Validating the effect of the persuasive game design principle simulation on attitude change for multi-actor decision-making

Shanita Rambharos
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4292251

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Author

Name : Shanita Rambharos
Student Number : 4292251
Study programme : Complex Systems Engineering and Management
Faculty : Technology, Policy & Management, Delft University of Technology

Graduation committee

Chairperson : Prof. dr. ir. A. Verbraeck, Section Policy Analysis
First Supervisor : Dr. L. J. Kortmann, Section Policy Analysis
Second Supervisor : Dr. G. de Vries, Section Organisation & Governance
External Supervisor : Drs. A. E. Erdbrink, Section Policy Analysis

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Preface

This report contains the final result of my master thesis project, which is the final step for acquiring the degree of Master of Science in Complex Systems Engineering and Management. This research was partly funded by TKI Dinalog, who provided the Mobinn game that was used in this research.

I started my master thesis project as a gaming enthusiast who was lucky enough to conduct a project involving my favourite activity. But I was also up for a big challenge, considering that this research is the first that aims at validating persuasive game design principles in isolation. Yet, it was a challenge to be excited about because I was given the opportunity create something entirely new using my own creativity and competences that could be of value for the gaming discipline and for society. This not always fun and games, as this research required me to assess a lot of complex theories and literature from the field of psychology, which made me sometimes question whether I was acquiring a degree in psychology. Nevertheless, I was able to present an exciting result, which could bring the gaming discipline closer towards the validation of persuasive game design principles. Considering this, I can confidently say that I came out of my master thesis project as a game enthusiast who also appears to be an independent researcher.

However, none of this was possible without proper guidance. Therefore, I would like to thank Alexander Verbraeck and Rens Kortmann for giving me the push for not being too critical on my work and for not being too modest about my results. Furthermore, I would like to thank Gerdien de Vries for all advise during the creation of the methodology for my research and for guiding me through the field of psychology. Also, I would like to thanks Annebeth Erdbrink for guiding me through the field of psychology, for guiding me through the field of persuasive games and for always being available whenever I was stuck in this project.

Furthermore, I would like to thank Chris van Bergen and Laurane Macquart for always being there with me in project room 4 during this process, and for always being in the mood to play games. Also, I would like to give a special thanks to Rens van Voskuijlen for helping me to create games, for reminding me to take breaks and for the love. Finally, I would like to thank my parents for all the love and emotional support during this process.

Let the games begin.

Shanita Rambharos
Delft, August 21 2019

Executive summary

Persuasive games have great properties for facilitating lasting attitude change for complex societal issues, making them a valuable tool for achieving attitude change towards cooperation and information sharing that is often necessary for effective multi-actor decision-making. It is assumed that persuasive game design principles are key drivers for conceiving successful persuasive games, however, their effect on attitude change and attitude reinforcement has not been validated. Little guidance is therefore provided for persuasive game designers and researchers when it comes to selecting persuasive game design principles that can successfully achieve the intended attitude change. This could lead to poorly chosen principles making persuasive game designer and researchers unable to achieve their goal regarding attitude change, or to games that are even counterproductive.

To get one step closer towards validated persuasive game design principles, this research aimed at validating the most frequently used persuasive game design principles for persuasive game for multi-actor decision-making: simulation. For this research, the persuasive game design principle simulation is defined as follows: *Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality.* Considering that the two most important constructs for effective multi-actor decision-making are cooperation and information sharing, it was assessed whether the persuasive game design principle simulation is effective for reinforcing/changing attitudes towards these constructs. The main research question was formulated as follows: *What effect does the persuasive game design principle simulation have on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making*?

As a first step to get to the answer of this research question, a theoretical framework was conceived which formed the basis for explaining the effect of the persuasive game design principle simulation on attitude change. The relationship between the persuasive game design principle and attitude change could best be explained through the Elaboration Likelihood Model of Persuasion (Petty & Cacioppo, 1986). The persuasive game design principle simulation could be considered to contribute to the *knowledge and understanding* aspect of the *Ability to process* determinant in the model, which is one of the two prerequisites for processing a persuasive message through the route that results in a lasting attitude reinforcement or change. By providing players with a mechanism to see the cause-and-effect relationship of their behaviour in the game and its link to reality, it provides them with knowledge and understanding for formulating and examining arguments regarding the persuasive message the game aims to convey. The other prerequisite for this route is that the persuadee should be *Motivated to process* to process the external message. Achieving this can be done externally by enhancing personal relevance and personal responsibility.

In order to be able to verify the relationship assumed by the theoretical framework, a methodology was conceived for measuring the effect of the persuasive game design principle simulation on attitude change in isolation. This research is the first research that aims to validate the effect of the persuasive game design principle simulation on attitude change in isolation, therefore a suitable method for this purpose was not yet available. For this research, game sessions were conducted in the form of laboratory experiments. Different versions of the Mobinn game that is created by researchers at the faculty of Technology, Policy and Management at the Delft University of Technology were conceived in which the presence of the persuasive game design principle was varied. Attitudes were assessed by conducting quantitative and qualitative analyses. For the quantitative analyses,

direct attitude measurements using surveys were conducted before, after and one week after the game sessions to be able to compare initial, short-term and long-term attitudes. For the qualitative measurements, semi-structured were conducted after the game session.

The quantitative analyses showed that there were attitude changes within all game versions. However, only a statistical significant change was found for attitude toward information sharing on the long-term in the versions in which the persuasive game design principle was present. However, the attitude change was not bigger in the version in which the persuasive game design principle simulation was present to a greater extent. For attitude towards cooperation, only a statically significant difference was found on the short-term in one of the versions in which the persuasive game design principle was present at the intermediary level. However, initial attitudes towards cooperation were already relatively high. Therefore, there was little room for the attitudes to improve, which may explain why no statistical significant differences were found in other cases for attitude reinforcement towards cooperation.

The qualitative analyses confirmed that the results of the quantitative analyses, however, after combining both data types no hard evidence was found to support that the attitude change was caused by the persuasive game design principle simulation. A variety of elements that could have caused for the attitude change were mentioned during interviews including prior knowledge, time pressure, external events (game element), the persuasive game design principle self-monitoring and the persuasive game design principle simulation. The persuasive game design principle was not mentioned during the interviews. In most cases, a combination of these elements was mentioned. Based on the integration of quantitative data, qualitative data and theory, assumptions were made about whether the elements mentioned above may have affected attitudes. However, based on current data, these assumptions cannot be confirmed. Additional research is required for further interpretation.

These results provide the following answer to the main research question: Based on the current findings, it cannot be confirmed nor denied that the persuasive game design principle has affected attitude change regarding cooperation and information sharing in this research. Therefore, it cannot be specified what effect the persuasive game design principle simulation has on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making. Due to the lack of proper insights, the assumed relation between the persuasive game design principle simulation and attitude change based on the ELM can also not be verified. Therefore, an answer to this question cannot also not be derived from the theoretical base that was presented in this research.

Despite the fact that the main research question could not be answered, this research is still perceived to be of great value for persuasive game designers and researchers in all domains. This research is the first that aims at validating the effect of persuasive game design principles in isolation and the first to design a methodology for this purpose. The presented methodology appeared to be suitable to measure the effect of persuasive game design principles in isolation, although some improvements are suggested for qualitative measurements and to prevent social desirability bias. A good basis for getting to the answer of the research question is thus provided by this research. It is believed that with some fine-tuning, the answer to this research question can be provided in a near future and bring game designers and researchers closer towards validated persuasive game design principles.

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1. Introduction

This chapter aims at proving the research definition for this thesis. In section 1.1, the problem underlying this research is introduced. In section 1.2, background information is presented and the knowledge gap regarding validated persuasive game design principles is identified. Based on this a demarcation is presented for the research, resulting in the main research question. Section 1.3 presents the main research methods and required sub-questions for answering the main research question. Finally, in section 1.4 the structure of this thesis is presented.

1.1 Problem introduction

Multi-actor decision-making, or rather ineffective multi-actor decision-making is one of the main focuses of the master's programme Complex Systems Engineering and Management (CoSEM) at the Delft University of Technology. Based on Beroggi's (1999, p. 232) definition of decision maker, decision-making can be defined as assessing decision options and participating in the process of making choices regarding these options. Multi-actor settings can either be characterized as settings where single decisions have to be made by an entire group, or where each actor involved can make a personal choice (Beroggi, 1999, p. 232). The focus in the master's programme is often on the former.

In almost every case of multi-actor decision-making in socio-technical systems, actors are known for having different views of reality due to having different goals, interests, perceptions and resources (De Bruijn & Herder, 2009). Cooperation is therefore not something that will occur naturally in such settings, yet it is crucial due to the interdependencies between the actors in such settings (De Bruijn & Herder, 2009). Besides cooperation, there is another important aspect for multi-actor decision-making that is inherent to cooperation: information sharing (Toma & Butera, 2009). Information could be considered an important resource for actors to make quality decisions in a multi-actor setting (De Bruijn & Ten Heuvelhof, 2008, p. 70). However, although this may be the case, it is widely known that in such settings information is being shared strategically or is not shared at all (Wittenbaum, Hollingshead & Botero, 2004; Mitusch, 2006). This is often done out of competitive motives or because actors are guided by their own interest (Toma & Butera, 2009).

It is widely known that issues and innovation in can only be solved and realized through an all-round cooperative approach, instead of a linear evolutionary process or by individual efforts of actors only (De Bruijn & Herder, 2009; Kono & Kagami, 2015). However, achieving this is difficult if cooperation and information sharing are perceived as unnecessary or as things that can cause actors more harm than benefits. It seems to be necessary for actors to change their attitude towards cooperation and information sharing to make a step in the right direction for achieving effective decision-making in a multi-actor setting is.

According to Ajzen & Fishbein (2000), *attitude* refers to "the evaluation of an object, concept, or behavior along a dimension of favour or disfavour, good or bad, like or dislike." Attitude change can be achieved by *persuasion*, which refers to "a successful intentional effort at influencing another's mental state through communication in a circumstance in which the persuadee has some measure of freedom" (O'Keefe, 2002, p. 5). A relatively new tool for achieving persuasion that is gaining popularity is persuasive gaming. Persuasive games are games that intentionally convey a persuasive message to achieve attitude change that lasts outside game sessions (De la Hera Conde-Pumpido, 2013). According to the definition of persuasion and as stated by Oinas-Kukkonen (2010, p. 6), "persuasion relies on

the user's voluntary participation in the persuasion process". Persuasive games can therefore not force attitude change to happen in an unwilling way.

The term persuasive game is often used alongside the terms serious games and gamification. According to Bogost (2007, p. 58), the definition of serious games is commensurate with the definition of persuasive games as serious games are aimed at invoking support, doubt or debates regarding existing situations. Therefore, these terms can be used interchangeably. However, gamification refers to "the use of game design elements in non-game contexts" (Deterding, Dixon, Khaled & Nacke, 2011) and is often aimed at increasing motivation and reducing complexity within settings (Kapp, 2012). Gamification is therefore not necessarily aimed at changing human attitudes. In this research, the term persuasive game will be used to refer to games that comply with the aforementioned definitions of persuasive and serious games.

Persuasive games are nowadays widely used in more serious domains like politics, education, health care, (national) security, spatial planning, emergency management and engineering (Bogost, 2007, p. ix; Vargas et al., 2014). The increasing popularity of persuasive games is no surprise, as they have great properties not only causing for attitude change beyond game sessions, but also for bringing people with different perspectives together and creating awareness. In essence, "a game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context"(Abt, 1987, p. 6). This allows for a dynamic environment where players have the freedom to include different opinions and perspectives regarding an issue without being rejected. In addition, due to their ability to naturally engage people, persuasive games can increase the participation of players (Deterding et al., 2015). This allows for learning, creating experiences and bringing people together in a more casual setting than for example with a formal training activity. Furthermore, different than with training activities, persuasive games often include a simplified representation of reality, making it a good preparation for dealing with issues in the real world (Abt, 1987, p. 13). Moreover, having this simplified reality in a persuasive game also allows for evaluating consequences of decisions and behaviour for the real world in a safe setting (Abt, 1987, p. 13).

Considering these properties of persuasive games, persuasive games seem like an instrument that can come to the rescue of ineffective multi-actor decision-making processes. It is therefore no surprise that they are being increasingly developed for this purpose at the faculty of Technology, Policy and Management at the Delft University of Technology. However, while they are gaining popularity, little is yet known about what specific game elements actually lead to the targeted attitude change and is responsible for the creation of successful games. A possible explanation is that most persuasive games are developed as black boxes (Vegt, Visch, Vermeeren & de Ridder, 2016), which makes it hard to study and identify game elements. Still, in the gaming discipline it is assumed that persuasive game design principles (e.g. competition, comparison or simulation), also referred to as game elements (Visch, Vegt, Anderiesen & Van der Kooij, 2013), game mechanisms (Siriaraya, Visch, Vermeeren & Bas, 2018) or strategies (Orji, Vassileva & Mandryk, 2014), are key factors for conceiving successful games (Schrier, 2017). However, although they are already being widely used in the design of persuasive games in various domains, little is known about their effectiveness as their effect on attitude reinforcement or attitude change is not validated (Jacobs, 2017).

When it comes to selecting persuasive game design principles for games that effectively convey a persuasive message, little guidance is thus provided. Currently, the choice for

persuasive game design principles is often based on the intuition of designers (Orji, Vassileva & Mandryk, 2014). This could lead to persuasive games that do not achieve the aimed attitude change, or even to persuasive games that are counterproductive (Kaptein, De Ruyter, Markopoulos & Aarts, 2012). However, considering the importance of efficient decision-making between actors for successful innovation processes (Kono & Kagami, 2015) and maintaining efficiency in socio-technical systems (e.g. Kurapati et al., 2017) that are important to society, and the values that persuasive games in all domains bring to society, it can't be afforded to have persuasive games that cause for deleterious effects.

The lack of validated persuasive game design principles could thus be considered a serious issue for conceiving persuasive games for multi-actor decision-making, for the game discipline in general and society. The ultimate goal to solve this issue would be to validate all available persuasive game design principles. However, as the time-span of this research is limited, it is perceived to only be feasible to validate one persuasive game design principle. Therefore, most frequent used persuasive game design principle for persuasive games for multi-actor decision-making will be identified and selected for this research. The aim of this research is to validate the effect of this persuasive game design principle on attitude change towards cooperation and information sharing will be validated in this research, as they are both important aspects for a successful multi-actor decision-making process as stated above. This is perceived to be a valuable first step towards validated persuasive game design principles, which can benefit game designers, researchers and society.

1.2. Research background, demarcation and research question

1.2.1 Persuasive game design principles: an overview

Strategies for achieving persuasion have been studied since the past decade. Nowadays, a large number of strategies are available. Notable examples are the six principles for persuasion by Cialdini (2001), the seven persuasive 'tools' developed by Fogg (2002) and the 28 principles for designing persuasive system content by Oinas-Kukkonen & Harajumaa (2009). For the purpose of researching persuasive gaming, Orji, Vassileva & Mandryk (2014) narrowed the large amount of available strategies down to ten commonly used persuasive technology strategies in persuasive games, which are selected from the work of Fogg (2002) and Oinas-Kukkonen & Harajumaa (2009). Selecting the strategies was done by an extensive literature review on persuasive strategies used for the design of persuasive games (Orji, Vassileva & Mandryk, 2014). An overview of the ten commonly used persuasive technology strategies in persuasive gaming, which will be considered persuasive game design principles in the remainder of this proposal, and their definitions are presented in table 1.

Table 1: overview of the ten commonly used persuasive technology strategies (persuasive game design principles) in persuasive gaming and their definitions

Persuasive Technology Strategy	**Definition**
Competition	Players are allowed to compete with each other or with the system
Cooperation	Players are required to work together to accomplish a communal goal
Self-monitoring (or feedback)	Players are able to track their in-game performance and behaviour which allows them to monitor their past and current states
Comparison	Players are able to see their performance and compare it to that of the players
Suggestion	Players are suggested to do certain tasks in order to achieve favourable game outcomes
Simulation	Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game

Customization	Players are provided with the opportunity to accustom content and functionalities to their liking
Personalisation	Players are provided with system content and functionalities tailored to their personal needs and preferences
Praise	The player is verbally or non-verbally applauded for performing the target behaviour by means of personal positive feedback
Reward	Players are virtually rewarded for performing the target behaviour

1.2.2 The known effects of persuasive game design principles: a gap analysis

In the problem introduction, the issue regarding the lack of validated persuasive game design principles was briefly introduced. In this section, a gap analysis is presented to demonstrate the knowledge gap regarding validated persuasive game design principles in current theories and models for designing and analysing persuasive games.

For studying and designing persuasive games, persuasive game designers and researchers are now provided with guidance for conceiving effective games in the form of models, methods and paradigms such as the Persuasive Game Design model (Visch, Vegt, Anderiesen & Van der Kooij, 2013) and A cookbook method for Persuasive Game Design (Siriaraya, Visch, Vermeeren & Bas, 2018). The former focuses on capturing the real world in the game world, and transferring the game world to the real world. The latter provides a complete design process for conceiving persuasive game, mainly focused on user characteristics and the position of the designer in the design process. But none focuses on the specific effects of persuasive game design principles on attitude change. In fact, research on the effect of persuasive game design principles in isolation has not been performed yet (Siriaraya, Visch, Vermeeren & Bas, 2018). A methodology to measure the pure effect of a persuasive game design principle without inference of all other elements that are present in a persuasive game or game session is therefore yet to be conceived. A crucial part of this research will thus be to design a method that enables evaluating the effect of persuasive game design principles in isolation.

Nevertheless, there are some notable research that have been conducted regarding the effectiveness of the aforementioned persuasive game design principles. Orji, Vassileva & Mandryk (2014) studied within the healthcare domain how the ten most frequently used persuasive game design principles were received by different gamer personalities, also referred to as gamer types. They provided an overview of what strategies will have a positive influence on players and what strategies are likely to demotivate players based on their gamer types. In 2017, a similar research was conducted in which the persuasive game design principles were linked to personalities instead of gamer types (Orji, Nacke & Di Marco, 2017). Another similar study was conducted in 2018 in which persuasive game design principles were linked to gamification user types (Orji, Tondello & Nacke, 2018). Moreover, the reception of six persuasive strategies by Cialdini (2001) (authority, reciprocity, scarcity, liking, commitment, and consensus) by different cultural backgrounds was studied in 2016 by Orji (2016).

While these research provide designers with some guidance for selecting persuasive game design principles, it is questionable whether this knowledge contributes to creating effective persuasive games for multi-actor decision-making. A first point of critique is that these research only study the reception of persuasive game design principles and not their actual effect on attitude change. This indicates that perceived persuasion is measured, instead of actual persuasion. Moreover, within these studies, storyboards are used instead of actual games. This means that the reception of the principles has not been assessed in a gaming

setting in which game elements are present as well. Furthermore, these research have been conducted within the domain of healthcare, focussing on motivating player's to perform healthier behaviour. The goals within those types of game are more on a personal level, while in persuasive games for multi-actor decision-making, the focus is more on what can be achieved collaboratively. Finally, the focus within these research seems to be more on behaviour while the mental state of interest in this research is an enduring attitude change.

1.2.3 The most frequent used persuasive game design principle in multi-actor decision-making

In the problem introduction, it was mentioned that the most frequent used persuasive game design principle for multi-actor decision-making will be validated in this research. In order to assess what the most frequent used persuasive game design principle for multi-actor decision-making is, a literature review was conducted using articles that include the design of persuasive games for multi-actor decision-making. Eventually, ten articles containing persuasive games for creating awareness in complex multi-actor situations or games that structure communication in such settings were selected for this review. Using the ten most commonly used persuasive game design principles presented in section 1.2.2, it was assessed which of these principles were the most frequently used.

Table 2 provides the overview of the ten selected articles together with the extracted persuasive game design principles and the assessment of to what extent the extracted persuasive game design principles were validated. The latter was extracted to see to what extent persuasive game design principles are validated within this application domain, which could be considered a further identification of the knowledge gap from a practical point of view.

A first striking observation made during the literature review was that persuasive game design principles are not being referred to as persuasive game design principles in the articles. They are called often 'game elements' or are not addressed at all. Extracting the design principles was therefore challenging, as they it was often not made explicit what principles were used. As a result, it could be the case that some principles have been overlooked. Another observation is that most of the games are multi-player games and require players to take upon a role during the game play. The only single-player games were the micro-game designed by Lukosch, Groen, Kurapati, Klemke & Verbraeck (2016) and the simulation game by Sušnik et al. (2018). The latter provides the possibility to play the game both in a single-player and multi-player mode.

Nine out of ten games were simulation games and incorporated the persuasive game design principle simulation as defined in table 1. This makes the principle the most frequent used within this specific domain. A notable observation was that when applying the simulation principle, not only the cause-and-effect relationship of player's behaviour in the game was provided but also the link to reality. Thereby, it was shown what consequences of player's behaviour would be on real life scenarios. The link to reality is also made in the work of Orji, Vassileva & Mandryk (2014), however, this aspect is not specifically mentioned in their definition of the design principle.

The motivation behind using the persuasive game design principle simulation is often that it can provide insights and support in complex decision-making issues, as they can simulate the consequences of a decision (e.g. Valkering, Van der Brugge, Offermans, Haasnoot, & Vreugdenhil, 2013). Although this might be true, none of the authors actually attempted to validate whether the effectiveness of their game conveying the persuasive message was due

to the use of this specific principle. All designers evaluated the effectiveness of their entire games, however, they did not reflect on the effectiveness of their design principles, regardless of what principles they used.

Table 2: Overview of extracted persuasive game design principles and assessment of validated persuasive effects

Article reference	**Design principle**	**Validation of persuasive effect of persuasive game design principle**
Sušnik et al. (2018)	Simulation Rewards Suggestion Cooperation	No
Gissi & Garramone (2018)	Simulation Cooperation Self-monitoring	No
Keijser et al. (2018)	Cooperation Simulation Self-monitoring	No
Sordoni et al. (2010)	Simulation Cooperation Self-monitoring	No
Estrada et al. (2017)	Simulation Rewards	No
Lukosch et al. (2016)	Simulation Rewards	No
Khoury et al. (2018)	Simulation	No
Valkering et al. (2013)	Simulation Cooperation	No
Craven et al. (2017)	Simulation Cooperation	No
Parker et al. (2016)	Cooperation	No

1.2.4 Research focus and research questions

In this section, the knowledge gap regarding the persuasive power of persuasive game design principles was demonstrated. From a theoretical point of view, it was shown that no research has been conducted yet on the effect of persuasive game design principles in isolation. This means that no effective methodology is available yet and has to be created. Furthermore, the effectiveness of persuasive game design principles has only been assessed in the health care domain. However, this only considered the perceived persuasiveness of the principles instead of actual attitude change. Furthermore, their effectiveness has only been assessed by using story boards instead of actual games. This confirms that little guidance is provided from a theoretical point of view for designers and researchers for persuasive games for multi-actor decision-making.

From a practical point of view, it was shown that persuasive game design principles are being widely used in persuasive games for multi-actor decision-making, although game designers and researchers do not acknowledge their use. It was shown that the persuasive game design principle simulation is the most frequent used in this domain, which indicates that it intuitively may be perceived as an effective strategy for conveying a persuasive message in a game. However, although being widely used, game designers actually never assess the effect of the persuasive game design principle simulation on successfully conveying the persuasive message of their game.

Considering the knowledge gap and practical use of persuasive game design principles, validating the effect of the persuasive game design simulation on attitude change is therefore perceived to be very relevant for the gaming discipline and for facilitating multi-actor decision-making. Moreover, considering that multi-actor decision-making is crucial for realizing innovations (Kono & Kagami, 2015) and for maintaining efficiency in socio-technical systems (e.g. Kurapati et al., 2017), gaining this knowledge is relevant for society as well. Therefore, this research will focus on validating the persuasive game design principle simulation.

As mentioned in the problem introduction, considering that the two most important constructs for effective multi-actor decision-making are cooperation and information sharing, it will be assessed whether the persuasive game design principle simulation is effective for reinforcing/changing attitudes towards these constructs. Furthermore, for this research, the definition of the persuasive game design principle simulation that was given by Orji, Vassileva & Mandryk (2014) will be slightly altered. In the previous section it was pointed out that when the persuasive game design principle simulation is included in persuasive games, not only the cause-and-effect relationship of behaviour in the game is shown but also the link in the system that the game represents. Thereby, it is shown what the potential consequences of player's decisions would be in the real world. Furthermore, the current definition of Orji, Vassileva & Mandryk (2014) is closely related to any type of feedback that occurs in a persuasive game, whether it is consciously (e.g. feedback is provided by a facilitator) or unconsciously (e.g. players see a negative effect on the game score when making certain decisions). Since this principle as defined by Orji, Vassileva & Mandryk (2014) is always present in persuasive games, it makes it impossible to remove the principle from any game in order to evaluate the effect on attitude reinforcement with and without the principle. Therefore, the following definition of the persuasive game design principle simulation will be used in this research: *Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality.*

Considering all above, the main research question for this research is formulated as follows:

> *What effect does the persuasive game design principle simulation have on attitude on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making?*

1.3 Research approach, methods and instruments

1.3.1 Mixed methods: more than just mixing methods

For this research, a mixed methods research approach will be carried out. This means that in both quantitative and qualitative data are collected, analysed and combined for answering the main research question (Creswell & Clark, 2007, p. 2). This method is chosen because it is perceived that using a single quantitative or qualitative method would not be sufficient for answering the main research question due to the biases and constraints when using a single quantitative or qualitative method. This is also the rationale behind the mixed methods research approach (Greene, Caracelli & Graham, 1989).

Qualitative methods often face limitations regarding reliability. Conducting qualitative measurements in a game research specifically can be challenging, considering that in-game events are often dependent of a variety of possible unforeseen factors, such as having

diverse participants, making each situation unique. This causes challenges regarding the generalizability and refutability of the research (Lieberoth & Roepstorff, 2015). In this regard, quantitative tools have the advantage of being scalable and efficient. However, contextual information can often not be derived from such measurements, making it challenging to explore concepts influencing human aspects in more depth (Malina, Nørreklit & Selto, 2011). By using both approaches, the reliability can be enhanced while more detailed insights can be provided. Combining, or 'mixing' these methods thus allows for the methods to complement each other and to cancel out limitations (Abbas & Charles, 2003, p. 211). Mixed methods research is thus more than just mixing methods; it is about the value that is created by mixing the methods (Lieberoth & Roepstorff, 2015).

The mixed methods research design

Mixed methods research can be derived in various ways. Regardless, there are three steps that are recommended to carry out in mixed methods research: deciding on the theoretical basis, identifying appropriate data collection methods and identifying methods for the data analysis and integration (e.g. Creswell, 1999). Deciding on the theoretical basis is a common step in scientific research and is often done by assessing existing theories and literature on the phenomenon to be studied. Regarding the collection of data, a persuasive game will be used considering that this tool is the main focus of this research. The collection of data for assessing attitude change will be done before, during and after the game session to be able to compare changes in attitudes. In mixed methods research, it is often seen that often a combination of surveys (quantitative method) and interviews (qualitative method) is used for data collection (Bryman, 2006). These methods will also be used in this research, as they are perceived to be feasible to create and use within the time frame of this research.

For the analysis and integration of data, the concurrent triangulation design will be carried out. In this design, qualitative and quantitative data will be gathered and analysed simultaneously, however the analysis of both data types will be done separately (Hanson, Creswell, Clark, Petska & Creswell, 2005). The integration of both data types will be done when results are interpreted. Combining different methods allows observing the object of interest, in this case attitude change towards cooperation and information sharing, from different perspectives and allows for more in depth results (Lieberoth & Roepstorff, 2015). This is referred to as triangulation (Lieberoth & Roepstorff, 2015).

Risks and challenges

A often perceived disadvantage of mixed methods research is that it can take a lot of time to conceive research instruments for all quantitative and qualitative approaches (Driscoll, Appiah-Yeboah, Salib & Rupert, 2007). This could cause for delays. Fortunately, research on attitudes has been conducted since the past decade (Petty & Cacioppo, 1986). Therefore, a variety of valid measurements techniques are already available for measuring attitudes through both qualitative and quantitative methods.

As mentioned before, the main instrument that will be required for validating the persuasive game design principle simulation in persuasive games will be a persuasive game. For this research, it is chosen to use an existing game as a base for the game design process. This is perceived to safe time as it does not require carrying out an entire game design process.

Different versions of the game will be conceived in which the persuasive game design principle simulation is gradually varied. This allows assessing whether having the persuasive game design principle simulation available in more/lesser has different effects on the attitude. Regarding this, it is assumed that at least two versions have to be created: a

version with and without the persuasive game design principle simulation. The selected game for this research is presented in the next section.

1.3.2 The existing game: Mobinn

The existing game that will be used for creating game versions that allow for evaluating the effect of the persuasive game design principle simulation on attitude change towards cooperation and information sharing is the Mobinn game. This game is part of the INDEEP (Innovation Network Design Enables Excellent Ports) project, funded by the Netherlands Organisation for Scientific Research (NWO). This is an on-going project, aimed at investigating why the actual and effective implementation of innovations in the transport and logistics domain in Europe is lacking while their theoretical introduction has been established (Roukouni, Lukosch & Verbraeck, 2019). The target group for this game are actors from the transport and logistics domain.

The game is designed to be flexible so that it could be played for different case studies and is therefore applicable to different innovations. Recently, game sessions were facilitated for truck platooning. The truck platooning innovation enables trucks to drive in a convoy, keeping short and equal distances apart. This leads to a more adept traffic flow, increased traffic safety, less fuel use and less CO2 emissions (Roukouni, personal communication, March 14, 2019). For this research, this case study will be used as all game elements for this case study are already conceived.

