

**INFLUENCING ATTITUDES AND PREFERENCES TOWARD CLIMATE CHANGE
USING A MULTI-PLAYER, TRANSPORTATION THEMED BOARD GAME**

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Alexandra Xiaoying Kjorven, B.Comm, University of Toronto, 2006

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Alexandra Xiaoying Kjorven

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Environmental Applied Science and Management
Ryerson University

ABSTRACT

Traditional tabletop board games have soared in popularity in recent years, and used often as tools for education and entertainment. Board games are an especially engaging format for studying themes of collective-action problem solving. This study looks at one of the most complex collective-action problems of this generation, climate change, and evaluates how individual attitudes and preferences may be altered by playing a board game specifically designed to influence how people relate to this issue. The board game *Wheels* was introduced and taught to 18 participants, who engaged in five separate playtesting sessions where observation, survey and interview data were collected. The study evaluates participants' attitudes and preferences toward certain transportation and climate change topics before and after playing the game. The game showed promise in changing players' preferences toward certain modes of transportation – increasing preference toward electric vehicles and cycling, and decreasing preference toward gas powered cars. These findings indicate that the effective combination of select climate change game mechanics in a highly personalized theme may produce an engaging and entertaining experience that has the potential to transcend the game board and impact players' outlook upon real life choices.

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Table of Contents

Author's Declaration	ii
Abstract.....	iii
Aknowledgements	iv
List of Tables	vii
List of Appendices.....	viii
1. Introduction	1
1.1 Background.....	1
1.2 Study Overview.....	2
2. Literature Review.....	5
2.1 Gamifying Climate Change	5
a. Climate Change Mechanics in a Board Game.....	6
b. Climate Change as a Serious Game.....	9
c. Importance of Player Roles in Climate Change Games	11
d. Gamifying Personal Transportation	12
2.2 User Engagement in Games and Methods for Evaluation	13
a. Evaluating Game Effectiveness.....	14
b. Optimizing Player Experience.....	14
3. The Game.....	16
3.1 A Selectively Competitive Game About Getting Around	16
3.2 The Game as it Relates to Study Objectives	20
a. Incorporating Climate Change Game Mechanics.....	20
b. Designing for Thematic Relatability and Entertainment Value	24
4. Approach and Method.....	28
4.1 Study Design.....	28
a. Survey and Interview Question Selection	29
b. Playtesting and Feedback Collection.....	30
c. Evaluation and Analysis	31
4.2 Recruitment.....	32
4.3 Ethics Review.....	32
4.4 Challenges and Limitations to Study.....	33
4.5 Achieving Study Objectives	34
a. Measuring Effectiveness of Climate Change Game Mechanics	35
b. Measuring the Relatability of Personal Transportation as a Theme.....	36
c. Measuring Game Appeal and Mainstream Entertainment Potential	37
d. Measuring Changes in Player Preferences and Attitudes.....	39
5. Results and Discussion.....	41
5.1 How Effectively Do Players Engage With the Climate Change Game Mechanics?	41
5.2 Does the Theme of Personal Transportation Make the Game Applicable to Real Life?	46
5.3 Can the Game Be an Entertaining Experience for Mainstream Audiences?	53
5.4 What Changes Occur in Player Preferences and Attitudes After Playing the Game?	60
6. Conclusion.....	70
6.1 Significance	70
6.2 Looking Ahead.....	71

Appendices.....	74
References.....	86

List of Tables

Table 1 Data Gathered and Sample Questions.....	29
Table 2 Playtesting Session Outline.....	31
Table 3 Summary of Playtesting Sessions	41
Table 4 Survey Feedback on Game Mechanics	44
Table 5 Survey Feedback on Real Life Applicability	49
Table 6 Survey Feedback on Game Appeal.....	55
Table 7 Changes in Perceived Preference Toward Different Modes of Transportation	63
Table 8 Changes in Attitudes Toward Transportation Choices and their Consequences	66

List of Appendices

Appendix A Example of Game Board Set Up	74
Appendix B Abbreviated Game Rules.....	75
Appendix C Starting Neighbourhoods and Resources	76
Appendix D Public and Private Achievement Upgrades	77
Appendix E Pre- and Post-Game Survey Questions.....	78
Appendix F Semi-Structured Interview Guide	84
Appendix G Summary of Suggested Features or Game Edits for Consideration.....	85

1. Introduction

The games that we play have the ability to influence our behaviour and teach us important lessons. They are one of the oldest and most universal forms of social interaction and is ubiquitous in countless activities from education to entertainment. This is because games allow us to simulate endless scenarios of competition and collaboration, creating an especially engaging format for exploring themes of collective-action problem solving. This study looks at one of the most complex collective-action problems of our time, climate change, and evaluates how individual attitudes and preferences may be altered by playing a board game specifically designed to influence how people relate to this issue.

1.1 Background

Climate change is often described as a collective-action problem involving multiple actors dealing with short- and long-term challenges (Fennewald, 2012). These specific characteristics make climate change a popular issue to gamify and an increasingly attractive theme for game designers. This is because the nature of many issues related to climate change fit well into modern board game trends, which favour games that promote dynamic player interaction simultaneously with the strategic evaluation of trade-offs.

As a result, there exists an opportunity for a modern board game to help players better understand the relationship between their day-to-day decisions and climate change. The importance of understanding this relationship borrows from behavioural theory, which suggests that unless the individuals can see or feel the impacts of their actions – preferably immediately and on a continuous basis – they are unlikely to maintain the behaviours over time (Barkenbus, 2010).

While it can be argued that all climate change issues are impacted by individual behaviour, there are few drivers of greenhouse gas emissions that are as diffuse in origin and as significant in impact as personal transportation. Greenhouse gas emissions from the transport sector have more than doubled since 1970 and have increased at a faster rate than any other energy end-use sector, accounting for 14% of all direct CO₂ emissions (IPCC, 2015). Furthermore, personal travel is a ubiquitous activity where, for many, it is an essential link to employment (Blumenberg & Pierce, 2017), social interaction (Kim & Ulfarsson, 2008) and shapes a person's overall relationship with the built environment that surrounds them (Handy et al., 2002). Therefore, it is proposed that in addition to gamifying attributes of climate change, using a highly relatable theme such as personal transportation can further increase the game's relatability to real life and thus shape player's attitudes toward their own travel decisions outside the game and its impact on climate change.

1.2 Study Overview

The purpose of this study is to evaluate participant responses to a board game designed specifically to influence how players interact with issues related to climate change.

In this study, participants are taught to play the board game *Wheels*, a transportation-themed game where players work independently or collaboratively in using various modes of transportation to reach destinations, accumulate resources and work towards achieving individual as well as group goals. Using transportation as a theme, the game integrates a number of mechanics¹ specifically adapted to mimic attributes of climate change. Examples include mechanisms that mimic tragedy of the commons, delayed effects, and information and resource asymmetry. Furthermore, the game is deliberate in not being as overtly education-focused as many climate change games currently

¹ Game mechanics refer to the mechanisms by which players take actions in order to accomplish the goals of the game (Slack, 2017).

are, and was instead designed to emphasize player engagement and entertainment in order to appeal to wider audiences and increase commercialization potential.

Overall, the objectives for the game *Wheels* were to optimize climate change game mechanics, real-life applicability and mainstream appeal in a way so as to affect how players relate to climate change issues in real life. In order to evaluate how these design elements come together to influence player attitudes and preferences, the study is guided by the following questions:

- **How effectively do players engage with the climate change game mechanics?**
- **Does the theme of personal transportation make the game applicable to real life?**
- **Can the game be an entertaining experience for mainstream audiences?**
- **What changes occur in player preferences and attitudes after playing the game?**

This paper begins by providing the academic and commercial context within which these questions emerge. This includes a Literature Review introducing the climate change game mechanics that define the underlying structure of the game. The review also provides background on similar work done in the field of gamification and climate change, ultimately identifying the market opportunity and the rationale behind the research questions.

The next chapter of the paper introduces the game itself, and provides an overview of the game rules and a more in-depth look at how the game was designed to meet these market gaps and the objectives identified.

The study itself is conducted as a series of playtesting sessions involving volunteer participants. The methods for evaluating player interactions and responses to the game are outlined in the Approach and Methods chapter of the paper, where a combination of observation, survey and

interview techniques are used for each research session. Details on the overall study design, as well as challenges and limitations encountered during the research activities, are also discussed.

Overall findings from the study are described in detail at the end of the paper as responses to each of the research questions. Findings from observation, survey and discussions on each of the topics were consistent with intentions of how game mechanics could influence playing strategy and player interaction. Responses to the game were largely positive and the theme of personal transportation created an intuitive scenario that helped bridge players' lived experience with the intended lessons of the game. Most remarkably were findings associated with changes in preference toward certain types of transportation, where there was notable decrease in preference toward the use of gas-powered cars and increased preference for electric vehicles and cycling.

The findings provide a useful starting point for further research on how certain changes in attitude – inspired by an immersive board game experience – may contribute to changes in actual behaviour in real-life. The significance of these findings are further augmented by the possibility of such a game reaching mass markets through commercialization efforts targeting mainstream audiences. In other words, as more and more people turn to tabletop board games as a shared pastime, there exists a meaningful opportunity to use this social platform to create positive shifts in attitude around sustainable transportation and our shared responsibility toward climate change.

2. Literature Review

The Literature Review begins by exploring the field of academic research that studies gamification as a tool for simulating serious or complex topics for a range of purposes including education and awareness. Specifically, within this large subset of social science is research on the gamification of climate change. This review identifies a gap within the existing academic and commercial landscape of climate change games, making the case for a transportation-themed game to bridge the divide between education and commercial appeal.

The emphasis on individual responses to gamification is further explored in the Literature Review by taking a look into research that specifically evaluates user engagement in climate change games. These studies emphasize the importance of evaluating user experience during the game development process and identifies various studies and tools that can be used. This subsequent section of the Literature Review is important in providing examples and guidance for methods discussed later in this paper.

2.1 Gamifying Climate Change

The gamification of complex topics, described as “using game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems” (Kapp, 2012 p. 10), has led to a large subset of academic study focused on the use of game design as a tool for education and learning. For example, Wolfe’s (1997) study on the effectiveness of business games in strategic management concluded that game-based approaches produced significant knowledge-level increases over conventional case-based teaching. Sitzmann’s (2011) meta-study

on the instructional effectiveness of simulation games observed 20% higher confidence, 14% higher declarative knowledge and 9% higher retention rates as compared to traditional teaching formats.

The remainder of this chapter focuses specifically on the gaming landscape as it relates to climate change. Specifically, this section examines literature related to the defining characteristics of climate change game mechanics, the existing landscape of climate change games as well as the importance of understanding the role of the individual as it relates to intended game outcomes.

a. Climate Change Mechanics in a Board Game

The nature of many issues related to climate change fit well into modern gaming trends, which favour games that promote dynamic player interaction simultaneously with the strategic evaluation of trade-offs. Furthermore, simulated scenarios are known to be excellent formats for learning (Gosen & Washbush, 2004) and the tabletop board game, unique in its requirement for in-person player interaction, provides a tactile and immersive experience for players to see and feel the impacts of their decisions in a simulated format. The board game, with its physical components and direct player interaction, allows for endless scenarios of competition or collaboration, making it a fascinating tool to use in simulating one of the most complex collective-action problems of this generation: climate change.

There are many attributes of climate change that are suitable for gamification, many related to the “tragedy of the commons” (Hardin, 1968), whereby shared, freely accessible resources are destined for overconsumption due to economic and human tendencies to maximize individual benefits. Similarly, the role of externalities, the consequences of a player’s actions that affects others but is not captured in the cost of the activity, is another

attribute of climate change that is often gamified in attempts to simulate collective-action problem solving. For example, The Externalities Game was designed for the purpose of immersing students in “questions of fairness, justice, and equity in the context of sustainability” (Seager et al., 2010, p.1). Externalities are gamified using non-cooperative game theory, whereby all players are impacted by the consequences of other players’ actions, forcing them to come to terms with their obligations to others and evaluate how much they are willing to sacrifice or contribute in order to support collective well-being. The game *Wheels* is part of a broad category known as “serious games”, those designed to have underlying educational or instructional objectives (Wu & Lee, 2015), as is the case with many existing climate change games (Reckien & Eisenack, 2013).

Perhaps the most relevant study on integrating climate change attributes into game mechanics was conducted by Fennewald and Kievit-Kylar in 2012. They specifically studied defining characteristics of climate change and how these attributes are used in popular climate change games – specifically how these characteristics get over simplified or omitted. The research identifies four important characteristics of climate change that are rarely simultaneously addressed; this highlights a key gap and opportunity in the existing game landscape.

- *Conflicts in climate change are often not inherently zero-sum.* This is counter to the binary nature of most board games, which are either competitive (one winner, the rest losers) or collaborative (all winners or all losers). In other words, many climate change games fail to effectively simulate non-zero sum game objectives and player

interactions, whereby players determine when and how they collaborate, and whether there will be one, many or no winners.

