software engineering. In the original game, players score points for building railroad tracks[1]. The process of building railroad tracks is comparable to that of building software products. A railroad network consists of interconnected stations, just like larger software products consists of smaller interconnected components. And just like there are multiple ways to connect two stations with railroad tracks, there are multiple ways to integrate two features of your software. In the future, a fully software-themed map with game pieces is therefore possible. However, due to resource constraints the current version of our game is directly built upon *Ticket to Ride: San Francisco* and reuses some of its game assets (the board and game pieces). Our game therefore functions as a prototype of an expansion pack to *Ticket to Ride: San Francisco*, rather than a stand-alone game.

The following sections first summarizes the rules of the base game, then explains how our expansion changes the base rules through the replacement and addition of certain game assets and game mechanics. Finally, we explain why we decided to make these specific changes to the base game.

2.1 The base game

This section will not explain all the rules for *Ticket to Ride: San Francisco*, but give an overview of the basics necessary to understand the game. The exact rules required to play the game can be downloaded from the official website [13].

The objective of the game is simple: the player with the most points at the end wins. Points are earned in three ways: by claiming Routes, by collecting unique Tourist Tokens, and by completing Destination Tickets.

At the beginning of the game, each player picks a colored set of Cable Cars. Each player is also given a set of Transportation Cards and Destination Tickets. Transportation Cards are used to claim Routes, while Destination Tickets show two destinations that should be connected by Routes. Tourist Tokens with the same logo are placed in stacks on the Tourist Locations on the board, and the game may begin.

On each turn, players may only do one of the following actions: draw Transportation Cards, draw Destination Tickets, or claim a Route. To claim a Route, the player must play the specified amount of Transportation Cards of the same color as the Route. The player's Cable Cars are then placed on the Route to mark it as claimed.

The game ends when a player has less than three Cable Cars remaining. To determine the winner, the points for each player are tallied. Points are given for each claimed Route, each completed Destination Ticket, and each unique Tourist Token collected. Points are deducted for each failed Destination Ticket in the player's possession.

2.2 Changes our game makes to the base game

The majority of the game rules overlap with the game rules from the previous section, so this section will only discuss what we have changed from the base game. The complete list of rules required to play our our game can be found in appendix A.

Our game adds one new game asset and replaces two of the original game assets, which can be downloaded from our repository[2]. The most important asset is the Sustainability Cards, as they contain information on sustainability issues in software engineering. Of course, we do not want the players to feel like they are simply playing *Ticket to Ride: San Francisco* with different playing cards and tokens, we want them to actually engage with the new game assets to better internalize sustainable software engineering issues. We therefore also added new game mechanics that work with the new assets. Table 1 gives a full overview of the changes. The rest of this section explains each asset and mechanic in more detail, and justifies why we implemented these specific designs. Appendix C shows some examples of the designs of

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[1] *Ticket to Ride: San Francisco* is already a smaller variant of the original game and changes the theme slightly: trains are replaced by the famous cable cars of San Francisco.

[2] https://github.com/OttoKaaij/Ticket-To-Sustainability/

Original	Our game	Type of Change
Transportation Cards	Sustainability Cards (Clean and Dirty types)	Asset Replacement
Tourist Tokens	Green Foundation Tokens	Asset Replacement
-	Sustainability Tokens	Asset Addition
-	Discussion Mechanic	Mechanic Addition
-	Earning/Spending of the new tokens	Mechanic Addition

Table 1. List of the changes we made to the original game.

our expansion pack. It also shows what a gameplay session might look like.

Sustainability Cards directly replaces the Transportation Cards in the base game. There are 44 cards in total: 6 colors with 6 cards each, and 8 wildcards. The colors are separated into Dirty and Clean cards, where each color corresponds to a category relevant to software engineering. Clean cards include: mobile (yellow), data centers (green), artificial intelligence (red), and general software design patterns (blue and purple). These cards contain good practices that can be used to reduce the energy consumption or carbon footprint of software. Similarly, Dirty Cards (black) contain bad practices or interesting facts that put into perspective how bad the energy consumption of software can be. Since energy consumption of processes or products are dependent on many confounding factors (e.g., room temperature, background processes, etc.), the values presented on the Dirty Cards are not absolute and should be taken with a grain of salt. The information on the Dirty cards should be read as entertaining more so than factual. Routes built by Clean Cards then become Clean Routes, whereas Routes built by Dirty Cards become Dirty Routes. Each Clean Card comes with a Discussion Prompt tailored to the contents on the card.