The game is designed using the Triadic Game Design method by Harteveld (2011). According to Harteveld, designing a serious game requires a balance between three components: play, meaning and reality. Play refers to elements, criteria or mechanics for creating immersive and fun games. Meaning refers to the communication (e.g. persuasive message) and learning elements that are incorporated in the game. Reality refers to how the real system is captured and represented in the game (Harteveld, Guimarães, Mayer & Bidarra, 2010). The game design process was not formally documented as it consisted of a lot of brainstorm sessions and playtesting (Roukouni, personal communication, April 5, 2019). Moreover, when designing the game, the designers did not take into account the persuasive game design principles presented by Orji, Vassileva & Mandryk (2014). However, besides from suggestion and praise, all other design principles are currently present in the Mobinn game to a certain extent according to Natasa Roukouni (personal communication, April 5, 2019). Especially cooperation is present in the current version according to the designer.

However, after analysing the game based on the persuasive game design principles definitions presented in section 1.2.2, only self-monitoring and cooperation appear to be present to a full extent in the current version of the game. The persuasive game design principle as defined by Orji, Vassileva & Mandryk (2014) is also present to full extent in the current game, however, there is no link made to the consequences of behaviour and reality in the game itself. Therefore, the persuasive game design principle as defined for this research (*Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality*) is not yet present in the game.

While the game is relatively simple, it still maintains to capture the reality of this complex socio-technical system, making tensions and relationships between real life actors explicit (Roukouni, Lukosch & Verbraeck, 2019). Furthermore, winning the game requires decision-making in a multi-actor setting and it could therefore be considered a multi-actor decision-making game. The goal of the game is to create awareness among actors regarding the necessity to cooperate and share information in order to be able to implement an

innovation. This is believed to be the step that prepares actors for making decisions in a multi-actor setting (Lukosch, personal communication, March 15, 2019). The persuasive message of the game is that innovations cannot be implemented unless actors are willing to interact with each other and cooperate. During the debriefing, players seemed to be aware of this persuasive message as well. However, whether the game has lead to a lasting attitude change is yet to be measured.

Considering the properties of the Mobinn game, it provides all elements necessary for answering the main research question: a persuasive game for multi-actor decision-making and a persuasive message that aims at achieving attitude reinforcement/changes towards cooperation and information sharing. The persuasive game design principle simulation as defined in the previous paragraph is not yet present in the game, however, this provides the possibility to add and vary the presence principle to observe its effect when present in different extents. Therefore, the Mobinn game seems highly suitable for conducting this research.

1.3.3 Conceiving game versions: Duke's paradigm for game design

Although the original Mobinn game is designed using the Triadic Game Design method by Harteveld (2011), this method lacks concreteness as it does not include a sequence of steps that need to be carried out during the research. Therefore, A paradigm for game design by Duke (1980) is selected for designing the different versions of the game while maintaining the persuasive goal of the game. Duke's paradigm includes the following steps:

1. Formulate written specifications for the game design (requirements and constraints)
2. Develop a comprehensive schematic representation of the problem (e.g. a systems diagram)
3. Select components of the problem to be gamed
4. Plan the game with the Systems Component Gaming Element Matrix
5. Describe the content of each cell (in the Systems Component Gaming Element Matrix) in writing
6. Search my "repertoire of games" for ideas to represent each cell
7. Build the game
8. Evaluate the game (against the written specifications of step 1)
9. Test the game in the field, and modify

Not all steps have to be carried out during this research since there is already a playable version of the game available. Furthermore, as the aim of this research is to validate a persuasive game design principle instead of creating a new game, some adjustments will be made to some steps.

Step 1 will be carried out to formulate specifications for the different game versions that will be conceived for this research. Step 2 and 3 will require little input during this research, as most of the problem specification and scoping has already be done by the researchers when creating the first version Mobinn (Roukouni, Lukosch & Verbraeck, 2019). Step 4 and 5 will be used to provide an overview of all existing game elements in the current version of the game, including the scenario, steps of play, rules and roles. The matrix will then be used to systematically adjust the game into versions that allow measuring the effect of the persuasive game design principle simulation in persuasive games for multi-actor decision-making. Step 6 will be used to gain inspiration on how the persuasive game design principle simulation can be varied. The remaining steps, steps 7 through 9, will form the iterative process of designing and testing the games for this research.

1.3.4 Sub-questions and research instruments

In the previous sections, requirements for answering the main research question were presented. Answering the main research question requires at least the following: deciding on the theoretical base for the research (section 1.3.1), the design of a methodology that allows for measuring the effect of the persuasive game design principle simulation in isolation (section 1.2.2), the creation of multiple game versions of the Mobinn game (section 1.3.2 and 1.3.3) and measuring the effect of the persuasive game design principle on attitude changes at different time-frames towards cooperation and information sharing (section 1.3.1). These are considered constructs of which each will assemble the answer to the main research question. These constructs have been translated into five sub-questions:

1. What is the relationship between the persuasive game design principle simulation and attitude change from a theoretical point of view?
2. What method allows for measuring the effect of the persuasive game design principle simulation on attitude change in isolation?
3. What persuasive game can be developed that allows for measuring the effect of the persuasive game design principle simulation on attitude change in isolation within the time frame of the research?
4. What is the short-term effect of the persuasive game design principle simulation on attitude change regarding cooperation in persuasive games for multi-actor decision-making?
5. What is the long term-effect of the persuasive game design principle simulation on attitude change regarding cooperation in persuasive games for multi-actor decision-making?

For sub-question 1, literature on the origin of persuasive game design principles, gaming-simulations and attitude theories from the field of social psychology will be assessed to be able to approach the creation of a theoretical base from different points of view. For sub-question 2, a literature review will be combined with expert interviews. The latter research method is chosen as an addition because it can shorten the data gathering process of the literature review since experts can provide inside information and advice on how to search for methodologies or for theories to create one (Meuser & Nagel, 2009). For the expert interviews, researchers and game designers with different backgrounds at the Delft University of Technology will be approached. This allows for different perspectives and richer insights on how to create a feasible and effective methodology.

For sub-question 3, the relevant steps of Duke's paradigm for game design (1980) as presented in section 1.3.3 will be carried out. Finally, the constructs for answering sub-question 4 and 5 will be provided by facilitating game sessions using the method provided by sub-question 3 and performing attitude measurements in the form of interviews and surveys. As mentioned in section 1.3.1, in mixed methods research it is often seen that often a combination of surveys and interviews is used for data collection (Bryman, 2006). Also, creating instruments for these methods is perceived to be feasible within the time frame of this research.

1.4 Thesis structure

The aim of this chapter was to define the research, which is done by providing a problem introduction, background information to the problem and a demarcation, the main research methods and the research questions. This thesis will proceed as follows. In chapter 2 the theoretical base supporting the persuasive power of the persuasive game design principle simulation will be reviewed. Based on that, a theoretical framework will be conceived that

will form the theoretical basis for this research. In chapter 3, the methodologies and measurement instruments for evaluating the effect of the persuasive game design principle simulation on attitude change in isolation will be discussed, resulting in a methodology design for this research. Next, the design process will be presented in chapter 4. In chapter 5, the results of the game sessions and the quantitative and qualitative analyses will be presented and integrated to validate the effect of the persuasive game design principle simulation on attitude change towards cooperation and information sharing. Finally, the research will be finalized by listing all conclusions, discussions, limitations and advise for future work in chapter 6. A complete overview of the thesis structure is depicted in figure 1.

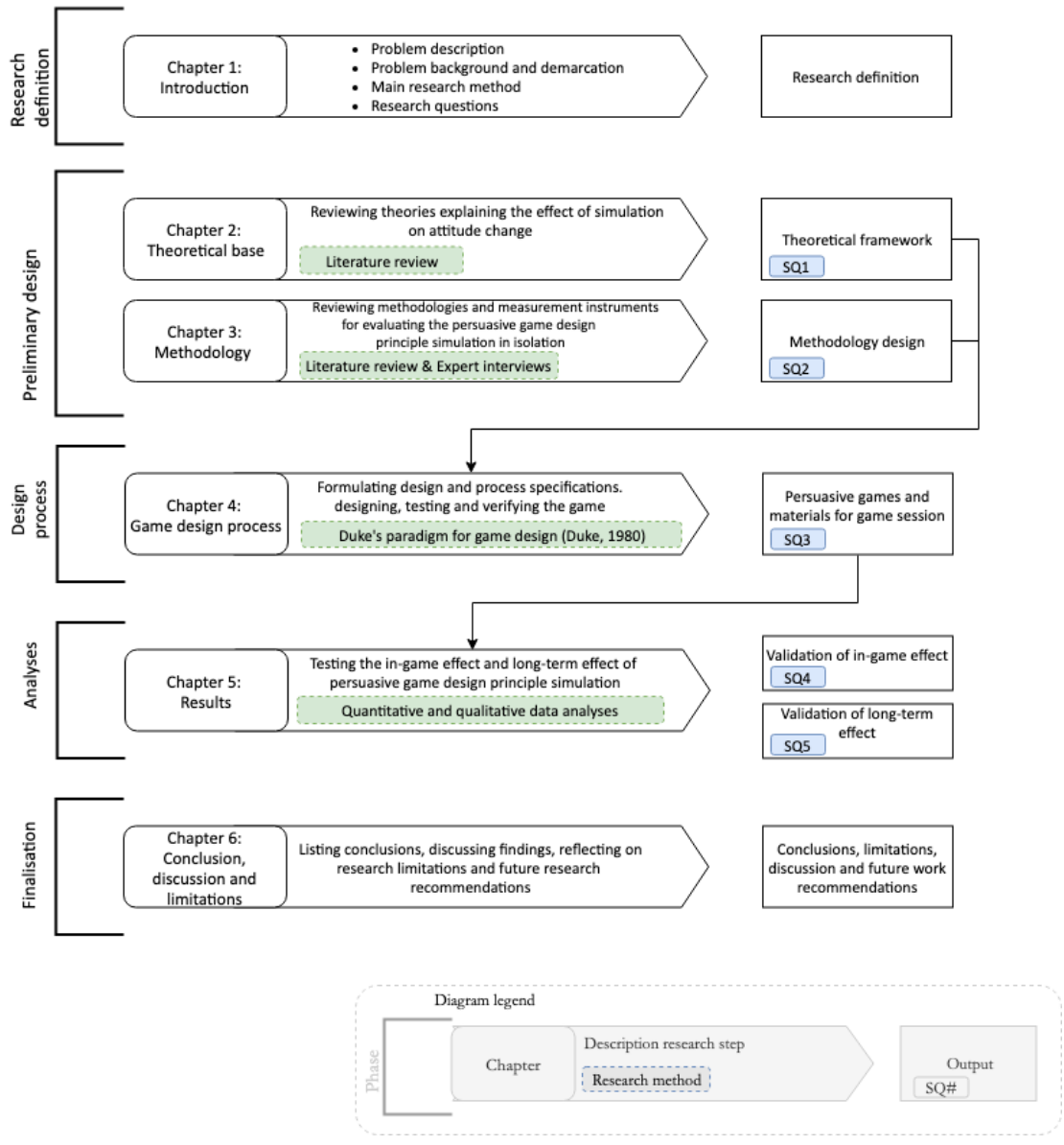

Figure 1: Research flow diagram as depiction of thesis structure

2. The persuasive power of the persuasive game design principle simulation: a theoretical framework

This chapter aims at answering the sub-question *What is the relationship between the persuasive game design principle simulation and attitude change from a theoretical point of view?* In order to be able to research the effect of the persuasive game design principle on attitude change, the relationship between the persuasive game design principle simulation and attitude change needs to be understood to be able to plan the research. Therefore, a theoretical base will be formed that will be translated into a theoretical framework which will function as the blueprint for this research. The construction of the theoretical framework is done by approaching the persuasive game design principle from three theoretical lenses: the origin of the persuasive game design principle simulation, gaming-simulations and attitude theories from the field of social psychology. Each lens approaches the persuasive power of the persuasive game design principle from a different point of view and is expected to provide complementary knowledge for the creation of the theoretical framework.

The creation of the theoretical framework was done by conducting a literature review. Key topics in this literature review include persuasive games, persuasive technology, simulations, gaming-simulations and attitude theories from the field of social psychology. For this literature review, the databases TUlibrary, Scopus and Sciencedirect are used to retrieve scientific papers, conference papers and books. These databases are chosen because it is assumed that they provide reliable literature of academic quality. Google scholar is only used to retrieve articles that were not accessible for free, considering that it is known for providing obscure information (Falagas, Pitsouni, Malietzis & Pappas, 2007).

The outline of this chapter is as follows. In section 2.1, the persuasive power of the persuasive game design principle simulation is assessed using literature regarding the origin of the persuasive game design principle simulation. In section 2.2, the persuasive power of the persuasive game design principle simulation is assessed using literature on gaming-simulations. Next, the persuasive power of the persuasive game design principle simulation is assessed using attitude theories from the field of social psychology in section 2.3. Based on the findings, a theoretical framework is constructed and presented in section 2.4, which will serve as the blueprint for this research and provides and answer to the abovementioned sub-question. Finally, in section 2.5, implications regarding the application of the persuasive game design principle simulation in this research are discussed.

2.1 The origin persuasive game design principle simulation

The persuasive game design principle simulation as presented by Orji, Vassileva & Mandryk (2014) originates from the work of Fogg (2002), who studied how websites, applications and mobile devices can be deployed as means to change human attitudes and behaviour. When using interactive computer technology for the act of persuasion or social influence without any form of force, they are referred to as persuasive technology Fogg (2002, p. 1).

Fogg (2002, p. 16) proposed the 'functional triad' as a classification model for classifying persuasive technology based on their functional roles. Within this categorization,

simulations are considered persuasive sensory media. In his work, Fogg (2002, p. 62) proposes three categorizations of simulations relevant to persuasive technology: simulated cause and effect scenarios, simulated environments and simulated objects. The definition of Orji, Vassileva & Mandryk (2014) is derived from the concept of simulations and is based on the categorization of *simulated cause and effect scenarios*. The underlying principle of this categorization is the principle of cause and effect, which is defined as follows: "simulations can persuade people to change their attitudes or behaviours by enabling them to observe immediately the link between cause and effect" (Fogg, 2002, p. 63). Like Orji, Vassileva & Mandryk (2014) and in the persuasive games evaluated in the literature review in chapter one, Fogg also makes a link to reality when discussing simulated cause and effects, although it is not mentioned in any definition. The examples provided by Fogg about systems or games that include simulated cause and effects often include a simulated real world or real world data to present the consequences of decisions in the real world.

Fogg names a variety of reasons why cause-and-effect simulations can be used as persuasive media, which he claims are supported by literature from social sciences. However, after reviewing this literature, it appeared that they do not actually support the claims regarding the persuasive power of cause and effect simulations. In fact, they just motivate why simulations should be used in general and what their advantages are, while it is assumed that these lead to persuasion. Another striking observation is that Oinas-Kukkonen & Harajumaa (2009), who used the work of Fogg to formulate 28 design principles including the simulation principle for persuasive system content, also don't provide supportive theories or validated evidence for the persuasive power of the simulation principle. Still, the principle is widely applied in persuasive games and other persuasive technology, as was also shown in chapter 1.

While the origin of the design principle does not provide a sound basis to explain and motivate the persuasive power of the principle, it has to be acknowledged that not all game designers and researchers make use of the categorization of persuasive game design principles presented by Orji, Vassileva & Mandryk (2014). A reason could be that the work of Fogg (2002), Oinas-Kukkonen & Harajumaa (2009) and Orji, Vassileva & Mandryk (2014) mostly focuses on persuasion in the healthcare domain. Still, the lack of a basis for explaining the persuasive power of the persuasive game design principle simulation could therefore be considered a serious knowledge gap, considering that is being widely used.

2.2 The persuasive power of gaming-simulations

In most literature, 'simulation' refers to "an operating model of central features or elements of a real or proposed system, process or environment" (Greenblat, 1988, p. 14). A specific type of simulation that has been studied in terms of attitude change in the learning domain and that is more of interest for this research are gaming-simulations (Greenblat, 1988, p. 16; Kriz, 2003). Different than regular simulations, gaming-simulations function partly or fully through decisions made by players instead of machines (Greenblat, 1988, p. 14). Decision and their consequences are simulated in these games to demonstrate the impact of the decisions on the system, process or environment the simulation represents (Kriz, 2003). Therefore, the concept of gaming-simulation seems closely related to the persuasive game design principle simulation.

According to Greenblat (1988, p. 16), gaming-simulations can meet learning objectives that are closely related to persuasion:

- Increasing the motivation and interest of a player regarding a certain topic or a research field
- Developing skills regarding critical thinking, interacting, communication, negotiation and decision-making
- Changing attitudes regarding social values such as competition or cooperation
- Allowing for self-evaluation or evaluation by others resulting in awareness regarding one's attitude, skills, assumptions or abilities

While these successes of gaming-simulations might be promising, especially concerning the attitude change that persuasive games for multi-actor decision-making aim to achieve, it often remains unclear what specific aspects of a gaming-simulations is responsible for reinforcing or changing attitudes.

The Multiple Identification Theory by Williams & Williams (2007) can possibly come to the aid to provide an interpretation of how gaming-simulations can change attitudes. The theory aims to help designers of gaming-simulations to achieve attitude change, but can also used to explain the persuasive power of specific aspects of gaming-simulations for this research. In their theory, Williams & Williams (2007) describe three types of identification that need to be present in a simulation game to be able to encourage attitude change: affective, cognitive and behavioural identification. Affective identification refers to whether a player becomes emotionally devoted to the outcome of a simulation game. When players get emotionally devoted to the outcome of the gaming-simulation, it may personally motivate players to perform better. That way, players stop holding on to their initial attitudes in order to be able to be seen in a better light (Williams & Williams, 2007). Cognitive identification refers to identifying the gaming-simulation with reality. When this type of identification occurs, the message or lesson that the game tends to convey will be considered credible to players. This can lead to the creation of cognitions in real world that reflect the insights that are gained during the gaming-simulation, which can lead to attitude change (Williams & Williams, 2007). Finally, behavioural identification refers to the player learning from its behaviour and decisions during the gaming-simulation and the consequences that are linked to them. It aids players in personally elaborating on their behaviour and decisions and gain understandings on what personal changes they need to be make. This is considered the deepest level of attitude change (Williams & Williams, 2007).

The concept of behavioural identification seems to explain the cause-and-effect of behaviour aspect of the persuasive game design principle simulation, while cognitive identification explains the reality aspect of the principle. However, in the explanations of Williams & Williams (2007), both types of identification seem to contribute to the occurrence of learning, which is then expected to contribute to attitude change. Also Greenblat (1980) makes the link between learning in gaming-simulations and attitude change. This suggests that for understanding the relationship between the persuasive game design principle simulation and attitude change, the relationship between learning and attitude change needs to be understood as well.

Learning and attitude change

For understanding the relationship between learning and attitude change, the concept of learning needs to be understood first. A widely accepted and used definition of learning is given by Schunk (2012, p. 3): "learning is an enduring change in behavior, or in the capacity to behave in a given fashion, which results from practice or other forms of experience". The concept of "enduring behaviour change" in the definition suggests that learning is equivalent to persuasion. However, according to social psychologist Greenwald (1968), the

difference between learning and persuasion is that the focus with learning is on acquiring knowledge and understanding, while in persuasion it is about the acceptance of the content.

Still, there is certainly a relationship between the two concepts. A widely accepted assumption in psychology is that the attitude is composed of affective, behavioural and cognitive components (e.g. Katz & Stotland, 1959). Within the psychology domain, it is also widely accepted that cognitions that are related to a psychological object act as important factors for the constitution of the attitude toward that object (Greenwald, 1968). Learning could thus contribute to the creation of the cognitive components of which attitudes consist. Furthermore, as the definition of learning stated above suggest, learning is also known to contribute to behavioural changes (e.g. De Hei, Strijbos, Sjoer & Admiraal, 2016), such as for example obtaining skills for performing the desired behaviour in a persuasive game. Therefore, learning can also contribute to the constitution of the behavioural component that the attitude consists of. Finally, learning is also known to contribute to the affective component, as it can for instance affect changes in motivation and confidence in for example an attitude (Rogaten et al., 2019).

While these findings about learning explain how the persuasive game design principle simulation can possibly contribute to the construction of the three components that the attitude exists of, it does not necessarily explain how it contributes to conveying a persuasive message in a persuasive game. Additional information is still necessary to provide a complete overview for the creation of this theoretical base to understand the effect of the persuasive game design principle simulation in the context of persuasive games. Therefore, attitude theories in social psychology will be assessed in the next section.

2.3 Through the lens of social psychology

Attitude theories in social psychology

Considering that attitudes have been studied since the past decade (Petty & Cacioppo, 1986), a lot of attitude theories are available. However, considering the time span of this research, it is only possible to analyse a fraction of these theories. Based on the work of Teng, Kong & Goh (2015), who compared attitude-behaviour theories in general and in social media context, it seems reasonable to say that often used psychological theories and models to explain attitude change in general are the Theory of Planned Behaviour (TBT) (Ajzen, 1991), the Cognitive Dissonance Theory (CDT) (Festinger, 1957), the Elaboration Likelihood Model of Persuasion (ELM) (Petty & Cacioppo, 1986), Social Judgement Theory (SJT) (Sherif & Hovland, 1961) and the Heuristic-Systematic Model (HSM) (Chen, Duckworth & Chaiken, 1999). For the creation of this theoretical base, these five theories were selected for further analyses.

Over the years, all theories also have received both acclaims and criticism regarding their ability to predict and explain the process attitude change. An overview of those strengths and limitations was given by Teng, Kong & Goh (2015) and is used to critically assess whether they can provide an explanation of the persuasive power of the persuasive game design principle simulation.

Eventually, the ELM appeared to be the most suitable for explaining the persuasive power of the persuasive game design principle simulation in the context of persuasive games. Both the CDT and SJT don't provide an overview of critical factors that may affect attitudes (Teng, Kong & Goh, 2015). Since this research tries to assess and explain if and why the persuasive game design principle simulation is a critical factor in attitude change, having a theory that

lacks such crucial components as a base is believed to constraint this research. Furthermore, while TPB seems to be considered a model for explaining attitude change, it seems to focus more on predicting behaviour rather than attitudes while this research focuses on attitudes. Moreover, the ELM was chosen over HSM as it lacks a conceptual framework (Teng, Kong & Goh, 2015), making it hard to apply the theory to this research.

An additional advantage of the ELM is that it has been previously used in research regarding attitude change caused by persuasive games (e.g. Malliet & Martens, 2010: Kors, Van der Spek & Schouten, 2015). Therefore, there is already a base to use and interpret the ELM in the context of persuasive games.

Zooming in on the ELM

The ELM was created by Richard Petty and John Cacioppo and has been widely used in studies regarding persuasive communication (Teng, Kong & Goh, 2015). Elaboration refers to "the extent to which a person thinks about the issue-relevant arguments contained in a message" (Petty & Cacioppo, 1986).

The ELM considers two relatively distinctive routes according to which a persuasive message can be processed which are presented in figure 2. Through which route a persuasive message will be processed depends on a person's motivation and ability to employ issue-relevant thinking. These determinants are referred to as *motivation to process* and *ability to process*. If a person is motivated and able to process a message, the persuasive message will be processed through the *central route* (Petty & Cacioppo, 1986). This route uses careful and thoughtful considerations, such as critical arguments supporting or disproving of the message (Petty & Cacioppo, 1986; Howard, 1997). Processing through the central route is believed to result in a lasting attitude change, which can predict behaviour.

If a person is not motivated and able to process a message, the message will be processed along the *peripheral route* (Petty & Cacioppo, 1986). In this route, the processing of information requires less cognitive effort (Petty & Duane, 1999, p. 42). Persuasion through this route occurs by simple cues that act as stimuli for attitude change such as the attractiveness of the message source (Petty & Cacioppo, 1986). This often leads to shallow message processing that requires less cognitive effort. This can still lead to attitude reinforcement or change, however, it is perceived that this attitude reinforcement or change is only temporary and leads to unpredictable behaviour (Petty & Cacioppo, 1986).

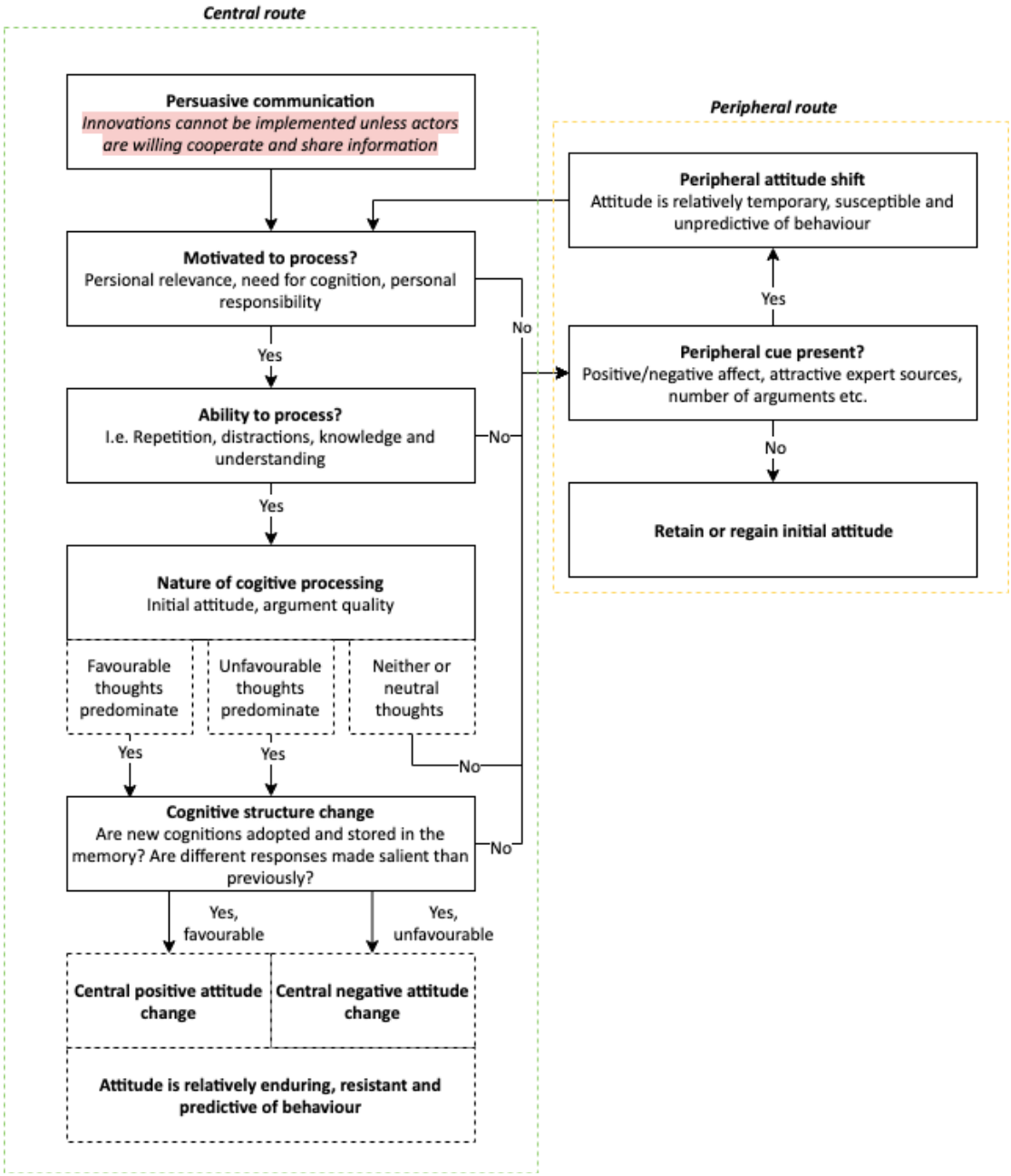

Figure 2: The Elaboration Likelihood Model based on the work of Petty & Cacioppo (1986)

Key factors for Motivation to process and Ability to process

Persuasive games are not only aimed at changing attitudes during a game session but also beyond that (De la Hera Conde-Pumpido, 2013). This could be considered a lasting attitude change, which according to the ELM can be achieved by processing a message through the central route.

As mentioned in the previous section, whether a message is processed through the central route depends on two determinants: *motivation to process* and *ability to process*. According to Petty & Cacioppo (1986), key motivational factors are *personal relevance*, *personal responsibility* and *need for cognition*. While there are various definitions of personal relevance in social psychology, in this research personal relevance refers to whether the issue is perceived as important on a personal level. This could also be considered the general definition that Petty & Cacioppo (1986) use for this component. Personal responsibility

refers to whether the person feels personally responsible for a task. Need for cognition refers to "a need to structure relevant situations in meaningful, integrated ways" (Cohen, Stotland & Wolfe, 1955). Need for cognition could be considered a personal characteristic, considering it is depending on a person's personal need to elaborate on situations (Kors, Van der Spek & Schouten, 2015). Personal responsibility and personal relevance on the other hand can be influenced externally, for example through the design of a persuasive game (Kors, Van der Spek & Schouten, 2015).