- *Climate change dilemmas often involve multiple actors each with different abilities and unique goals.* To capture this in a board game, mechanics need to incorporate elements of diverse player objectives and resource asymmetry. This reflects not only the dynamics between developed versus developing nations at the global level, but also simulates inequalities as it relates to resource availability, but also differences in individual aspirations and abilities.
- *The politics of climate change is both a collective-action problem and a social dilemma.* Gamifying this characteristic requires designing mechanics whereby players, with unequal abilities, can cooperate and compete for common resources needed for their independent win objectives.
- *Climate change is a process that includes both short-term and longer-term delayed effects.* An example of this mechanism would be the impact of a game action that immediately translates to a positive or negative impact on players (i.e. immediate penalty/health impacts due to smog or air pollution produced from an identifiable source) as well as incorporates a delayed consequence that is less predictable, less direct and not easily attributable to single identifiable sources (i.e. extreme weather caused by global warming).

A key finding from the Fennewald and Kievit-Kylar (2012) study was that while many climate change games address one or some of the aforementioned themes and game mechanics, there lack attempts to incorporate all of these aspects into a single game. Similar

academic and market scans addressed in the next section also confirm the limited scope of most climate change games – many focusing in on just a few, select attributes of climate change.

b. Climate Change as a Serious Game

Games can simplify complex relations between actors, such as those between nation-states, transnational, subnational or individual, while offering new ways to raise awareness and empower people to seek solutions collectively or individually (Eisenack & Reckien, 2013). Many of these existing climate change games are considered “serious games”, that is those designed to have underlying objectives beyond simply entertainment (Charsky, 2010), and have been used across a number of disciplines from classroom learning to simulation and training.

In 2013, researchers Reckien and Eisenack performed a detailed review of 52 sophisticated climate change games, it was discovered that the landscape consists mostly of role-play or management games, followed by online and simulation game formats. Some notable games identified in the study include:

“*TRICO2LOR*: Example of how games can address the issue of intergenerational justice. This role-play highlights the implications of personal decisions on energy use for global warming. It simulates the actions of at least three generations and their use of fossil fuel and adoption of more efficient or renewable energy sources. The actions of one generation have an impact on the future generations. One generation can win, but in order to take care of the climate, intergenerational conferences are possible. It comprises a board game and a visual representation of the world climate on the Internet.” (Reckien & Eisenack, 2013, p. 265).

“*KEEP COOL*: The first commercial CC [Climate Change] board game integrating multiple global and local issues. In this negotiation game, each player takes the role of an actor in global climate politics and has to pursue the actor’s main strategic business interests. Actors include, among others, the United States and its partners, Europe, the developing countries, emerging economies, and the former Soviet Union, as well as lobbying groups, that is, the oil industry and environmental non-governmental organizations. During the game, players have to choose between climate protection measures and actions to further their own strategic business interest. However, actions can be thrown off course by unpredictable catastrophes. Whoever achieves their strategic goals first wins; yet if players are not cooperative enough, all players can lose.” (Reckien & Eisenack, 2013, p. 265).

“*LOVE LETTERS TO THE FUTURE (2009)*: An example that stretches the definition of a game, but illustrates further ways to approach the issue. This is a cross-platform multimedia experience designed to raise awareness about the rapidly expanding danger of global warming. It is an innovative online game, buried artfully in a website that contains user-generated letters about the future of our planet. It was launched prior to the UN Climate Change Conference in Copenhagen in December 2009. It has been nominated in the Best Activism category of SXSW Web Awards and has won two Webby Awards.” (Reckien & Eisenack, 2013, p. 265).

Board games, which differ in terms of user interaction and game mechanics, represented only a small fraction of climate change related games available. The same study also indicated that most climate change related games originate from academic or research institutions (Reckien

& Eisenack, 2013), most of them falling in the category of serious games, which may not be optimized for commercial appeal and not readily available for purchase by mainstream players.

Overall, as the existing landscape of climate change games suggests, using “serious games” to teach and encourage deeper understanding of the complexities of climate change can be very effective. However, when climate change games are designed with education and academic outcomes as the primary objective, it leaves a gap in the gaming landscape for a climate change game that is designed instead to prioritize mainstream appeal and player engagement.

c. Importance of Player Roles in Climate Change Games

The Reckien and Eisenack (2013) study provided an overview on the range of climate change related games currently available, while also highlighting the limited availability of games that combine themes of group and individual impact. For example, most climate change games use themes of energy infrastructure and politics. This includes games such as *CO2* designed by Vital Lacerda in 2012, players represent regional energy companies bidding for government contracts and carbon credits. *Keep Kool*, designed by Klaus Eisenack and Gerhard Petschel-Held in 2004, was highlighted in the Reckien and Eisenack (2013) study and features players acting as superpowers, developing nations or continents trying to balance economic interests with environmental considerations.

Unfortunately, a consequence of trying to capture climate change at the infrastructure or political level is that players end up taking on roles and making decisions that are inevitably quite removed from their real life behaviours and actions. This is of particular importance because behaviours of individuals and consumers are often at the centre of many challenges related to climate change mitigation (Wells et al., 2011). The importance of relatability at the

individual or consumer level borrows from behavioural theory, which suggests that unless the individuals can see or feel the impacts of their actions – preferably immediately and on a continuous basis – they are unlikely to maintain the behaviours over time (Barkenbus, 2010). In other words, the personal and real-life applicability of problems or challenges experienced through a game scenario can directly impact the likelihood of that experience transcending beyond the game board and into sustained attitude or behavioural change toward similar issues in real life. In the case of climate change, this may be achieved with a board game that is not only centred around a climate change issue that is directly linked to individual behaviour, but also one which reflects day-to-day activities with which most players can directly relate and engage.

d. Gamifying Personal Transportation

While it can be argued that all climate change issues are impacted by individual behaviour, there are few drivers of greenhouse gas emissions that are as diffuse in origin and as significant in impact as personal transportation. Greenhouse gas emissions from the transport sector have more than doubled since 1970 and have increased at a faster rate than any other energy end-use sector, accounting for 14% of all direct CO₂ emissions (IPCC, 2015). Furthermore, personal travel is a ubiquitous activity where, for many, it is an essential link to employment (Blumenberg & Pierce, 2017), social interaction (Kim & Ulfarsson, 2008) and shapes a person's overall relationship with the built environment that surrounds them (Handy et al., 2002).

What makes transportation an appealing theme for game design, and unique as compared to other major contributors to greenhouse gas (GHG) emissions, is the decentralized nature of

decision-making when it comes to influencing outcomes. Unlike energy production, where individuals have little control over sources of energy, transportation decisions are often made at the individual level. This is supported by a growing field of study on the psychology of sustainable transportation behaviour (Gehlert, et al., 2013), recognizing that mitigation or adaptation efforts are often all attempts at modifying human behaviour (Fujii, 2010; Buehler & Pucher, 2011).

In summary, a review of the landscape and research surrounding climate change gamification suggests a number of opportunities to advance the use of board games as a tool for influencing how players relate to issues of climate change. Specifically, this section highlighted the opportunity to incorporate several, often over-looked climate change game mechanics and also highlighted the lack of climate change games that emphasize player relatability and mass market appeal. It leads to the proposition that gamifying personal transportation can be a novel way to portray themes and lessons associated with climate change mitigation. Personal transportation being highly relatable to the day-to-day activities of individual players increases the potential for fun and engaging game interactions across broad audiences.

2.2 User Engagement in Games and Methods for Evaluation

The literature review around the gamification of climate change was conducted to provide an overall understanding of the climate change gaming landscape as well as to highlight gaps and opportunities for future game development. This section provides a review of how games are evaluated and the tools that are available to help determine the effectiveness of certain game strategies and improve the games' ability to meet specific objectives.

a. Evaluating Game Effectiveness

Wu and Lee (2015) conducted a similar study to that of Reckien and Eisenack (2013), except with a focus specifically to evaluate the effectiveness of climate change games as tools for education and engagement. The study argues that recent efforts using gaming as a tool for addressing climate change are promising for increasing civic engagement at both the local and global level (Wu & Lee, 2015). Their study focused on providing an overview of the various game formats and related objectives, concluding that games can be well suited for education and for providing interactive models to explore decisions affecting climate change. However, the authors are clear in suggesting that further research is needed to evaluate how games can influence long-term behavioural effects.

These findings are consistent with a growing field of study on the effectiveness of gaming experiences. Hamari et al. (2014) performed a Literature Review of 24 empirical studies on the effectiveness of gamification. Their findings suggest that many evaluations of gaming experience focused on behavioural outcomes and most of those used only quantitative methods, including experiments, log data analyses and quantitative questionnaires, which are used to make inferences about behaviour. It was revealed that qualitative measures, such as interviews or observations, can be especially useful in understanding the underlying relationships between data points.

b. Optimizing Player Experience

Evaluating user experience is also closely connected to game development (Bernhaupt, 2010), especially for commercial purposes where game objectives are focused more on what makes a game fun to play rather than to understand how the game affects the player. Nonetheless, successful methods used for testing and improving user engagement in games include

playtesting, semi-structured interviews, observation and questionnaires that can be tailored to focus on player attitudes and experiences (Bernhaupt, 2010; Hamari et al., 2014). An example of this is the Game Experience Questionnaire, a tool developed by researchers specifically for measuring game engagement (IJsselstijn et al., 2013) and used as a validation instrument for assessing user experience in games (Barbara, 2017).

The use of observation combined with post-game player feedback, through surveys and interviews, is a well-established approach used to evaluate simulation-based gaming experiences as well as to examine the effectiveness of game objectives (Bernhaupt, 2010; Barbara, 2017). It allows researchers to observe group behaviour and interaction during social game play as well as pose specific questions related to these observations, or general game objectives, to individual players. The same mixed methods approach has been used in a range of game-testing scenarios, from evaluating gamification concepts as a teaching methodology (Taspinar et al., 2016) to evaluating the effectiveness of gamifying specific scenarios such as emergency room patient management (Chan, 2018).

Overall, this Literature Review looked at the landscape of climate change games in introducing the opportunity to gamify transportation as a new way to influence preferences and awareness around climate change issues. More importantly, the growing field of study on evaluating the effectiveness of gaming provides useful strategies and tools that can be adapted for evaluating whether such a game is capable of achieving this objective.

3. The Game

Wheels is a board game prototype created by Alex Kjørven in 2018 in response to a gap in the market for climate change-inspired games that engage players in a fun and relatable gaming experience than those currently available to the public. The aim was to create a commercially-viable board game that can be thought-provoking and highly entertaining, without overtly emphasizing education in the way of many existing climate-themed games. Transportation and personal mobility were selected as a theme due to its direct relationship to GHG emissions and its relatability to the day-to-day lives of many.

Wheels was developed over a period of six months and was influenced by existing literature around the gamification of climate change, board game mechanics, and optimizing user experience in game design. This was followed by comparing and studying the existing landscape of climate change games as well as other games that exemplify mechanics consistent with properties of highly interactive and appealing games. The prototype being used for purposes of this research also reflects input and feedback from game design experts, board game enthusiasts and users from various age groups.

3.1 A Selectively Competitive Game About Getting Around

The game prototype combines the pursuit of individual objectives together with the constraints of shared consequences. Players must achieve individual goals related to mobility and resource accumulation while strategizing around the activities of other players, the use of non-renewable resources and its delayed effects on all users. Players navigate challenges associated with personal

transportation as a way to increase awareness of its tradeoffs, and how their decisions impact shared consequences related to climate change. A high level² overview of the current game is described below (Appendix B outlines abbreviated, quick reference rules used in the game).

- The game requires 3 to 5 players and includes a game board, player tokens, home base markers, movement cards, Disaster cards, Development cards, resource and point tokens, neighbourhood and destination markers. Appendix A contains an image of the game board before game play.
- The game board is made up of square tiles, each with four road segments and designed to resemble a city grid, subway stations and buildings representing unique destinations. The game board is designed in such a way that road segments can be added or taken away during a game. The board itself can change from game to game depending on how road segments are initially set up.
- Each player begins the game with different starting locations around the periphery of the game board. The most valuable destinations are located at the centre of the board and players must follow available road infrastructure in order to get around. A player's starting location is known as their home base. This is referred to as their starting "Neighbourhood", and also determines their starting resources as well as unique advantages they may have. Each Neighbourhood has its own unique identify. For example, Petroport is one Neighbourhood, offering players cheaper access to Fuel. Wellsville is another Neighbourhood and allows players the ability to extend walking

² Detailed game characteristics, full rules and all the features of the game are not included in this overview for simplicity and for copyright purposes. Instead, detailed descriptions of certain game characteristics as they relate to research findings are provided in the footnotes where necessary.

range. Appendix C contains images of each of these Neighbourhoods and the starting resources available to players who begin there.