Green Foundation Tokens directly replaces the Tourist Tokens. These tokens are placed on specific Green Foundation Locations on the map. If the player arrives at one of these locations, they will be rewarded for their sustainable efforts by the Green Foundation only if they have built more Clean Routes than Dirty Routes.

Sustainability Tokens are new tokens meant to parallel the use of carbon credits in the real world. These tokens are awarded for being sustainable: building Clean Routes and for participating in Discussions. To build a Dirty Route, players must pay one token. Players must therefore carefully plan their use of Dirty Routes, which may sometimes be the shortest path or unavoidable altogether. The tokens are converted to points at the end of the game, emulating the

fact that the impact of sustainable solutions are usually not immediately profitable or apparent.

Discussion Mechanic. To build a Clean Route, the player must initiate a discussion using a Discussion Prompt. This is to ensure that the players actually read, discuss, and internalize the information provided on the Clean Cards. Dirty Cards do not have Discussion Prompts to emulate the feeling that dirty solutions may be quick and easy, while sustainable solutions often require more effort.

2.3 Justification of design decisions

Our design decisions were guided by the following main goal: to raise awareness of sustainable software engineering issues in an engaging, fun way. [4] proposes that economic and environmental problems are inherently social issues that need social change to be solved successfully. To achieve social change you need to first create change within the individuals that make up society. And this game is meant to engage individuals in the topic of sustainability in software engineering and raise their awareness of it. This will then hopefully drive them to change their perspective and serve as a small step toward societal change.

We created the Sustainability Cards to replace the Transportation Cards. The Sustainability Cards provide information regarding sustainable software engineering issues, and is the main method of raising awareness among the players. As mentioned in the introduction, [5, 12, 15] highlight how games are well suited to introducing people to new concepts.

The original Transportation Cards have no information on them as only their color matters for gameplay. Players could therefore choose to ignore the information on the Sustainability Cards and end up learning nothing about sustainable software engineering. Furthermore, pausing the game to read the cards may feel stressful and disconnected from the rest of the game. The game therefore needed a mechanic that forces players to read and digest the information on the cards. To solve this problem, we added Discussion Prompts to the Sustainability Cards and came up with the Discussion mechanic. The Discussion mechanic allows each player to digest the information on their card and at the same time share their findings with the group through an open discussion. The Discussion mechanic brings up another problem, however. Discussions take time and effort, so why would players engage in it?

This leads us to the next problem: how do we make the players care about more sustainable software engineering, and care about engaging in the discussions? Translating this goal into game terms, playing sustainably and engaging in discussions should be rewarding and increase your chances of winning. We therefore introduced the Sustainability Tokens as a new asset, which are awarded for making sustainable choices and to incentivize everyone to participate in the discussions. These tokens are then translated into points at the end of the game. By recognizing cooperation

during the discussions, the players will be more motivated to participate [9].

Another issue we wanted to tackle is how to make the game reflective of sustainability challenges in the real world, and give the players a sense of the dilemmas that are often present in practice. Sustainable solutions are often only profitable long-term, and sometimes not viable at all. Less sustainable solutions may be quicker and cheaper to implement, and may sometimes be your only option. This is reflected in our game where players must connect Locations by Clean or Dirty Routes. While there are several paths to the same Location, sometimes a Dirty Route will be the quickest path or the only reasonable option. Dirty Cards therefore do not have a Discussion Prompt so they are quick to play. Playing too Dirty, however, is discouraged by requiring players to pay Sustainability Tokens to claim Dirty Routes, which parallels carbon tokens in practice. Sometimes, going out of your way to be more sustainable may give you favorable public attention. We have reflected this in our game by replacing the original Tourist Tokens by Green Foundation Tokens, which can be collected from stacks situated at the edges of the map.