Regarding the second determinant, *ability to process*, Petty and Cacioppo (1986) describe a variety of aspects that can determine a person's ability to process a persuasive message. However, as they are not all relevant for this research, only three have been selected for a further elaboration. The first aspect is *repetition* and refers to repeated exposure of the persuasive message (Petty & Cacioppo, 1986). The second aspect is *distractions* and refers to "the presence of some distracting stimulus or task accompanying a persuasive message" (O'Keefe, 2002, p. 101). Finally, there is the *prior knowledge* aspect, also referred to *knowledge and understanding* (e.g. Kors, Van der Spek & Schouten, 2015). This refers to a person's knowledge and understanding of the persuasive topic that allows formulating and assessing arguments in favour or not in favour of the psychological object that is subject to persuasion. This can decrease the effect of peripheral cues in the process, which allows for better engagement in the elaboration process (e.g. Laczniak, Muchling & Carlson, 1991). Like the personal relevance and personal responsibility aspects, the aspects enabling *ability to process* can also be influenced externally, such as through a persuasive game (Kors, Van der Spek & Schouten, 2015).

2.4 The blueprint for the research: a theoretical framework

Now that the persuasive game design principle simulation has been approached from three theoretical lenses, different insights were gained. It is assumed that the persuasive powers lays in its ability to contribute to learning, which is believed to contribute to all three components that the attitude consist of: the affective, behavioural and cognitive component. While the findings about learning explain how the persuasive game design principle simulation can possibly contribute to the construction of the three components that the attitude exists of, it does not necessarily explain how it contributes to conveying a persuasive message in a persuasive game. Luckily, the ELM seems to capture the learning component that the persuasive game design principle simulation assumingly contributes to while providing a complete overview of critical factors for processing a persuasive message that can be placed into the context of persuasive games. Considering this, it is chosen to use this model as the theoretical base for the creation of the theoretical framework for this research. In this section, it will be explained how the persuasive game design principle simulation connects to the theory and an overview of the theoretical blueprint for this research will be provided.

Connecting the persuasive game design principle simulation to the ELM

The simulation principle is defined as follows: *Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality.* The persuasive game design principle simulation could be considered to contribute to the *knowledge and understanding* aspect of the *Ability to process* determinant. By providing players with a mechanism to see the cause-and-effect relationship of their behaviour in the game and its link to reality, it provides them with knowledge and understanding for formulating and examining arguments regarding the persuasive message the game aims to convey. As was stated in the previous section, knowledge and understanding can be gained through learning. This suggest that the concept of learning that was linked to the persuasive

game design principle simulation from the theoretical lens of gaming-simulations (section 2.2) can be placed at this aspect in the ELM.

However, while the effect of the persuasive game design principle simulation can be partly predicted through the *knowledge and understanding* aspect of the *Ability to process* determinant, the *Motivation to process* determinant still needs to be fulfilled for a lasting attitude reinforcement/change to occur. Achieving this can be done externally by enhancing personal relevance and personal responsibility.

This theoretical framework suggests that in order to be able to validate the effect of the persuasive game design principle simulation, the motivation to process determinant has to be fulfilled as well. This is could be considered a condition that has to be met for the persuasive game design principle simulation to achieve attitude change. For this research, this will be done as follows. Personal responsibility is by default already present in the Mobinn game, as all players are responsible for winning or losing the game. There are no individual winners or losers. Personal relevance will be maintained by selecting participants with that feel personally related to the realization process of truck platooning.

Based on this, and considering the importance of the *Motivation to process* determinant in the elaboration process, the following relationship is assumed between the persuasive game design principle simulation and attitude change for this research (figure 3):

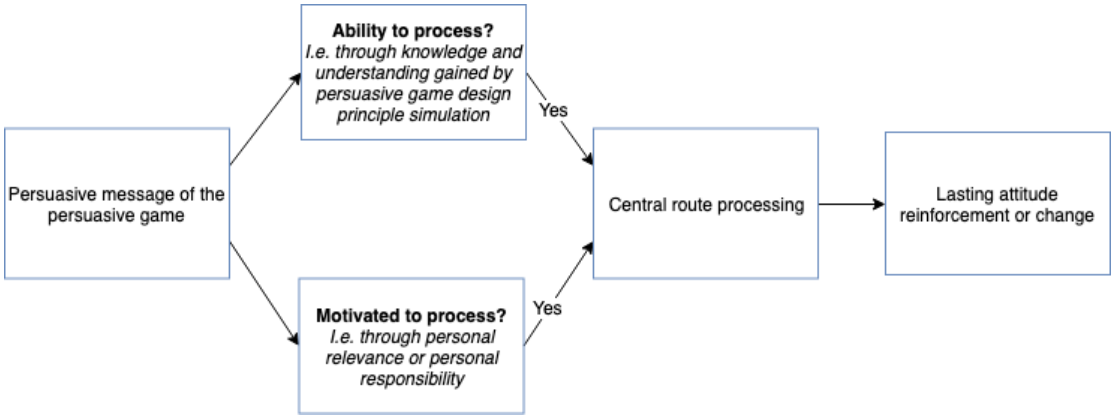

Figure 3: Theoretical framework: the persuasive power of the persuasive game design principle simulation explained through the ELM

2.5 Implications for this research

Limitations of the ELM in existing literature

There are a few limitations regarding the ELM that can pose some risks for conducting this research. The first limitation is that the ELM does not provide and overview of the conditions under which a given variable plays a role in the attitude change process (O'Keefe, 2008). This poses a risk for wrongfully applying the persuasive game design principle simulation in persuasive games, and more importantly in this research. Furthermore, it constraints the ability to reflect on the persuasive game design principle simulation in the design of the game. Unfortunately, there are no known solutions for this limitation.

A second limitations is that the ELM does not specify to what extent a person must feel personally related to the issue that is the subject of the attitude change process (the personal relevance factor for the motivation to process determinant). It has been suggested that variations in personal relevance can lead to different outcomes in the persuasion

process (O'Keefe, 2008). For this research, it could mean that the effect of the persuasive game design principle simulation on attitude change is depending on the participants that are selected for the research. Therefore, the participants should be carefully selected.

Other implications

When using simulations in general, there are implications that should be taken into account that should also be taken into account when using the simulation principle. The first implication is that of designer bias (Fogg, 2002, p. 67). The cause-and-effect relationship that is presented during a game is often a perception of how the designer perceives this relationship. This may not always resemble reality. Fortunately, when conceiving the Mobinn game, the reasons behind the problems of innovation adoption in a complex socio-technical system were closely identified and translated in the game (Roukouni, Lukosch & Verbraeck, 2019). However, not all game designers are fortunate enough to have time to conduct information regarding this relationship and have the ability to translate it in a game. A way to deal with this subjectivity is to reveal designer bias (Fogg, 2002, p. 68; Oinas-Kukkonen & Harajumaa, 2009). From an ethical point of view, it would be fair to inform the player about possible biases. However, revealing this bias is not always possible as designers are not always aware of the bias, or it can be ineffective as it can damage the credibility of the designer and its product (Fogg, 2002, p. 68).

Another implication that concerns the subjectivity of simulations is what is referred to as simulation fever (Bogost, 2008, p. 106). This refers to someone's reaction towards simulation. Simulation fever can either occur as simulation resignation or simulation denial. Simulation resignation refers to the blind acceptance of simulation models, regardless of knowing that they include biases and limitations concerning the representation of the system of interest. This is often done because it is believed that there is no better model available to represent the system of interest (Bogost, 2008, p. 107). Simulation denial refers to the negative feelings a player has regarding a simulation. Since simulations are considered a subjective representation of reality and can only represent reality to a certain extent, simulation deniers often perceive simulations as useless, unreliable or dangerous (Bogost, 2008, p. 107).

While simulation fever can occur either in simulation resignation or simulation denial, for the purpose of this research, only the latter is of interest. This type of simulation fever could influence the game play and the effect of the simulation principle, as players can perceive the cause-and-effect relationship of their behaviour that is provided in the game as something subjective. Moreover, when the shown cause-and-effect relationship of their behavior is too confronting, they can even argue that the game is 'just a game' and that the principle does not represent reality (Bogost, 2008, p. 109). This could influence the effect of the simulation principle on attitude change.

3. Research design for evaluating the effect of the persuasive game design principle simulation in isolation

The goal of this chapter is to answer the sub-question: *What method allows for measuring the effect of the persuasive game design principle 'simulation' on attitude change in isolation?* As argued by Siriaraya, Visch, Vermeeren & Bas (2018) and to the best of my knowledge, research on the effect of persuasive game design principles in isolation has not been performed yet. Therefore, an important step in this research is to design a methodology that allows for evaluating the effect of the persuasive game design principle simulation on attitude change towards cooperation and information sharing in isolation.

To come up with a feasible design for this research, inspiration and knowledge was gained by conducting a literature review together with expert interviews. The expert interviews were conducted with researchers from the Delft university of Technology. Fifteen researchers were approached for the expert interviews. These were selected based on their research background and experiences with evaluating a variable or factor in isolation. Eventually, three researchers agreed to participate in the interviews. The first interview was conducted with Gerdien de Vries, a researcher at the faculty of Technology, Policy and Management with a background in social and organizational psychology who focuses on influence techniques - such as framing and nudging - in multi-actor settings. The second interview was conducted with Niko Vegt, a post-doctoral researcher at the faculty of Industrial Design. Niko wrote his dissertation on how games can be used for behaviour change. More specifically, he wrote how using gamification could enhance teamwork. The final interview was conducted with Maria Freese, a game researcher at the faculty of Technology, Policy and Management. During the interviews, they were asked about their experiences and the do's and don'ts when conducting this type of research. Their input and the input retrieved from additional literature will be discussed in the following subsections.

The most important insights regarding the design of the game and game sessions, evaluating a variable in isolation and measuring attitudes gained from the expert interviews and literature review are presented in section 3.1. Based on that, the methodology for conducting this research will be designed and presented in section 3.2, which also provides the answer to the abovementioned sub-question.

3.1 Analyses of suitable research methods

3.1.1 Possibilities for measuring the effect of a variable in isolation

The analyses on possible methodologies for measuring the effect of a variable in isolation resulted in two possibilities. The first possibility is to use multivariate regression. This technique was not mentioned during the expert interviews, but could be considered a widely used technique in statistics for estimating the causal relationships between two variables while controlling for confounding variables. Multivariate data analysis refers to "all statistical techniques that simultaneously analyse multiple measurements on individuals or objects under investigation" (Hair, Black, Babin & Anderson, 2014, p. 4). Thereby, the weight of the effect of multiple variables that are interrelated on a single dependent variable can be estimated (see A in figure 4).

Furthermore, the interaction between different confounding variables can be estimated (interaction effects) (see B in figure 4) (Hair, Black, Babin & Anderson, 2014, p. 176). Knowing these weights allows estimating the partial correlation between the independent variable of interest (the persuasive game design principle simulation) on the dependent variable (attitude change towards cooperation and information sharing) while other confounding variables are being controlled for (Hair, Black, Babin & Anderson, 2014, p. 208). However, a multivariate regression preferably requires 100 observations (Hair, Black, Babin & Anderson, 2014, p. 172), and having that many participants in this research is probably not doable considering the time span. Furthermore, having data on all possible confounding factors during the game play would require an endless questionnaire.

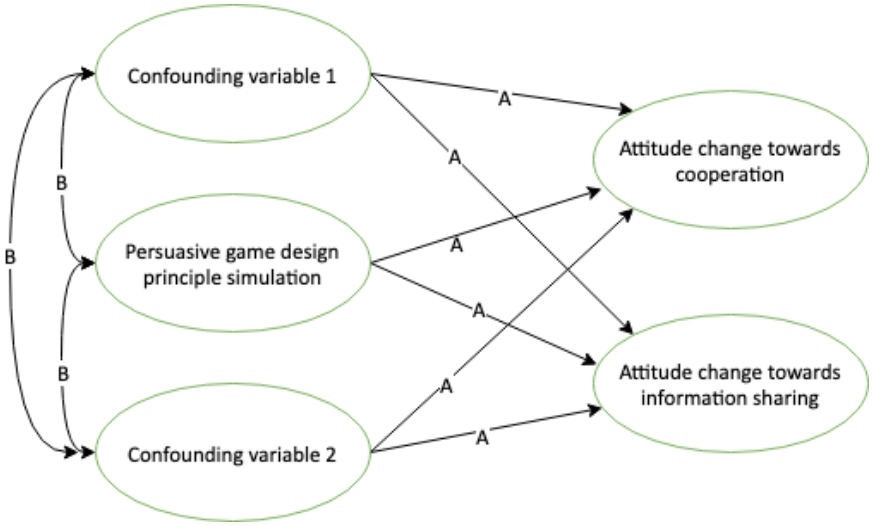

Figure 4: Multivariate regression

The second possibility is to use an experimental method in which possible confounding variables are kept constant (Riemsdijk, 1999, p. 145). These are referred to as laboratory experiments, which allow for examining research objects in a controlled environment (Cooke et al., 2017). Due to the controlled environment in laboratory settings, possible confounding variables can be kept constant during research. This allows for examining the isolated effect of an independent variable on a dependent variable (Eysenck, 2005, p. 277).

Laboratory experiments were recommended by all researchers who participated in the expert interviews. For their own research, they have successfully used laboratory settings as well to examine the isolated effect of a particular variable. Furthermore, conducting experiments in such setting is by many social scientists and natural scientist perceived as "one of the defining characteristics of scientific inquiry" (Webster & Sell, 2014, p.1). Considering the limitations of multivariate regression and the advise of the researchers during the expert interviews, conducting laboratory experiments where confounding variables are being controlled for is probably the most feasible option for this research.

Standardization in laboratory experiments

As mentioned before, laboratory experiments allow for environments to be controlled for in order to be able to evaluate the effect of a variable or component in isolation. For controlling the environment, it is often advised to standardize the conditions of an experiment. For animal experiments, standardization refers to "the defining of the properties of any given animal (or animal population) and its environment" (Richter, Garner

& Würbel, 2009). Based on this definition, for a game research, standardization would mean to define the properties of players or the population and their environment.

Standardization in research is important because it reduces the variation in data, which increases test sensitivity (Richter, Garner & Würbel, 2009). Test sensitivity refers to the measurement of the proportion correctly identified positive results (Šimundić, 2009). This measurement is of great importance in medical sciences, as it says something about the probability of a wrong diagnosis when testing for a disease. However, this measurement can also be of great importance to this research as it says something about the probability of correctly identifying attitude change. Furthermore, when the test sensitivity is high, a lower sample size is allowed (Richter, Garner & Würbel, 2009). This is an advantage for this research, as a limited amount of game sessions can be conducted within the time frame of this research.

Still, one thing that remains questionable is whether standardization actually increases the reproducibility of the research. It is widely known that reproducibility of scientific evidence is one of the core principles for conducting scientific research. Reproducibility is not determined by the variation within an experiment, but between experiments (Richter, Garner & Würbel, 2009). However, not all environmental factors can be controlled for, such as interfering noise or the room climate (Richter, Garner & Würbel, 2009). This makes it hard for different laboratories to standardize different local environments.

Furthermore, with standardization, it remains questionable whether the results of a particular research will also be applicable to other conditions, settings or populations. This is referred to as external validity (Campbell, 1957). For this research, it could mean that the evaluated effect of the persuasive game design principle simulation on attitude change would only occur in settings that are similar to the setting that is used in this research. Limitations regarding reproducibility can therefore be considered a point of discussion in this research.

Another common objection to this approach is that it produces unrealistic data (Falk & Heckman, 2009). Such processes, in which everything is controlled for, do not resemble real-world processes. Due to this, the external validity of the research could be lower (Landers & Bauer, 2015). However, since laboratory experiments allow for greater control in experiments, it could increase the internal validity of research (Landers & Bauer, 2015). It seems that a trade-off has to be made between the internal and external validity of the research.

Game design for laboratory experiments

Regarding the game design, testing the persuasive game design principle simulation in isolation would require making multiple versions in which the treatment variable, in this case the persuasive game design principle simulation, would be varied. Initially, the idea was to create two game versions (see chapter 1). The first version would be a shorter version of the original game that is playable within one hour. The second would be a version without the simulation principle, which is also playable within an hour. However, since there are in total three persuasive game design principles present to full extent in the game (cooperation and self-monitoring), having just two versions which do or do not contain the simulation principle would make the research too fragile according to all experts. Therefore, it is advised by all experts to conceive more than two versions for the research. Regarding this, two options have been proposed for the game design.

The first option is to vary all persuasive game design principles that are currently present in the game to full extent and the persuasive game design principle simulation. This would result in four game versions: a version with all principles, a version with simulation and cooperation, a version with simulation and self-monitoring and a version self-monitoring and cooperation. This design would also provide the possibility to observe the effect of self-monitoring and cooperation, which would be a great addition to this research. However, conceiving four games would require more time and more participants for the research. Besides that it would require more time for the game design itself, this design would also require to analyse more data. Therefore, it is questionable whether that is doable within the time frame for this research.

The second option is to only vary with the persuasive game design principle simulation. This would result in three game versions: a version where the simulation principle is fully present, a version without the simulation principle and an in between version in which simulation is present in lesser amount. Making three versions seems doable within the time frame of this research, considering that one version will just be a shorter version of the original game. Furthermore, only varying the simulation principle allows for keeping the other persuasive game design principles that are present to full extent in the game (cooperation and self-monitoring) to remain constant. How the persuasive game design principle will be varied in the game versions will be discussed in chapter 4.

3.1.2 An overview of possible confounding variables

In the previous section it was mentioned that to be able to conduct experiments in a controlled setting, possible confounding variables have to be identified and controlled for. In this section, possible confounding variables for this research will be discussed that came up during the literature review and expert interviews.

Persuasive game design principles

What is often seen in research regarding persuasion is that they often include multiple persuasive game design principles (Orji, Vassileva & Mandryk, 2014). The Mobinn game that will be used in this research, currently includes two persuasive game design principles as presented by Orji, Vassileva & Mandryk (2014) to full extent: **cooperation** (*Players are required to work together to accomplish a communal goal*) and **self-monitoring** (*Players are able to track their in-game performance and behaviour which allows them to monitor their past and current states*). Removing the cooperation and self-monitoring principle to be able to measure the effect of the simulation principle in complete isolation is not an option, because that could possibly cause the game to lose its persuasive power (Lukosch, personal communication, March 15, 2019) and would probably make the game less of a game and more of an exercise. And having the persuasive game design principle tested in an exercise would be less valuable to this research, as the aim of this research is to validate persuasive game design principles for persuasive games.

Furthermore, the effects of these persuasive game design principles is assumed to be depending on a person's gamer type and personality (Orji, Vassileva & Mandryk, 2014; Orji, Nacke & Di Marco, 2017). Gamer type and personality can be easily assessed using existing validated questionnaires (Freese, personal communication, March 29, 2019). However, an issue brought up during the expert interviews was that the effect of personality or gamer type on the simulation principle can probably not be thoroughly interpreted and explained due to limited knowledge on psychological concepts. Therefore, it is decided not to take personality, gamer type and their effects on persuasive game design principles into account in this research.

Game experience
Game experience is perceived as a crucial factor in game research. In this research, game experience refers to how the game is experienced by the players. Since there will be different versions of the game, there is a possibility that the game experience of the games will be different. However, it cannot be ruled out that changes in attitude are not just a result of the games being experienced different. Therefore, in this case, game experience is definitely a variable that must be taken into account in this research.

Participants
Other common confounders in game research according to Maria Freese are gender and age. Since there is little known about the effect of persuasive game design principles, there is no sound base to make assumptions regarding gender and age acting as confounding factors. Furthermore, according to the ELM (Petty & Cacioppo, 1986), there are no reasons to assume that these will act as confounding factors as well. However, from a game research perspective, there is no base to assume that these variables will not have any effect at all. Since this research aims to add new knowledge regarding the effectiveness of persuasive game design principles, it would be a waste if they would not be considered at all.

However, another thing that should be standardized in laboratory experiments are research subjects (Richter, Garner & Würbel, 2009). For this research, all experts who participated in the expert interviews recommended including a homogeneous sample group. This would allow to draw conclusions on whether the changes in attitude change are actually due to the simulation principle, instead of factors or attributes that are linked to a particular person in sample group (De Vries, personal communication, March 26, 2019).

This would mean that socio-demographic factors, such as gender, age and education, would have to be kept constant in this research. This is at odds with examining the effect of gender and age on the persuasive game design principle. Since the main goal of this research is to study the effect of the persuasive game design principle simulation on attitude change, it is chosen to mainly focus on this objective. Explaining the effect of the persuasive game design principle based on gender and age will therefore not be the primary focus, but of course it would be a nice feature.

Game elements
Gerdien de Vries and Maria Freese pointed out that game elements could also act confounding factors. Game elements in persuasive games can encompass many things, such as roles, rules, scenario's, debriefing and the role of the facilitator. The following game elements are advised to kept constant during the research:

- **Briefing of the game**: This includes the introduction to the game and presentation of the game instructions
- **Briefing of the research:** Besides introducing the game, it is also usual to do a briefing on the research itself. This includes informing players about the goal of the research, the general structure of the research and information about the measurement tools
- **Cover story:** Instead of revealing the true goal of the research regarding attitude change, it is advised to use a cover story to prevent any biases from occurring
- **Debriefing:** The post-game debriefing of a game is considered one of the most important aspects of game-play considering that not all participants are equally able to draw conclusions from the game-play, reflect on their in-game experiences and translate those to real life situations (Peters & Vissers, 2011)

- **Facilitator presence and communication:** The presence and communication of a facilitator is believed to be of influence on the outcome of game research as it can lead to interruptions, distractions and biases (Freese, personal communication, March 29, 2019)

Regarding two game elements, two decisions are made to reduce the occurrence of biases. First, the decision is made to conceive games that are playable without facilitator to prevent any interruptions, distractions or biases caused by the facilitator. Maria Freese recommended not to answer questions of participants, unless they are necessary for understanding the game. This would also allow the researcher just to focus on the research instead of ensuring that the game is well lead.

Second, it is chosen to not include a post game debriefing. This means that the game session will not end with a plenary debriefing in which a discussion is led by the facilitator about the game play and insights gained during the game. As mentioned before, the goal of a debriefing is to provide players with information to draw conclusions from the game-play, reflect on their in-game experiences and translate those to real life situations (Peters & Vissers, 2011). However, this could be considered as a confounding variable as postgame debriefings are believed to contribute to establishing behavioural and cognitive identification, which can result in attitude change (Williams & Williams, 2007). Therefore, there is a risk that not the persuasive game design principle simulation will cause an attitude change but the debriefing, which would make this research invalid.

Furthermore, for the debriefing the facilitator would have to actively pay attention to all actions carried out in the game. This would make it hard to focus on the purpose of this research during the game session. Therefore, it is chosen to move the debriefing after the research is finished. It was chosen to send participants an email with an explanation of the game and the goal of the game. Furthermore, they will be given the possibility to ask questions about the game and their gameplay.

Confounders according to the ELM

In chapter 2, it was discussed that the persuasive game design principle simulation can be placed at the determinant 'ability to process' in the ELM. By providing players with a mechanism to see the cause-and-effect relationship of their behaviour in the game, it provides them with knowledge for examining arguments regarding the attitude change that the game aims to achieve and thereby contributes to their ability to process the persuasive message.

According to the model, a prerequisite for attitude change is that the person subject to attitude change is *motivated to process* the persuasive message (Petty & Cacioppo, 1986). Key motivational factors are personal relevance, personal responsibility and need for cognition (Petty & Cacioppo, 1986). However, as mentioned in chapter 2, only personal relevance and personal responsibility can be controlled for externally. Personal responsibility is by default already present in the Mobinn game, as all players are responsible for winning or losing the game. There are no individual winners or losers. Personal relevance will be maintained by selecting participants with that feel personally related to the realization process of truck platooning.

A limitation regarding personal relevance was also mentioned in chapter 2. The ELM does not specify to what extend a person must feel personally related to the issue that is the subject of the attitude change process (personal relevance). It has been suggested that

variations in personal relevance can lead to different outcomes in the persuasion process (O'Keefe, 2008). For this research, it could mean that the effect of the persuasive game design principle on attitude change is depending on the participants that are selected for the research. Therefore, the participants should be carefully selected in order to keep the level of personal relevance constant.

3.1.3 Attitude measurement instruments

Another important decision that has to be made to measure the effect of the simulation principle in isolation is how to measure attitude change. Although attitudes are often considered to be something internal, they can still be evaluated and made explicit. In this section, possible ways for assessing attitudes that are likely to be approved by the Human Ethics Committee of the Delft University of Technology will be assessed and discussed. Based on this analyses, a choice will be made for the attitude measurement instrument for this research.

Direct measurements

One way to measure attitudes is by simply asking respondents to report their beliefs or evaluation regarding an object, concept or behaviour. This is referred to as direct attitude measurement (Bohner & Wanke, 2002, p. 22). Within direct attitude measurements, attitude scales such as the Likert scale, Thurstone scale or Semantic Differential are often used to assess a person's attitude. However, these types of measurements are self-report measures and therefore, it is questionable how reliable they are and if the reported attitudes are also representative in other situations (Bohner & Wanke, 2002, p. 33). Furthermore, self-report measures are known for having limitations such as social desirability bias (Fisher, 1993), potential for misunderstandings (Stone, Bachrach, Jobe, Kurtzman & Cain, 1999, p. 1), giving people incentives for misreport (Stone, Bachrach, Jobe, Kurtzman & Cain, 1999, p. 5) or engaging in impression management (Tedeschi & Rosenfeld, 1981). These could lead to random errors or systematic errors (Bohner & Wanke, 2002, p. 31), making the attitude measurements less valid and reliable.

Indirect measurements

Another way to measure attitudes is by using indirect measurements. One of the proposed methods for indirect measurement that could be applied are projective techniques. These are a type of disguised attitude measure. The idea is that respondents are presented with inconclusive material (e.g. a word or a picture) and are being assessed on their interpretation or association of this material (Bohner & Wanke, 2002, p. 34). In the case of the Mobinn game, players could be asked what their associations are with cooperating in a multi-actor decision-making setting. The rationale behind this technique is that the respondents will express hidden feelings and opinions. However, the validity of these types of techniques is doubtful (Bohner & Wanke, 2002, p. 35). Many psychologists perceive these types of techniques are perceived as techniques that are not supported by research (e.g. Thelen, Varble & Johnson, 1968). Furthermore, by using inconclusive materials such as a word or pictures to assess attitudes, there will be also a probability that respondents perceive those words or pictures differently. Therefore, it is questionable whether these techniques will actually be of use for measuring the attitude change of interests.

Nonreactive measurements

A third way to measure attitudes is by using nonreactive measurements. Because these measurements do not require the cooperation of respondents (e.g. researchers do not have to ask them to answer questions), respondents are often not aware that measurements are taken place. Behavioural observations are considered nonreactive measurements and could be easily applied in a game setting. As mentioned before, it is assumed that behaviours are

related to attitudes (e.g. Katz & Stotland, 1959) and therefore, it is assumed to be possible that attitudes can be inferred from behaviours. However, behaviours can be influenced by other variables then attitudes, such as economic instruments like pricing and taxes to achieve desirable environmental behaviour (Owens & Driffil, 2008). Moreover, especially in a group setting, which will be the setting of the Mobinn game experiment, player's perception can be influenced by other people's perception in a group, even when these perceptions consider widely held values (Stoner, 1968). Furthermore, actions do not always resemble attitudes and can even contradict attitudes (LaPiere, 1934). It would therefore be questionable what these behavioural observations will actually measure and if the measurements are valid, considering all factors that can influence behaviour.

Conclusion
All attitude measurements will have limitations. However, when it comes to validity, direct measurements, especially the semantic differential scale, appears to be the most reliable for measuring attitudes in a game setting and are the most frequently used. Furthermore, direct measurements have also previously been used for assessing attitude change caused by persuasive board games (Kurapati et al., 2017).

For this research, quantitative attitude measurements will be done attitudes using four 9-point semantic differential scales that can be summed into one index that represents the attitude towards a psychological object (Petty & Cacioppo, 1984). Within these measurements, a psychological object is presented (in this case attitude towards cooperation and information sharing) and participants are asked to assess them using the following four items: "cooperation/information sharing is [good/bad, beneficial/harmful, foolish/wise, and unfavourable/favourable]". This is a validated method that has been widely known and used in research in social psychology.

It is chosen no to add a self-enhancement scale to control for impression management, considering that it is not usual in these type of research and does not guarantee that self-enhancement is correctly measured. This self-enhancement will be acknowledged as a limitation of this research. Still, a limitation that will be controlled for is that of potential misunderstandings (Stone, Bachrach, Jobe, Kurtzman & Cain, 1999, 1999, p. 1). Before the survey, a pilot survey will be tested with to measure how the statements are perceived. Furthermore, another idea is to add an example to clarify what is meant with the psychological object or to ask the respondents to give an example themselves to check whether they have understood the psychological object subject to change correctly. In this case, the psychological objects will be the attitude towards cooperate and sharing information.

3.2 Research design

3.2.1 Research setup

Participants
For this research, in order to get as much data as possible while maintaining the requirement to have a homogeneous group, a feasible sample group will be students. More specifically, students from the transportation domain of the master's programme CoSEM. Students are allocated to groups based on their day of preference. However, it will be aimed to distribute them randomly over the groups to prevent those students that may know each other affect the game-play.

The advantage of having students as the sample group is that they are fairly similar to each other, considering that the background knowledge, level of education and age. The main difference will be the gender of the students.

Another advantage of having students as the sample group, especially from the aforementioned master's programme, is that they already know something about the topic and about challenges regarding decision-making processes. Therefore, the personal relevance regarding the topic could be maintained at the same level and the prerequisite mentioned in chapter 2 to have participants that are *motivated to processs* a persuasive message can be met. Furthermore, when having students that are not familiar with the topic or issue, it can be expected that such a game would always have an effect on them. As mentioned by Gerdien de Vries: "*if you would conduct this research with a group that has no knowledge on decision-making or transportation technology, then you would have a chance that the simulation principle would have an effect on them because it is something new to them. Therefore, it would be favourable to have a group where you would expect that the results would not be as strong than with another group."* This is called a conservative research.