- The primary currencies of the game are Wealth, Health and Influence resources, which are collected from various destinations around the city. Fuel is a secondary commodity in that it is not acquired at destinations, rather can be purchased at any time using Wealth units.
- The purpose of the game is to accumulate five “Achievements”, also known as game upgrades. There are a number of ways to reach Achievements, which are either public or private. Each type of Achievement requires the accumulation of different combinations of Wealth, Health or Influence. Appendix D represents the menu of Public and Private Achievements available in the game, along with their associated costs and benefits.
- Private Achievements benefit only the individual player, and includes upgrades such as the purchase of an Electric Vehicle (cost = 5 Wealth + 1 Influence + 1 Fuel), adding a Family Member (Cost = 5 Wealth + 3 Health + 2 Fuel) or the straight up purchase of an Achievement using 15 Wealth, 10 Health or 10 Influence, for example instead of performing an upgrade, a player can purchase an Achievement by accumulating a single resource.
- Public Achievements are those that require a minimum of two players to combine resources in order to perform an upgrade to the game board that may benefit all players. This includes adding an additional road segment (cost = 1 Influence + 5 Wealth + 2 Fuel), or building a new metro station (cost = 3 Influence + 8 Wealth + 2 Fuel). Players must determine among themselves how the costs of Public Achievements are split

among those who wish to take part. For example, if three players wanted to contribute to building a road segment, one player may contribute 1 Influence, another contributing 2 Fuel and 1 Wealth, and the third player contributing 4 Wealth. How these costs are split depends on the scarcity of the resource as well as how desperately other players need this upgrade.

- Players must have a mix of both Public and Private Achievements in order to meet the winning criteria.
- Throughout the game, players select from different modes of transportation in order to reach destinations offering the type of resource that they may be seeking (Appendix B includes a table listing the travel rules associated with each available mode of transportation).
- Each form of transportation has associated restrictions, costs and tradeoffs. For example, cycling is free, but can only go a limited distance. Choosing to use gas-powered transportation methods is often more efficient at getting a player to their desired destination; however, doing so not only depletes a common Fuel resource, but also, increases the probability of Disasters affecting the game. This is because used Fuel tokens are put into the Carbon Bag, which consists of Development tokens and used Fuel tokens. When a Development token is drawn, a Development card is revealed, which generally offers a positive addition or bonus for players. A Disaster card is revealed each time a Fuel token is drawn; hence, the more Fuel tokens used, the greater the probability of Disasters.
- The choice of transportation can also affect other players through a traffic jam mechanism, where traffic jams are triggered if more than half of the transportation

choices are cars. In this instance, traffic jams are randomly assigned around the board based on the number of vehicles on the road. A road segment affected by a traffic jam counts as two road spaces, thus increasing the cost or reducing the distance a player can move on their turn.

- The game end is triggered by the first player to reach five Achievements, at which point, the round is completed with remaining players finishing their turn. In other words, when a player has placed their fifth and last Achievement token, and they are not the last player in that round, other players will still take one final turn, creating the possibility where there may be more than one player to have five Achievements by the end of the last round.
- Game end is also triggered when all common resources are depleted or when a fifth Disaster event is revealed, regardless if there are any winners. In other words, there may be one or many winners, or everybody loses.

3.2 The Game as it Relates to Study Objectives

As discussed in earlier chapters, the game was specifically designed to integrate specific climate change game mechanics, while optimizing player relatability and game appeal. The following section describes how each of these objectives were built into the game.

a. Incorporating Climate Change Game Mechanics

The Literature Review identified four specific game mechanisms that are not only emblematic of climate change dynamics but also are rarely effectively combined in a single

game. The ways in which each of these game mechanisms were built into the game being studied are discussed below.

Non zero sum interactions – In climate change scenarios, all, some or none of the players may succeed (Fennewald & Kievit-Kylar, 2013); this is a key differentiator from common board games that feature binary scenarios of collaboration or competition, also known as “zero-sum” games. In other words, to adequately simulate the nature of collective-action problems, players in the *Wheels* game have the opportunity to seek winning conditions independent of other players while recognizing the possibility of one, multiple, or no winners. In this game, instead of encouraging the singular pursuit of point maximization as the way to determine the ultimate winner, players can instead pursue multiple paths to victory via the accumulation of Private and Public Achievements. In doing so, players will be able to choose when and how to collaborate with others as Public Achievements require explicit negotiation and deliberation among players.

To further encourage strategic interactions and problem solving among players, the triggers for the game’s end are designed such that it is possible for all players to lose simultaneously, or, if planned carefully, many or all players may achieve their win objectives. The game ends immediately, and all players will lose simultaneously, if all the Fuel tokens from the common supply is depleted. This may happen if one or several players are intentionally choosing to sabotage the game, likely to prevent others from winning in an “if I can’t win, then we all lose” effort, or if a Development or Disaster event depletes the final Fuel tokens

unexpectedly³. The game will also end immediately for all if, or when, the maximum number of Disaster cards have been drawn. In this instance, players will have no way of knowing when this will happen, except that the number and likelihood of Disaster cards that could be drawn increases as non-renewable resources are consumed. Finally, the game ends after the round when the first player completes their final (fifth) Achievement, or if several players collaborate to complete their final Achievement together. Everyone finishes their turn in this round, meaning that more than one player may be successful in accumulating five Achievements by the time the final round is over and the game ends.

Actor diversity and resource asymmetry – In real-life climate change dynamics, actors are seldom identical in their priorities and rarely equal in power and capabilities. This multiplicity and diversity among actors can be represented in a gamified scenario by creating conditions where players of various strengths and abilities work toward independent objectives (Fennewald & Kievit-Kylar, 2013). In the game *Wheels*, this is simulated through the choice of home base via Neighbourhoods that offer residents different starting resources and different advantages throughout the game. This pushes players to develop their own strategies based on their differing capabilities or limitations.

Use of a common resource pool and shared consequences – Transportation in the context of climate change is a type of social dilemma known as a common pool resource dilemma, where many actors can freely access common resources for personal benefit; however, doing so will conflict directly with the interests of a larger group of which they are also a part

³ Certain Development or Disaster events deplete Fuel resources from the common supply. Players do not know in advance which Development or Disaster cards will be drawn.

(Fennewald & Kievit-Kylar, 2013). To simulate this, the game allows players free access to a limited pool of common resources – fuel – to power their personal transportation goals and fund Achievements; however, depletion of this resource triggers negative consequences for all players by increasing the probability of drawing Disaster cards. This is done through use of the “Carbon Bag”, whereby each time a Fuel token is consumed, it is added to the Carbon Bag. Inside the bag are green Development tokens and spent Fuel tokens, the latter increasing throughout the game as Fuel is consumed. At the end of each round, a player draws two tokens from the Carbon Bag. A green token means selecting a Development card, which is generally positive for all players and includes a plethora of game enhancements such as the addition of destination buildings to the board, subsidies for vehicle upgrades, or even additional collaboration mechanisms such as voting for bonuses. A black Fuel token means a Disaster card is revealed, which generally has negative consequences for all players, increasing in severity as the game progresses. Examples of Disaster events include oil spills, where Fuel from the common supply is considered lost and goes straight into the Carbon Bag; air pollution, where players risk losing Health; or road and building destruction due to major storms or flooding.

Delayed effects – A defining feature of climate change is the delay and psychological distance that exists between the emission of greenhouse gases and the subsequent environmental, social and economic consequences (Shirkey, 2015). Delayed effect mechanics in this game include Disaster events, where the probability of drawing a Disaster is directly associated with the consumption of Fuel (i.e. via the “Carbon Bag” described previously). Players can consume Fuel freely throughout the game, reaping the benefits of

accelerated transportation to their desired destinations. However, they know that every Fuel token spent goes into the Carbon Bag, increasing the ratio of Fuel tokens to Development tokens and thus increasing the probability of Disasters being drawn. In this way, there is no immediate or direct negative consequence of using Fuel, only the probability that it will contribute to potential harm for all players down the road.

Overall, the use of delayed effect mechanics in the game represents an attempt to simulate and accelerate certain real-life feedback systems that individuals may never become aware of or witness in their lifetime. Awareness toward negative externalities becomes an important step toward changing attitudes among players.

b. Designing for Thematic Relatability and Entertainment Value

Because many climate change games may be easily dismissed as being too education focused, a challenge for *Wheels* was to capture the attention of mainstream player populations by using the theme of personal transportation and mobility in an entertaining and engaging way.

Efforts to build consistency between themes of personal transportation and climate change began by looking at ways to gamify sustainable transportation behaviour. Gehlert et al.'s (2013) study into the psychology of sustainable travel behaviour provides a useful example of real-life decision frameworks, and how they may be captured in a game context. The study suggests that travel activity and behaviour all fall within a hierarchy of decisions, whereby decisions at higher levels influence those at lower levels. For instance, travel behaviour on a day-to-day basis is primarily influenced by the higher-level decision of choosing where to live

or work. This is adapted into the game by requiring players to begin with making high level decisions about starting placement (i.e. home base) on the game board, followed by the remainder of the game being dominated by lower-level decisions that shape how they move to or from their starting placement. As players navigate the game, they may realize that living too far from their most desired destinations was too costly, and then pursue strategies that allow them to invest in a housing upgrade⁴ that, while initially costly, would grant them more valuable benefits over time.

Furthermore, the rules dictating movement in the game were designed in a way to closely mimic real-life attributes of various forms of transportation. Appendix B includes movement rules associated with each form of transportation, which best illustrates the tradeoffs associated with each (e.g. distance versus cost). For example, driving gas cars allows players to travel unlimited distance; however, it costs them one Fuel token per road space crossed. Conversely, walking is free, however players are limited to travel only three road spaces per turn. Other forms of transportation include driving electric, biking, transit or carpool – each with its own distance and cost characteristics. In this way, players are offered a plethora of options on how to move around the board as well as the option to combine different forms of transportation, just as in in real life.

Allowing players to mix and match travel options leaves room for creative adaptations that players may discover on their own. This creative flexibility not only enhances the game's ability to more closely mimic real-life scenarios, but also is critical in maintaining player

⁴ A form of Private Achievement in the game that allows players to relocate their home base, most likely toward a more desirable or frequently visited destination in order to reduce travel distance and cost in subsequent rounds.

engagement by allowing players to personalize their strategies. Similarly, examples of other design elements used to increase game appeal and entertainment potential include:

- *Multiple paths to victory* – The scoring mechanics of the game were described in detail in earlier sections; however, it is worth mentioning here that allowing players different options and ways to acquire game winning resources is important in making the game accessible to players with different levels of experience with games. The game is forgiving in the sense that mistakes early on in the game do not cripple a player's ability to win; the game winning conditions are flexible to allow for shifting or combining strategies. For example, at various points throughout the game players may choose to focus primarily on collaborative, public investments, or focus instead on the sole pursuit of resources for personal upgrades. The game also allows for creative ways to accumulate resources (e.g. trading through the carpool barter system) rather than only by travelling to different resource generating destinations.
- *Balancing the element of unpredictability* – Striking the right balance between luck and strategy is one of the key challenges of designing a game that is enjoyable and fun to play (Slack, 2017), without being dull or overly frustrating. As a result, the game is fundamentally a strategy game but elements of unpredictability are introduced through the distribution of traffic jams, the placement of new destinations and of course the consequences of Disaster events.
- *Player interaction* – Building a game that encourages player interaction supports not only collective-action problem solving, but also make games more interesting by allowing player personalities to influence the game experience. The type of negotiations required

between and among players in making public investments, the banter leading up to players selecting their movement decisions, and even the playful teasing among players all help to create a gaming experience that is enriched by the relational dynamics between players.

4. Approach and Method

The purpose of this research is to study the outcomes of playing a transportation-themed board game designed to influence player preferences and attitudes toward climate change. In order to influence player preferences and attitudes, the game should be successful in its adaptation of climate change game mechanics, its ability to entertain and appeal to mainstream players, and its relatability to the real-life experiences players.

4.1 Study Design

An observation-based, mixed methods study was used to capture both qualitative and quantitative indicators associated with player response and the game experience. A similar, mixed methods approach was used by a team of physicians at McMaster University, led by Dr. T. Chan, to evaluate engagement, usability, fidelity, acceptability and applicability of a board game to simulate emergency room patient management (Hale & Chan, 2019). This approach, centred around multiple, in-person playtesting sessions of the game with numerous research participants, is especially suitable for purposes of improving game quality, as well as to evaluate how the game impacts player outcomes for the purpose of evaluating its effectiveness against specific objectives. The three stages of research activity include:

- Survey and interview question selection;
- Playtesting and feedback collection;
- Evaluation and analysis;

a. Survey and Interview Question Selection

The first stage of research activity was the development of questions to be used in each playtesting session. Survey and interview question selection were informed by research that focused on game evaluation strategies and the importance of balancing quantitative and qualitative data points (Barbara, 2017, Bernhaupt, 2010, Wu & Lee, 2015, Taspinar et al., 2016). Furthermore, specific questions related to evaluating player immersion, challenge levels and other negative and positive experiences with the game, were selected from existing user experience evaluation frameworks such as the Game Experience Questionnaire (IJsselsteijn et al., 2013). Appendix E and F contain the full list of survey and interview questions used. Table 1 below outlines the types of data gathered as well the method used (i.e. observation, survey or discussion). Examples of questions used are also included for reference.