Our game design choices were often supported by the existing literature on gamification. One concept central to the effectiveness of gamification is player autonomy; players can choose themselves how to reach the goal set by the game. In our case, the players do not only have the choice of which routes to build, but also which discussion prompts to discuss when they do build one. Autonomy is important because it can increase a player's Intrinsic Motivation (IM) [11]. IM can also be increased by challenge and feedback [9], which is why we have the option for other players to provide their own input for the discussion prompt of another. The other players can even be rewarded if they can meaningfully contribute to the discussion.

Another gamification technique that is already included in the base game, but is also especially relevant for serious games is the replayability of the game which introduces a form of distributed learning [9]. By playing the game several times with different people, players will have several opportunities to consider the discussion prompts and hear different reactions, further cementing the concepts in their minds.

Fun and engagement are qualities that are difficult to measure and anticipate. We hope that by making the new assets and mechanics interconnected and reflective of real life sustainability challenges, the game will feel more fun and engaging than if we simply replaced the playing cards. To determine how fun and engaging our game really is and whether our design decisions have the impact we expected, we must perform validation testing.

3 Validation

Validation of the game is a crucial step in ensuring that the product effectively achieves its intended goals. The purpose of this validation is to confirm that the game promotes awareness and discussion of sustainable software engineering practices among developers. Due to time constraints, no complete validation was carried out. However, we play-tested the game during development, and are confident it is a fun way to engage with sustainable software engineering ideas.

While these play-tests provide valuable insights, it is not a comprehensive assessment of the game's effectiveness and efficacy. We recognize that a proper validation of the game would involve more extensive research with a larger and more diverse group of software developers.

The play-test would be followed by a short survey (see B) designed to collect feedback on the game's ability to promote discussion, identify areas of improvement, and motivate developers to implement sustainable software engineering practices. Proper validation would also involve conducting a controlled study. The study would involve randomly dividing participants into two groups, with one group playing the game and the other not playing the game. The study would then evaluate the differences in understanding and awareness of sustainable software engineering practices between the two groups. In addition, we could create a more extensive survey, and incorporate more open interviews.

The results of this study would contribute to our understanding of the game's efficacy. By comparing the two groups, we could assess the impact of the game on sustainable software engineering practices more accurately. Additionally, a larger sample size would increase the statistical power of the study, making our conclusions more robust.

4 Discussion & Future Work

The goal of this research is to raise awareness of sustainable software engineering issues in an engaging, fun way through the creation of a board game. While we have succeeded in creating a board game, our solution has several potential limitations to consider.

Firstly, our game is a low-fidelity prototype that is not ready for physical or commercial distribution. All components necessary to play the game are available online in an easily printable format that can be cut out and used to play the game. Because of this, however, it requires more effort from the player to obtain the game initially compared to a ready-to-play game. On the other hand, since our game is a prototype, the low-fidelity aspect is advantageous as research shows it invites players to provide feedback and to propose or make their own modifications to the game [17].

Secondly, because our game serves as a direct extension to an existing game, players must first purchase the base game.

These two points may increase the barrier to entry, or effort required to try the game.

Thirdly, the game in its current state is lacking in proper validation. It remains to be seen to what extent our board game is able to raise awareness and engagement regarding sustainable software engineering issues. Furthermore, even if future validation shows our game is successful in increasing awareness and discussion on the topic, this alone does not guarantee practical significance: i.e., that the players change their software engineering practices to be more sustainable. Raising awareness and encouraging discussion is part of a low-touch approach [17], which is easy to do but does generally not have a significant effect on behavior change. To make individuals change their behavior, the new behavior must first become a habit, which requires action. In other words, because our game only provides information about sustainable software practices, it is not guaranteed that it will change the players' current software engineering practices. However, tackling larger sustainability issues is more likely to succeed when backed by societal change [4]. A first step towards achieving societal change is to instill a change in perspective in individuals, which is exactly what our game aims to do. Although our game may not be suitable as a direct solution to making current software engineering practices more sustainable, it is a good starting point to increase the chance of successful adoption of more sustainable software engineering practices in the future.