Moreover, having students as the sample group that already know something about the topic and about decision-making processes, also gives a realistic representation of the setting in which the game would be used in real-life. The Mobinn game is designed to change the attitude of actors (e.g. legislators, transport engineers, users) who are already involved in the issue of realizing innovations in the transport and logistics domain. Therefore, they are already familiar with such topics and decision-making processes, as are the students that will participate in the research. Still, a limitation of course would be that these students can only empathize with their in-game role to a certain extend.

A disadvantage of having students to participate in the game session is the occurrence of social desirability bias, considering that this research is conducted by a student as well. Measuring attitude change and conducting interviews should be done with careful consideration. Any suspicion regarding social desirability bias will be documented and considered as a limitation.

Finally, the students will be recruited by approaching them personally, via group texting, via Facebook and by approaching teachers from transportation courses to place announcements on the learning platform Brightspace. Furthermore, teachers will be asked to present a slide with an invitation to the game session and sent an email with the invitation to students. Also, snowballing will be used.

Game session set-up

As mentioned in the game description in chapter 1, the original game can be played with a minimum of four players considering that there are four roles in the game. In the game sessions that were conducted with the original game, it was possible for more than one player to play a particular role together (Roukouni, personal communication, May 3, 2019). While the advantage of having more participants in the game sessions would be that more data will be generated for this research, due to the chance of people influencing each other's perceptions in group settings as mentioned by Stoner (1968), it might be risky to assign a role to more than one person. This would mean that the generated data would be less reliable. It is therefore decided to have a maximum of four players per game session.

As mentioned before, three game versions will be created for this research: a version in which the simulation principle is present to full extent, a version in which it is present to a lesser extent and a version in which it is not present at all. The aim is to conduct at least two game sessions per game version. This would mean that a total of six game sessions will be conducted in total, which should be doable within a week. In total, 24 students are needed to participate in the game experiments. Considering the amount of first and second year CoSEM students in the transportation domain, recruiting this amount of students should be feasible.

Considering that there will be only one facilitator for the game and research, it is chosen to conduct two game sessions for each version on the same day. This is chosen because it is perceived to be risky to conduct game sessions for different game versions on the same day due to mistakes that can be made in the preparations and explanations of the game. Therefore, it is probably wise to focus on just one game version per day.

The order in which the game versions will be played is as follows. On the first day, the no-simulation version will be played, on the second day the in between and on the final day the simulation version. This order is chosen to prevent that any research bias will occur due to the observations that are made during the game play. It is expected that the simulation version will lead to the strongest attitude change or attitude reinforcement. Therefore, when having participants playing this version first, certain assumptions may or may not be fulfilled, which could lead to research bias in the interviews.

To maintain standardization in the environment of this research, all game sessions will be held at the same time from 2 PM to 3 PM. This means that on one day, two simultaneous game sessions are held for one game version. For all game sessions, the same type of rooms will be booked to prevent any distractions caused by the room setting. The rooms will be across from each other so that the facilitator is able to walk around in case of any questions. Finally, all groups will be provided with drinks and snacks during the game. This will be done at the beginning and end of the game to prevent any distractions from happening during the game.

Game session procedure

Before participating in the game session, participants are required to fill in the pre-game survey via the online survey tool LimeSurvey. The survey will be sent at least 72 hours before the game session. During the game session, all groups will be given the same plenary introduction and presentation to the research and to the topic of the game to ensure standardization of game elements. Furthermore, all groups will be given a plenary explanation on how to play the game. Additionally, all groups will be provided with written instructions during the game in order to prevent interactions with the facilitator during the game. The groups will be only allowed to ask questions if they were necessary to be able to play the game. Any other questions regarding the research are not answered.

After the game play, the post-game attitude measurements will take place using an analog survey. This survey also contains the questions for assessing game experience. After finalizing the post-game surveys, participants that have not agreed to participate in the interviews will be asked to leave. The interviews will be conducted in the rooms in which the games are played so that participants are able to point out game-elements when asked what game elements affected them the most.

Approximately one week after the game session, participants are asked to fill in the survey for the long-term attitude measurements via the online survey tool LimeSurvey. Finally, they will be sent an email containing the debriefing of the game and an explanation of the research. They will be allowed to ask questions regarding the game or research as well.

3.2.2 Measurement instruments

Game experience measurements

Game experience was previously mentioned as a variable that should be kept constant to be able to evaluate the effect of the persuasive game design principle simulation in isolation. However, it is perceived to be hard as a designer to assess whether the game experience remains the same throughout the different versions that will be created. Therefore, the Game Experience Questionnaire by Ijsselsteijn, De Kort & Poels (2013) will be used to assess whether the game experience is the same among the different versions of the games and the different game sessions. More specifically, the in-game version of the GEQ will be used as it is believed to be a valid method to assess game experience without burdening participants with too many questions.

The in-game GEQ questionnaire exists of fourteen statements, which measure seven components on a 5-point interval scale (0 = not at all, 1 = slightly, 2 = moderately, 3 = fairly and 4 = extremely). The seven components are competence, sensory and imaginative immersion, flow, tension, challenge, negative affect and positive affect. For each component, the questionnaire included two items (see table 3). The questionnaire will be presented immediately after the game play.

For measuring the component scores, the two items measuring the component were averaged, as is supposed to do according by Ijsselsteijn, De Kort & Poels (2013). The averaged scores for each component for each game version is used for the comparison of the game experience in the different groups.

Comparing group means is often done by performing a one-way ANOVA. However, since the sample size per group will be less than $N = 30$, it cannot be assured that the normality assumption will not be violated (Razali & Wah 2011; Ghasemi & Zahediasl, 2012). This means that conducting a one-way ANOVA on the data for the comparison of game experience can jeopardize both the probability of the Type I error as well as the statistical power of the comparison (Lix, Kesselman & Kesselman 1996). Therefore, the Kruskal-Wallis H test will be used to compare the means of the game experience between the different groups. This is an alternative to the to the one-way ANOVA that is used if the normality assumption and homogeneity of variance assumption are violated (Tomarken & Serlin, 1986).

Table 3: Items for measuring game experience (from the work of Ijsselsteijn, De Kort & Poels (2013)

Item	**Component**
● I felt successful ● I felt skilful	Competence
● I was interested in the game's story ● I found it impressive	Sensory and imaginative immersion
● I forgot everything around me ● I felt completely absorbed	Flow

● I felt frustrated ● I felt irritable	Tension
● I felt challenged ● I had to put a lot of effort in to it	Challenge
● I felt bored ● I found it tiresome	Negative affect
● I felt content ● I felt good	Positive affect

Quantitative attitude measurements

For the quantitative attitude measurements, surveys will be used to assess the attitudes of participants at different time frames. First, a pre-game survey will be conducted to assess the initial attitudes of participants. The aim is to do this at least 72 hours before the game session to prevent that the survey will be fresh in mind and bias the game play. Immediately after the game play, a post-game survey will be conducted to assess the attitudes of participants immediately after playing the game. Finally, participants are sent a survey one week after the game-play to assess what their attitudes are on the long term. The differences in attitudes will be assessed to provide insight regarding attitude change.

The design of the survey will be as follows. Participants are presented with six strategies and are asked to indicate what their thoughts are regarding using that attitude in an innovation process that includes multiple actors. Participants are asked to indicate their thoughts towards the aforementioned strategies on the four 9-point semantic differential scales mentioned before [bad/good, harmful/beneficial, foolish/wise and unfavourable/ favourable] that are proposed by Petty & Cacioppo (1984). When these four items are highly intercorrelated, the items are believed to measure the same construct and can therefore be aggregated into one index that represents the attitude towards a psychological object (Petty & Cacioppo, 1984).

Potential for misunderstanding was previously mentioned as one of the implications for direct attitude measures. The word 'thought' will be used instead of attitude, as attitude can be considered a vague term and could therefore pose the risk of misinterpretation and therefore the risk of measuring the wrong thing. Furthermore, for improving understanding, scenarios are added to the survey that indicate how the survey items should be assessed.

Moreover, it was chosen to include six strategies towards which participants had to indicate their attitude towards to although this study only focuses on two (competition, protecting your values, being better of than others, modifying yourself to other actors, cooperation and information sharing). The reason for this approach is that when providing only the two strategies of interest, especially in the pre-game measurements, participant might get the impression that this research focuses on these strategies and therefore would adjust their game strategy and answers to this information. This could lead to social desirability bias. By adding four non-related but contrasting strategies, it was tried to mitigate this risk.

Moreover, as the items do not provide any context themselves, a multi-actor decision-making scenario was added in the pre-game survey. Participants were asked to keep in mind the scenario and that the ultimate goal was to realize truck platooning when indicating their thoughts towards the aforementioned strategies. For the post-game measurement, it was not necessary to add a scenario as participants were provided with a scenario during the

game. This was also the case for the long-term measurement, however, as the measurement was done six to eight days after the game-play, for clarification, it was chosen to add a summary of the scenario of an innovation process based on the scenario of the pre-game measurement scenario. In all surveys, the same strategies are presented to participants but in a different order. A complete overview of all three surveys can be found in Appendix A.

To ensure that the items measure the same construct and thus are highly intercorrelated, the internal consistency of the items will be measured by performing a reliability analysis. Aggregating the scales will be done by averaging the scores of the items, which is the common used approach in research (Hair, Black, Babin & Anderson, 2014, p. 124). This approach is also preferred over calculating the sum scores of the items, as it allows for interpretation of the attitudes.

Assessing whether attitudes are reinforced after playing the game will be done by paired tests. The paired sample T-test is a commonly used test for this purpose. However, since this study will deal with small sample sizes ($N < 30$ for each group) it cannot be guaranteed that the normality assumption is not violated. Therefore, a non-parametric test will be used for assessing attitude change/reinforcement, which is the Wilcoxon Signed Ranks Test.

Qualitative measurements

As mentioned in chapter one, interviews will be used for qualitative measurement. Based on the theoretical framework (see chapter 2) for this research, there are already some assumptions made regarding the effect of the persuasive game design principle simulation. Based on those assumptions, themes and questions are prepared as a basic guideline for the interviews. The questions are related to simulation fever, the persuasive message of the game, cooperating in the game, knowledge and understanding (ELM) and the persuasive game design principle simulation. A complete overview of the interview questions and protocol can be found in Appendix A.

The aim of this guideline is to serve as a checklist to see whether all insights were gained that the interview aimed to gain. Predetermined questions will not be literally asked to maintain an informal setting in during the interview. The interviews will rather be semi-structured interviews. All questions will be asked as open questions. No direct questions will be asked regarding whether the persuasive game design principle simulation has lead to attitude change. This will be done to prevent that participants will get the impression that this is the element of interest for the research and will provide biased answers. Instead, participants are asked what game elements or parts of the game affected them the most during the game-play.

Participants in the game session can voluntarily participate in the interviews. When recruiting participants for the game session, it will be immediately asked if they would like to participate in an interview after the game session as welWith the consent over the interviewees, the interviews will be recorded.

For the analyses of the qualitative data, a thematic analysis will be performed on the interview data according to the six phases proposed by Braun, Clarke, Hayfield & Terry (2019, p. 60). First, the data will be transcripted to get familiar with the data. During the transcription of the data, insights will be highlighted that are assumed to be important to answer the main research question. Afterwards, the data will be coded. During the coding process, there will be a predefined list of codes that are formulated based on the theoretical framework (chapter 2) for this research. However, the list will be non exhaustive and the

coding will be done at the semantic level to prevent any misinterpretation or research biases. Based on the identified codes, themes are formulated to structure the relationships found in the data. There will be no strict rules for the proportion of the data for it to be considered a theme. Single data will also be considered a theme in case they present relevant information for answering the research question. Finally, the themes will be reviewed and defined.

4. Game design process

The aim of this chapter is to answer the sub-question *What persuasive game can be developed that allows for measuring the effect of the persuasive game design principle 'simulation' on attitude change within the specified time frame?*

In chapter 1, Duke's paradigm for game design was selected as the foundation of the game design process for this research. As this research does not aim to create a new game, but to make adjustments to an existing game for research purpose, it is not necessary to carry out all steps of the paradigm during the game design process. Therefore, only the steps necessary for making the different game versions are selected to be carried out, of which some in adjusted form.

The design process starts with the first step of Duke's paradigm for game design (Duke, 1980), which is formulating written specifications in the form of expectations and constraints for the game and the game design process. Knowledge derived from the theoretical framework and methodology design in the previous chapters is used as input for formulating the specification for the game and the game process.

The design process then proceeds with an adjusted form of the fourth and fifth steps of Duke's paradigm for game design (Duke, 1980): planning and describing the game with the Systems Component/Gaming Element Matrix (Duke, 1980). Ordinarily, the Systems Component/Gaming Element Matrix is used to describe elements of the system for which a game is being designed and for translating them to game elements. However, this is not necessary for this research since the system is already captured in game elements of the Mobinn game. The Systems Component/Gaming Element Matrix is therefore only used to analyse all current game elements of the Mobinn game. This allows for an overview of current game elements, which is used to analyse how adjustments could be made to the original game. Based on this analysis, a new 'basic' game is designed that is playable within an hour.

Afterwards, additional game versions are created in which the persuasive game design principle simulation is varied for evaluating the persuasive game design principle simulation in isolation. This is done by assessing literature on strategies for applying feedback and testing them in a game setting. Finally, the final three steps of Duke's paradigm for finalizing the game design process are carried out which consist of building, evaluating, testing and modifying the game versions.

This chapter is outlined as follows. In section 4.1, artefacts and process specifications are presented. Section 4.2 presents the adjustments made to the original Mobinn game. In section 4.3, decisions for varying the persuasive game design principle simulation are presented. Finally, section 4.4 presents the verification of the games and the outcomes of the game design process using the written specifications presented in section 4.1. The outcomes of this chapter provides the answer to the sub-question *What persuasive game can be developed that allows for measuring the effect of the persuasive game design principle 'simulation' on attitude change within the specified time frame?*

4.1 Artefact (game) and process specifications

As mentioned previously, the written specifications for the game and game design process are presented in this section. Two types of specifications are presented: artefact specifications that provide the demands and constraints for the game versions, and process specifications that provide that demands and constraints for the game design process. All specifications are presented with an identifier, consisting of two letters and two numbers. The letters indicate whether they are artefact specification (AS) or a process specification (PS). The numbers indicate the sequence of the specifications. The identifiers will be used to refer to the specifications for the verification of the game versions and the outcomes of the game design process in section 4.4.

4.1.1 Artefacts specifications

AS01: The games should maintain the persuasive message of the original Mobinn game

The persuasive message of the Mobinn game is that innovations cannot be implemented unless actors are willing to share information and cooperate. This persuasive message is an important element for answering the main research question, as the aim is to validate the effect of the persuasive game design principle simulation on attitude change towards information sharing and cooperation.

AS02: The games should maintain the original roles of the Mobinn game

The researchers who created the original game incorporated real life dilemmas when conceiving the roles. Originally, the game was conceived for actors in the transportation and logistics domain. Since the game will be played with students in this research, maintaining these roles would allow them to capture the real life barriers for multi-actor decision-making in the transport and logistics domain.

AS03: The games should represent the real life dilemmas in multi-actor decision-making

Multi-actor decision-making is another important element that needs to be present in this research in order to be able to answer the main research question. Currently, the Mobinn game already provides a multi-actor decision-making setting in which real life dilemmas are present. These should be maintained in the new game versions.

AS04: The games should be playable within an hour

Considering that facilitating a game sessions can require a lot of energy from researchers, participants and that participants have to fill out a questionnaire before and after the game session, it will be aimed to make games that are playable within an hour.

AS05: The games should be playable without a facilitator

In chapter 3, it was addressed that in game research, a facilitator can bias participants. Since the original version of the game is playable without a facilitator, it will be aimed to have the new versions to be playable without a facilitator as well in order to prevent from any biases to occur that can decrease the reliability of the results.

AS06: The games should be understandable for master students from the transportation domain of the master's programme Complex Systems Engineering and Management at the Delft University of Technology

While the original game is designed for actors involved in the innovation process of truck platooning, in this research, the game experiments will be conducted with students. As mentioned in chapter 3, due to the background of the students, it is expected that they are already familiar with the topic and about challenges regarding decision-making processes. However, as they are only students and probably lack practical experiences, they only can

understand the dilemmas to a certain extent. Therefore, the games should be created in such a way that they can.

AS07: The games will be physical board games containing physical content
Considering that the original game is a physical board game and the time frame of this research, the easiest way to create game versions within the time frame of this research is to use the original game content and make adjustments to it.

AS08: The games should remain games and not be stripped down to exercises
In chapter 3 it was mentioned that when removing certain game elements, there is a risk of the game becoming less of a game and more of an exercise. Since the aim of this research is to validate persuasive game design principles within a persuasive game, conceiving a persuasive game is thus required.

AS09: The games should not contain more persuasive game design principles to full extend than the persuasive game design principles currently present to full extend in the original game (cooperation and self-monitoring)
A big challenge for this research is to evaluate and measure the effect of the persuasive game design principles simulation in isolation. In chapter 3, possible confounding factors have been presented and it was discussed how they will be controlled for. A challenge when designing the new versions of the game is not to include more confounding variables, and in particular, not to add more persuasive game design principles.

4.1.2 Process specifications

PS01: The designer should conceive three games in which the persuasive game design principle simulation is being gradually varied in each
As mentioned in chapter 3, there will be a version where

1) The simulation principle is present to full extent
2) The simulation principle is not present
3) The simulation principle is present to a lesser extent that the version 1

PS02: The designer should conceive all three game version within three weeks
This is necessary to finish this research within the 25 weeks time frame.

PS03: The deliverables of the game design process will include scripted game elements
In order to maintain consistency between all game sessions, the following will be standardized:

- Briefing of the game
- Briefing of the research
- Cover story
- Debriefing (for after the research)

PS04: The deliverables of game design process will include self-explanatory game instructions
This is a requirement to have the games be playable without a facilitator, in order to prevent any biases that can occur by the facilitator.

4.2 Adjusting the original game

After receiving all game components from Natasa Roukouni (one of the designers of the Mobinn game), an analysis was conducted on the current game elements to provide an overview of possible elements that could be changed for the purpose of this research. Afterwards, the original game was played several times to analyse the game flow, play time and if to what extent the requirements mentioned in chapter 4 were already met. An overview of the test sessions can be found in Appendix B.

An overview of all current game elements according to Duke's Systems Component/Gaming Element Matrix (1980) are presented in table 4. For this research, an additional element was added to the matrix: persuasive game design principles. This element assesses how persuasive game design principles are currently present in the game. Furthermore, table 4 presents an overview of the changes that are made to game elements. In the remainder of this section, the most radical changes to the original game will be elaborated on.

More reality components

As mentioned before, the original game is designed to be played with real life actors who are involved in real innovation processes of transportation innovations. However, for this research, students will be recruited to play the game. It is expected that students will play the game more strategically than real life actors, considering that the real life actors feel more personally connected to the actions and events happening in the game. This was expectation was confirmed by Natasa Roukouni, who facilitated game sessions with both real life actors and students. She confirmed that students played the game with a strategy to win the game from the beginning, while real actors focussed much more on the negotiations because they included information they were familiar with from real life barriers (Roukouni, personal communication, May 3, 2019).

To prevent that students would only pay attention the statistical aspects of the game rather than the context, dilemma and persuasive message, it was decided to add an extra objective for players to make them empathize more with their roles and game context. On each role card, certain issues were described that a certain actor would like to see solved. Solving the issues could be done by playing their action cards, of which the original text was adjusted to link to one of the issues of the actor. Players did not receive extra points or tokens when solving their own issues, but could regard it as a personal goal. This was done to prevent the addition of the persuasive game design principle competition, which would mean that specification AS09 would be violated.

Furthermore, to give students more feeling of the real life situation, it was chosen to give all players two extra players except for the policy maker, who received three tokens. This idea was brought up by Natasa Roukouni, who received it as feedback on the original Mobinn game. During her game session, players pointed out that they missed some reality aspect, of which one was that it was not made clear enough that the government is the richest actor in reality (Roukouni, personal communication, May 3, 2019).

Less frustration

A first observation that was made when playing the original game was that early on, the game gives players the impression that they cannot win the game. Especially the event cards in the game (from now on external events), which are events that set back the scores of the players and add a chance for them to lose their tokens, had a de-motivating effect on the game-play. Natasa Roukouni confirmed that it was not possible to win the game. The

designers choose to do so to initiate a discussion between actors during and after the game play (Roukouni, personal communication, May 3, 2019). While this is a good way to get a conversation going on in a decision-making game, this element could cause for frustration and distractions during this research, which could obstruct the persuasive message of the game to be processed (Petty & Cacioppo, 1986). Therefore, it was chosen to reduce the frustration in the current game. This was done in two ways. First, the negative effects of some external event cards were reduced, meaning that players would lose less tokens. Second, the start level of the KPI's were moved one level up. By doing so, players would still have the impression that they could reach the goal of the game when their scores were set back due to the external event cards.

Cycle sequence and steps of play

The first three steps of the original cycle sequence of the game will remain in the game sessions of the research. Based on the materials provided by Natasa Roukouni, a scripted introduction is formulated which includes the briefing of the game, the briefing of the research, the cover story and an introduction to the truck platooning technology. This introduction can be found in Appendix C.

The main adjustment that is made is that the debriefing is moved to after the game. In the original game sessions, players are given feedback in the plenary debriefing (Roukouni, personal communication, May 3, 2019). However, as mentioned in chapter 3, this could be considered as a confounding variable as postgame debriefings are believed to contribute to establishing behavioural and cognitive identification, which can result in attitude change (Williams & Williams, 2007). Therefore, there is a risk that not the persuasive game design principle simulation will cause an attitude change but the debriefing, which would make this research invalid.

For the original debriefing, facilitators were able to track down what cards were played in which order by having an additional board on which all action cards were indicated. By removing the debriefing from the cycle sequence and have the debriefing after the research was finished, this game board will not be necessary anymore. This board is therefore removed from the game. It was chosen to send participants an email with an explanation of the game and the goal of the game, which means that the game board on which all action cards are indicated will be removed from the game. Furthermore, they will be given the possibility to ask questions about the game and their gameplay. The scripted debriefing and feedback can be found in Appendix C.

Finally, a small adjustment has been made to the steps of play. In the current game version, it is not specified when players will receive extra tokens and how these will be distributed. It was chosen to hand out the extra tokens before drawing the external event cards, to prevent situations where players will not have enough tokens to pay up what the external event card requires them to pay. Furthermore, it was randomly chosen to assign the player who plays the role of the Developer to hand out the extra tokens to maintain consistency throughout all games.

Playtime

As mentioned before, the current game takes too long to be finished for this research. Therefore, adjustments had to be made to reduce the playtime and to comply with specification AS04. After extensively testing, it was chosen to reduce the amount of rounds to four. Playing the game with four rounds took up to 40 minutes, which is ideal considering that the game session will include an introduction and surveys that have to be filled in.

Furthermore, with four rounds, players would still be able to more or less experience an innovation process to full extent.

Table 4: Overview of current game elements in the Mobinn game and adjustments

Game element	**Current version**	**Adjustments**
Scenario	Players all represent an actor that is important for the realization of truck platooning. They are all invited to a decision-making process where they will make decisions about investments for the realization of truck platooning.	Remain the same
Pulse (Events)	External events: events that cannot be prevented, but influence the KPI scores and the amount of tokens of a player	The effect of some external events are adjusted to prevent players from becoming demotivated
Cycle sequence (Macro Cycle)	1. Introduction to subject of the game (Truck Platooning) 2. Rules of the game 3. Play of the game 4. Debriefing	Debriefing will be done after finishing the research
Steps of play (Micro cycle)	1. Decide to play an action card or to remain inactive 2. Share your decision by simultaneously putting your action cards on the board 3. Pay for your own action card 4. Decide together which action cards will be activated 5. Follow the instructions of the activated action cards and return the non-activated cards to the player. Investment on the non-activated cards are returned to the pile of money. 6. Draw an event card and receive extra tokens	The order of step 6 was not specified in the original game. Therefore, a step is added between step 5 and 6 for each players to receive extra tokens first before drawing the event card. This steps also included who will distribute the extra tokens: ● The developer (D) will hand out the extra tokens. All players receive 2 extra tokens, except for the policy maker, who receives 3 extra tokens

Rules	● Players have to put their action cards simultaneously on the board when revealing their decision to play an action card or not ● A player has to pay for his/her own action card: you have to put the amount of tokens related to your role on your action card before asking others for their contribution ● In order for a card to be "activated" and count in for the game, it has to receive all the necessary support from the parties mentioned on it ● In case a card is not selected, the tokens invested on it are lost and the card is returned to the player ● In case a card is activated, all players follow the instructions mentioned on the card. ● Players must draw an event card at the end of each round and follow the instructions of the cards ● Players are allowed to talk, negotiate, and can ask for help. ● The game will exist of 5 rounds ● The KPI's start at the levels indicated on the game board ● The game is won when all three KPIs are in the green area in the end of game play.	● The amount of rounds is limited to 4 instead of 5 for the sake of time ● The KPI's start one level higher than is currently indicated on the game board
Roles	Gamed roles: Policy maker, Freight forwarder, Transporter and Developer	Remain the same
Model	Analogue model: game parallels real world phenomena and decisions regarding truck platooning	Additionally: ● Policy maker receives more tokens as the government is the richest actor in reality ● Players are faced with issues that their actors face in real life by adding the objective to solve those issues
Decision sequence and linkage	All players follow the steps of play; no distinctions are made between the different roles	Developer is asked to distribute the extra tokens after all activated action cards are played.
Accounting system	● All action and event cards provide instructions on how many tokens an actor has to pay or loses, and how much a KPI will go up or down ● Each player receives one extra token after the round is finished	The amount of extra tokens is changed: each player receives 2 tokens accept for the policy maker who receives 3 tokens

Indicators	Game board showing the current levels of the KPI's and to the corresponding coloured areas	Remain the same
Symbology	● KPI's can reach the levels 1 to 9 ● Levels are subdivided in coloured areas; 1-3 is red, 4-6 is yellow and 7-9 is green	Remain the same
Paraphernalia	● Game board ● Board for tracking which action cards have been played ● Tokens ● Role cards ● Action cards ● Event cards	Board for tracking which action cards have been played was removed as the debriefing was removed; text of the action cards and role cards is adjusted to ensure that they are linked to each other
Persuasive game design principles	**Cooperation:** players have to accomplish a communal goal **Self-monitoring:** although there are no mechanisms provided for self-monitoring, players are still able to track their in-game performance and behaviour by comparing how they are doing now versus how the were doing in previous rounds for themselves	Remain the same

4.3 Varying the persuasive game design principle simulation

In chapter 3, it was discussed that assessing the effect of the persuasive game design principle simulation would be done by making three version in which the simulation principle would be varied. In order to make an informative decision on how to vary the design principle, literature was assessed. As seen in chapter 2, little literature is available about the persuasive game design principle simulation. Moreover, for this research, an own definition was given to the design principle. Therefore it was necessary to assess literature from other domains.

Eventually, it was chosen to assess literature on feedback because the concept of feedback is closely related to that of the persuasive game design principle simulation. Feedback can be defined as "information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way " (Ramaprasad, 1983). By providing players with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality, the persuasive game design principle simulation could be considered giving information that can be used to alter the gap between the actual level and reference level. The main difference between this concepts however is that the link between reality is explicitly made by showing consequences for the real system a game represents.

When it comes to giving feedback, there are four strategies in which feedback can vary (Brookhart, 2017, p. 15): timing, amount, mode and audience. Timing refers to when the feedback is given, and how often. Amount refers to the richness of the feedback, i.e. how much feedback is given and on how many different points. Mode refers to the mode that is used to provide feedback, which usually varies from oral, written or visual feedback. Finally, audience refers to whether the feedback is given plenary or individually.

Eventually, it was chosen to vary the persuasive game design principle simulation using the timing strategy. Varying the mode and audience strategies would not provide game versions in which the persuasive game design principle simulation would be present to different extents; it would only vary the way in which the persuasive game design principle simulation is presented. Furthermore, varying these strategies could require the presence of a facilitator, which would violate specification AS05. Moreover, varying the amount of the feedback may cause for difficulties, as providing richer feedback can give away too much information on how the game should be played. This could lead to deviations in the game flow and the game experience, which would make it difficult to measure and compare the effect of the persuasive game design principle simulation.

As mentioned before, the timing strategy can be varied in two ways: how often the principle occurs and when it occurs. It is chosen to only vary how often the simulation principle occurs in the game. This allows for observing the effect on attitude reinforcement/change when the persuasive game design principle simulation is more/less present or not present at all, which is of interest for answering the main research question. Varying 'when' the persuasive game design principle is present in the game (e.g. at the beginning, middle or end) would only allow to compare at which momentum in the game the persuasive game design principle would be more effective.

Varying timing of the simulation principle and formulating the message

The implementation of the timing strategy (how often) will be as follows. There will be one game version where the simulation principle will not occur at all, which will be called the 'no simulation' version. Next, there will be a version in which the simulation principle will be present at each round, called the 'simulation' version. Finally, there will be a game version where the simulation principle will only be present between the second and third round, called the 'in between' version.