Table 1 Data Gathered and Sample Questions

Data Captured	Observation of Play	Pre- or Post-Game Survey	Post-Game Discussion	Sample Questions
Quantitative				
i. Responses to engagement and interaction mechanisms used DURING the game and perceptions of game applicability and appeal as measured using a series of Likert scale questions (e.g. Agreement – strongly agree to strongly disagree).		✓		How satisfied were you with the ease of learning the game? How would you evaluate the relevance of game strategies to your day to day life?
ii. Responses to engagement and interaction mechanisms used DURING the game and perceptions of game applicability and appeal as measured in response to YES/NO questions.		✓		Would the game have benefited from more resource scarcity? Would you buy this game?
iii. Attitude toward transportation choices as measured using a series of Likert scale questions BEFORE the start of each game.		✓		The environmental impact of my transportation choices are important to me (Strongly agree, agree, somewhat agree, do not agree)

iv. Preference toward transportation choices as measured using an unmarked scale ranging from highly preferred to least preferred, BEFORE the start of each game.		✓		Please indicate, anywhere along the scale, your desired preference for each of the following modes of transportation.
v. Attitude toward transportation choices as measured using a series of Likert scale questions AFTER the end of each game.		✓		The environmental impact of my transportation choices are important to me (Strongly agree, agree, somewhat agree, do not agree)
vi. Preference toward transportation choices as measured using an unmarked scale ranging from highly preferred to least preferred, AFTER the end of each game.		✓		Please indicate, anywhere along the scale, your desired preference for each of the following modes of transportation.
vii. # of players, total playing time, # of rounds, game outcomes.	✓			N/A
viii. Player experience as measured in response to questions related to players' social presence and engagement during game play.		✓		Please indicate how you felt while playing the game for each of the items: (I felt challenged, I felt frustrated)
Qualitative				
ix. Field observations regarding overall player interaction, adopted strategies, types of discussions observed and other behaviours not captured in a quantitative format.	✓			N/A
x. Player comments in free text fields of survey as it relates to the game's overall applicability and appeal.		✓		Please provide any additional suggestions for ways to improve game scenarios.
xi. Direct participant or group feedback in response to semi-structured interviews to better understand their group or individual game play experience, rationale for strategies adopted and other behaviours observed.			✓	During the game you chose to do X, why did you do this?
xii. Direct participant or group feedback in response to semi-structured interviews to better understand changes to their responses between the pre- and post-game surveys.			✓	You described your attitude toward driving to be X before the game and Y after the game, can you elaborate on what changed?

b. Playtesting and Feedback Collection

Playtesting took place over a period of two months and included a total of 18 participants across five playtesting sessions. This is comparable to similar studies done using a single

variation of a game, which ranged from 2 to 10 sessions (Fennewald & Kievit-Kylar, 2013). Each playtesting session involved 3-4 players and consisted of the activities outlined in Table 2.

Table 2 *Playtesting Session Outline*

Activity	Description	Duration
Group Orientation and Session Overview	Participants are provided an overview of the research project, guided through a detailed review of the consent form, and provided opportunities to ask questions about their involvement or the project.	10 minutes
Research Phase #1: Preliminary Survey	Participants are asked to complete a brief Pre-Game Survey to measure existing transportation preferences and attitudes.	10 minutes
Research Phase # 2: Game Play in a Group Setting	Participants are introduced and taught to play a board game prototype in a group setting ranging from 3-4 players. Players are observed and data will be gathered related to how players respond to certain game mechanics, point accumulation, game strategies taken, play time etc.	60-90 minutes
Research Phase # 3: Post-Game Evaluation via Survey and Group Discussion	Following completion of the game, participants are provided a Post-Game Survey to collect specific feedback related to the playing experience, followed by a group interview to collect feedback on game strategies and player interactions.	Survey: 15 minutes Group Interview: 25 minutes

c. Evaluation and Analysis

The game was evaluated based on both quantitative and qualitative outcomes, following a similar approach to that used by Chan (2018) for the evaluation of GridlockED, a game to teach medical practitioners on emergency room management (Sneath et al., 2017). Specifically, quantitative responses to survey questions were tabulated and analyzed based on comparing responses across the sample population, and also among individual participants as

part of tracking how their responses changed before and after the game (e.g. whether their Likert ranking in response to the same question differed between the pre-game survey as compared to the post-game survey). Observational data as well as qualitative responses to survey or interview questions were analyzed for common themes and sentiments, and anecdotal/direct quotations were extracted as evidence to supplement and assist in the interpretation of quantitative data.

4.2 Recruitment

Participants of this study included individuals representing a diverse range of familiarity with board games and also diversity of experiences as it relates to personal transportation. Specifically, participants selected for playtesting all have experienced the process of driving and/or have autonomy over local travel decisions (i.e. to work or school) on a regular basis. There was no control group, since this is an exploratory and observational study. Recruitment was initiated through a series of direct email requests made to groups of individuals within the existing personal network of the principal investigator (i.e. community forums, peers, acquaintances or friends). Those receiving an invitation were also asked to share the invitation with those they think may be interested, or those with whom they may enjoy a board game playing experience together. These invitations to secondary contacts were not within the specified scope of formal recruitment efforts and hence may have been done via word of mouth or email. In all instances, interested participants were asked to contact the principal investigator directly.

4.3 Ethics Review

A Research Ethics Board review was completed and approved on January 7, 2019 prior to the commencement of recruitment.

4.4 Challenges and Limitations to Study

First and foremost, the research was limited in size and participant diversity by the number of test players that can feasibly be recruited and the number of playtesting sessions that can be accommodated within the timelines allocated. In this instance, a reasonable sample base was for number of playtesting sessions was five, and the total number of players recruited for each game ranged from three to four. The study involved a total of 18 participants. To maximize diversity in players, the sessions were scheduled to allow for a mix of games played among friends (i.e. where all participants know and/or recruited each other) and those played among strangers (i.e. where not all participants know one another). This allowed for the study to capture diversity in player behaviour that may or may not be influenced based on familiarity with other players.

Second, the relationship between principal investigator and the participants was an important factor to consider with regards to the objectivity of certain types of feedback. Specifically, in evaluating enjoyment and mainstream appeal of the game, it is possible participants may have withheld harsh feedback, knowing that it was being provided directly to the principal investigator who is also the game designer, and favored more positive feedback. While the empathy factor cannot be fully eliminated, attempts to mitigate this included recruitment efforts to encourage volunteers to bring friends to play, where being among familiar company provides greater confidence to players. Players were also explicitly encouraged to be forthcoming in their critique, which included prompts to ask players to identify what they did not like about the game or what they would like to see changed. Again, the player-designer empathy factor is considered to have primarily affected feedback around game enjoyment, as questions and evaluation strategies in other categories were non-personal and inherently more objective.

Finally, the applicability of research findings was limited to the information collected from participants immediately before and after game play. Specifically, the extent to which the game was able to influence specific outcomes could only be measured by observation and direct first-person feedback collected through pre- and post-game surveys and discussion. To truly measure the impact of a single-play session on player attitudes would require observation or study of player behaviour in real-life scenarios outside of the game and over a period of time, ideally using validated psychometric measurements. For example, Hamari et al. (2014) identified a number of quantitative and qualitative studies focused on measuring behaviour outcomes and provides a critique of the methods used. Measuring long-term behaviour change is beyond the scope of this study. Instead, this study only went so far as to measure the changes in expressed attitudes and preferences toward transportation and climate change, and where possible, made inferences about how these changes may translate to changes in behaviour. More specifically, the study took feedback and insight collected from participants to make improvements to the game for future iterations, in hopes of further improving its ability to inspire shifts in personal attitudes and preferences toward transportation and climate change.

4.5 Achieving Study Objectives

The following section presents each research objective individually and describes what is being studied as well as how the research methods described earlier in the Chapter are adapted according to the questions being answered.

a. Measuring Effectiveness of Climate Change Game Mechanics

Wheels was developed to incorporate game mechanics that, when combined, are designed to engage participants in thoughtful decision making around resource consumption and how they interact with fellow players. These climate change game mechanics were carefully studied by Fennewald and Kievit-Kylar (2013), and are outlined in greater detail in the Literature Review. The game mechanics studied by Fennewald and Kievit-Kylar (2013) are not easily incorporated into a single game, thus highlighting a gap in the existing landscape of climate change games and an opportunity to improve the gamification of climate change. These mechanics are recognized by Fennewald and Kievit-Kylar (2013) as key success factors in simulating collective-action problem solving. An overview of the various game features and how these mechanics are incorporated into game play were described in Chapter Three, and highlight the following elements:

- Non-zero sum interactions;
- Actor diversity and resource asymmetry;
- Use of a common resource pool with shared consequences; and
- Experiencing short-term and delayed effects.

The first research activity was to evaluate players' response to these adapted game mechanics in a transportation-themed scenario, and how these mechanics may be further refined in order to increase player understanding and engagement with climate change. It is important to note that the specific types of player interactions encouraged by these mechanics are key differentiators between collaborative games versus traditional games that incentivize players primarily based on greed or desire to outperform others (Fennewald, 2015).

The approach taken to answer this research question includes:

- Observation and identification of specific cooperative versus competitive behaviours during game play, such as negotiation strategies behind public versus private investments, response and reactions to game ending win/loss scenarios, response and reactions to Disasters, player discussions and strategies regarding use of non-renewable resources and their consequences;
- Gathering and analyzing responses to survey questions around game mechanics and rules, such as Likert scale questions related to the appropriateness of resource scarcity or frequency and severity of delayed effects; and
- Gathering and analyzing responses to semi-structured group questions around game mechanics and strategies; question include ones such as “During the game, you chose to perform X action, when you had the option to perform Y action, what was the rationale behind this?”, or “Can you share some of the individual or group strategies you used during the game? Did they work?”.

b. Measuring the Relatability of Personal Transportation as a Theme

Suggesting that transportation can be an effective theme for a climate change game is predicated on the proposal that personal transportation is a highly ubiquitous activity and relatable by many in their day-to-day lives. As such, a key success factor to be evaluated in the game is whether or not players find the game scenarios and challenges applicable to their real life decisions and struggles. The appropriateness of transportation tradeoffs, how they influence decisions and how well these tradeoffs resemble players’ lived experiences may be

primary indicators of overall relatability, increasing the likelihood of key learnings from the game to transcend beyond the game board.

The approach taken to answer this research question includes:

- Observation and identification of player dialogue that demonstrates game scenarios being projected into real life experiences and vice versa; these would include player banter, side commentary or the natural emergence of vocabulary or terms that are not explicit in the game itself;
- Gathering and analyzing responses to survey questions directly meant to evaluate real-life applicability, including the use of Likert scale questions to measure whether players felt the game was applicable to real-life; and
- Gathering and analyzing responses to semi-structured group questions meant to directly and indirectly solicit feedback on applicability; examples of questions include: “What did you enjoy most/least about the game?”, “In what ways can the game be changed to make it more like real life?”.

c. Measuring Game Appeal and Mainstream Entertainment Potential

Reckien and Eisenack’s (2013) research revealed that the primary audience for most climate change games are young adults between the ages of 12-18, in second place are games that target those engaged in forms of academic or management training. In other words, education is an explicit objective in many climate change games. This often comes at the expense of these games gaining mainstream popularity. As an example, one of the most often cited and

studied climate change board games, *Keep Cool*, was developed by a group of scientists at the Potsdam Institute of Climate Change Research (Eisenack, 2012). This became one of the first climate change board games to become commercially available (Wu & Lee, 2015). Yet despite its popularity within academic study, the game scores 6.3/10 and ranks 10,361/15,397 on Boardgamegeek.com, the online encyclopedia for board games and player reviews (Boardgamegeek.com, 2018). Evaluating the overall appeal of the board game as a fun and engaging experience for players is critical to a game's success among broad audiences. Many existing climate change games prioritize education and learning outcomes as primary objectives, where player enjoyment and entertainment value become nice-to-have by-products (Wu & Lee, 2015). For *Wheels*, participant feedback and interaction with the game will serve as a proxy for evaluating how the game may be received by broader audiences. Evaluating game appeal will not only include direct player feedback on playability and entertainment but will also examine the depth of engagement and enjoyment players have toward solving the explicit challenges presented in the game.

The approach taken to answer this research question includes:

- Observation and identification of player behaviours that demonstrates enjoyment, amusement, frustration or impatience; these would include player banter, side commentary or direct comments related to how players feel during, or in response to, game outcomes;
- Gathering and analyzing responses to survey questions directly meant to evaluate game appeal, including the use of Likert scale questions to measure whether players had fun playing the game, was bored, or found it impressive. Yes/No questions were

also used to ask players whether this is a game they would play again, or recommend to friends, and;

- Gathering and analyzing responses to semi-structured group questions meant to directly and indirectly solicit feedback on game appeal; examples of questions include: “What did you enjoy most/least about the game?”, “In what ways do you think the game could be changed in order to make it more fun to play?”.

d. Measuring Changes in Player Preferences and Attitudes

Providing an interactive model for players to make decisions and engage with the resulting outcomes is an important aspect of altering attitudes toward climate change (Wu & Lee, 2015). The final step is to evaluate whether the effectiveness of the previous key success factors result in a measurable change in player preferences and attitudes following the game experience.