Finally, the focus of this paper was more so on developing the game than in teaching the players about exact energy consumption. As mentioned before, the information included on the Dirty Cards is not entirely accurate; they should rather serve as short reminders to players how much of our energy is consumed by the computers we use. Hopefully in future versions these cards can be improved using research into more (accurate) energy consumption measures.

Future work can address these limitations by focusing on improvements in validation, content, and outreach. Validation should involve controlled playtesting to determine how well our game raises awareness and engagement, and guide future improvements on content. To increase the wider impact of our game, future work could also focus on outreach by distributing the game to computer science and/or engineering universities and software companies.

Similar to the board game IT Start Up[3] which also provides a printable version of their game online[4]), a Kickstarter funded printed version could be realized if the game catches on. By providing the cards in a pdf format people can easily expand the game with their own cards, or update the existing cards. Future work could therefore focus on updating and extending the card deck to stay up to date with the latest sustainable software engineering research.

A future version of, or sequel to our game could be more focused on the practical application of sustainability engineering, to take people from awareness to acting on that awareness to achieve a more direct impact on sustainable software engineering.

5 Conclusion

We created the board game *Ticket to Sustainability* to raise awareness of sustainable software engineering issues in an engaging way. Creating a game from scratch is difficult as there are no set formal or scientific rules that determine what makes a game "good". This is why *Ticket to Sustainability* was created as a direct extension to an existing successful game, *Ticket to Ride: San Francisco*, to ensure that the core gameplay is fun. We extended the game by replacing and adding new game assets and mechanics. The original card deck was replaced by Sustainability Cards which inform players of good and bad software engineering practices in terms of environmental sustainability. Bad practices are included to emulate the sustainability dilemmas often encountered in software engineering in practice. The game encourages discussion of software engineering issues through discussion prompts with tokens as rewards for engagement.

While research is enthusiastic about how gaming is effective in introducing and engaging people in new, unfamiliar topics, it remains to be seen how well our game's design decisions introduce and engage its players in sustainable software engineering issues. Because the aim of *Ticket to Sustainability* is to mainly raise awareness of sustainability issues, the game alone will not make software engineering more sustainable; however, it can be used as a good starting point to increase the chance of successful adoption of more sustainable software engineering practices in the future.

6 Acknowledgements

References

[1] [n. d.]. *13 Board Game Statistics - All You Need to Know in 2023.* https://techjury.net/blog/board-game-statistics/

[2] Alex Baker, Emily Oh Navarro, and André Van Der Hoek. 2003. Problems and Programmers: an educational software engineering card game. In *25th International Conference on Software Engineering, 2003. Proceedings.* IEEE, 614–619.

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[3] https://shop.playitstartup.com/
[4] https://www.reddit.com/r/boardgames/comments/gml5zd/card_game_about_programmersit_free_print_play_it/, last accessed on: 13-04-2023

[3] Lotfi Belkhir and Ahmed Elmeligi. 2018. Assessing ICT global emissions footprint: Trends to 2040 recommendations. *Journal of Cleaner Production* 177 (2018), 448–463. https://doi.org/10.1016/j.jclepro.2017.12.239

[4] Robert HW Boyer, Nicole D Peterson, Poonam Arora, and Kevin Caldwell. 2016. Five approaches to social sustainability and an integrated way forward. *Sustainability* 8, 9 (2016), 878.

[5] Fong-Han Chen and Shin-Jia Ho. 2022. Designing a Board Game about the United Nations' Sustainable Development Goals. *Sustainability* 14, 18 (2022), 11197.

[6] @daysofwonder. [n. d.]. *Ticket to Ride: San Francisco (Board game) - Official trailer*. Youtube. https://www.youtube.com/watch?v=4cgmsv3N51Y Accessed on March 30, 2023.

[7] Ericsson. 2020. A quick guide to your digital carbon footprint: Deconstructing Information and Communication Technology's carbon emissions. (2020). https://doi.org/10.3390/su10093027

[8] João M Fernandes and Sónia M Sousa. 2010. Playscrum-a card game to learn the scrum agile method. In *2010 Second International Conference on Games and Virtual Worlds for Serious Applications*. IEEE, 52–59.