The 'feedback' provided by the persuasive game design principle simulation will be presented as written text on cards, which are called simulation cards. Written text is preferred over audio or visual presentations as it is believed that it allow people to carefully process arguments for persuasion for themselves. When using other modes, players can be given the impression that issue-relevant arguments are forced upon players and gives them less opportunity to process the message themselves (Petty & Cacioppo, 1986). Furthermore, using written text was also more convenient as it does not require for the presence of a facilitator during game sessions.

To comply with the definition of the persuasive game design principle simulation, the format of the simulation cards should at least include the cause and effect relationship of the behaviour, and the link to reality of their behaviour. However, the message should be carefully formulated as it should not suggest how the game should be played or about how the game can be won. This would allow for the persuasive game design principle 'suggestion' to be added to the versions with the simulation cards, which would violate specification AS09. Therefore, the words 'cooperation' and 'information sharing' will not be used. Instead, the word 'together' will be used to indicate whether the players are using the right strategy (cooperation and information sharing) for reaching the goal of the game.

Regarding the written text, two options have been tested. In the first option, there was only given feedback on the general process, saying *'Due to your inability to make truck platooning together, you were not able to reduce CO2 emissions/Traffic accident/Traffic congestion/Fuel use'*. In the second option, the feedback was focussed on one of the three KPIs (technology

maturity, infrastructure maturity and innovation adoption). For each KPI, a card would be drawn depending on the coloured area the KPI has reached after playing a round (see figure 6). The card would for example indicate what it means if the players were unable to get the KPI technology maturity to pass the red area (level 1 to 3) and the effects of that for the realization of truck platooning, and on the environment or economy: *'The technology maturity has reached its lowest level, meaning that the technology enabling truck platooning is not ready for the future at all. There are safety, standardization and efficiency issues. Due to your inability as a group of decision-makers to improve the technology and get the technology maturity to the required level together, there is no prospect yet of realizing truck platooning. Reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seem far away.'*

It appeared that the richer message was preferred during playtesting, as it gave players also more context on the three KPI's in the game, which were before the addition of the simulation cards referred to as "just letters without context".

Additionally, it was pointed out during the test sessions that the message should be more positive or negative when a certain KPI goes up or down due to the game play. Therefore, it was chosen create multiple cards for each coloured area for the simulation version and place them in a certain order on the board. If the KPI technology maturity would remain in the red area for example, players get to draw another red simulation cards in which the message would be more negative, considering that there is a long way to go to real the goal of the game. If the KPI would reach or remain in the yellow area, the message would be less negative than in the red area since the KPI was getting closer to the goal. When reaching the green area, the message was more positive. However, the messages needed to be framed in such a way that they don't praise players for their game play, as that would allow for the addition of the 'praise' principle and again violate specification AS09.

In total, for the simulation version, 36 simulation cards were formulated (for each KPI four red, yellow and green cards). For the in between version, twelve simulation cards were created (for each KPI one red, yellow and green card). The messages were not completely identical, as that could cause for frustration and boredom with the players. However, the core of the messages remained the same. An overview of the cards can be found in Appendix D5.

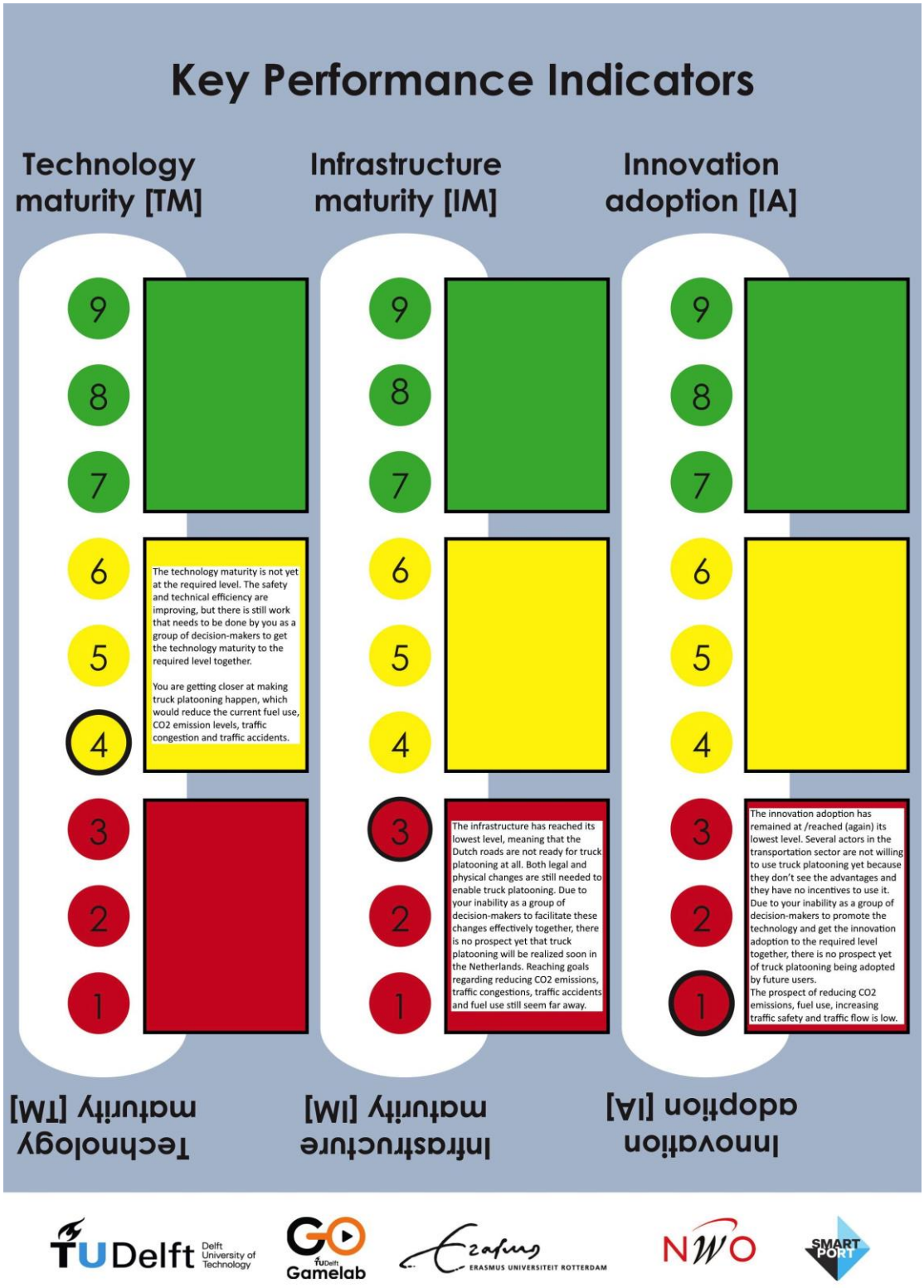

Figure 6: Drawing simulation cards corresponding to the coloured area of the level that is reached for the KPI in a certain level (indicated with a bold black ring). To improve readability, a complete overview of the text can be found in Appendix D5.

Game play with the simulation cards

In the no simulation version, no simulation cards will be drawn as the persuasive game design principle is not present in the game. For this version, the original steps of play will be followed:

1. Decide to play an action card or to remain inactive
2. Share your decision by simultaneously putting your action cards on the board
3. Pay for your own action card
4. Decide together which action cards will be activated
5. Follow the instructions of the activated action cards and return the non-activated cards to the player. Investment on the non-activated cards are returned to the pile of money.
6. Draw an external event card and receive extra tokens

For the in between and simulation version, the simulation cards are incorporated as follows. The simulation cards will be referred to as 'KPI level cards' to prevent any bias from occurring by the name of the cards. These will be drawn after the external events cards are drawn (the last step of the original steps of play). By doing it in this way, the regular game play in all versions will not be interrupted.

In the in between version, the steps of play will be as follows:

7. Decide to play an action card or to remain inactive
8. Share your decision by simultaneously putting your action cards on the board
9. Pay for your own action card
10. Decide together which action cards will be activated
11. Follow the instructions of the activated action cards and return the non-activated cards to the player. Investment on the non-activated cards are returned to the pile of money.
12. Draw an external event card and receive extra tokens
13. **Between the 2nd and 3rd round, draw a KPI level card for each KPI that corresponds to the colour of the area in which the KPI level currently is. Read the KPI level cards out loud, and set the cards it aside. Remove the remaining cards from the board and proceed to the 3rd round.**

In the simulation version, the steps of play will be as follows:

1. Decide to play an action card or to remain inactive
2. Share your decision by simultaneously putting your action cards on the board
3. Pay for your own action card
4. Decide together which action cards will be activated
5. Follow the instructions of the activated action cards and return the non-activated cards to the player. Investment on the non-activated cards are returned to the pile of money.
6. Draw an external event card and receive extra tokens
7. **Draw a KPI level card for each KPI that corresponds to the colour of the area in which the KPI level currently is. Read the KPI level cards out loud, and set the cards it aside.**

It was chosen to require players to remove the remaining and used cards from the board to prevent a mechanism would be added that would allow players to monitor their progress. This would allow for the persuasive game design principle self-monitoring to be more present in the games than in the no simulation version, and thus violate specification AS09.

For both versions, the text used for the simulation cards can be found in Appendix D. For all versions, the steps of play are elaborated on in a self-explanatory document that includes all game instructions that will be handed out to players during the game play. These can be found in Appendix C.

4.4 Verifying the game versions and game design process

For the verification of the game designs, it will be assessed whether the specifications formulated in chapter 4 are met. All specifications were formulated based on the literature and expert interviews regarding the design of persuasive games and the design of laboratory experiments. Therefore, when all specifications are met, it is perceived that the designed games and accompanying constructs for the game session are suitable for conducting this research.

The verification of the game versions was done by playtesting the games with four students. In table 5, an overview of the evaluation is presented. It appeared that all specifications for the game versions were met and therefore, all game versions are assumed to be suitable for this research. A complete overview of the game materials can be found in Appendix D.

Table 5: Overview of the reflection on the design and process specification

ID	Short description	Met?	Notes
AS01	Maintain the persuasive message of the original Mobinn game	Yes	
AS02	Maintain the original roles of the original Mobinn game	Yes	
AS03	Games include real life dilemmas regarding cooperation in multi-actor decision-making	Yes	More dilemmas added by adding objective to solve the issues of the actors
AS04	Games are playable within one hour	Yes	
AS05	Games are playable without facilitator	Yes	
AS06	Games are understandable for CoSEM T&L students	Yes	
AS07	Games are physical board games containing physical content	Yes	
AS08	Games remained games and are not stripped down to exercises	Yes	
AS09	Games don't include any additional persuasive game design principles	Yes	
PS01	Three game versions are conceived in which the persuasive game design principle simulation is being gradually varied	Yes	Varied according to timing strategy
PS02	All three game version were conceived within three weeks	Yes	
PS03	The deliverables include scripted briefing of the game, briefing of the research, cover story, debriefing and facilitator feedback	Yes	Debriefing was moved to after the research was finished
PS04	The deliverables include self-explanatory game instructions	Yes	

5. Results: assessing the persuasive power of the persuasive game design principle simulation

This chapter aims to answer the final two sub-questions of this research:

- *What is the short-term effect of the persuasive game design principle simulation on attitude change regarding cooperation in persuasive games for multi-actor decision-making?*
- *What is the long term-effect of the persuasive game design principle simulation on attitude change regarding cooperation in persuasive games for multi-actor decision-making?*

Using the research method, measurement instruments and persuasive games that were designed and presented in the previous chapters, five game sessions were conducted. Before and after the game sessions, quantitative and qualitative measurements were derived in order to be able to assess attitude change and the effect of the persuasive game design principles and to answer the aforementioned sub-questions.

In this chapter, the analyses are presented that were performed on the quantitative and qualitative data. In section 5.1, general insights regarding participant characteristics and the course of the game session are discussed. Section 5.2 presents the results of the quantitative analyses, including an assessment of the game experience between the different game versions and attitude changes. Finally, in section 5.3, the qualitative analyses are presented together with a triangulation on the results of the quantitative analyses and theories.

5.1 General insights

5.1.1 Participants characteristics

The aim was to recruit students from the transportation domain of the CoSEM master's programme to ensure that varieties in personal relevance maintained the same. However, only three students agreed to participate in the study that met this requirement. As it appeared to be difficult to find twenty-four students that met all requirements and that were able to participate in a one hour game session on a given day, it was decided to also recruit students from other domains of the CoSEM master's programme and from other master programmes at the Delft University of Technology.

Eventually, twenty students agreed to participate in the study, of which two female and eighteen male students. From all students, sixteen students were from the master's programme Complex Systems Engineering and Management, one from the study Engineering and Policy Analysis, one from the study Management of Technology and one had completed the bachelor study Molecular Science and Technology. The age of the participants was varying from 21 to 38, with an average of 25,7 years.

The sample group cannot be considered entirely homogeneous based on study background and age. Therefore, it cannot be excluded that study background and age have acted as possible confounding factors. Furthermore, it cannot be ensured that the level of personal

relevance is the same among all students. This will be considered a limitation to this research. Nevertheless, all students are students from a technical university who have completed a bachelor's degree. Also, students were provided with information about truck platooning before playing the game to ensure that all students had the same basic knowledge.

Finally, it will not be possible to provide insights on the influence of gender on the effect of the persuasive game design principle simulation considering that there are too few observations for the female gender (*N* = 2). All students were allocated to groups based on their days of preference. Pictures of the game sessions per game version are presented in figure 7, 8 and 9.

Figure 7: Game session for the no simulation version

Figure 8: Game session for the in between version

Figure 9: Game session for the simulation version

5.1.2 Unequal groups

In chapter 3, it was discussed that the aim was to conduct at least two game sessions for each game version. Considering that each game session requires four players and that there are three versions, at least twenty-four students had to be recruited. However, as mentioned in the previous section, only twenty students agreed to participate in the study. In order to be able to conduct an equal amount of game sessions for all game versions, the game sessions were postponed for a week to buy more time to recruit participants. Unfortunately, this attempt was unsuccessful. Postponing the game sessions further was not possible due to the limited time span of this study.

Consequently, for one game version, the *no simulation version*, only one game session has been conducted instead of two. This means that unequal groups will be compared in this study and considering that the amount of observations within the no simulation version is very small (*N*= 4), chances are higher that no statistically significant effect will be found in the attitude measurements when assessing the no simulation version.

5.2 Quantitative results

5.2.1 Game experience

To ensure that the game experience of all game versions has remained equal and thus to assess whether game experience may have acted as confounding variable, the in-game version of the Game Experience Questionnaire (GEQ) by Ijsselsteijn, De Kort & Poels (2013) was used as a tool to measure the game experience within the three different game versions. The questionnaire exists of fourteen statements, which measure seven components on a 5-point interval scale (0 = not at all, 1 = slightly, 2 = moderately, 3 = fairly and 4 = extremely). The seven components are competence, sensory and imaginative immersion, flow, tension, challenge, negative affect and positive affect. For each component, the questionnaire included two items (see chapter 3).

As mentioned in chapter 3, due to the small sample sizes, the Kruskal-Wallis H test was performed for each game experience component to compare the averages of the three groups. The results showed that there are no statistical significant differences in game experience between the different groups at the alpha 0.05 level. This indicates that game experience has maintained the same throughout all game versions and that game experience may not have acted as confounding variable within this research. Table 6 provides an overview of the means and standard deviations of each component per group, together with the H statistics and corresponding p-values.

Table 6: Means (and standard deviations) for game experience components per group

Component/Version	**No simulation (*N*=4)**	**In between (*N*=8)**	**Simulation (*N*=8)**	**Kruskal-Wallis H (and p-value)**
Competence	1.50 (0.91)	1.38 (1.22)	2.38 (0.58)	3.40 (0.18)
Sensory and imaginative immersion	3.13 (0.85)	2.19 (1.25)	2.63 (0.88)	1.82 (0.40)
Flow	1.75 (0.96)	1.44 (1.15)	2.31 (0.75)	2.17 (0.34)
Tension	1.38 (0.48)	1.81 (1.13)	1.56 (0.86)	0.73 (0.69)
Challenge	2.50 (0.41)	2.25 (0.71)	1.94 (1.10)	2.47 (0.29)
Negative affect	0	0.63 (0.69)	0.19 (0.26)	4.92 (0.09)
Positive affect	1.88 (1.03)	1.63 (1.30)	2.63 (0.35)	2.66 (0.27)

5.2.2 Attitude reinforcements: a quantitative analysis

Reliability analysis: checking if the same attitude construct is measured

As mentioned in chapter 3, the internal consistency of the items was measured by performing a reliability analysis. This allows for measuring the reliability coefficient with Cronbach's alpha. In general, when values for Cronbach's alpha are lower than $\alpha = 0.7$, the internal consistency is perceived to be too low and aggregating the items would not provide a reliable construct (Hair, Black, Babin & Anderson, 2014, p. 123).

Table 7 provides an overview of the internal consistency of the four items for cooperation and information sharing in the pre-game measurements, post-game measurements and long-term measurements. As mentioned before, all items for the attitude measurements were assessed on a 9-point semantic differential scale using four items [good/bad, beneficial/harmful, foolish/wise, and unfavourable/favourable] (see chapter 3). For the attitude towards cooperation construct, the reliability analysis showed that aggregating all four items would provide reliable constructs. Removing any item would not provide a more reliable construct. For the attitude towards information-sharing construct however, for the post-game survey, aggregating all four items would not provide a reliable construct ($\alpha = 0.691$). However, when removing the unfavourable-favourable item, Cronbach's alpha would increase to $\alpha = 0.883$. Since the constructs are being compared in the three different measurements, to prevent any bias, it was decided to remove the unfavourable-favourable item in all measurements for the information-sharing construct in all measurements. Removing this item would slightly increase Cronbach's alpha in the pre-game measurements ($\alpha = 0.916$), but decrease in the long-term measurements ($\alpha = 0.797$). However, the value of Cronbach's alpha still exceeds the lower limit of 0.7 and is thus still acceptable.

For this research, the construct for attitude towards cooperation will consist of the average of all four items. For the information-sharing construct, one item (unfavourable-favourable) is removed and thus, the construct will consist of the average of three items instead of four.

Table 7: Reliability analysis on the cooperation and information-sharing construct (Cronbach's alpha)

Construct	**Pre-game**	**Post-game**	**Long-term**
Cooperation (with 4 items)	α = 0.790	α = 0.837	α = 0.836
Information sharing (with 4 items)	α = 0.914	α = 0.691	α = 0.844
Information sharing (without unfavourable-favourable item)	α = 0.916	α = 0.883	α = 0.797

Initial attitudes

A first assessment was done on the pre-game attitudes, which are referred to as the initial attitudes. For the interpretation of the attitudes, it was chosen to consider attitude scores lower than 5 negative attitudes (unfavourable thoughts), scores higher than 5 positive attitudes (favourable thoughts) and scores of 5 were considered neutral attitudes. This is similar to the classification of attitudes by Petty & Cacioppo (1984) and in the ELM (Petty & Cacioppo, 1986).

For attitude towards cooperation, all participants had a positive initial attitude, with an average score of 7.61. The average score for the attitude towards information sharing was 6.17. Five participants had a negative initial attitude towards information sharing, with scores varying from 1 to 4.66. One participant had a neutral initial attitude towards information sharing with a score of 5. If the attitude towards information sharing has become positive for these participants after the game-play, it will be considered an attitude change. For participants with positive initial attitude towards cooperation and information sharing, it will be considered attitude reinforcement.

The initial attitude towards cooperation and information sharing in the different groups is depicted in the boxplots in figure 10 and figure 11. A striking observation is that the initial attitude scores in the in between group are lower than in the other groups. For attitude towards cooperation, the in between group had an average score of 6.69; while in the other groups had average scores of 8.31 (no simulation) and 8.19 (simulation). The Kruskal-Wallis H test confirmed that there is a statistically significant difference between the groups at the alpha 0.05 level (p = 0.03).

The difference between the groups cannot be explained by deviations in study background and age and are probably caused by coincidence. Although there were more students with a different study background in the in between group than in the other groups, the Kruskal-Wallis H test indicated that there was no statistical significant difference between the attitudes of students from CoSEM (N = 5, M = 6.70) and with other study backgrounds (N = 3, M = 6.67) at the alpha 0.05 level (p = 0.88). Furthermore, there were no outliers for age in the in between group. The average age was 24.5, which is relatively close to the average age of all participants (M = 25.7).

The average scores for attitude towards information sharing between the groups were fairly close, with an average score of 6.41 for no simulation, 5.88 for in between and 6.25 for simulation. Although the average attitude score is lower in the in between group, the Kruskal Wallis test confirmed that there are no statistically significant differences between the groups at the alpha 0.05 level (p = 0.62).

Based on these results, it cannot be claimed that the groups are entirely homogeneous. Due to the differences in initial attitude towards cooperation, comparing attitude reinforcements between the groups will be difficult. Still, comparing attitudes towards information sharing between the groups is possible since there is no statistical significance difference found for initial attitudes between groups. Furthermore, the initial attitude towards cooperation is already fairly high in the no simulation and simulation groups. This means that within these groups, there is little room for the attitudes to improve. It is therefore expected that the attitude towards cooperation can only reinforce to a small amount, which may be too small to be detected by a statistical test.

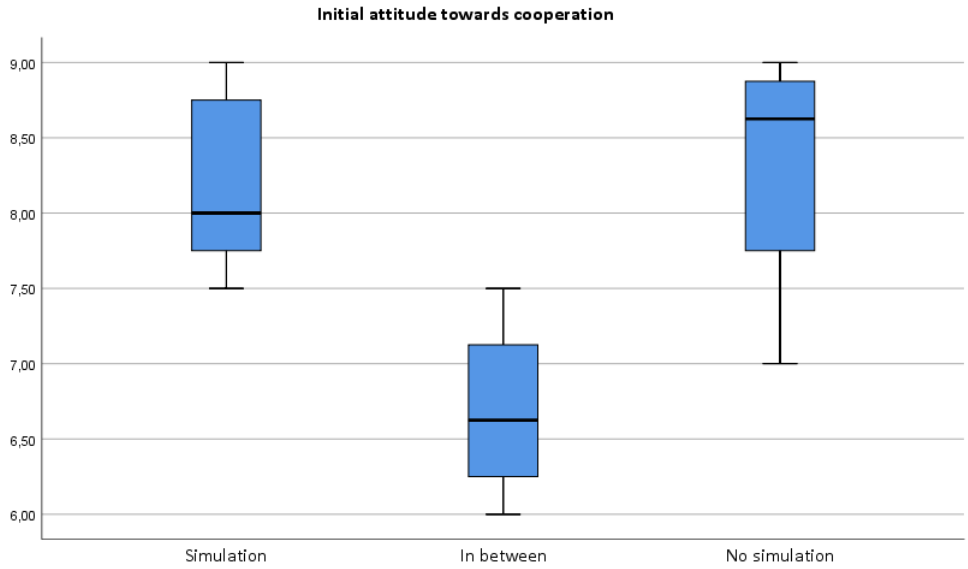

Figure 10: Boxplots of initial attitudes towards cooperation per group

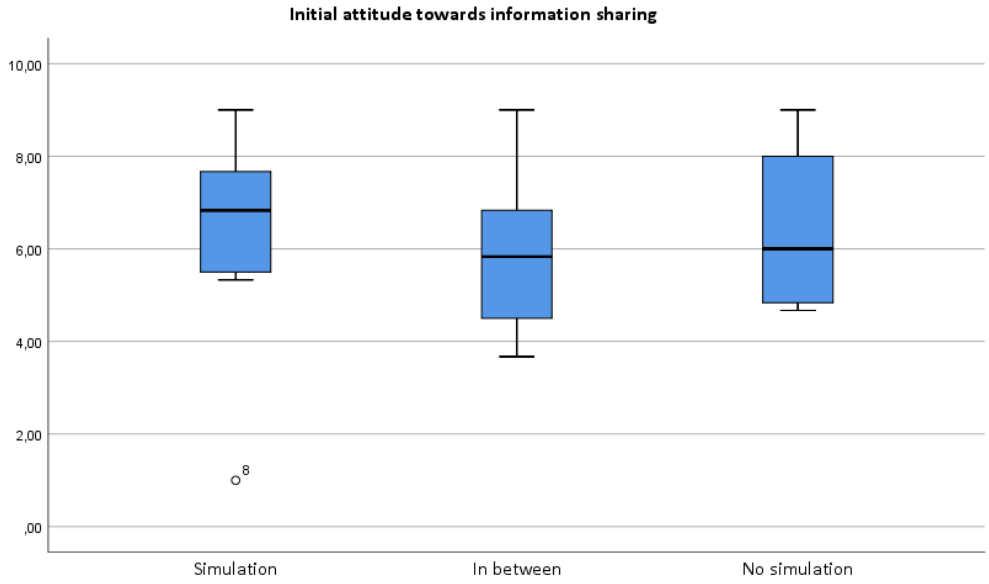

Figure 11: Boxplots of initial attitudes towards information sharing per group

The short-term effects

On the short-term, attitude towards cooperation was reinforced within all groups. However, there was only one group for which a statistical significant difference was found between the initial attitudes and after-game (short-term) attitudes at the alpha 0.05 level. The Wilcoxon Signed-Ranks Test indicated that for the attitudes of the participants who played the *in between version* (*N* = 8), there is a statistical significant difference at the alpha 0.05 level between the attitude towards *cooperation* immediately after the game play (*Mdn* = 8.500) and before the game play (*Mdn* = 6.625), with *Z* = -.521 and *p* = 0.006. When assessing the ranks, it shows that for the majority of cases there was an attitude reinforcement towards cooperation (*N* = 6), while there was one case in which the attitudes has remained the same (*N* = 1) and one case where the attitude towards cooperation had become more negative after playing the game (*N* = 1).

Regarding the attitude towards information sharing, there were also attitude changes and reinforcements within all groups on the short-term. There were two groups for which a statistical significant difference was found between the initial attitudes and after-game (short-term) attitude at the alpha 0.05 and 0.01 level. The Wilcoxon Signed-Ranks Test indicated that for the attitudes of the participants who played the *simulation version* (*N*= 8), there is a statistical significant difference at the alpha 0.01 level between the attitude towards information sharing immediately after the game play (*Mdn* = 8.667) and before the game play (*Mdn* = 6.830), with *Z* = -2.336 and *p* =0.009. When assessing the ranks, it shows that for the majority of cases there was an attitude reinforcement towards information sharing (*N* = 7), while there was one case in which the attitudes has remained the same (*N* = 1) and no cases where the attitude towards information sharing had become more negative than the initial attitude (*N* = 0).

Furthermore, the Wilcoxon Signed-Ranks Test indicated that for the *in between version* (*N* = 8), there is a statistical significant difference at the alpha 0.05 level between the attitude towards information sharing immediately after the game (*Mdn* = 8.667) and before the game play (*Mdn* = 5.830), with *Z* = -2.371 and *p* = 0.018. This means that immediately after the game, participants who played the in between version had a more positive attitude

towards information sharing than they did have before playing the game. When assessing the ranks, it shows that for the majority of cases there was an attitude reinforcement towards information sharing (*N* = 7), while there was one case in which the attitudes has remained the same (*N* = 1) and no cases where the attitude towards information sharing had become more negative than the initial attitude (*N* = 0).

The long-term effects

On the long-term, attitude towards cooperation was reinforced within all groups. However, there were no statistical significant difference found between the initial attitudes and long-term attitudes at the alpha 0.05 level.

Regarding the attitude towards information sharing, there were also attitude reinforcements and changes within all groups on the long-term. Again, there were two groups for which a statistical significant difference was found between the initial attitudes and long-term attitudes at the alpha 0.05 and 0.01 level. The Wilcoxon Signed-Ranks Test indicated that for the attitudes of the participants who played the *simulation version* (*N*=8), there is a statistical significant difference at the alpha 0.01 level between the attitude towards information sharing after the game play (long-term) (*Mdn* = 8.165) and before the game play (*Mdn* = 6.380), with *Z* = -2.371, *p* = 0.009. When assessing the ranks, it shows that for the majority of cases there was an attitude reinforcement/change towards information sharing (*N* = 7), while there was one case in which the attitudes has remained the same (*N* = 1) and no cases where the attitude towards information sharing had become more negative than the initial attitude (*N* = 0). This is identical to the results of the short-term measurements and indicates that there was a lasting attitude reinforcement/change for the simulation group.

Furthermore, the Wilcoxon Signed-Ranks Test indicated that for the attitudes of the participants who played the *in between version* (*N* = 8), there is a statistical significant difference at the alpha 0.01 level between the attitude towards information sharing after the game play (long-term) (*Mdn* = 8.335) and before the game play (*Mdn* = 5.380), with *Z* = -2.117 and *p* = 0.019. When assessing the ranks, it shows that for the majority of cases there was an attitude reinforcement/change towards information sharing (*N* = 6), while there was one case in which the attitudes has remained the same (*N* = 1) and one case where the attitude towards information sharing had become more negative than the initial attitude (*N* = 1). It appears that over time, one person has obtained a more negative attitude towards information sharing. On the short-term however, no participants had obtained a more negative attitude towards information sharing after playing the game. This means that in one case, there was not a lasting attitude change. Still, based on the result it could be said that on the long-term, participants who played the in between version had a more positive attitude towards information sharing than they did before playing the game. This indicates that there was a lasting attitude reinforcement/change for the in between group.

The means and standard deviations of the attitude towards cooperation and information sharing on the short-term and long-term are presented in table 8. Figure 12 and 13 present the boxplots of the initial, short-term and long-term attitudes towards cooperation and information sharing per group.