The approach taken to answer this research question include:

- Observation and identification of player dialogue or commentary that explicitly expresses a shift in perspective or a new learning;
- Gathering and analyzing responses to survey questions from before and after gameplay; for example, changes in preferences toward certain types of transportation may be measured by asking players to indicate their preference along an unmarked

scale both before and after game play⁵, which can be used as indicators of awareness around how their actions impact the environment; other, more direct questions include both pre-game and post-game Likert scale responses to statements such as: “I want to make changes to the way I, and those around me, make choices about transportation”, or “The environmental consequences of my transportation choices are important to me”; and

- Gathering and analyzing responses to semi-structured group questions meant to extract explicit feedback on how the game inspired changes in survey responses; examples of questions include: “[For those who] indicated a change in desirability toward different forms of transportation from before and after playing the game, can you think as to why this changed?” or “[For those who] indicated a change in your desire to adapt how you or those around you make choices about transportation, can you think as to why this changed?”.

⁵ The scale is marked with only “highly preferred” on one end, “least preferred” on the other end, and “somewhat prefer” in the middle. Measuring preferences this way decreases the likelihood of players remembering what their exact responses were from one survey to the next, allowing for a less biased self-evaluation of any changes that may have taken place.

5. Results and Discussion

This Chapter presents the findings gathered from applying the approach and methods described in Chapter Four. Specifically, this Chapter is organized based on each research question, with data from each of the play testing sessions (Table 3 below) aggregated and presented according to each of the three data collection methods; this includes a general summary of observations, analysis of survey data, and summary of group discussions. Table 3 provides an overview of the diversity in playtest scenarios and game outcomes.

Table 3 *Summary of Playtesting Sessions*

Session ID	# of Players	Total Playing Time	Rounds of Play	# Disasters Triggered	Win/Loss Outcome
#1	3	1hr 15 mins	8	3	2 winners, 1 loser
#2	3	1hr 30 mins	4	2	2 winners, 1 loser
#3	4	1hr 10 mins	4	5	Everyone lost
#4	4	1hr 40 mins	6	2	2 winners, 2 losers
#5	4	1hr 35 mins	6	3	3 winners, 1 loser

5.1 How Effectively Do Players Engage With the Climate Change Game Mechanics?

Overall, the climate change mechanics used in the game were successful in steering game play and player strategies as intended. However, depending on player characteristics, group dynamics and other random elements such as the frequency of Disaster cards, these mechanics interacted differently in shaping overall game outcomes or player strategies (Table 3 shows the various game outcomes from each playtesting session). These findings are further elaborated through each of the three data collection methods.

a. General Summary of Observations

First of all, as it relates to non-zero sum scenarios, the mechanics used to simulate these characteristics were assessed as having been successfully incorporated into the game: players understood the nature of collective win or loss scenarios, recognized the challenge of avoiding group Disaster, and engaged in various dialogue, negotiation and discussion as it relates to strategizing around these game conditions. However, as the overall game results demonstrate, it is worthwhile noting that while the possibility of group loss was real, and at times imminent, in no game did players deliberately *or* successfully achieve a group win scenario, one where all players win the game simultaneously. This is not surprising in that general observation around player response to the non-zero sum mechanics is that in almost all cases, players began the game with narrow objectives around personal victory and resource accumulation. Players were more open to collaboration in the beginning of the game, when resources seemed more abundant and individual objectives quite varied, whereas collaborative acts later in the game were only initiated when there was direct and immediate shared benefit for all parties.

This is directly related to observations of player engagement with the other game mechanics simulating delayed effects, use of common resources, and shared consequences. For instance, while everyone understood that the sole pursuit of individual benefit maximization would increase the likelihood of catastrophe for all, altruistic behaviours (i.e. player contributions toward public investments that have no immediate benefit to themselves) were only exhibited once an individual had achieved a degree of security over their own game winning objectives, or when the threat of Disaster was immediate.

One of the most overt examples of a delayed effect mechanic and collaboration to avoid shared Disasters is through a Public Achievement upgrade known as “Preserve Green Space”⁶. This upgrade can potentially prevent a scenario where everyone would lose, if say the Disaster count was already high. However, this is the most expensive upgrade and requires that every player contribute toward the cost of the upgrade. A key observation was that while multiple attempts were made, across numerous games, to solicit support for activating the Preserve Green Space upgrade, it was never successfully activated in any game. The dynamic observed was very similar across all attempts: one or more players would advocate for the need to make this investment, usually early when only one or two Disasters have been drawn and the threat of calamity low, but resource availability is high. Others would evaluate the investment to be too costly at that point in time and thus prevent its activation by refusing to contribute resources. Then as the game progresses, and players become acutely aware of the increased probability of Disasters (e.g. as Fuel is consumed and visibly accumulates in the Carbon Bag from which Disaster tokens are drawn), it was almost always the case that there were no longer enough resources around the table to complete this upgrade, even once all players now desired it.

In summary, game mechanics used to simulate shared consequences around the depletion of common resources were successfully combined with those used to highlight issues of psychological distance created by delayed effects. The use of these mechanics on player

⁶ This upgrade, when successfully activated, provides all players immunity from the next Disaster card that is drawn, essentially extending the game by preventing a scenario where all players may all lose simultaneously. This upgrade requires the greatest amount of resources compared with any other upgrades, as well as “sacrificing” a game tile, which may have valuable infrastructure on it, by removing it from the game.

interactions are most notably observed through the nature of the Carbon Bag combined with the “Preserve Green Space” public upgrade option. Player behaviours in response to these game elements very closely mimicked some of the most fundamental challenges associated with how we respond to trade-offs between personal versus public benefit and immediate versus delayed costs and benefits.

b. Survey Questions and Group Discussion

In the post-game survey, players were asked to rate the appropriateness of statements related to their evaluation of specific game outcomes. Responses are summarized in Table 4.

Table 4 *Survey Feedback on Game Mechanics*

Response Category	Not at all 1	Slightly 2	Moderately 3	Fairly 4	Extremely 5	Mean
There needs to be more player interaction.	39%	22%	28%	6%	6%	2.2
There needs to be greater sense of resource scarcity.	22%	39%	22%	17%	0%	2.3
Disasters should be more frequent or damaging⁷.	17%	17%	22%	28%	0%	2.7

The interpretation of results suggests that many players (39%) felt there was good balance with regards to independent versus co-operative interactions. However, the same proportion of players (39%) indicated a need for a “slightly” greater sense of resource scarcity, which

⁷ This question was framed in a way where players needed to indicate whether Disasters should be “more/less” frequent or damaging in addition to the extent to which they felt this was necessary (i.e. 1 to 5). sixteen percent of players indicated that disasters needed to be “less” damaging; this is not included in Table 4.

may have made the game more challenging by presenting players with more difficult choices. A strong majority (60%) indicated the need for more frequent or damaging disasters, suggesting that there was a need for Disasters to play a bigger role in the game.

The frequency of Disasters was often mentioned in post-game discussions in response to questions about what player strategies were used or how these strategies may change next time the game is played. Most notably, players all recognized the damage potential of Disasters, however they acknowledged that the threat “did not feel imminent”, or that it did not alter any strategies until a player was directly hurt by it. The suggestion that Disasters should be more frequent or damaging is itself a direct testament of players recognizing among themselves that the infrequency, unpredictability and unequal impact of Disasters is exactly what makes it difficult to take seriously, until it is too late. This is important as it confirms the game's ability to simulate the psychological distance created by delayed effects, one of the most fundamental challenges associated with efforts to mitigate the effects of climate change. When asked why players did not feel the need to better prepare for Disasters, responses included:

- “[I]didn’t think the Disasters would have escalated so quickly.”
- “Preserving greenspace is the most expensive [investment] and payoff did not seem worth it at the time.”
- “[The reserving greenspace upgrade] requires someone to lead it.”
- “Why would I give up working toward [my goals] to do this?”
- “Consumption of carbon didn’t really restrict [our] movement. I would have liked to see that happen more.”

Other post-game discussion topics around collaboration and competition scenarios presented mixed views among players about their own choices to collaborate versus to compete. For example, some players expressed regret in their openness toward collaboration too early in the game, while others realized that they “could have collaborated more [as a group].” Interestingly, while these views were expressed by different players across different games, there would also be instances where both these responses were expressed by different players in the *same* game (including the one game where everyone lost due to Disasters), suggesting that viewpoints toward collaboration or competition are highly subjective and influenced by how we personally gain or lose as a result.

In conclusion, observations, survey responses, and discussion with players suggest that the climate change game mechanics adapted for use in this game were effective in steering game play as intended. Specifically, these mechanics were effective in evoking the type of strategic challenges that are representative of the collective-action challenges we see in real-life climate change mitigation efforts.

5.2 Does the Theme of Personal Transportation Make the Game Applicable to Real Life?

The use of personal transportation as a theme was universally understood and embraced by all players. The presumption that personal transportation and mobility is ubiquitous in the day-to-day habits of participants, and thus highly relatable as a game theme, proved appropriate and resulted in a level of ease when it came to understanding game rules as well as creating a strong

cognitive connection with real life experiences. The intuitiveness of game play also reflects successful simulation of real-life travel dynamics and tradeoffs, while dialogue among participants further emphasized the different ways in which players internalized game scenarios and adapted playing styles based on their personal experiences with transportation. These findings are further elaborated through each of the three data collection methods.

a. General Summary of Observations

One of the primary observations related to participant interaction with the transportation theme was in the way players named the various destinations. The game itself does not label the destinations where resources are acquired, they are simply identified as, for example, “W5”, “I3” or “H3” markers on the game board, with the letter indicating the type of resource (W for Wealth, I for Influence, and H for Health) and the number indicating the units to be claimed at that destination. Instead, as the game progressed and players discussed among themselves where to go each round, they began to refer to the different destinations in a way that mimics how they may be referenced in real life, using phrases such as “going to the office”, “sending my kids to school” or “meet me at the gym”, respectively. The familiarity of these locations, named and labeled entirely by the players, brought a new level of liveliness to the game and galvanized all types of discussion and banter among players making it more personal and immersive.

These locations and their associated activities would subsequently influence player dialogue and playful teasing, occasionally having the effect of mirroring real life social dynamics as well as travel behaviours. For example, players would lament over another player reneging

on commitments to join them “at the gym⁸”, while feigning scorn at being “stood up”. While these types of player interactions have little effect on player strategy or game outcomes, it is evidence that the thematic underpinning of the game was effective in simulating life-like situations in which players were able to use their imaginations combined with their real-life experiences to enhance the playing experience.

Another worthwhile observation of how players relate to the transportation theme came in the form of the various alternative or advanced strategies introduced by players. These tactics and strategies were never explicitly the intention or expectation of original game design, but only emerged because players recognized there was an opportunity to mimic something they experience in real life. For example, several players recognized that they could add an additional vehicle purely to use as an “income vehicle” and shuttle people around who could not afford to drive on their own. They realized this could be especially profitable if done with an electric vehicle. In this instance, players are drawing on their experiences with ride share schemes such as Uber or Lyft, recognizing that they could bypass the entire premise of gaining points via Destinations and instead accumulate resources from other players by charging for rides, creating a new economic engine for themselves. This is remarkable not only because the strategy itself fit quite seamlessly into the existing mechanics of the game, but also because it highlights the importance of building flexibility into game design. This is further evidence that the transportation theme was effectively implemented, allowing for creative adaptations such as these that further mirror real-life strategies.

⁸ There are certain Health destinations where players receive more points if they are joined by others. All other destinations allow only one player to occupy it at a time.

b. Survey Questions and Group Discussion

In the post-game survey, players were asked questions intended to both directly and indirectly capture their evaluations of the game's real-life applicability and relatability.

Responses are summarized in Table 5.

Table 5 Survey Feedback on Real Life Applicability

Question	Not at all 1	Slightly 2	Moderately 3	Fairly 4	Extremely 5	Mean
It felt applicable to real life.	0%	17%	17%	28%	39%	3.8
I felt competent	0%	6%	22%	56%	17%	3.9
	Disappointed 1	Not satisfied 2	Somewhat 3	Very 4	Extremely 5	Mean
How satisfied were you with the ease of learning the game?	0%	0%	44%	50%	6%	3.6

Over two thirds (67%) of participants found the game fairly or extremely applicable to real-life. Questions used to evaluate the intuitiveness of game play were meant to serve as an indirect way to assess real-life applicability. This includes questions regarding personal sense of competence in navigating the game and the ease of learning the game. These questions were selected because games with well adapted, true-to-life themes are often highly intuitive to play and learn because players are able to draw upon their existing understanding of a specific reality to augment their learning and their strategy. Therefore, a strong sense of

competence and ease of learning the game was considered a good indicator for a well-adapted game. In this instance, close to three quarters (73%) of participants felt fairly or extremely competent in playing the game, an impressive result given the diversity of players and their varying levels of experience with more advanced board games.⁹ Similarly, 56% of participants expressed that they were very or extremely satisfied with the ease of learning the game, another impressive result seeing that to some, the game felt intimidating at first given the advanced game mechanics used and the numerous stages to follow in each round of gameplay.