[9] Karl M Kapp. 2012. *The gamification of learning and instruction: game-based methods and strategies for training and education.* John Wiley & Sons.

[10] Mehmet Kosa, Murat Yilmaz, Rory O'Connor, and Paul Clarke. 2016. Software engineering education and games: a systematic literature review. *Journal of Universal Computer Science* 22, 12 (2016), 1558–1574.

[11] Thomas W Malone and Mark R Lepper. 2021. Making learning fun: A taxonomy of intrinsic motivations for learning. In *Aptitude, learning, and instruction.* Routledge, 223–254.

[12] Jonathan L Miller, Michael T Wentzel, James H Clark, and Glenn A Hurst. 2019. Green machine: A card game introducing students to systems thinking in green chemistry by strategizing the creation of a recycling plant. *Journal of chemical education* 96, 12 (2019), 3006–3013.

[13] Days of Wonder. [n. d.]. *Ticket to Ride San Francisco - a board game by Alan R. Moon.* https://www.daysofwonder.com/tickettoride/en/san-francisco/ Accessed on March 30, 2023.

[14] Days of Wonder. [n. d.]. *Ticket To Ride Series.* https://www.daysofwonder.com/en/products/guide/ticket-to-ride/ Accessed on March 30, 2023.

[15] Marios Stanitsas, Élise Vareilles, Konstantinos Kirytopoulos, and Michel Aldanondo. 2018. Sustainable development in serious games: rethinking game-based learning strategies for master's degree engineers. In *MOSIM'18-12ème Conférence internationale de Modélisation, Optimisation et SIMulation.* 8–p.

[16] Jennifer J Vogel, David S Vogel, Jan Cannon-Bowers, Clint A Bowers, Kathryn Muse, and Michelle Wright. 2006. Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of educational computing research* 34, 3 (2006), 229–243.

[17] Stephen Wendel. 2020. *Designing for behavior change: Applying psychology and behavioral economics.* O'Reilly Media.

A Game rules

The objective. Have the most points at the end of the game to win. Points are earned in three ways: 1) claiming Routes, 2) collecting Sustainability Tokens, 3) collecting unique Green Foundation Tokens, and 4) completing Destination Tickets. Points are deducted for failed Destination Tickets.

The setup. Before the first round is played, each player receives: 1) 20 Cable Cars in a color of their choosing, 2) two randomly drawn Sustainability Cards, 3) two randomly drawn Destination Tickets, of which one may be discarded. The board is then setup by placing five randomly drawn Sustainability Cards face-up, and by stacking Green Foundation Tokens of the same symbol on the Green Foundation Locations marked red on the board.

Taking turns. On a player's turn, they may do only one of the following actions:

- *Draw Sustainability Cards.* The player may draw two cards randomly from the deck or from the face-up cards. Cards taken from the face-ups, must be immediately replaced from the deck. If the player picks a wildcard from the face-ups, they may only draw once.
- *Draw two Destination Tickets.* They may discard one.
- *Claim a Route and initiate a Discussion.* Each route consists of a number of colored blocks. The player must play the same amount of Sustainability Cards in the same color as the colored blocks. To mark the Route as claimed, the player places its Cable Cars on the blocks.
  - Claiming a Clean Route initiates a Discussion. The player may choose one of the Discussion Prompts from one of their played Clean Cards. The initiating player may contribute to the Discussion first. Other players are then welcomed to contribute. The majority of the group then decides whether a contribution was positive, i.e. it provided a valid or interesting point. Each positive contributor receives one Sustainability Token.
  - If the Route connects with a Green Foundation Location, the player is rewarded one Green Foundation Token if they have claimed more Clean Routes than Dirty Routes.
  - Dirty Cards do not have Discussion Prompts, so no Discussion can be initiated when claiming Dirty Roads.
  - Claiming a Route with Dirty Cards costs one Sustainability Token, whereas using Clean Cards rewards one Sustainability Token.
  - Grey Routes can be claimed by a set of same-colored Sustainability Cards in the color of the player's choosing.
  - Wildcards can take any color.