Table 8: means (and standard deviations) of the attitude towards cooperation and information sharing on the short-term and long-term effects per group

Attitude towards	**Cooperation**	**Information sharing**

Version	Initial	Short-term	Long-term	Initial	Short-term	Long-term
Simulation	8.19 (0.59)	8.47 (0.41)	8.06 (0.88)	6.25 (2.44)	8.50 (0.56)**	8.08 (0.90)**
In between	6.69 (0.53)	8.44 (0.55)*	7.66 (1.30)	5.88 (1.73)	8.50 (0.62)*	7.88 (1.44)*
No simulation	8.31 (0.90)	8.75 (0.50)	8.19 (1.46)	6.49 (2.01)	8.58 (0.50)	7.67 (1.36)

**Statistically significant difference found at the alpha 0.05 level*
*** Statistically significant difference found at the alpha 0.01 level*

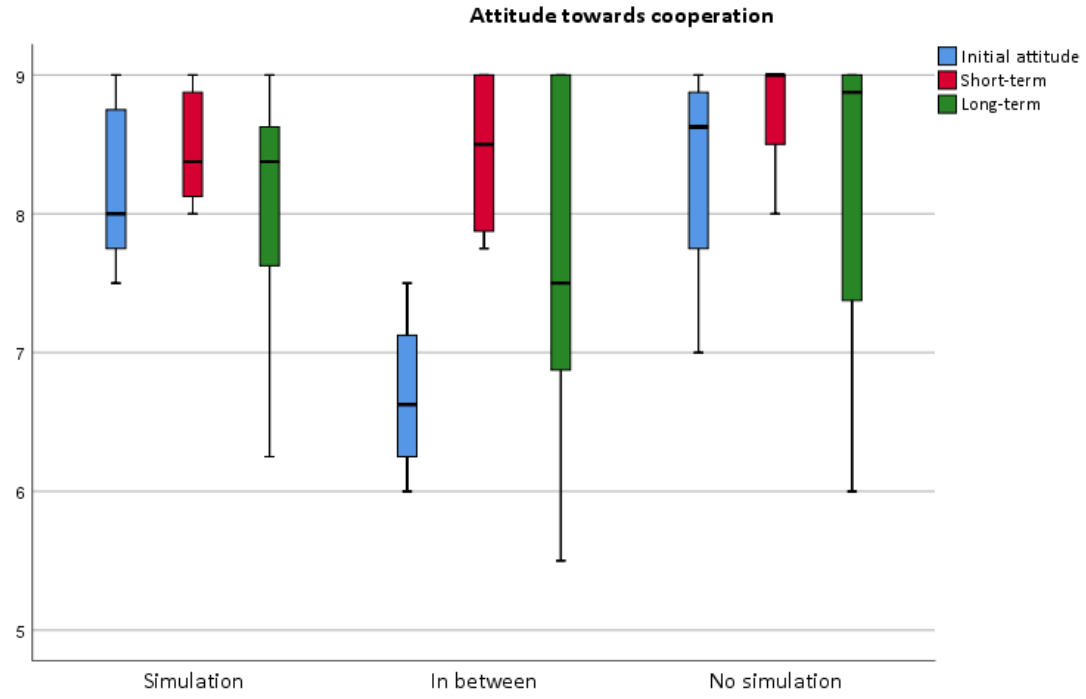

Figure 12: Boxplots of initial, short-term and long-term attitudes towards cooperation per group

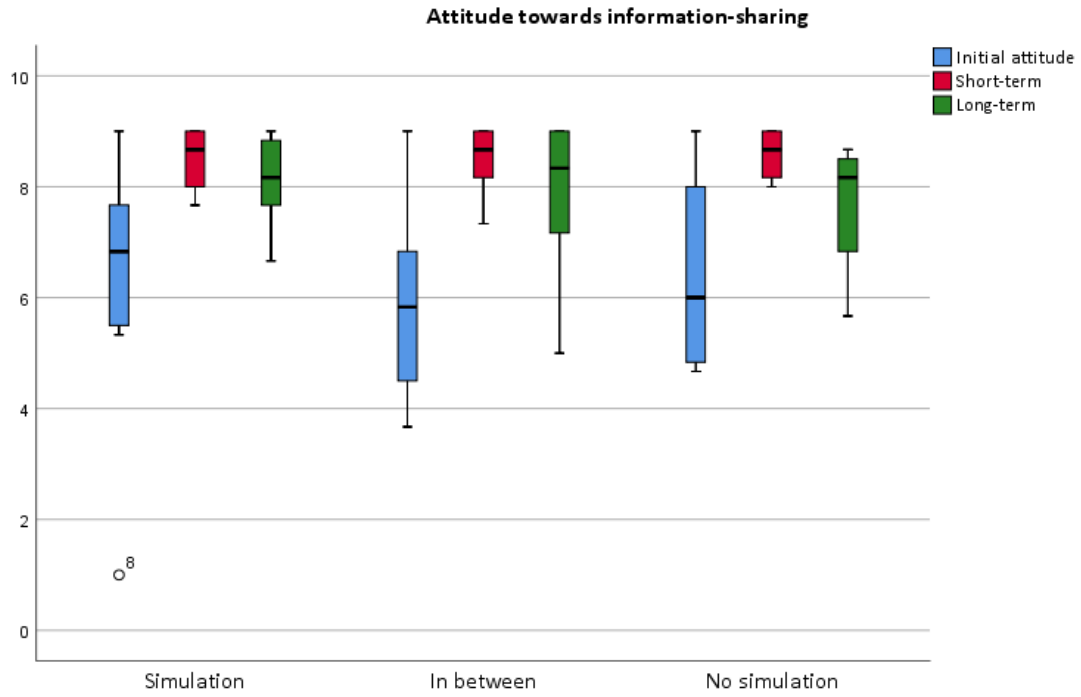

Figure 13: Boxplots of initial, short-term and long-term attitudes towards information sharing per group

Comparing short-term and long-term effects on attitude change towards information sharing

When comparing the attitude reinforcement towards information sharing found in the in between and simulation group, an interesting observation was made. Participants who played the in between version experienced a slightly stronger attitude reinforcement (Δ = 2.62) than participants who played the simulation version (Δ = 2.25) on the short-term. This also appeared to be the case for the long-term effect (Δ = 2.00 for in between version and Δ = 1.83 for simulation version). However, participants in the in between group had a lower initial attitude score than participants in the simulation group. The attitude reinforcements and changes could therefore be considered equally as strong.

5.2.3 Reflection on quantitative results

The quantitative results indicate that only for attitude towards information sharing there have been statistically significant differences found in the in between and simulation groups on the short-term and long-term. This indicates that within these groups, there has been a lasting attitude change. The main difference between these groups and the no simulation group is the presence of the persuasive game design principle simulation.

The results indicate that the presence of the persuasive game design principle simulation might have an effect on a lasting attitude reinforcement/change towards information sharing. However, statements about the effect of the persuasive game design principle simulation cannot be done just based on the results of these quantitative analyses. First of all, as mentioned before, this study deals with small sample sizes. As a result, standard deviations are bigger than they would be when the sample sizes would be bigger. Due to this, the power to detect the true effect on attitude reinforcement/change is lower (Baldi & Moore, 2009, p. 379). This means that there is a chance that it has been wrongfully rejected that there has been no statistical significant attitude reinforcement/changes in the other cases. Furthermore, when comparing means (table 8), it is clearly shown that there have

been attitude reinforcement/change towards both cooperation and information sharing in all groups.

Second, as mentioned before, initial attitudes towards cooperation were already relatively high. Therefore, there was little room for the attitudes to improve, which may explain why no statistical significant differences were found for attitude reinforcement towards cooperation.

Still, the quantitative results point in a certain direction, which is that the persuasive game design principle simulation may have affected attitude reinforcement/change towards information sharing. To confirm these findings, it will be assessed in the next section whether the complementary qualitative analyses provide consistent and convergent results.

5.3 Triangulation: mixing quantitative and qualitative data on the effect of the persuasive game design principle simulation

Qualitative data has been gathered in the form of interview data. For each game version, two game sessions were conducted except for the no simulation version. From each game session, one participant was interviewed. From the game session for the no simulation version, two participants were interviewed. This makes a total of six interviewees.

The aim of the qualitative analyses is to assess whether the quantitative results can be confirmed. Additionally, the qualitative data also provides the opportunity to explore what factors or elements contributed to the occurrence of attitude reinforcement/change. In the coming sections, the qualitative results are presented together with a triangulation of the quantitative results and theories. This allows for assessing attitude change from different perspectives, which allows for a richer understanding of the attitude change that has occurred in this research.

5.3.1 General insights regarding game-play and insights gained by participants

The game play in all versions was fairly similar. All participants emphasized with their roles and tried to protect the core values that they were given. In the early rounds, there was little cooperation and information sharing, however, most groups realised after a round or two that it was more efficient to cooperate and share information. There was only one group who played that immediately started to cooperate and share information (simulation version). It was overheard that one player in this said that these two strategies were mentioned in the pre-game survey and that they should probably be applied in the game. The interviewee from this group also expressed his concerns regarding the effect of pre-surveys:

"I think the survey that is given in advance has a great influence on the way you play the game. Or what is really important in the game."

It is assumed that the pre-game survey induced a bias in this group. In most cases, the pre-game survey was filled less than 24 hours before the game session, which could explain why the strategies were still fresh in memory. The pre-game survey may have caused for the creation of cognitions regarding cooperation and information sharing, which may have been activated during the game play by game elements and caused for participants to play in favour of these strategies. In social psychology this is referred to as priming (Bargh, Chen & Burrows, 1996).

However, the text used in the pre-game survey was not in favour of any particular strategy (see Appendix A). Favourable thoughts regarding cooperation and information sharing were thus not brought upon participants by the pre-game survey, but there is a possibility that the pre-game survey, study background and prior knowledge regarding cooperation and information sharing combined may have played a priming role together. By causing for a different game flow, it is possible that this priming effect may have caused for a different game experience. However, the game experience assessment showed that there were no statistical significant differences for game experience between groups, indicating that this may not has acted as a confounding variable in this research.

Eventually, all interviewees from all game versions mentioned that the most important lesson that they took away from the game was that information sharing and cooperating is very important when realizing an innovation process. This seems to be in line with the quantitative results, which showed that in all groups there was attitude reinforcement/change towards both constructs although they were not statistically significant in all groups (see table 8).

Still, interviewees emphasized their thoughts and insights gained regarding information sharing more than cooperation. This indicates that information sharing affected them more, which is also consistent with the quantitative results. Some notable quotes from all game versions were:

"It was really nice that you can see that sharing information is actually really useful between different actors and that you can actually contribute, not only for your goal but for the common goal. And even if you don't.. like don't invest in your projects, you can still gain profits from investing in the other projects."- No simulation I2

"Sharing information really helped us.. knowing what the problems or benefits are for other parties." – In between I4

"Information sharing, when reaching a common goal, is very useful. […] If possible, put your personal interests aside as much as possible and put the interests of the group first" – Simulation I5

5.3.2 Explanations for attitude change towards cooperating and information sharing

In order to be able to track down what factors/game elements has caused the participants to make strong statements about the importance of cooperating and sharing information, they were asked what factors/game elements had contributed to gaining those insights. During the interview, the physical game elements were present so that interviewees were able to point them out. Participants were only asked to elaborate on the factors/game elements that they pointed out themselves. These will be categorized and briefly discussed in the remainder of this section.

It was not directly asked how the simulation cards affected them. As mentioned before, this was done to prevent that participants would get the impression that this is the element of interest for the research and will provide biased answers. During the game sessions, indeed participants gave the impression that they were searching for what game elements were of interest for this research. Consequently, they tried to give desirable answers regarding the elements they thought were of interest.

Prior Knowledge

Two interviewees, one who played the in between version and one who played the simulation version, expressed that they had prior knowledge on the importance of cooperating and sharing information during in multi-actor settings:

"It was actually already with the survey that you had sent in advance .. with such things I would always fill yes cooperation is best. I mean, here at Delft University of Technology you always have to work together and then thwarting each other a little makes no sense at all" – Simulation I6

"[…] Something professor Hans de Bruijn always says: good communication between everybody, what does everyone want and how do you get the best out of it" - In between I3

For both interviewees, no new ground-breaking insights were thus gained. However, interviewee In between I3 did acknowledged that for him, the game did contribute to his insights by confirming his prior thoughts:

"[...] I don't think the game has changed much in that respect, that insight with me. [...] But in that regard, it confirmed what I already thought, so that was very nice."

Prior knowledge, or knowledge and understanding, is known as one of the factors that affect the ability to process a persuasive message according to the ELM (O'Keefe, 2002, p. 144). It allows people to employ issue-relevant thinking, which can increase the strength of arguments when elaborating on the persuasive message of the game. This can decrease the effect of peripheral cues in the process, which allows for better engagement in the elaboration process (e.g. Laczniak, Muchling & Carlson, 1991). In this case, the prior knowledge was in favour of attitude towards cooperation and information sharing, which may have caused for stronger arguments in favour of cooperation and information sharing resulting in the desired persuasive effect.

Time pressure

For all game versions, when asked what provided them with insights to change their strategies in the game, there were some participants that indicated that they felt like the limited amount of rounds forced them to work more effectively together. The expressed that they experienced time pressure:

"It was just four rounds. So you can really not pay so much attention to your own personal issues if you want to reach the main goal. You have to play together with the others, maybe to first to reach the goals of the others and then to concentrate on your own." – No Simulation I2

"This was mainly because the fourth round was indeed the last round. And then everyone started to realize 'okay we only have 1 round and we have to get those goals in the green and they not even close yet.' So at that moment all personal interests were discarded." – Simulation I5

Time pressure is known to reduce the cognitive ability to process a persuasive message and could therefore attenuate processing a persuasive message through the central route of the ELM (e.g. Bitner & Obermiller 1985). However, the quantitative analyses provide contradicting results for attitude change towards information sharing and cooperation, showing that there was a lasting attitude change in all groups. This indicates that time

pressure may not have acted as a barrier for processing the persuasive message through the central route in this case, which shows of conservative results.

External events (game element)
A game element that was frequently mentioned in all game versions as a reason that made participants realize that they had to work together was the external events. The external events always had a negative effect on scores and amount of tokens. While most participants expressed that they felt frustrated due to the external events, in the in between and simulation group it led to the realization that participants had to work together more effectively in order to mitigate the events despite these frustrations:

"At one point we only had one external event card left. That made us turn that if we do not communicate what we are going to play and only discuss what we are going to do, then we are going to get in trouble" – In between I4

"The event card, which gave a setback that made everyone think that.. these tickets going to work against us so we have to anticipate that a little bit and if we don't do that, we probably won't succeed [at winning the game] [...] Due to that I thought that maybe the cooperation should increase more. But of course, I can't speak for the other players but this is what I thought." - In between I3

Still, as mentioned in chapter 4, intuitively one would think that this frustration could cause for distractions, which is one of the factors that may interfere with the ability to process a persuasive message according to the ELM (Petty & Cacioppo, 1986). It would therefore be expected that this game element might have acted as a barrier for elaborating on the persuasive message of the game. However, the quantitative results show the opposite. This could either indicate that the external events may not have caused for distractions, or it shows of a conservative result.

Still, a possible explanation for the fact that this specific game element was pointed out is due to social desirability bias. As mentioned before, it was noticed during the interviews that participants were actively looking for what game elements were of interest for this research. Participants gave the impression that they had the feeling that the elements of interest for this research were the external event cards. Therefore, there is a possibility that participants shed light upon this specific game element because of their own assumptions regarding the focus of the research.

Persuasive game design principles self-monitoring
Participants in the no simulation and in between version also indirectly indicated that insights regarding the importance of information sharing were gained through the persuasive game design principle self-monitoring (*Players are able to track their in-game performance and behaviour which allows them to monitor their past and current states*):

"So this was the contribution of the game.. how the information is flowing.. the information flow between the others and how this is.. The more you do this the more you know about the others and the more you are willing to the others. And you see that the results are getting higher and higher much faster than in the first round.. when I said I am going to be on my own" – No simulation I2

"Yes, because like I said, we had one round in which we actually shared little information, but compared to all other rounds, it was a bad round .. we made little progress" – In between I4

Self-monitoring is also referred to as feedback by Orji, Vassileva & Mandryk (2014). As mentioned before, feedback can be defined as "information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way " (Ramaprasad, 1983). By showing past and current states, self-monitoring can be considered providing information for closing the gap between the actual and desired level. In the same line as with the persuasive game design principle simulation, self-monitoring can thus contribute to gaining knowledge and understanding. This can increase the ability to process a persuasive message, which is considered an important determinant for elaboration to occur according to the ELM (Petty & Cacioppo, 1986). This can result in a lasting attitude change, as was outlined in the theoretical framework in chapter 2.

Self-monitoring was present in all game versions, which may explain why attitude reinforcement/change occurred in all groups as was shown by the quantitative results. Still, there was not a statically significant difference found in all groups. Also, self-monitoring or feedback was not literally mentioned by interviewees or addressed as the main reason for gaining knowledge and understanding regarding the important of cooperation and information-sharing. Nevertheless, the concepts of simulation and self-monitoring are closely related, which may have caused for interference in this study.

Persuasive game design principles cooperation

Regarding cooperation, different participants in the in between and simulation version indicated that for them it was obvious that they had to work together due to the cooperation principle (*Players are required to work together to accomplish a communal goal*):

"It is a cooperative game. So that already indicates like 'we are in this together so we are buddies here' " – In between I4

"If you were to play a board game like this and you had to win something yourself, it [cooperating] would be a bad strategy of course. But now it was also the goal to reach something together" – Simulation I6

According to the theory of the ELM, it is questionable whether the persuasive game design principle lead to reinforcements at all, considering that participants indicated that they felt like the game required them to cooperate. Due to this, cooperation may have been forced upon players by this persuasive game design principle. This may have provided them with less opportunity to process and elaborate on issue-relevant arguments for cooperation (Petty & Cacioppo, 1986). Still, there was an attitude change towards cooperation found in this group. This can also indicate a conservative result.

Simulation denial

During the interviews, it was also asked whether they thought that the game was a good representation of reality. This was asked to assess whether the implication of simulation denial (as part of simulation fever) mentioned in chapter 2 was present in the study. As mentioned before, simulation denial refers to the negative feelings a player has regarding a simulation. Since simulations are considered a subjective representation of reality and can only represent reality to a certain extent, simulation deniers often perceive simulations as useless, unreliable or dangerous (Bogost, 2008, p. 107).

Regarding simulation denial, participants stated that the game was a good representation of a real word situation up to a certain extent. Most participants in all game versions however questioned whether making decisions in a real life multi-actor decision-making process would go as swift as it went in the game:

"We soon abandoned our own interests, something that does not happen in the real world because people want to be better off themselves. We were basically throwing away everything just to raise as many KPIs as possible, but that won't happen in the real world" - In between I3

"*Maybe for the ideal situation it [the game] is representative, but for reality, especially from the government's point of view, I think [in reality] the process is quite lengthy because of what is unknown the process.*" - Simulation I5

Still, most participants praised the game, saying that it was a good way of creating awareness regarding cooperation and information sharing in multi-actor decision-making processes. Furthermore, none of the participants indicated that they regarded either of the game versions as useless, unreliable or dangerous due to it being a subjective representation of reality. Simulation denial may not have caused for implications in this research.

Persuasive game design principle simulation

Participants who played the versions in which the persuasive game design principle simulation was present (the in between version and simulation version) did mention little about the game elements that were added to the game to represent the simulation principle. Only one interviewee in the in between version briefly mentioned the simulation cards and its effect:

"We had the idea that those would also be events, but in the end it was more a description of how bad we were doing. But that also provided a reason for us to want to get up"

This indicates that the simulation principle may had an effect on the game play, however, when directly asking about the effects of the simulation cards after they were pointed out, the participant continued:

"The fact that they were there before they were turned over gave the impression that we had to do our best because probably, if we soon get into the green [area], then we would get a kind of benefit because we are doing well. Or we will be punished, but I hoped that that did not would be the case. But once they were gone, the effect was gone and it appeared that they were not that exciting at all."

Furthermore, these statements indicate that the simulation cards, and thus the persuasive game design principle simulation, may not have stood out in the game. A possible reason could be the mode that was chosen to present the persuasive game design principle (cards with text). It was noticed during the game play of the in between and simulation versions that the texts on the simulation cards were not always read out because they did not have any effect on the game play. Whether they had any effect in the game remains questionable, considering that only one interviewee pointed them out.

In attempt to gain more insights about the effect of the persuasive game design principle simulation without asking participants directly, participants were asked if they became aware of the cause and effect relationship of their behaviour and its link to reality (the

definition of the persuasive game design principle simulation), and how that affected them. Regarding the cause and effect relationship of their behaviour, most participants said that they did see that not cooperating and sharing information with others had a bad influence on the game play. This was because the negative effects of not cooperating and sharing information was reflected on the game scores. This indicates that self-monitoring (feedback) may have played a role in gaining knowledge and understanding regarding the importance of cooperating and sharing information. However, none of the interviewees mentioned the word concept of self-monitoring or feedback.

A striking observation is that none of the interviewees made the link to real system that the game represents, or did even think about the consequences of not cooperating and sharing information for the real innovation process, the economy or the environment. Regarding the latter, the majority of the participants indicated that they did not pay attention to the context of the game:

"Of course we understand the idea of truck platooning, that it has positive effects and things like that. But from a game perspective, it is hard to keep that in mind because you are mainly looking at whether you can get the statistics right again instead of how you can get the story right" – In between I4

"But in the end if you are playing the game then it is mainly 'playing the game and following those rules and scoring points.' And then the story of platooning is perhaps a kind of context that doesn't really matter." - Simulation I6

When asked if they could explain why little attention was paid to the context of the game, participants indicated that the texts on the action cards were too long and that playing such a game with students from the Delft University of Technology is also not helpful, considering that they are all focusing on the 'game statistics'. Natasa Roukouni, who facilitated game sessions for the original Mobinn game with both real life actors and students, also noted the difference between playing the game with students and real actors. She confirmed that students played the game with a strategy to win the game from the beginning, while real actors focussed much more on the negotiations because they included information they were familiar with from real life barriers (Roukouni, personal communication, May 3, 2019). Considering that there has been an attitude change in all groups on the long term, this indicates that although personal relevance may have been low, participants were motivated to process the persuasive message.

5.3.3 Reflection on qualitative results

The integration of quantitative and qualitative analyses and theory did not confirm that the statistical significant difference found during the quantitative analyses for attitudes towards information sharing in the in between and simulation version are caused by the persuasive game design principle simulation. However, it can also not be confirmed that any of the other factors elements mentioned above have caused attitude changes to occur. Based on the triangulation, assumptions were made about whether the abovementioned elements may have affected attitudes. However, based on current data, these assumptions cannot be confirmed. It is assumed that social desirability bias and the use of indirect interview questions regarding the effect of the persuasive game design principle simulation may have caused for implications in this research, which also made the data less suitable to draw conclusions from.

6. Conclusion, limitations, discussion and future research

In this chapter, the conclusions, limitations, discussion and future research recommendations will be presented. In section 6.1, the answers to all sub-questions are presented of which each provide a construct for answering the main research question. Based on these answers, the answer to the main research question is provided. In section 6.2, the limitations of the research will be discussed. Section 6.3 provides a discussion and reflection on the results. Finally, section 6.4 will be present the recommendations for future work.

6.1 Conclusion

Persuasive games have great properties for facilitating lasting attitude changes for complex societal issues, making them a valuable tool for achieving attitude change towards cooperation and information sharing that is often necessary for effective multi-actor decision-making. It is assumed that persuasive game design principles are key drivers for conceiving successful persuasive games, however, their effect on attitude change and attitude reinforcement has not been validated. Little guidance is therefore provided for persuasive game designers and researchers when it comes to selecting persuasive game design principles that can successfully achieve the intended attitude change. This could lead to poorly chosen principles making persuasive game designer and researchers unable to achieve their goal regarding attitude change, or to games that are even counterproductive.

To get one step closer towards validated persuasive game design principles, this research aimed at validating the most frequently used persuasive game design principles for persuasive game for multi-actor decision-making: simulation. For this research, the persuasive game design principle simulation is defined as follows: *Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality.* Considering that the two most important constructs for effective multi-actor decision-making are cooperation and information sharing, it was assessed whether the persuasive game design principle simulation is effective for reinforcing/changing attitudes towards these constructs. The main research question is formulated as follows:

What effect does the persuasive game design principle simulation have on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making?

Answering this research question required five different sub-questions (SQ) of which each will provide a construct to answer the main research question. These sub-questions and the answers to them are discussed below.

SQ1: What is the relationship between the persuasive game design principle simulation and attitude change from a theoretical point of view?

The relationship between the persuasive game design principle simulation and a lasting attitude reinforcement or change can best be explained through the Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986). According to the ELM, an enduring attitude reinforce/change can only occur if a persuasive message is processed trough the central route. Processing a message through this route requires two things: a person must be motivated to process (*motivated to process*) a persuasive message and a person must be

able to process a persuasive message (*ability to process*). The persuasive game design principle simulation could be considered to contribute to the *knowledge and understanding* aspect of the *ability to process* determinant. By providing players with a mechanism to see the cause-and-effect relationship of their behaviour in the game and its link to reality, it provides them with knowledge and understanding for formulating and examining arguments regarding the persuasive message the game aims to convey. This increases their ability to engage in issue-relevant thinking and to process the persuasive message via the central route resulting in a lasting attitude reinforcement or change. Still, for the processing through the central route to occur, it is required for the persuadee to be motivated to process the persuasive message. This could be considered a condition that has to be met for the persuasive game design principle simulation to achieve attitude change. To meet this condition, the presence of personal responsibility and personal relevance was guaranteed.

SQ2: What method allows for measuring the effect of the persuasive game design principle simulation on attitude change in isolation?

In order to be able to verify the relationship assumed by the theoretical framework, a methodology was conceived for measuring the effect of the persuasive game design principle simulation on attitude change in isolation. This research is the first research that aims to validate the effect of the persuasive game design principle simulation on attitude change in isolation, therefore a suitable method for this purpose is not yet available.

Game sessions in the form of laboratory experiments appeared to be the most suitable approach for measuring effect of a persuasive game design principle in isolation for this research. This refers to controlling or standardizing possible confounding variables in order to create a controlled environment in the effect of a research subject can be measured. Possible confounding variables were identified and standardized or controlled for. It has to be acknowledged that laboratory experiments tend to reduce the external validity of outcomes. For this research, it could mean that the evaluated effect of the persuasive game design principle simulation on attitude change would only occur in settings that are similar to the setting that is used in this research. Additional research is necessary to assess whether this method affected the external validity of this research.

Different versions were created of the existing persuasive game Mobinn for the game sessions, which is a game that aims at achieving cooperation and information sharing between actors in a multi-actor decision-making setting to realize truck platooning. In each of these game versions, the persuasive game design principle was present to different extents. All other game elements maintained the same throughout all game versions to be able to observe the effect of the persuasive game design principle simulation in isolation.

Finally, for assessing attitude change, both quantitative and qualitative measurement instruments were used. By using both, the reliability of results could be enhanced while more detailed insights could be provided. For the quantitative measurements, direct attitude measurements in the form of surveys were conducted using semantic differential scales. Identified implications for using direct attitude measurements were social desirability bias and potential for misunderstandings. Potential for misunderstandings was reduced by presenting a scenario in the survey that allowed for a better understanding on how the survey items should be assessed. Social desirability was managed by presenting additional items that were not focused on cooperation and information sharing to not give participants the impression that the research was focusing on these two constructs. These measurements were conducted before, immediately after and one week after the game play to be able to assess changes in attitudes at different time frames.

Qualitative measurements were conducted in the form of semi-structured interviews that were conducted immediately after the game play. No direct questions were asked regarding the effect of the persuasive game design principle simulation to prevent social desirability bias. The interviews were conducted immediately after the game play with participants who beforehand agreed to participate in them.

SQ3: What persuasive game can be developed that allows for measuring the effect of the persuasive game design principle simulation on attitude change in isolation within the time frame of the research?

Within the time frame of this research, it was feasible to conceive three versions of the Mobinn game in which the persuasive game design principle was varied. The most suitable strategy for varying the persuasive game design principle appeared to be the timing strategy, which refers to how often the persuasive game design principle is present. Applying this strategy allows for observing the effect on attitude reinforcement/change when the persuasive game design principle simulation is more/less present or not present at all, which is necessary for answering the main research question. However, since this is not an official strategy for varying the persuasive game design principle simulation but for feedback, it is unknown whether this strategy provides the best possibility for this research. Additional research on using other strategies for varying the persuasive game design principle simulation is necessary.

Using this strategy, a *no simulation* version was conceived in which the principle was no present at all, an *in between* version in which it was only present in one round and a *simulation* version in which it was present in each round. All other games elements were kept constant. The persuasive game design principle simulation was incorporated on game cards with text in which the cause and effect relationship of behaviour was presented along with possible consequences for reality. Written text was preferred over audio or visual presentations as it is believed that it allow people to carefully process arguments for persuasion for themselves. When using other modes, players can be given the impression that issue-relevant arguments are forced upon players and gives them less opportunity to process the message themselves (Petty & Cacioppo, 1986).

SQ4 & SQ5: What are the short-term and long-term effect of the persuasive game design principle simulation on attitude change regarding cooperation in persuasive games for multi-actor decision-making?

The quantitative results showed that there were attitude reinforcements and changes on the short-term and on the long-term towards cooperation and information sharing for all three game versions. However, only for attitude towards information sharing, there was a statistical significant difference found on the short-term and long-term in the in between version and simulation version. These results indicate that the presence of the persuasive game design principle simulation might have an effect on a lasting attitude reinforcement/change towards information sharing, considering that there was only a lasting change in the versions in which the persuasive game design principle simulation was present. Since the persuasive game design principle was present to a greater extent in the simulation version, one would assume that the change in this group should be bigger. However, the attitude reinforcements and changes were equally as strong in both versions.