Post-game discussion around these topics provided additional feedback on real-life relatability and insights into the responses above. Some notable feedback on ways to make the game more life-like are described below; some touch on deliberate omissions in game design while others reflect the deeper level of thinking that the game inspired in players (Appendix G provides a summary of all potential edits suggested in this paper).

- *Cycling safety* – Cycling safety is something that was top of mind for several participants who reside in Toronto, and have a specific relationship with cycling in the city. Having said that, the safety dynamic was not a factor in the game, thus creating incongruence for these individuals in terms of the evaluation of tradeoffs in real-life versus in the game. This was not a feature that was considered in original game design; however, it may be considered for a subsequent revision and added as part of a Disaster or Development card.

⁹ The diversity in gaming experience referenced here is based on observations and voluntary information provided by participants throughout the course of gameplay.

- *Family upkeep* – While players remarked and joked about the accuracy of costs required to add a family member (specifically the amount of Health resources required), several players commented on the lack of ongoing costs required to support an expanded family as something inconsistent with real life. It was argued that an unfair advantage would emerge for the remainder of the game for those who could afford the family upgrade and those who could not, whereas in real life, larger families require more resources to sustain and significant investments before these family members become productive workers. While this feature was indeed considered in depth as part of game design, the idea of requiring an ongoing resource commitment (i.e. a feed-your-family payment or requirement) was deemed too complex to add to the current version of the game. Instead, transportation mechanics were prioritized over life-building mechanics.
- *Environmental/social justice* – Players mentioned in post-game feedback how the game setting created a fascinating opportunity to better simulate real-life social injustices caused by environmental inequalities. Examples of this include the challenges faced by those who had the strongest will to behave more sustainably or support more social initiatives, however had the least Influence to do so. Furthermore, these individuals may have poor resource accumulation potential, compounding the challenges they face and making it exceptionally difficult for them to gain the Influence or resources they need to ever catch up. This was an extraordinary observation made by participants and an especially complex issue to intentionally gamify. While there are no intentions at the time to evolve the game to more deliberately capture these dynamics, an important finding is that the game, even as it is, has captured the negative externalities of climate change in a way so as to inspire thought and deliberation around these issues.

In addition to input on game improvements described above, players also consistently praised several game elements for its ability to capture real-life aspects of transportation and its relationship to collective-action problem solving. Select commentary worth highlighting from the post-game discussions is identified below.

- Players could sense that their existing live/work/commute situations influenced their playing styles, i.e. “I recently made the decision to get a property downtown...rather than in the [suburbs], and I felt that attitude being emulated in my playing style. Where do I live so I can walk to work every day?”
- The traffic jam feature was consistently well received and players were generally amused and impressed with the simplicity of the logic being gamified. Players appreciated that the location of traffic jams was random; just like in real-life the extent and location of traffic jams and how they will specifically affect your travel plans can be unpredictable.
- Despite the many components and the lengthy explanation of rules, which make the game seem intimidating at first, almost all players commented in the post-game discussion that the sequencing and logic of the game rules and mechanics were very intuitive after one or two rounds were played. As mentioned earlier, this is further testimony to the familiarity of the theme and the ability for players to draw on real life experiences in order to complement their understanding of the game.

In conclusion, observations, survey responses and discussions with players suggest that the use of transportation as a theme was effective in evoking familiarity with game mechanics, tradeoffs and scenarios among players. Many of the game dynamics were intuitively and

inherently understood by all players, allowing the game to help create a bridge between players' lived experiences and the intended lessons of the game.

5.3 Can the Game Be an Entertaining Experience for Mainstream Audiences?

Results from both direct player feedback as well as observations suggest that participants genuinely enjoyed their time playing the game as well as interacting with other players. Participants demonstrated laughter, and playful and imaginative behaviours while providing overwhelmingly positive feedback in both survey and discussion responses. Overall, evaluation of game appeal and player enjoyment, while highly subjective, provide valuable indicators on whether or not the game has adequately packaged the educational objectives related to climate change and can be accepted by mainstream board game players as a commercial board game rather than just an educational tool. It is worth noting here, however, that player feedback related to game enjoyment is the one area where players may be most sensitive to the fact that feedback is being provided directly to the principal investigator, who is also the game designer. This dynamic is further explored in the Challenges and Limitations section of Chapter Four; however, it is unlikely to have materially influenced the results identified. Findings from evaluating game appeal are further elaborated through each of the three data collection methods.

a. General Summary of Observations

The most telling observational finding as it relates to player enjoyment is simply whether or not players appeared to be having fun. These highly subjective observations include laughter, excitement, joking, friendly competition and banter, as well as comradery between the

players. All of these characteristics were observed to varying degrees in all games, across different skill levels and social dynamics. Much of the amusement and humor during the game was found to be closely linked to how players projected game attributes into personal or real-life attributes. For example, the player who never expanded their family but goes on to purchase a second electric vehicle immediately became playfully known as the “wealthy bachelor” with more cars than he can drive – a persona that then became the source of further banter and humor.

Similarly, much of players’ enjoyment across all games came from making Public Investments, arguably the most interactive part of the game¹⁰, where the process of building or breaking alliances in order to conduct public upgrades was often the source of highly entertaining negotiations. In fact, as confirmed through post-game discussions, the level of interactivity among players proved to be an important characteristic in the overall enjoyment of the game. This was the case for all games regardless of whether players were familiar with one another prior to the study. As a matter of fact, it is worth noting that a number of players arrived rather uncertain or skeptical of what a research-focused game testing session would entail. This was specifically the case for those participants that were recruited by their friends, rather than those who responded to the call for playtesters directly. The fact that all players were learning the game for the first time turned out to be a powerful equalizer; this combined with the highly relatable theme proved conducive to all players embracing the objectives of the game and quickly jumping into group interactions.

¹⁰ Public Investments are always initiated one player at a time, the active player selects the investment they would like to build and then solicits resources from other players who may be interested in supporting this upgrade. Through this process, players negotiate and sometimes bid on who takes part in the upgrade and how much each person will contribute.

b. Responses to Survey Questions and Group Discussion

In the post-game survey, players were asked a number of questions intended to evaluate their enjoyment of the game both directly and indirectly, as well as how it may be received by broader audiences. Responses are summarized in Table 6.

Table 6 Survey Feedback on Game Appeal

Question	Not at all 1	Slightly 2	Moderately 3	Fairly 4	Extremely 5	Mean
I had fun playing the game	0%	0%	11%	39%	50%	4.4
I felt challenged	0%	11%	33%	44%	11%	3.6
I found it impressive	0%	6%	6%	44%	44%	4.3
I felt bored	83%	11%	6%	0%	0%	1.2
I felt frustrated	56%	28%	6%	11%	0%	1.7
It was too easy	61%	11%	22%	6%	0%	1.7
It was too hard	67%	11%	17%	6%	0%	1.6
Question	Yes	No				
Is this a game you would recommend to others?	89%	11%				
Is this a game you would purchase for yourself?	67%	33%				

When asked directly in the post-game survey, 89% of participants found the game “Fairly” or “Extremely” fun to play. Other indirect ways to measure player enjoyment include the degree to which players felt challenged. Too much challenge would suggest that the game may be beyond the comfort level of average mainstream players, and too little would suggest that the game is too rudimentary and unlikely to be engaging. In this regard, 77% of participants evaluated the game to be “Fairly” or “Moderately” challenging – a healthy result considering the varied skill levels among participants. Players were also asked directly to rate the level of difficulty; close to two thirds of participants found it not at all too easy or too difficult, with 22% and 17% rating as moderately easy and difficult, respectively.

Players were also asked to evaluate their level of boredom as well as frustration felt during the game as another indirect measure of overall game appeal. Results were consistent with the above findings, whereby 83% and 53% felt not at all bored or frustrated, respectively. Twenty-eight percent of players expressed slight frustration during the game, this is further elaborated in the post-game discussion and became understood to be the result of frustrations felt toward “inefficient” travel decisions made by other players, those that did not make the best use of the resources available, or frustrations toward having made inappropriate choices leading to disadvantages during the game. As described in Section 5.1d., this type of frustration is strongly associated with changes in player attitudes toward certain transportation activities.

In evaluating the commercial appeal of the game, 89% of players indicated this is a game they would recommend to others and 67% expressed interest in purchasing the game for themselves if or when it becomes commercially available.

Post-game discussion on this topic consisted of direct questions to gather feedback on what players liked or did not like about the game, including suggestions on how to make the game more fun for future iterations. Specifically, some notable feedback on ways to make the game more enjoyable for future audiences included:

- *Carbon transparency* – Players were generally quite impressed with the concept and mechanics behind the Carbon Bag, which consists of green Development tokens as well as used, black Fuel tokens. Each time Fuel is consumed it is added to the Carbon Bag and at the end of each round two tokens are randomly drawn from the bag to determine whether Development Cards are played (if green tokens are drawn) or a Disaster Card is played (if black Fuel tokens are drawn). Players had fun with the playful banter that comes with picking on the person who consumed the most Fuel, blaming them for the draw of Disasters. This inspired the suggestion that this feature could be made more fun by labelling the Fuel tokens. Whereby each player will have unique coloured Fuel tokens, so that when one is drawn everyone knows exactly who contributed the Fuel that triggered the Disaster. This could have the effect of bringing even more awareness toward consuming Fuel – knowing that even the smallest contribution to the Carbon Bag could mean your Fuel token getting drawn and you having to face whatever penalty this entails. This led to some very thought-provoking post-game discussion around climate change accountabilities and how tracking the consequences of our own specific carbon

footprint could influence individual behaviours. While there are no intentions currently of making this adaptation, it is worth noting that while full transparency over the consequences of our own pollution or carbon footprint can never happen in real life, to simulate this in a game scenario could be an interesting way to further emphasize the challenges of collective-action problem solving and managing externalities.

- *Less predictability* – Another recurring point of feedback around improving the entertainment potential of the game was with regards to adjusting its predictability. This was valuable input as the right balance of surprise/uncertainty is very important for game enjoyment; however, game predictability was not specifically covered in survey questions or discussions. Near the end of several games, the choices players would make became more predictable, which included being able to anticipate what destinations they would visit or upgrades they would make. This is because one can see how close that person is to victory and exactly what resources they have available. Therefore, one adaptation to the game to improve the element of uncertainty, and thus entertainment value, may be to simply have players hide their available resources.
- *More negative impacts and tradeoffs to consider* – In games where the occurrence of Disasters was infrequent, players expressed that the game could be more fun if there were more imminent threats or negative consequences to consider at the personal level rather than negative consequences only being at the group level (i.e. traffic jams, Disaster cards). For example, this may mean adding “maintenance costs” such as higher property taxes or family support costs that need to be paid every round. It could also take the form of a dice roll whenever players take public transit or ride a bike, which can be used to determine if their turn will be negatively impacted by a delay or an accident, causing

greater travel cost or damage to Health, respectively. These additional tradeoffs could potentially make the game more challenging by providing more elements of risk and give players more to think about when making decisions.

Several aspects of the game were also consistently praised by participants as key factors that defined an enjoyable playing experience. These included:

- *Player interaction* – Dynamics between players represent some of the most pervasive post-game feedback across all playtesting sessions. Players especially enjoyed “interacting with other players”, “collaboration between players” and “that it wasn’t a co-operative game but there were opportunities to be co-operative”; this emphasizes the novelty value of a game that gives players choice on when and how they collaborate.
- *Diversity of choice and ways to win* – An important design objective was to create a gaming experience where there are multiple paths to victory and the game is forgiving enough in that it does not prevent players from adapting their playing strategies if needed based on how the game evolves. Player’s remarks around the diversity of choice suggests that personal transportation is an interesting and engaging concept to gamify. It also further reinforces the game’s success in making these transportation mechanics highly life-like and relatable.
- *Sophistication of the game* – Players often remarked on the impressiveness of the game as a whole, commenting on “[the] good combination of different game mechanics” and “stories and event cards felt familiar but with a more interesting theme.” Feedback like this from more experienced players were highly valued in this specific instance as they were able to more appropriately benchmark the sophistication of this game against other

strategy games on the market. These players recognized the different types of game mechanics used and were impressed with how they were integrated using a more “interesting theme” as compared to other strategic games they may have played previously.

In summary, the entertainment objective of the game was achieved as a result of the successful integration of all other game objectives. The use of game mechanics that balance competitive and collaborative interaction among players, and the efforts to create relatable real-life scenarios came together as intended – contributing to a fun and engaging game-playing experience.