Ending the game. When a player has less than three Cable Cars remaining, everyone gets one final turn. Points are scored for:

- *each claimed Route.* Longer routes give more points, as stated on the board.
- *each completed Destination Ticket*, as stated on the Destination Ticket. Deduct the stated points for each failed Destination Ticket.
- *each unique Green Foundation Token collected.* The more unique tokens you have the more points you get, as stated on the board.
- *each Sustainability Token*, which gives one point each.

B Evaluation Survey

- How enjoyable did you find the game? (1-5, n.a.)
- How well did the game promote discussion among the team? (1-5, n.a.)
- How well did the game help identify areas where your team could improve in terms of sustainable software engineering practices? (1-5, n.a.)
- How easy was the game to understand and play? (1-5, n.a.)
- Would you recommend the game to other software development teams? (Yes/No)
- Do you feel more motivated to implement sustainable software engineering practices after playing the game? (Yes/No)
- Do you have any suggestions for improving the game or making it more effective in promoting sustainable software engineering practices?
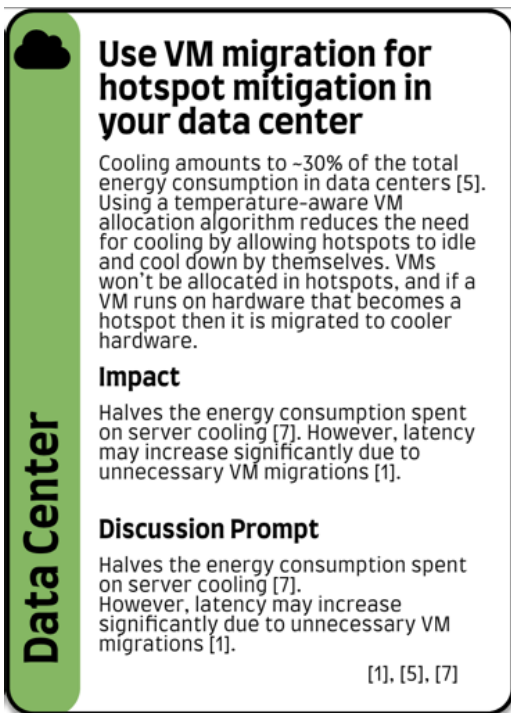
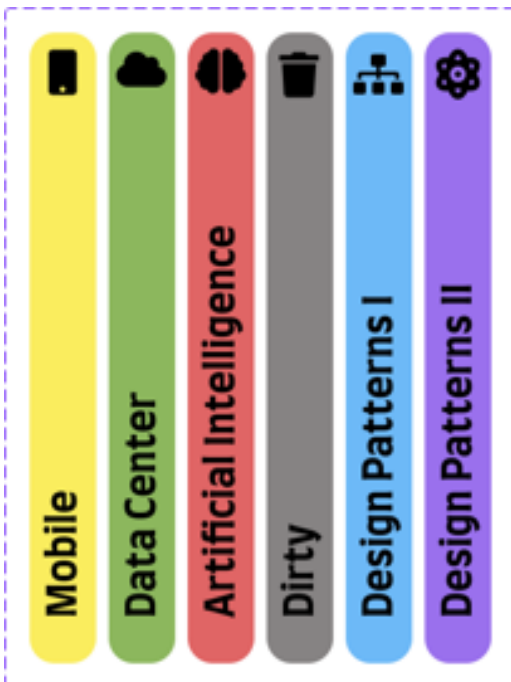## C   Game Design

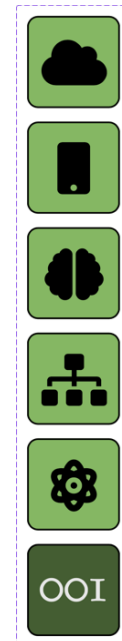**Figure 1.** Card design example

Figure 2. Category card designs

Figure 3. Token designs

Figure 4. Example of what a session might look like.