For attitude towards cooperation, there was only a statistical significant difference found for the in between version on the short-term. No statistical significant effects were found on the long-term, which indicates that the attitude change found in the in between version may not have been a lasting attitude change. However, it has to be acknowledged that initial

attitudes towards cooperation were already relatively high. Therefore, there was little room for the attitudes to improve, which may explain why no statistical significant differences were found in other cases for attitude reinforcement towards cooperation.

The qualitative results confirmed that there were attitude reinforcements and changes on the short-term and on the long-term towards cooperation and information sharing for all three game versions. Like in the quantitative results, the qualitative results indicated that information sharing affected participants more. Unfortunately, no hard evidence was found that the persuasive game design principle has caused for the attitude changes. When asked about what game elements lead to participants gaining knowledge and understanding, a variety of elements were mentioned including prior knowledge, time pressure, external events (game element), the persuasive game design principle self-monitoring and the persuasive game design principle simulation. In most cases, a combination of these elements was mentioned. This might indicate that in this game setting, a combination of factors or elements may have caused together for the attitude change to occur. The persuasive game design principle simulation has not been pointed out as an element that may have caused for attitude change to occur. Furthermore, there were no statements provided by any of the groups that were clearly different from the other groups. Differences between the groups were therefore impossible to detect. Finally, although personal relevance appeared to be low, there was still an attitude change found in all game versions on the long-term although not all significant.

After integrating both quantitative and qualitative results and theory, it cannot be confirmed that the statistical significant difference found during the quantitative analyses for attitudes towards information sharing in the in between and simulation version are caused by the persuasive game design principle simulation. However, it can also not be confirmed that any of the other factors elements mentioned have caused attitude changes to occur. Based on the integration of quantitative data, qualitative data and theory, assumptions were made about whether the elements mentioned above may have affected attitudes. However, based on current data, these assumptions cannot be confirmed. Additional research is required for further interpretation. Finally, it is assumed that social desirability bias and the use of indirect interview questions regarding the effect of the persuasive game design principle simulation may have caused for implications in this research, which made the data less suitable to draw conclusions from. An adaption to the aforementioned method could possibly prevent these implications from occurring in future research.

The answers to these sub-questions provide all required constructs for answering the main research question. This answer is formulated as follows:

What effect does the persuasive game design principle simulation have on attitude on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making?

Based on the current findings, it cannot be confirmed nor denied that the persuasive game design principle has affected attitude change regarding cooperation and information sharing in this research. Therefore, it cannot be specified what effect the persuasive game design principle simulation has on attitude change regarding cooperation and information sharing in persuasive games for multi-actor decision-making. Due to the lack of proper insights, the assumed relation between the persuasive game design principle simulation and attitude change based on the ELM can also not be verified. Therefore, an answer to this question cannot also not be derived from the theoretical base that was presented in this research.

Despite the fact that the main research question could not be answered, this research is still perceived to be of great value for persuasive game designers and researchers in all domains. This research is the first that aims at validating the effect of persuasive game design principles in isolation and the first to design a methodology for this purpose. The presented methodology appeared to be suitable to measure the effect of persuasive game design principles in isolation, although some improvements are suggested for qualitative measurements and to prevent social desirability bias. A good basis for getting to the answer of the research question is thus provided by this research. It is believed that with some fine-tuning, the answer to this research question can be provided in a near future and bring game designers and researchers closer towards validated persuasive game design principles.

6.2 Limitations

Throughout this research, limitations regarding the research have been briefly mentioned. These are listed below, together with a reflection on their possible impact on this research.

Small sample sizes

The sample sizes within this research were very small. Appropriate measures were taken to mitigate this limitation in the form of alternate statistical tests to compare group means and assess differences in attitudes. However it has to be acknowledged that a small sample size can decrease the statistical power of a statistical test. This means that there is an increased chance for the type II error to occur (concluding that there are no statistical significant differences when there are). Considering that the sample size in the no simulation version was very small (N = 4), and no statistically significant difference was found within this group, there is chance that it is wrongfully concluded that there were no attitude changes within that group.

Unequal group sizes

In this study, groups were compared from unequal sizes. In the no simulation version (N = 4), the group size was smaller than in the in between and simulation version (N = 8). This may have influenced the outcome of the quantitative results considering that there are no statistical significant attitude changes or reinforcements were found for the no simulation group. Unfortunately, it was not possible to conduct an extra game session within the time-span of this research to mitigate this limitation. Conclusions should therefore be carefully interpreted.

Social desirability bias

Measures were taken to prevent the occurrence of social desirability bias such as using 'dummy items' in the survey and asking indirect questions during the interviews. However, participants still gave the impression that they were searching for what game elements were of interest for this research. Consequently, they tried to give desirable answers regarding the elements they thought were of interest for the research, possibly to please the researcher. This could have lead to unreliable answers during the interviews.

Indirect interview questions

It was not directly asked how the persuasive game design principles (simulation cards) affected players in order to prevent that participants would get the impression that this is the element of interest for the research and will provide biased answers. However, the indirect questions did not provide sufficient insights to be able to analyse the effect of the persuasion game design principle simulation. Therefore, it is expected that richer insights would have been gained if direct questions were used.

6.3 Discussion and reflection

The main scientific contribution of this research is the creation of a sufficient method for evaluating the effect of persuasive game design principles on attitude change in isolation. As mentioned by Siriaraya, Visch, Vermeeren & Bas. (2018) and to the best of my knowledge, research on the effect of persuasive game design principles on attitude change in isolation was not done before. In previous research, the effectiveness of persuasive game design principles was assessed using storyboards (Orji, Vassileva & Mandryk, 2014; Orji, 2016; Orji, Nacke & Di Marco, 2017; Orji, Tondello & Nacke, 2018). However, doing this may decrease the external validity of the research considering that a gaming setting differs tremendously from a setting in which a storyboard is presented. Furthermore, these research focussed on perceived persuasiveness instead of actual attitude change. This research provided the means to conceive a method that allows for assessing the effect of persuasive game design principles on attitude change in isolation, on actual attitude change, using actual games.

Still, there are some points of discussions regarding this research. Based on current findings, it could not be confirmed nor denied that the persuasive game design principle has affected attitude change regarding cooperation and information sharing in this research. A scenario that should be considered is that persuasive game design principle simulation may have an unconscious effect on attitude change. In this research, it was not considered whether the processing of a persuasive message is something conscious or unconscious when creating the theoretical framework however. Therefore, the framework does not specify how the relationship between the persuasive game design principle simulation and attitude change should be assessed, which could have posed the risk of using the wrongfully assessing the effect of the persuasive game design principle simulation on attitude change.

Second, a limitation that was addressed regarding the ELM in this research was that it does not specify to what extend a person must feel personal related to the issue that is the subject of the attitude change process (personal relevance). Within this research, it appeared that participants did not pay attention to the context of the game, but only to statistics and strategies for winning the game. The story around the game was often discarded. This may indicate that the personal relevance was low. Although this was the case in most game versions, it appeared that there was still an attitude change in all game versions on the long-term although not all statistically significant. This could indicate that for persuasive games, personal relevance might not be a prerequisite as is suggested by the ELM.

A final point of discussion is whether it is possible to measure the effect of persuasive game design principles in isolation. Within this research, participants mentioned a variety of game elements when asked what element has caused for them to gain knowledge and insights that they had to change their behaviour. This might indicate that in this game setting, a combination of factors or elements may have caused together for the attitude change to occur. However, this poses the question whether it is a single game element that causes an attitude change in persuasive games, or if it is a combination of game elements that might reinforce each other. Still, it remains questionable how this can be assessed considering that elements may interfere with each other. Therefore, it would be difficult to pinpoint at what combination of elements may have caused attitude change to occur.

Reflection

Considering the above, if this research were to be conducted again the following changes would have been made to the research design. First of all, a critical assessment would be done on the theoretical framework that was used for this research for explaining the

persuasive effect of the persuasive game design principle simulation. Currently, the theoretical framework provides an explanation for the persuasive power of the persuasive game design principle simulation, but it does not specify whether these are conscious or unconscious effects. As a result, it may have been the case that measuring the effect of the persuasive game design principle has been done incorrectly by only measuring conscious effects. Therefore, additional theories or experts would be consulted to reflect on whether and how the proposed relationship in the theoretical framework could be measured.

Second, direct questions would be used during interviews instead of indirect questions. The main reason for using indirect questions in this research was to prevent from social desirability bias to occur. However, a way for incorporating direct questions in the interviews while controlling for social desirability bias could be by using the same approach that was used for controlling social desirability bias in the survey. Researchers could ask direct questions regarding the effect of multiple game elements of which not all might be relevant to the research. By doing so, participants will not be given the impression that the research focuses on a specific element and alter their answers accordingly to please the researcher. Moreover, it is recommended to conduct more than two interviews per group to have more reference material to compare statements within groups and between groups.

Finally, in this research, it was assumed that social desirability bias occurred as participants gave the impression that they wanted to please the researcher with their answers. It was assumed that this was the case because the researcher was a student as well, and because participants wanted the student to successfully finish the master thesis project. When conducting the research again with students or peers, other people will be approached for facilitating game sessions and conducting the interviews to prevent biases from occurring.

6.4 Recommendations for future research

A first recommendation for future research is to validate the proposed method in this research. Since a method for this purpose has not been conceived before, there was no reference material to assess whether the designed method is valid. Furthermore, considering the limited time span, it was not possible to validate the method by comparing it to other methods for laboratory experiments. Therefore, a recommendation for future research is to validate the proposed method. This can be done by comparing similar methods for laboratory experiments from other research domains to this method, or by recreating this method in a new research and compare the outcomes to this research.

Another recommendation for future research is to have at least 30 participants per group when assessing the persuasive effect of a persuasive game design principle. The small sample size in this research caused for big standard deviations and increased the chance of wrongfully concluding that there are no statistical significant differences when there are (type II error). With bigger groups, standard deviations will possibly be smaller which decreases the chance of the type II error. Furthermore, having a greater sample size allows for conducting more robust statistical tests, which also increases the chance to measure the true effect of a persuasive game design principle on attitude change.

It is also recommended to assess the external validity of this research. As mentioned before, having a controlled environment can jeopardize the external validity of a research. This research was demarcated to the domain of persuasive games for multi-actor decision-making. However, considering that persuasive games are nowadays also used in other serious domains like politics, education, health care, (national) security, spatial planning, emergency management and engineering (Bogost, 2007, p. ix; Vargas, García-Mundo,

Genero & Piattini, 2014), it would be of value if these results could be generalized for creating effective persuasive games for those domains as well. A logical next step would be to assess the effect of the persuasive game design principle in a natural setting, including real life actors and natural gaming settings, and in other persuasive game domains.

Moreover, it is recommended to assess to what extent personal relevance plays a role in attitude change in persuasive games. It might be interesting to vary personal relevance within a game study and compare the differences in attitude change to investigate whether it is necessary to include elements in a persuasive game to would enhance personal relevance. A possibility to facilitate this is by conducting a game study with students (perceived low personal relevance) and with real actors (perceived high personal relevance).

A final recommendation is to assess the effectiveness of other strategies for varying the persuasive game design principle simulation than the strategy used in this research. This would also allow for evaluating the effectiveness of the methodology and could bring new knowledge. The persuasive game design principle simulation was varied using the timing strategy (how often the persuasive game design principle occurred) (Brookhart, 2017, p. 15). While this may have been an effective strategy for applying the persuasive game design principle simulation for this research, there are also other strategies that can be used to vary the persuasive game design principle such as amount, mode and audience. However, since these are not specifically strategies for varying the persuasive game design principle simulation but for feedback, it is unknown whether applying these strategies on the persuasive game design principle simulation would have an effect on attitude change or possibly be more effective. In this research, a written mode was chose. In digital persuasive games however it is often seen that the cause-and-effect relationship and its link to reality is simulated, giving players a realistic feel to their in-game behaviour and its consequences. For future research, it would be interesting to assess what the effect of the different strategies for applying the persuasive game design principle simulation would be on attitude change. This may provide game designers and researchers with insights on how the persuasive game design principle can be effectively applied in persuasive games, and provide new insights on the effectiveness of the method that was used in this research.

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Appendix A: Measurement instruments

A1: Pre-game survey

Thank you for your participation in the master thesis research study Mobinn.

This study is being done by Shanita Rambharos, a master student from the TU Delft. The purpose of this research study is to gain insights on the effects serveral of game elements. As part of this study, you are asked to answer some questions about your thoughts on strategies that you can use during an proposed innovation process.

You are asked to fill out this survey before participating in the Mobinn game session. It will take you 5-10 minutes to complete this survey.

Section A: Informed consent

Before the official start of this survey, I kindly ask you to read the following text and tick the appropriate box.

A1. Please read the following text carefully:

I understand that my participation in this study is entirely voluntary and that can withdraw at any time, without having to give any reason. I understand that there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. I understand that my data will be depersonalized and will be securely stored at the TU Delft data center. This data will not include any personal information, such as my name or email address, that can identify me as a natural person.

If you have any questions about your this informed consent, please contact S.A.Rambharos@student.tudelft.nl

Yes ☐

No ☐

Section B: ID-Number

B1. Before answering the questions of the survey, I want to ask you to fill out the ID-number your received in the email together with this survey.

What are is your ID-number?

You can find your ID-number in the email in which the link to this survey is attached. If you cannot find your ID-number, please contact me at S.A.Rambharos@student.tudelft.nl

☐☐

Section C: Introduction

Truck platooning Truck platooning enables trucks to drive in a convoy, keeping short and equal distances apart. This could lead to a smoother traffic flow, increased traffic safety, less fuel use and less CO2 emissions. The theory needed to make truck platooning happen has been available for a while, however, bringing this theory to practice seems to be a struggle. It seems that the input of different actors is needed at different moments of the innovation process for the realization of the innovation.

Imagine the following scenario:

You are a representative of a freight forwarding company *(a freight forwarding company arranges to pick up or deliver goods for individuals or corporations).* Your company values the environment and the growth of your company. The goal is to offer your clients "the greenest solution" (green = little CO2 emissions) and the lowest prices to get their freight transported. You are interested in the new truck platooning technology considering that it can have great advantages for your company. But you are worried that the technology might increase your prices due to the additional equipment needed in order for it to be operational.

You are invited to a decision-making process with other actors on how to make truck platooning happen. Each actor has important resources that are needed to make realize truck platooning. Your company has important information that would be of great value for the decision-making process and afterwards, which would mean that the realization of truck platooning will be one step closer. However, your goals conflict with those of the other actors, meaning that the decision-making process can lead to a decision that has disadvantageous economic and environmental consequences for you.

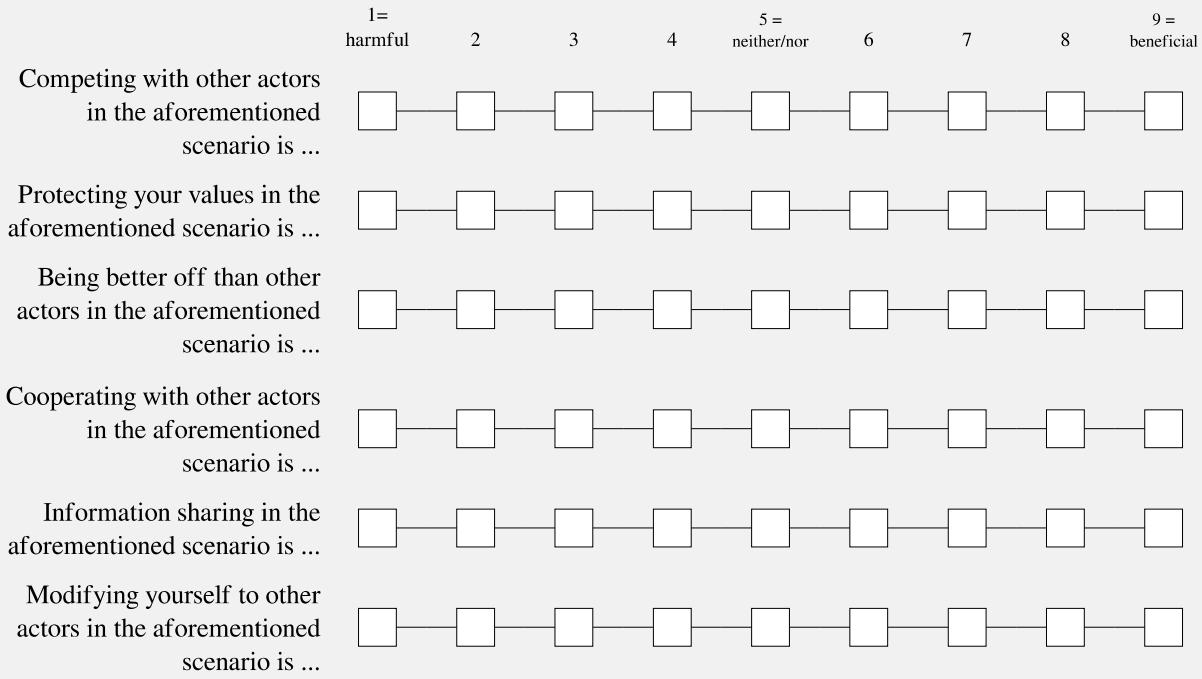
C1. You will now be presented with the questions of the survey. You will be presented six possible strategies that you can use when realizing truck platooning. You are asked to indicate what your thoughts are towards them on a 9 pointl scale. Consider 1 = Bad and 9 = Good.

Please keep in mind the aforementioned scenario and that the ultimate goal is to realize truck platooning when answering the questions.

	1 = bad	2	3	4	5 = neither/nor	6	7	8	9 = good
Competing with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Protecting your values in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being better off than other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cooperating with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Information sharing in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Modifying yourself to other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐

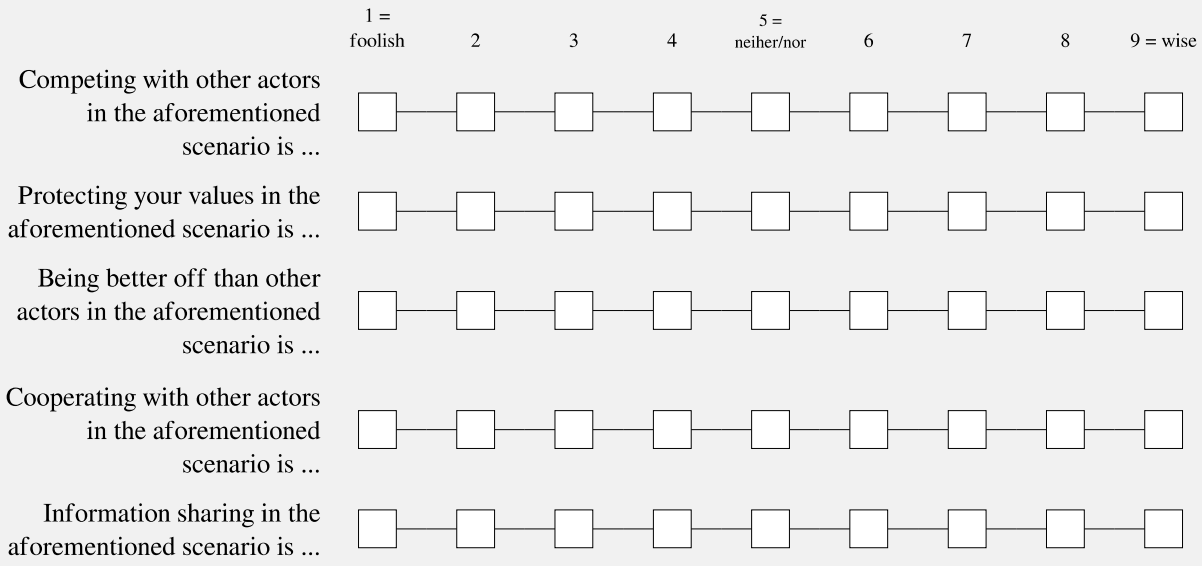
C2. **You are again presented with the six possible strategies and are asked to indicate what thoughts are towards them. This time, you have to indicate your thoughts on another scale. Consider 1 = Harmfull and 9 = Beneficial.**

Please keep in mind the aforementioned scenario and that the ultimate goal is to realize truck platooning when answering the questions.



C3. **You are again presented with the six possible strategies and are asked to indicate what thoughts are towards them. This time, you have to indicate your thoughts on another scale. Consider 1 = Foolish and 2 = Wise.**

Please keep in mind the aforementioned scenario and that the ultimate goal is to realize truck platooning when answering the questions.



	1 = foolish	2	3	4	5 = neiher/nor	6	7	8	9 = wise
Modifying yourself to other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐

C4. **For the last time, you are presented with the six possible strategies and are asked to indicate what thoughts are towards them. Again, you have to indicate your thoughts on another scale. Consider 1 = Unfavourable and 9 = Favourable.**

Please keep in mind the aforementioned scenario and that the ultimate goal is to realize truck platooning when answering the questions.

	1= unfavourable	2	3	4	5 = neither/nor	6	7	8	9 = favourable
Competing with other actors in the aforementioned scenario is …	☐	☐	☐	☐	☐	☐	☐	☐	☐
Protecting your values in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being better off than other actors in the aforementioned scenario is	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cooperating with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Information sharing in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Modifying yourself to other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐

Section D: Final question

You have almost completed the survey. There is only one question left.

D1. **What are the four numbers of your year of birth?**

If you are born on the 1st of January on 1990, only fill out 1990.

☐☐☐☐

7 KLVLVWKHHQGRI VXUYH

7 KDQN\RX YHU\ P XFKIRUDQVZHULQJ WKHTXHVWLRQV , DP ORRNLQJ IRUZDUG WR VHH\RX DWWKH0 REIQQJDP HVHVLRQ VRRQ

) RUDQ\ TXHVWLRQV SOHDVHIHHOIUHHWR FRQWDFWP H

6KDQLWV5 DP EKDURV

(P DLO 6 \$ 5 DP EKDURV# VXGHQWWXGHDWQO

A2: Post-game survey

SURVEY 2 – MSc RESEARCH Mobinn

Thank you for your participation in the master thesis research study Mobinn. This study is being done by Shanita Rambharos, a master student from the TU Delft.

The purpose of this research study is to gain insights on the effects several of game elements. As part of this study, you are asked to answer some questions about your thoughts on strategies that you can use during a proposed innovation process and about your game experience.

You are asked to fill out this survey immediately after finishing the game session. It will take you 5-10 minutes to complete this survey.

INFORMED CONSENT

Please read the following text carefully and tick the appropriate box:

- I understand that my participation in this study is entirely voluntary and that can withdraw at any time, without having to give any reason.
- I understand that there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible.
- I understand that my data will be depersonalized and will be securely stored at the TU Delft data centre. This data will **not** include any personal information, such as my name or email address that can identify me as a natural person.

YES □ **NO** □

ID-NUMBER

Before filling out the survey, please fill out the numbers of the ID you received for survey. You can find the ID in the email you received for survey 1, or ask the researcher to look it up for you.

ID _____

START SURVEY

PART I

1. To what extent did <u>you</u> use the following strategies during the game-play?

A. Competing with other actors

To a great extent o o o o o Not at all

B. Protecting your values
To a great extent o o o o o Not at all

C. Being better off than others
To a great extent o o o o o Not at all

D. Cooperating with each other
To a great extent o o o o o Not at all

E. Information sharing
To a great extent o o o o o Not at all

F. Modifying yourself to other actors
To a great extent o o o o o Not at all

2. To what extent did you see <u>other players</u> use the following strategies during the game-play?

A. Competing with other actors
To a great extent o o o o o Not at all

B. Protecting your values
To a great extent o o o o o Not at all

C. Being better off than others
To a great extent o o o o o Not at all

D. Cooperating with each other
To a great extent o o o o o Not at all

E. Information sharing
To a great extent o o o o o Not at all

F. Modifying yourself to other actors
To a great extent o o o o o Not at all

3. Please indicate what your thoughts are about the following six strategies within the scenario that was presented during the game. Consider 1=bad and 9=good.

	1	2	3	4	5	6	7	8	9
Being better off than others is …	O	O	O	O	O	O	O	O	O
Modifying yourself to other actors is …	O	O	O	O	O	O	O	O	O
Information sharing is …	O	O	O	O	O	O	O	O	O
Protecting your values is …	O	O	O	O	O	O	O	O	O
Cooperating with each other is …	O	O	O	O	O	O	O	O	O
Competing with other actors is …	O	O	O	O	O	O	O	O	O

4. Please indicate what your thoughts are about the following six strategies within the scenario that was presented during the game. Consider 1=harmful and 9=beneficial.

	1	2	3	4	5	6	7	8	9
Being better off than others is …	O	O	O	O	O	O	O	O	O
Modifying yourself to other actors is …	O	O	O	O	O	O	O	O	O
Information sharing is …	O	O	O	O	O	O	O	O	O
Protecting your values is …	O	O	O	O	O	O	O	O	O
Cooperating with each other is …	O	O	O	O	O	O	O	O	O
Competing with other actors is …	O	O	O	O	O	O	O	O	O

5. Please indicate what your thoughts are about the following six strategies within the scenario that was presented during the game. Consider 1=foolish and 9=wise.

	1	2	3	4	5	6	7	8	9
Being better off than others is …	O	O	O	O	O	O	O	O	O
Modifying yourself to other actors is …	O	O	O	O	O	O	O	O	O
Information sharing is …	O	O	O	O	O	O	O	O	O
Protecting your values is …	O	O	O	O	O	O	O	O	O
Cooperating with each other is …	O	O	O	O	O	O	O	O	O
Competing with other actors is …	O	O	O	O	O	O	O	O	O

6. Please indicate what your thoughts are about the following six strategies within the scenario that was presented during the game. Consider 1=unfavourable and 9=favourable.

	1	2	3	4	5	6	7	8	9
Being better off than others is …	O	O	O	O	O	O	O	O	O
Modifying yourself to other actors is …	O	O	O	O	O	O	O	O	O
Information sharing is …	O	O	O	O	O	O	O	O	O
Protecting your values is …	O	O	O	O	O	O	O	O	O
Cooperating with each other is …	O	O	O	O	O	O	O	O	O
Competing with other actors is …	O	O	O	O	O	O	O	O	O

PART II

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

not at all slightly moderately fairly extremely
0 1 2 3 4

	0	**1**	**2**	**3**	**4**
1. I was interested in the game's story	O	O	O	O	O
2. I felt successful	O	O	O	O	O
3. I felt bored	O	O	O	O	O
4. I found it impressive	O	O	O	O	O
5. I forgot everything around me	O	O	O	O	O
6. I felt frustrated	O	O	O	O	O
7. I found it tiresome	O	O	O	O	O
8. I felt irritable	O	O	O	O	O
9. I felt skilful	O	O	O	O	O
10. I felt completely absorbed	O	O	O	O	O
11. I felt content	O	O	O	O	O
12. I felt challenged	O	O	O	O	O
13. I had to put a lot of effort into it	O	O	O	O	O
14. I felt good	O	O	O	O	O

Please specify your thoughts

1. To what extent did you gained some insights after this game? Why or why not?

2. Can you specify what specific parts in the game helped you to gain these insights?

3. Do you wish to express any other things about this game session?

END OF SURVEY
This was the end of survey 2, thank you very much for answering the questions. As a follow up, you will receive an email with the final questions for this research.

If you have any questions regarding the game session, the photo's that were taken during the game session or about the research, please feel free to contact me.

Shanita Rambharos
S.A.Rambharos@student.tudelft.nl

A3: Long-term survey

Thank you for your participation in the master thesis research study Mobinn.

This research is being done by Shanita Rambharos, a master student from the TU Delft. The purpose of this research is to gain insights on the effects of several game elements. As part of this research, you are asked to answer some questions about your thoughts on strategies that you can use during an proposed innovation process.

You are asked to fill in this survey after participating in the Mobinn game session. It will take you approximately 5-10 minutes to complete this survey.

Section A: Informed consent

A1. **Please read the following text carefully:**

I understand that my participation in this study is entirely voluntary and that can withdraw at any time, without having to give any reason. I understand that there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. I understand that my data will be depersonalized and will be securely stored at the TU Delft data center. This data will not include any personal information, such as my name or email address, that can identify me as a natural person.

If you have any questions about your this informed consent, please contact S.A.Rambharos@student.tudelft.nl

Yes ☐

No ☐

Section B: ID-number

B1. **Before answering the questions of the survey, I want to ask you to fill out the ID-number your received in the email together with this survey.**

What are is your ID-number?