5.4 What Changes Occur in Player Preferences and Attitudes After Playing the Game?

Discussions in earlier sections suggest that overall, the game was effective in integrating climate change mechanics into a transportation-themed game that is relatable and entertaining to play. This section looks at how these elements come together to inspire changes in player preferences and attitudes toward climate change as a result of playing this game. Overall, the evidence suggests that the game is successful in shaping player preferences toward certain modes of transportation and certain types of behaviours. These findings rely heavily on pre- and post-game survey data as this proved to be the most effective way of evaluating unbiased changes in player attitudes and preferences through indirect questioning. This is compared to direct questions related to the topic, where responses may be less consistent as players needed to have high levels of self-awareness in order to think critically about how their preferences or attitudes may have

changed. As a result, these self-evaluations of changes in attitude or perceived views were more anecdotal and subjective. Findings are further elaborated through each of the three data collection methods.

a. General Summary of Observations

Observation of game play was intended to identify player dialogue or commentary that would indicate revelations or specific shifts in personal views or bias. In this regard, a notable observation of game play was from commentary by individuals as they juxtaposed, and/or had realizations of how their real-life behaviours and decisions differed from their game strategies. An example of this was the investment in electric vehicles. While many players inherently understood and appreciated that electric vehicles are superior and better for the environment, they ultimately still viewed electric vehicles simply as a “nice to have” in real life. While playing the game, however, players were generally keen to invest in electric vehicles, which became a fun, low-stakes way to manifest their intentions of driving a more exotic vehicle and being part of the green trend. This was observed as players interacted with the simulated benefits of electric vehicles in the game, as they provided live commentary on how their understanding and relationships with electric vehicles changed. For example, players declared how electric vehicles “make so much more sense”, or exhibited a general giddiness whenever their choice of electric transport was clearly the superior option and gave them advantages over other players. If Fuel prices went up, electric vehicle owners felt especially satisfied because they would not be impacted. Players using electric vehicles would even go so far as to drive to places that were easily accessible by walking or cycling, simply to revel in the fact that driving now had zero consequences for them in the game. In other words, while the actual ownership of an electric vehicle was merely a simulation, the

sense of novelty and pride of ownership manifested in a very real way among players, resulting in notable changes in their attitudes toward this form of transportation following the game.

Attitudes toward electric vehicles were the most pronounced observable change among players, as seen through shifts in preferences toward driving electric vehicles and players' understanding of the actual costs and benefits of doing so. This is likely attributable to players' lack of familiarity with electric vehicles prior to the game, thus making room for new learning opportunities and thus a resulting shift in mindset. While players sometimes expressed similar shifts in preferences and attitudes toward other modes of transport during gameplay, these were often accompanied by self-rationalizing commentary on why their actions in the game may would be different than in real life, thus discounting the spontaneous nature of the observed behaviour.

b. Responses to Survey Questions and Group Discussion.

Chapter Four described how changes in desired preference for different modes of transportation were measured by asking participants to indicate their level of desirability along a horizontal, unmarked scale, with "Highly preferred" and "Least Preferred" on opposite ends, and "Somewhat prefer" in the middle of the line (Appendix E contains the survey questions). Players indicated their level of preference once in the pre-game survey and again in the post-game survey. The amount of change was measured to be the change in

distance of their markers along this line from before and after the game¹¹. Responses are summarized in Table 7.

Table 7 *Changes in Perceived Preference Toward Different Modes of Transportation*

Preference for each mode of transportation	Mean preference rating before the game	Mean preference rating after the game	% Change
Driving	6.0	4.6	- 13.4%
Driving Electric	7.1	7.2	+ 1.8%
Walking	8.4	8.2	- 1.9%
Cycling	6.0	6.6	+ 5.7%
Transit	4.8	4.7	- 1.4%
Ride Share	4.3	4.3	+0.1%

The most notable change in preferred modes of transportation occurred in the category of driving gas cars, where there was 13.4% decrease in the average level of preference for this form of transport. This is the most significant finding as the game deliberately prioritized the acceleration of feedback loops that lead to the negative consequences of driving, thus demonstrating that these mechanics were effective at influencing how players actually perceive the desirability of driving gas cars.

Changes in preference were also noted for driving electric cars, where on average, participants indicated a 1.8% increase in their preference for driving electric. The change in preference was less pronounced with electric cars as many respondents had electric cars already rated at the highest level in the pre-game survey, and thus indicated no change from this in the post-game survey. However, the increased preference was further emphasized in

¹¹ The actual length of the scale was 12.7 centimeters. Responses were measured and translated into a scale out of 10, where 10 is most preferred and 0 being least preferred.

the post-game discussions where players suggested that their decrease in preference toward gas cars was complimented by their new found appreciation for electric cars, which may be interpreted as a shift from one toward the other. This is because in the context of this game, electric cars were the most similar substitute for gas cars with the only trade off being a slight reduction in travel range in exchange for fuel-free driving.¹²

An increased preference of 5.7% toward cycling is reflective of its popularity in the game. Players were able to take increasing advantage of this free and pollution-free mode of transportation as they moved their home base closer to the downtown core or as they built new road segments to increase their accessibility to various destinations. While the survey showed a notable increase in preference, players were quick to discount the appeal of cycling in the post-game discussions as they highlighted some of the more practical challenges of cycling in the city that were non-issues in the game, such as safety and climate.

Changes in preferences were also measured for the remaining forms of transportation, where players on average indicated 1.9% decrease toward walking and little change in stated preference toward transit or ride sharing. Observation and post-game discussion indicated that players' ending preference for these specific modes of transportation were more likely linked to whether they were able to balance these tradeoffs to their advantage or disadvantage during the game itself. This is especially the case for walking, where on average, participants ended the game with a lower preference for walking. This is likely

¹² Gas cars can travel across an unlimited number of roads as long as the player has the Fuel to pay for each road crossed, whereas electric cars have no cost but are limited to only crossing five roads.

because walking during the game, while the cheapest, was the least efficient in competitive situations where players needed to access higher-value destinations that were usually claimed first by those who chose faster modes of transportation (i.e. those that were able to go farther).

In addition to measuring players' preference toward specific types of transportation, the pre- and post-game surveys also included a question that was aimed at understanding the factors (e.g. cost, comfort, availability etc.) that influenced this preference: questions #6 and #7 in the pre- and post-game surveys, respectively. It became evident as the surveys were analyzed that the question was interpreted inconsistently by players, where some players likely conflated "desirability" with "importance" within the same survey, thus resulting in inconsistent and inconclusive results. For example, a factor related to a certain mode of transport may have increased in importance specifically because it decreased in desirability. While players were given guidance on how to respond to these questions, it became evident that structuring the question in this particular format was too complex and ineffective in identifying patterns of change. As a result, results from this particular question were deemed inconclusive and omitted from this analysis, relying instead on responses from post-game discussions to provide anecdotal insights on the factors behind any changes in preference.

Players were also asked to rate their level of agreement with two specific statements before and after the game. Players had the choice to select one of five responses ranging from

“Strongly Agree” to “Strongly Disagree”¹³ to questions related to the importance of environmental consequences and their own desire to make changes in how they make choices about transportation (Appendix E).

Table 8 *Changes in Attitudes Toward Transportation Choices and their Consequences*

Question	Mean rating before the game	Mean rating after the game	% of players with no change from before to after the game
The environmental consequences of my transportation choices are important to me.	3.1	3.3	78%
I want to make changes to the way I, and those around me make choices about transportation.	3.1	3.5	67%

It is worth noting from the above results that a majority of players expressed no change from before to after the game. This is due to a large number of participants who were already at the highest level of agreement in the pre-game survey.

The increased desire to make change among themselves and those around them was further explored during the group interview. It became evident that this sentiment was primarily directed toward wanting to see change among others. Players revealed that their response to this survey question was a reflection of frustrations felt toward other players who made poor decisions that negatively impacted game outcomes for everyone (e.g. “[It was] easier to convince myself than others [to do the right thing]”). These insights suggest that the game

¹³ For the purpose of analysis, responses were assigned numerical values where 5=Strongly Agree and 1= Strongly Disagree.

was able to effectively simulate scenarios that cause frustrations associated with collective-action problem solving. Specifically, when the consequences of negative externalities are not always visibly linked to individual actions in real-life, the game was able to make some of these cause and effect chains more transparent and individuals more accountable.

In the post-game discussion, players were also asked directly to reflect on why their responses may have changed from before and after the game. This provided additional insight into the factors that may have influenced the changes noted above. Common reasons provided by players in response why their preferences or their feelings toward environmental consequences changed are highlighted below.

- *Increased awareness* – Players often remarked about the increased sensitivity they felt toward certain decisions or behaviours, recognizing that the game illuminated for them the dynamics of a system that they do not consider on a regular basis. Examples of comments along this theme included:
 - “[I] became more aware of the rational decision making behind certain actions.”
 - “[The game] made me more conscious.”
- *Highlighted inefficiencies* – Players recognized that the game highlighted inefficiencies and unintended consequences of specific types of transportation, many citing this as the reason for changes in preference. For example, players recognized how access to transit was a critical determinant of whether transit would be embraced as a superior form of transportation. Similarly, with ride sharing, the game highlighted the inconvenience of having to coordinate carpools with others and also the inefficiency of driving people

around in taxi-like services, which do not provide any fuel savings when compared to driving yourself. Comments included:

- “[The game] highlighted inefficiencies of certain transportation methods, mainly the barriers to transit and rideshare,”
- “I already knew these things, but the game solidified it for me.”
- *Anti-gas car, pro-electric car* - As mentioned earlier, one of the most notable change in preferences occurred between gas-powered cars versus electric vehicles. The quotes below represent some of the common responses from players when they were asked to reflect on the notable decrease in preference toward gas-powered cars and increased preference toward electric cars:
 - “[I] thought more about the cost of fuel.”
 - “My world is so car, the game was so anti-car!”
 - “[I] increased [my preference for] driving electric significantly, cost was low and there was no guilt and you’re not adding Fuel to the bag.”
 - “Seeing how well the EV [electric vehicle] worked on the board, [I] improved rating there.”
 - “Seeing carbon going into the carbon bank, you can visually see that you are contributing to something that is going to hurt you.”

In summary, the combination of climate change game mechanics, real-life relatability and player experience was successfully integrated into gameplay. This contributed to changes in players’ attitudes toward the shared environmental consequences of certain types of transportation activities. It is suggested that the collective-action mechanisms adapted for this

game not only increased awareness around environmental consequences but also evoked frustrations toward the poor decisions of others. Most notably, the game showed promise in steering players away from the most carbon intensive form of transportation and toward more sustainable modes of transit such as driving electric and cycling. When it came to driving electric cars in the game, players' emotional responses were similar to what one may expect after having taken a prolonged test drive in real life, which included feelings of novelty and delight, suggesting that the game can help reduce barriers toward accepting and embracing electric vehicles.

6. Conclusion

6.1 Significance

The classic tabletop board game has soared in popularity in recent years, with both exponential increases in the number of games published and the number of people playing them (Verstraeten, 2018). The motivation for this research stems from an appreciation of the board game's ability to shape player outcomes, leading to a desire to use board games to create more positive impacts on those who play them. This paper highlights the existing landscape of board games, which are designed primarily for entertainment purposes, optimizing for player experience, strategy, novelty, artwork or sometimes even shock value. Board games specifically designed for learning purposes are known as "serious games" and are seldom available to the public as they are often narrow in scope and purpose.

Results from this study suggest that it is possible to create a game that not only balances enjoyment with purpose, but also is capable of generating specific outcomes among players. The game being studied needs to integrate multiple objectives, optimizing for player experience as well impact. In this regard, observations of game play, surveys, and discussion with players reflected consistent outcomes in how game mechanics steered playing strategy and player interaction. Participants generally had positive playing experiences, where the theme of personal transportation created an intuitive scenario that helped bridge players' lived experiences with the intended lessons of the game.

The most significant of these findings were those measuring changes in player preferences and attitudes toward certain types of transportation following the game. Whereas existing research supports the connection between simulation and learning (Gosen & Washbush, 2004), findings from

this study contributes to this academic landscape by suggesting that simulation through gamification in this format may also influence preferences toward certain types of transportation activities among players. While the scope of this study included the evaluation of both conscious and sub-conscious preference changes through the use of direct and indirect questioning among participants, the changes observed suggest that there may be potential for board games to shape player mindsets as well, especially if given the opportunity for repeated play.

Furthermore, data collected from this study has been valuable in informing corrections and iterations to the game, and also in how it can be improved to increase market appeal (these are summarized in Appendix G). The consistently positive feedback received from participants in this study provided validation and encouragement toward the commercialization potential of the game. The significance of game appeal cannot be understated – a game created for a limited audience with narrow learning objectives benefits very few people. Instead, creating an engaging board game that effectively simulates the trade-offs and strategies behind collection action problem solving fits a specific gap in the landscape of climate change games, while creating positive attitude changes across a broad audience.

6.2 Looking Ahead

The game *Monopoly* was published by Parker Brothers in 1935. In the midst of the Great Depression, this niche real estate game went on to become one of the most popular games in history (Latson, 2014). *Monopoly* provided anyone the opportunity to escape reality for “the chance to become Uncle Pennybags for an afternoon” (Eskin, 2010). This escape from reality is precisely what makes board games fascinating tools for studying human behaviour. *Monopoly* itself has been the backdrop for research around how people’s preferences change in the face of wealth and

privilege; a popular study used the game to create conditions of artificial advantage and disadvantage, and studied how this affected player attitudes toward winning (Piff, 2013).

The game *Wheels* may be used to serve a similar purpose. Having established its effectiveness in simulating collective-action problem solving through themes of climate change and personal transportation, one area for future study may involve further manipulation of game mechanics to study its impact on player outcomes. This may include introducing more macro-level elements such as the role of government and politics, or more micro-level elements that further emphasize relationships and the social contracts that define them. These game manipulations can be made to further study how players' attitudes can be affected in light of more or less player autonomy, resource scarcity, collaboration or competition. Similar studies can also be carried out over multiple play sessions, to observe how changes in player attitudes may evolve as they become informed actors.

Another key aspect for further study is how observed changes in attitudes or preferences following game play translates to sustained behaviour change over time. A longitudinal study of how the game impacts players over time was not within the scope of the study; however, it may be especially valuable to study how changes in attitudes, inspired by playing a game, can actually lead to changes in behaviour over time. This would be the true test of a board game's ability to have lasting impact on its players.

As for the game itself, it is the intention of the designer to publish the game for commercial distribution. Player feedback collected from research activities, including those not directly relevant to the scope of the study, has already informed various revisions meant to further increase its commercial appeal. The game has been demonstrated at a local board game convention and has

received interest and positive feedback from potential publishers. While a complete prototype was used for purposes of this study, further improvements include refining game mechanics and game aesthetics. Furthermore, the game was designed to target a broad age group; however, many of the concepts surrounding urban transportation reflect that of more industrialized societies – so while the game is universally accessible by players from any market segment, there is a bias toward those with exposure to urban environments in more developed countries. This reveals an opportunity for future expansions or adaptations of the game to potentially incorporate themes from rural or non-westernized societies, as well as feedback from playtesters representing these alternative markets.

Overall, this study has provided valuable insight into how players interact with climate change game mechanics that were designed to simulate very specific collective-action problems. The results indicate promise for the game to be used as subject for further study as well as potential to reach larger audiences through commercial distribution.

Appendices

Appendix A Example of Game Board Set Up



Appendix B Abbreviated Game Rules

QUICK REFERENCE RULES

Standard Fuel Price:
1 WEALTH = 3 FUEL

Standard Transit Price:
1 WEALTH = 2 TOKENS

All used fuel and Transit Tokens go into the Event Draw Bag.

GAME PLAY STAGES:

1. **Mode Selection & Reveal**
2. **Assign Traffic Jams**
3. **Move & Get Paid**
4. **Invest**
5. **Draw Event Tokens & Resolve Events**
6. **Come Home**

You may access any destination that is directly adjacent, not diagonal, to the road or transit station you stop on.

Method	Distance	Cost	Restrictions/Notes
Car	Unlimited	1 Fuel per Intersection crossed.	Vehicles must be able to “park” on the road, next to their destination Cannot go where there are no roads.
EV	5 intersections	Free + 1 Fuel per additional intersection	Intersections affected by Traffic Jams, count as double when crossed.
Bike	5 roads	Free + 1 Health per add'l Road	Cannot go where there are no roads.
Walk	3 roads/spaces	Free + 1 Health per add'l Road	Can be COMBINED with Transit
Transit	Any 2 stations.	1 Token per ride.	Can be COMBINED with Walking. “Enter/Exit” from the nearest road.
Carpool	Walk + Pickup by another Driver	To be determined by driver of the car.	You may begin your turn with Walking or Pickup, but you must select Walking during Mode Selection.

Ties between 2 or more players are resolved in the following sequence, unless otherwise specified:

1. The player with the most Influence decides.
2. The player that roles the highest number on a single dice decides.

Appendix C Starting Neighbourhoods and Resources

Richtown

Start Resources:



Bonus: Trade →

Wellsville

Start Resources:



Bonus: Pay 1 for +1 Road when Walking/Biking.

Petroport

Start Resources:



Bonus: Pay 1 for 4 anytime.




The Hill

Start Resources:



Bonus: Trade →

Appendix D Public and Private Achievement Upgrades

PUBLIC ACHIEVEMENT			PRIVATE ACHIEVEMENT				
(MINIMUM 2 PLAYERS)		(ALL PLAYERS)	(ONCE PER ROUND)				
Build Road	Build Metro	Preserve Greenspace	Expand Family	Add Vehicle	Add Electric Vehicle	Buy a House	Purchase Achievement
1 Influence* 5 Wealth 2 Fuel	3 Influence* 8 Wealth 2 Fuel	8 Influence* 10 Wealth 1 Tile	5 Wealth 3 Health 2 Fuel	5 Wealth 1 Influence 1 Fuel	9 Wealth 1 Fuel	7 Wealth 1 Fuel	15 Wealth or 10 Influence or 10 Health
+ 1 ★ 	+ 1 ★ 	+ 1 ★ + 1 Health Avoid next disaster. 	+ 1 ★ + 1 Influence	+ 1 ★	+ 1 ★ + 2 Influence + 1 Health	+ 1 ★ + 1 Influence	+ 1 ★

Appendix E Pre- and Post-Game Survey Questions

Pre-Game Survey Questions

1. Name (First/Last):

2. Preferred Email Address (will only be used for communicating research results or updates if you selected to opt-in on your consent form):

3. Confirm that you are over the age of 18:

- a. Yes
- b. No

4. Please indicate how frequently you use each one of the following as your primary mode of transportation. Select **one** from each row:

Driving	Daily	Weekly	Occasionally	Rarely	Not Available
Driving Electric	Daily	Weekly	Occasionally	Rarely	Not Available
Walking	Daily	Weekly	Occasionally	Rarely	Not Available
Cycling	Daily	Weekly	Occasionally	Rarely	Not Available
Transit	Daily	Weekly	Occasionally	Rarely	Not Available
Ride Share	Daily	Weekly	Occasionally	Rarely	Not Available

5. Please indicate, anywhere along the scale, your **desired preference** for each of the following modes of transportation, assuming accessibility:

e.g. Skateboard	Highly Preferred	Somewhat Prefer	Least Preferred
Driving			
Driving Electric			
Walking			
Cycling			
Transit			
Ride Share			

6. For each mode of transportation, please assign a ranking of **1-6** to each factor **influencing desirability**. 1 being the **most** attractive feature and 6 being the **least** attractive. Use each number **only once** for each mode of transportation/row.

e.g. Private Jet	6 Cost	1 Comfort	3 Availability	2 Speed	5 Environment	4 Health
<i>(i.e. This response would indicate that the Comfort of a Private Jet is the most attractive factor, and the Cost of doing so is the least attractive, presumably considered too expensive.)</i>						
Driving	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Driving Electric	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Walking	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Cycling	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Transit	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Ride Share	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health

7. The environmental consequences of my transportation choices are important to me:
- a. Strongly agree
 - b. Agree
 - c. Somewhat agree
 - d. Disagree
 - e. Strongly disagree
8. I want to make changes to the way I, and those around me, make choices about transportation:
- a. Strongly agree
 - b. Agree
 - c. Somewhat agree
 - d. Disagree
 - e. Strongly disagree

Post-Game Survey Questions

1. Name (First/Last):

1. Please indicate how you felt while playing the game, for each of the statements, on the following scale:

1 – not at all

2 – slightly

3 – moderately

4 – fairly

5 – extremely

- a. ____ I had fun playing the game
- b. ____ I was bored
- c. ____ I felt challenged
- d. ____ I felt competent
- e. ____ It was too hard
- f. ____ It was too easy
- g. ____ I found it impressive
- h. ____ I felt frustrated
- i. ____ I felt it took too long to play
- j. ____ I felt the game was too short
- k. ____ It was thought-provoking
- l. ____ It felt applicable to real-life

Additional comments:

2. Please indicate the areas where you feel the game could be improved:

1 – not at all

2 – slightly

3 – moderately

4 – fairly

5 – extremely

- a. ____ there needs to be more player interaction
- b. ____ there needs to be greater sense of resources scarcity
- c. ____ the cost of game achievements need to be adjusted (please elaborate below as needed)
- d. ____ the points earned at destinations need to be adjusted (please elaborate below as needed)

- e. ____ there needs to be more/less (circle/one) destinations available for earning points
- f. ____ Disasters should be more/less (circle one) frequent or damaging

Additional comments:

3. How satisfied were you with the ease of learning the game?
- Extremely satisfied
 - Very satisfied
 - Somewhat satisfied
 - Not satisfied
 - Disappointed
4. Is this a game you would recommend to others?
- Yes
 - No
5. Is this a game you would purchase for yourself?
- Yes
 - No
6. Please indicate, anywhere along the scale, your **desired preference** for each of the following modes of transportation, assuming accessibility:

	Highly Preferred	Somewhat Prefer	Least Preferred
e.g. Skateboard	<div style="text-align: center;">X</div>		
Driving			
Driving Electric			
Walking			
Cycling			
Transit			
Ride Share			

7. For each mode of transportation, please assign a ranking of **1-6** to each factor **influencing desirability**. 1 being the **most** attractive feature and 6 being the **least** attractive. Use each number **only once** for each mode of transportation/row.

e.g.
Private Jet 6 Cost 1 Comfort 3 Availability 2 Speed 5 Environment 4 Health
(i.e. This response would indicate that the Comfort of a Private Jet is the most attractive factor, and the Cost of doing so is the least attractive, presumably considered too expensive.)

Driving	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Driving Electric	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Walking	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Cycling	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Transit	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health
Ride Share	___ Cost	___ Comfort	___ Availability	___ Speed	___ Environment	___ Health

8. The environmental consequences of my transportation choices are important to me:
- Strongly agree
 - Agree
 - Somewhat agree
 - Disagree
 - Strongly disagree
9. I want to make changes to the way I, and those around me, make choices about transportation:
- Strongly agree
 - Agree
 - Somewhat agree
 - Disagree
 - Strongly disagree

Appendix F Semi-Structured Interview Guide

Semi-Structured Interview Questions (Group)

Play Session ID:

Players:

Total Game Playing Time:

1. What did you enjoy most about the game? Least?
2. Can you tell me about some of the strategies you used during the game? Individually or as group?
 - a. Did they work?
 - b. Who else felt like they needed to use similar strategies?
3. During the game, you chose to do X (e.g. not preserve green space), when you had the option to do Y (e.g. prevent a Disaster), what was the thinking behind this?
4. Are there things you would have done differently next time you play? Individually or as a group?
5. Several of you answered differently in response to your desired modes of transportation or the factors influencing desirability at the start of the game, as compared to the end – does anyone care to describe why these preferences may have changed, or what caused these changes?
6. A number of you indicated also had different before and after responses in your desire to change the way you, or those around you, make choices about transportation – does anyone care to describe how or why these preferences may have changed following the game?
7. In what ways do you think the game needs to be made more/less challenging?
8. In what ways do you think the game could be changed in order to make it more fun to play?
9. In what ways can the game be changes to make it more like real life?
10. Do you have suggestions on how the game may be better explained/taught going forward?

Appendix G Summary of Suggested Features or Game Edits for Consideration

Suggested Feature or Game Edits for Consideration	Designer's Comments
Cycling safety	<ul style="list-style-type: none"> • May be added as part of a Disaster or Development event. • A dice roll mechanic could be used each time this mode is selected to see if the selected trip may be negatively impacted in some way.
Family upkeep	<ul style="list-style-type: none"> • Was considered for current version but deemed too complicated for a game that is already pretty rule laden. • May be implemented as an additional “feed your family” stage as seen in other worker placement games.
Environmental/social justice	<ul style="list-style-type: none"> • No intention to include these themes into existing game in favor of keeping the game focused on transportation. • May be considered in a future expansion when additional social, political and economic themes are also added.
More carbon transparency	<ul style="list-style-type: none"> • Possibly consider making personalized Fuel tokens (i.e. different colours for each player), so that the Fuel token triggering each Disaster could be traced back to the player who consumed that Fuel. • An interesting mechanic for game play, but one that compromises the thematic accuracy of the game in that the absence of this type of direct accountability is fundamentally what makes negative externalities difficult to manage.
Less predictability	<ul style="list-style-type: none"> • May consider encouraging players to hide their available resources.
More negative impacts and tradeoffs	<ul style="list-style-type: none"> • May consider adding “maintenance costs” such as paying property taxes based on how close players live to the central, most valuable tile. • May also consider additional dice roll mechanics to determine if certain trips may be subject to unforeseen delays or other forms of negative impact such as traffic jams but at a more individual level (e.g. what was suggested for cycling safety).

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