You can find your ID-number in the email in which the link to this survey is attached. If you cannot find your ID-number, please contact me at S.A.Rambharos@student.tudelft.nl

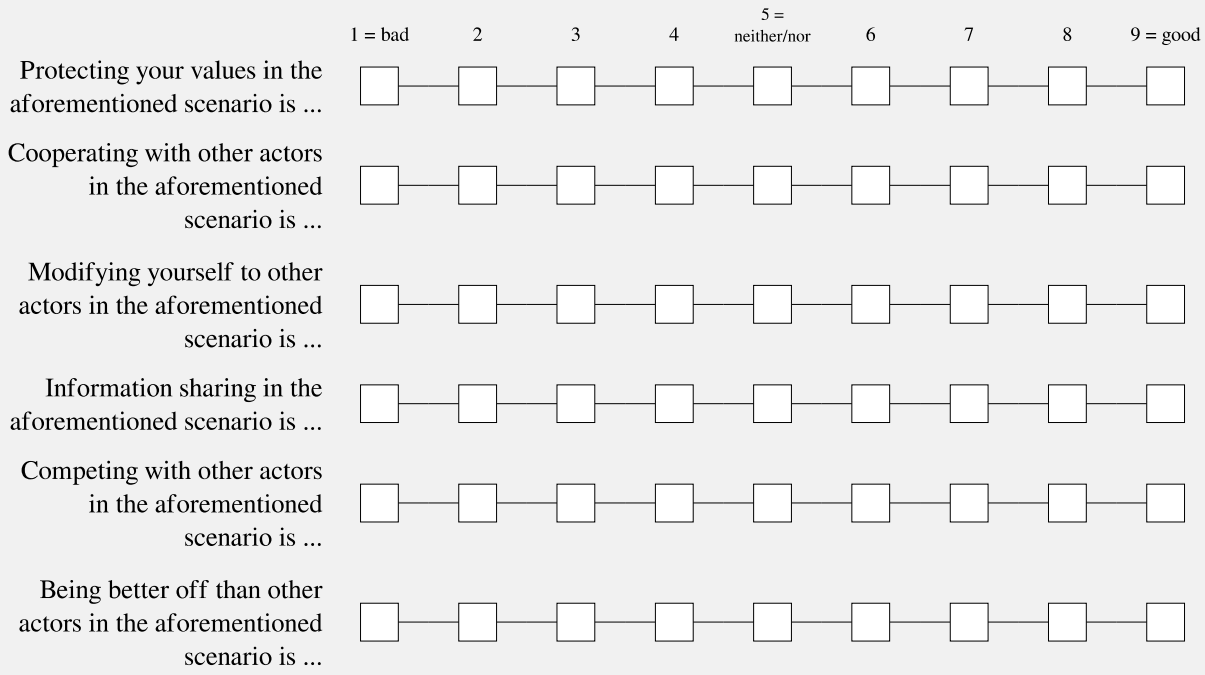
☐☐

Section C: Strategies

Imagine the following: You are an actor that is invited to an innovation process that aims to realize truck platooning together with other actors. Truck platooning can bring you, the environment and society a lot of advantages when realized. But you have some concerns regarding conflicting goals of the other actors that are involved in the innovation process, and the disadvantages that their decisions may have for you.

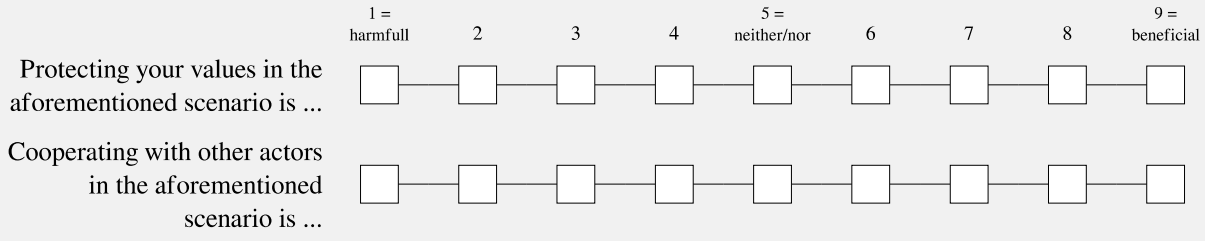
C1. **You will be presented six possible strategies that you can use when realizing truck platooning in an innovation process that includes different actors. You are asked to indicate what your thoughts are towards them on a 9 point scale. Consider 1 = bad and 9 = good.**

Please imagine the aforementioned scenario about the innovation process and keep in mind that the ultimate goal is to realize truck platooning when answering the questions.



C2. **You are again presented with the six possible strategies and are asked to indicate what thoughts are towards them. This time, you have to indicate your thoughts on another scale. Consider 1 = harmfull and 9 = beneficial.**

Please imagine the aforementioned scenario about the innovation process and keep in mind that the ultimate goal is to realize truck platooning when answering the questions.



	1 = harmfull	2	3	4	5 = neither/nor	6	7	8	9 = beneficial
Modifying yourself to other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Information sharing in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Competing with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being better off than other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐

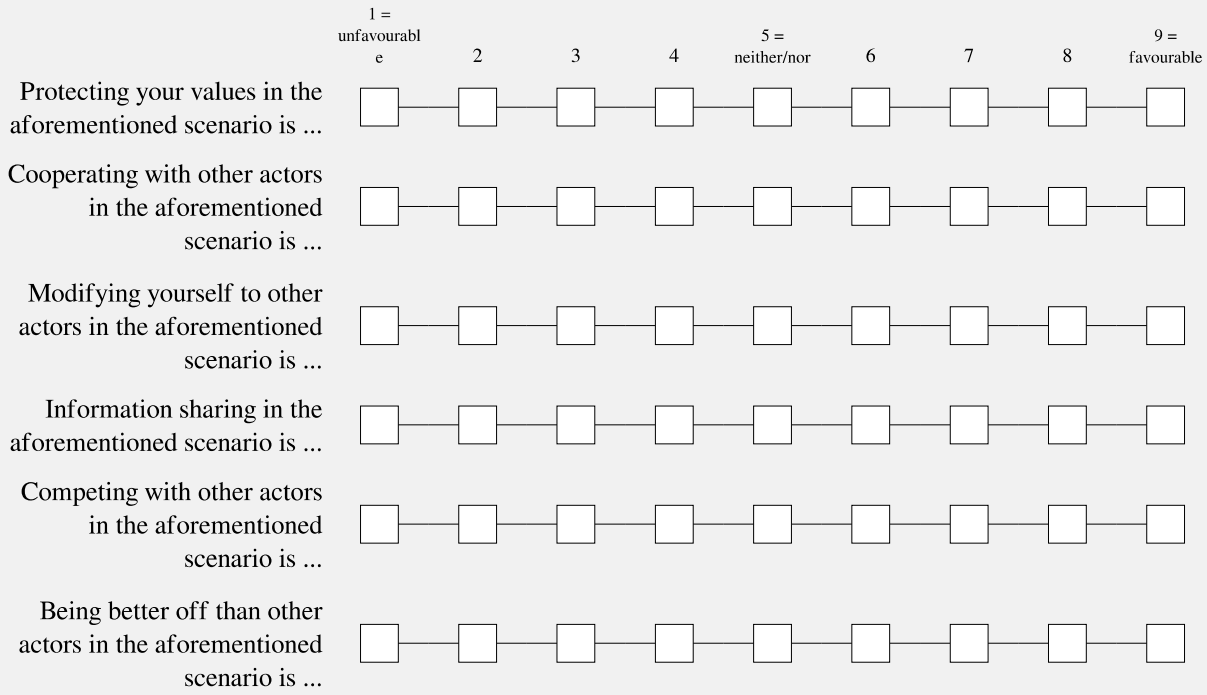
C3. You are again presented with the six possible strategies and are asked to indicate what thoughts are towards them. This time, you have to indicate your thoughts on another scale. Consider 1 = foolish and 2 = wise.

Please imagine the aforementioned scenario about the innovation process and keep in mind that the ultimate goal is to realize truck platooning when answering the questions.

	1 = foolish	2	3	4	5 = neither/nor	6	7	8	9 = wise
Protecting your values in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cooperating with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Modifying yourself to other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Information sharing in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Competing with other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being better off than other actors in the aforementioned scenario is ...	☐	☐	☐	☐	☐	☐	☐	☐	☐

C4. **For the last time, you are presented with the six possible strategies and are asked to indicate what thoughts are towards them. Again, you have to indicate your thoughts on another scale. Consider 1 = unfavourable and 9 = favourable.**

Please imagine the aforementioned scenario about the innovation process and keep in mind that the ultimate goal is to realize truck platooning when answering the questions.



This is the end of survey 3. Thank you very much for answering the questions and participating in the game session.

This is the final survey that has to be completed for this research. On Monday June 17, you will receive an email in which I will explain to you what the goal of my research is and how you contributed to my research.

For any questions, please feel free to contact me.

Shanita Email: S.A.Rambharos@student.tudelft.nl

A4: Interview protocol and questions

Introduction

- Thank the participant for his/her voluntary participation to this research.
- The participant may stop at any given moment, without a given reason.
- The interview is part of my master thesis research project that investigates the effects of several game elements.
- The goal of the interview is to find out how the participant experienced playing the game.
- The interview data will be stored securely at the TU Delft Datacentre.
- Check if the participant has any questions.

Double check if the participant is ok with recording the interview.
(NOTE: if yes, make sure you also record this consent on the recording itself)

General questions:

How did you experience playing the game *Mobinn?*
Follow up: Where you enjoying yourself? Why or why not?

What was the most valuable part of the game to you? Why?

[Simulation fever]

To what extent do you think the game was realistically representing an innovation process?

[Assessing whether persuasive message is conveyed]

What insights did you gain on the innovation process of truck platooning regarding the involved
actors?

- Can you specify what specific parts in the game helped you to gain these insights?
- Example: story, roles, rules, mechanisms or something else

According to you, what strategies should actors use to realize truck platooning and why?

- Can you specify specific parts of the game contributed to gaining these insights?

[Cooperating in the game]

At a certain point in the game, you were more willing to cooperate with each other. Why did you choose to do so?

- Can you specify what specific parts of the game contributed to you willingness to cooperate?

[Knowledge and understanding]

To what extent did you gain knowledge and understanding of the importance of cooperating and sharing knowledge in an innovation process?

- To what extent do you think that the game contributed to the knowledge and understanding of the necessity of cooperating and sharing knowledge?
- To what extent did you feel like something was missing in the game that could help you to gain this knowledge and understanding?

[Persuasive game design principle simulation]

To what extent did you feel like the cause and effect relationship of your behavior was simulated during the game?

- How did you experience this?
- How did this influence your game play?

To what extent were you able to link the consequences of you behavior to reality (for example, to the reality of realizing truck platooning and having the environmental and economic benefits)?

- How did you experience this?
- How did this influence your game play?
- Can you specify what specific parts of the game (story, roles, rules, mechanisms) contributed to this or were missing?

Appendix B: Test sessions

Test 1: Testing the original Mobinn game
Who played: 2 students, one male, one female

Observations	Notes	Adjustments
It does not feel like it is feasible to win the game at a very early stage of the game. Every time a KPI goes up, it goes down again through the external events. Even if players work well together and share information, this is still the case. This is de-motivating to players.		- The initial KPI's levels will all move one level up. - The negative effects of some external events will be adjusted
The game might take too long to be finished. The aim of the research is to have game sessions that don't take more than 1 hour. This includes briefing and debriefing.	In the game sessions conducted by the researchers that developed the Mobinn game, it took 1,5 to 2 hours to finish a game session. This included the briefing and debriefing as well.	Decrease the amount of rounds: 4 rounds instead of 5.
The transporter and the freight forwarder have relatively cheaper cards than the policy maker and the developer. However, their cards require less investments of players to be activated. But since there is enough money, the more expensive cards are being played to get the KPI's up. There is little incentive for them to play their cards.		Add a competitive component: make it a personal goal for players to play as much cards as possible from their own role. In their role descriptions, their interests and goals are already elaborated on.
There is no order specified for the actions that have to be done at the end of each round: getting tokens and drawing the event card.	We played it with first getting tokens and then drawing an event card so that there is a chance that people lose the money they just received.	Order that works: first new tokens, then event card. Otherwise there is a chance that people cannot pay up what the event card requires them to pay.

Test 2: Testing the new version of original Mobinn game with the adjustments of test session 1, except the personal goals
Who played: 2 students, one male, one female
What is included:

- 4 rounds instead of 5
- 5 cards per role
- 4 event cards: event card 2 was removed
- Each player can only select one card per round
- More than one card can be activated per round (so cards of multiple players can be selected)
- Policy maker gets one extra token after each round
- KPI's start at 5 [TM], 4 [IM] and 2 [IA]

Observations	**Notes**	**Adjustments**
It felt feasible to win the game. Players felt more motivated to play the game.		
The game was finished in less than 45 minutes.		
Less incentive to read the cards, so it doesn't matter if the case is about truck platooning	Does that mean that the game does not have to be played by transport students only?	Possibly: when following the instructions on the card, players have to read the text on the card as well

Ideas for in between and no simulation

- In between: if players select the card and have paid the required investments, they will not lose their investments when their card is not selected for activation
- No-simulation: when a player wants to select a card, he/she does not have to put any investments on it yet. When the card is selection for activation by all players, everybody has to pay for it.

Test 3: testing in between versions and personal goals
Who played: 3 students, all female
What is included:

- 4 rounds
- 5 cards per role
- 4 event cards: event card 2 was removed
- Each player can only select one card per round
- More than one card can be activated per round (so cards of multiple players can be selected)
- KPI's start at 5 [TM], 4 [IM] and 2 [IA]
- Competition element without point system

Observations	**Notes**	**Adjustments**
After 2 rounds, player's started to share information and cooperate. They negotiated about what cards they were going to play and if they had enough money to invest in the cards. They tried to find the most optimal solution. Due to that, everybody agreed on what cards should be selected before putting them on the table. Everybody agreed on investing in the card in advance, so no investments were loss. Therefore, changing the rules so that player's get their investments back does not have any effect if player's cooperate and share information.		- A new way has to be found for making the in between and no simulation version.

Test 4: Testing the adjusted simulation principle
Who played: 2 students, one male one female
What is included:

- 4 rounds
- 5 cards per role
- 4 event cards: event card 2 was removed
- Each player can only select one card per round
- More than one card can be activated per round (so cards of multiple players can be selected)
- KPI's start at 5 [TM], 4 [IM] and 2 [IA]
- Competition element without point system
- After each round: draw a 'simulation' card
    - Due to your inability to make truck platooning happen together, you have not been able to increase traffic safety, causing a lot of traffic deaths
    - Due to your inability to make truck platooning happen together, you are not able to contribute to a better traffic flow, resulting in more traffic jams.
    - Due to your inability to make truck platooning happen together, you are not able to contribute to fuel savings, which is disadvantageous for the economy and environment.
    - Due to your inability to make truck platooning happen together, CO2 emissions by freight forwarders are still rising.

Observations	**Notes**	**Adjustments**
The simulation cards provided information about the cause-and-effect relationship of the game and its link to reality, it is probably difficult for people to relate the cause-and-effect link of their behaviour to reality.		Write simulation cards for each KPI in each level
The developer has too little tokens to actively participate in the game		Adjust the events cards so that the developer will lose less tokens - E5: developer loses 1 token instead of 2 - E1: policy maker loses 2 tokens instead of 1
Debriefing was left out - A debriefing can be a confounding factor in game research	Options to choose from - Debriefing in game sessions - Debriefing after game session	Debriefing after the 'long-term effect' survey per email; also to inform students about what the research was about

Appendix C: Materials for game session

C1: Standardized introduction

During the game sessions, a standardized introduction was read to the participants, which included the briefing of the research, the cover story and an introduction to truck platooning. In all three game versions, the same introduction was used, which can be found below.

Master thesis project

- This research is part of my master thesis project.
- For my master thesis, I am researching the effects of several game elements. For the purpose of this research, I cannot specify what specific game elements I am studying.
- However, after the research is finished, I am happy to inform you about the goal of my research.

Outline of the research

- You have received a first survey - which you must have completed before participating in this game session
- Today we will have the game session, followed by a second survey and interviews with the players who have agreed to participate in the interviews.
- In a week, you will receive an email with the third and final survey
- After finalizing the final survey, you will receive an email in which I will explain what I studied during the game sessions and why.

So let's move on to the game: Mobinn

- This game is an adjusted version of the existing serious game Mobinn, which is a game that is designed by researchers here at the faculty of TPM.
- The game is part of the INDEEP project, which studies how transportation innovations can be effectively realized.
- The innovation of interest in this game is truck platooning.

About truck platooning

- For this game, it is not important to know all the details about truck platooning, but I will give you a small introduction to the innovation.
- In a truck platoon, trucks are driving automatically in small convoys, with a fixed short distance apart [point at picture]
- The truck at the head of the platoon acts as the leader, with the following vehicles behind reacting and adapting to changes in its movement.
- This results in in a smoother traffic flow, higher traffic safety, fuel savings and a reduction in CO_2 emissions.
- For truck platooning to be realized, we need the following things to be ready
    - The technology: we need safe and workable radars, cameras, GPS systems and wireless connections
    - The infrastructure: both physical and legal changes are needed to realize truck platooning. For example, it is now forbidden for trucks to drive with a short distance apart and the on- and off ramps on the high roads are currently too short for a convoy to drive on

- Finally, the users: the users must be able and willing to use truck platooning. However, before they can adopt the innovation, they need to be aware of the costs and benefits of the innovation.

It often appears that although the theory for realizing truck platooning is available, in reality, moving from theory to practice often takes a very long time. In fact, a lot of innovations remain their pilot phase.

I want to ask you to give it a shot. Now that you know what it takes to realize truck platooning, I want to ask you to play the game and make truck platooning happen.

C2: Game instructions

Game instructions for no-simulation version:

Story
You are all invited to a decision making process where you will make decisions about investments for the realization of truck platooning. Your goal is to get the technology, infrastructure and users ready to make truck platooning happen.

Game setup and materials
Before the game starts, you will each receive 1 role card and 5 actions cards. Each player starts with 5 tokens.

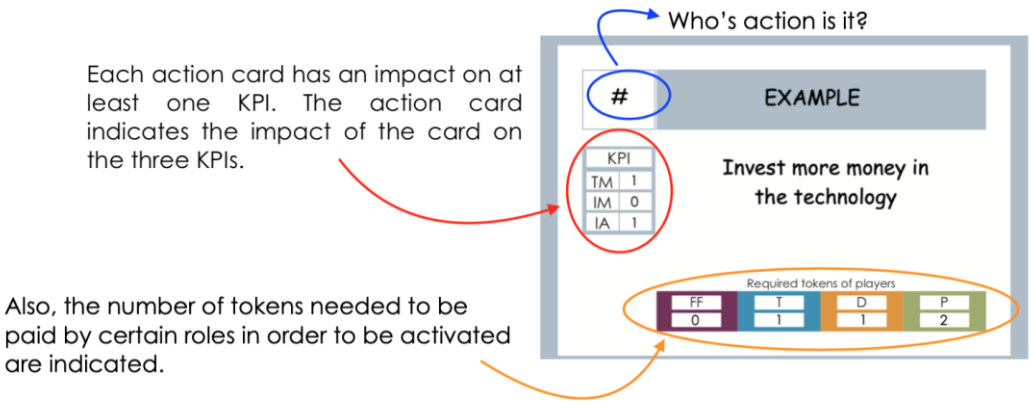
On the table you see the game board, which indicates the levels of the three Key Performance Indicators (KPI's): Technology maturity (TM), Physical/Legal Infrastructure maturity (IM) and Innovation adoption (IA). The TM starts at level 5, the IM at 4 and the IA at level 2.

There are also external event cards, which are the cards marked with a question mark, and KPI level cards.

Roles, action cards and goal
Each role card describes the issues that a certain actor is facing. You are asked to empathize with your role.

The issues that are mentioned on the role cards can be solved by playing your action cards. The more action cards you are able to play, the more issues you can solve for yourself. You can regard this as a personal goal. However, the goal of the game is to make truck platooning happen.

How to make truck platooning happen?
Your goal is to get **all KPI's** in the green area on the board (level 7 or higher). You can do this by playing your action cards:



But the innovation is influenced by:

- External events
  - Like the action cards, they can influence a KPI and

increase/decrease the amount of tokens of a player

- Limited budget
    - You will start with 5 tokens, and get 2 tokens extra after each round. The policy maker will receive 3 tokens, because in reality, the government is the wealthiest actor.
- Limited time: you only have 4 rounds to make truck platooning happen.

Steps of play

1. In the beginning of each round, you can decide whether you want to play **one of your action cards**. You can either choose to play one of your action cards or you can remain inactive, choosing not to play any card at the given round.
2. When you have decided to play an action card, you put the card upside down on the table and invest **the amount of tokens that your action card requires from your role**.
3. After all players have decided to play an action card or not, the decision phase starts. **All players** are included in the decision-making process; also the players who have decided to stay inactive.

   You have to decide together which cards will be activated in the given round. **You are allowed to activate action cards from multiple players.**

   For a card to be activated, all roles mentioned on the action card have to agree on supporting the action card. This means that they have to agree on paying the amount of tokens that is required from their role.
   a. If a card is **not** activated, the tokens invested on it are lost and the card is returned to the player.
   b. If a card gets activated, you are asked to follow the instructions on the card, which include:
      i. All roles mentioned on the action card paying the required amount of tokens
      ii. The KPI's mentioned on the action card are moved on the KPI board
4. After all activated action cards are played, you will all receive **extra tokens**. **The developer (D)** will hand out the extra tokens. All players receive 2 extra tokens, except for the policy maker, who receives 3 extra tokens.
5. After all roles have received their extra tokens, you have to draw an **external event card** (the card with the question mark (?)). All players have to follow the instructions on the card.
6. After finishing these steps, you proceed to the next round.

AFTER FINISHING ROUND 2, BEFORE PROCEEDING TO ROUND 3:

7. Between the 2nd and 3rd round, you are asked to draw a KPI level card. **For each KPI, you are asked to draw one KPI level card.** For each KPI, you look at the color of the level that the KPI is in after playing round 2. For each KPI, you pick up the card with the corresponding color. You read the feedback cards, and set the cards it aside.

Everything else is up to you. You can talk, you can negotiate, you can ask for help.

Game instructions for in between version:

Story
You are all invited to a decision making process where you will make decisions about investments for the realization of truck platooning. Your goal is to get the technology, infrastructure and users ready to make truck platooning happen.

Game setup and materials
Before the game starts, you will each receive 1 role card and 5 actions cards. Each player starts with 5 tokens.

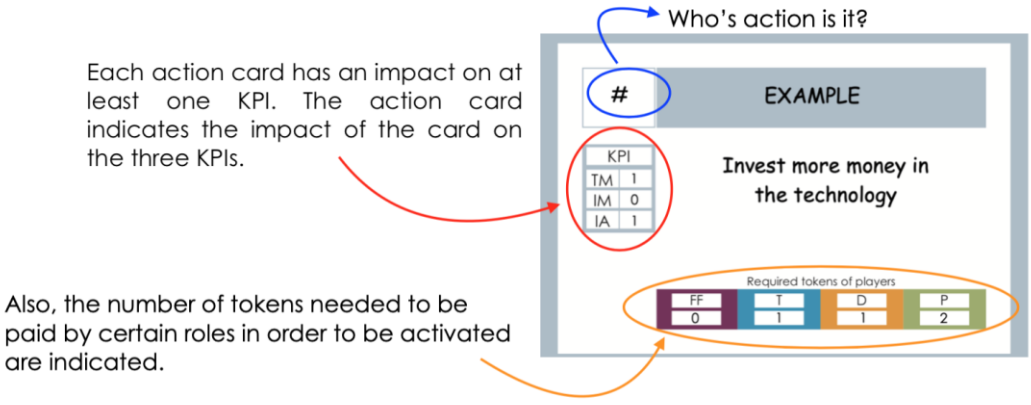
On the table you see the game board, which indicates the levels of the three Key Performance Indicators (KPI's): Technology maturity (TM), Physical/Legal Infrastructure maturity (IM) and Innovation adoption (IA). The TM starts at level 5, the IM at 4 and the IA at level 2.

There are also external event cards, which are the cards marked with a question mark, and KPI level cards.

Roles, action cards and goal
Each role card describes the issues that a certain actor is facing. You are asked to empathize with your role.

The issues that are mentioned on the role cards can be solved by playing your action cards. The more action cards you are able to play, the more issues you can solve for yourself. You can regard this as a personal goal. However, the goal of the game is to make truck platooning happen.

How to make truck platooning happen?
Your goal is to get **all KPI's** in the green area on the board (level 7 or higher). You can do this by playing your action cards.



But the innovation is influenced by:

- External events
  - Like the action cards, they can influence a KPI and increase/decrease the amount of tokens of a player
- Limited budget

    - You will start with 5 tokens, and get 2 tokens extra after each round. The policy maker will receive 3 tokens, because in reality, the government is the wealthiest actor.
- Limited time: you only have 4 rounds to make truck platooning happen.

Steps of play

1. In the beginning of each round, you can decide whether you want to play **one of your action cards**. You can either choose to play one of your action cards or you can remain inactive, choosing not to play any card at the given round.
2. When you have decided to play an action card, you put the card upside down on the table and invest **the amount of tokens that your action card requires from your role**.
3. After all players have decided to play an action card or not, the decision phase starts. **All players** are included in the decision-making process; also the players who have decided to stay inactive.

   You have to decide together which cards will be activated in the given round. **You are allowed to activate action cards from multiple players.**

   For a card to be activated, all roles mentioned on the action card have to agree on supporting the action card. This means that they have to agree on paying the amount of tokens that is required from their role.
   a. If a card is **not** activated, the tokens invested on it are lost and the card is returned to the player.
   b. If a card gets activated, you are asked to follow the instructions on the card, which include:
      i. All roles mentioned on the action card paying the required amount of tokens
      ii. The KPI's mentioned on the action card are moved on the KPI board
4. After all activated action cards are played, you will all receive **extra tokens**. **The developer (D)** will hand out the extra tokens. All players receive 2 extra tokens, except for the policy maker, who receives 3 extra tokens.
5. After all roles have received their extra tokens, you have to draw an **external event card** (the card with the question mark (?). All players have to follow the instructions on the card.
6. After finishing these steps, you proceed to the next round.

AFTER FINISHING ROUND 2, BEFORE PROCEEDING TO ROUND 3:

Between the 2nd and 3rd round, you are asked to draw a KPI level card. **For each KPI, you are asked to draw one KPI level card.** For each KPI, you look at the color of the level that the KPI is in after playing round 2. For each KPI, you pick up the card with the corresponding color of the level. You read the KPI level cards out loud, and set the cards it aside. You also remove the remaining cards from the board. After that, you proceed to the 3rd round.

Everything else is up to you. You can talk, you can negotiate, you can ask for help.

Game instructions for simulation version:

Story
You are all invited to a decision making process where you will make decisions about investments for the realization of truck platooning. Your goal is to get the technology, infrastructure and users ready to make truck platooning happen.

Game setup and materials
Before the game starts, you will each receive 1 role card and 5 actions cards. Each player starts with 5 tokens.

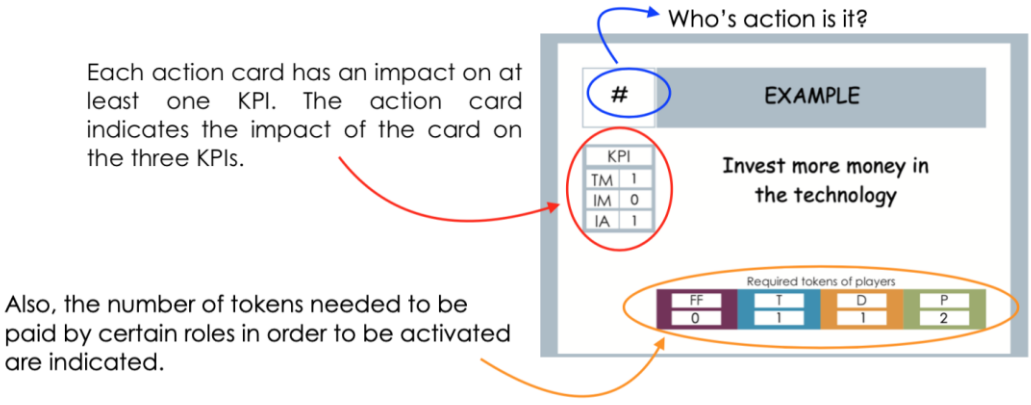
On the table you see the game board, which indicates the levels of the three Key Performance Indicators (KPI's): Technology maturity (TM), Physical/Legal Infrastructure maturity (IM) and Innovation adoption (IA). The TM starts at level 5, the IM at 4 and the IA at level 2.

There are also external event cards, which are the cards marked with a question mark, and KPI level cards.

Roles, action cards and goal
Each role card describes the issues that a certain actor is facing. You are asked to empathize with your role.

The issues that are mentioned on the role cards can be solved by playing your action cards. The more action cards you are able to play, the more issues you can solve for yourself. You can regard this as a personal goal. However, the goal of the game is to make truck platooning happen.

How to make truck platooning happen?
Your goal is to get **all KPI's** in the green area on the board (level 7 or higher). You can do this by playing your action cards.



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Steps of play

1. In the beginning of each round, you can decide whether you want to play **one of your action cards**. You can either choose to play one of your action cards or you can remain inactive, choosing not to play any card at the given round.
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5. After all roles have received their extra tokens, you have to draw an **external event card** (the card with the question mark (?)). All players have to follow the instructions on the card.
6. After drawing the external event card, you draw A KPI level card for each KPI. For each KPI, you look at the color of the level that the KPI is in after playing round 2. For each KPI, you pick up the card with the corresponding color of the level. You read the KPI level cards out loud, and set the cards it aside.
7. After finishing these steps, you proceed to the next round.

Everything else is up to you. You can talk, you can negotiate, you can ask for help.

C3: Debriefing

The following text was sent via email to all participants, both for the debriefing and for answering the most frequent questions that were asked during the game sessions.

A brief summary of the research purpose

My thesis focuses on design principles for persuasive games, which are games that intentionally convey a persuasive message that is aimed at altering human behaviour and/or attitudes beyond a game session. Persuasion relies on the user's voluntary participation in the persuasion process, therefore, these game are not aimed at forcing people to change their attitude/behaviour against their will. For creating these games, design principles are considered to be key drivers for conceiving successful games. However, there is a lack of validated persuasive game design principles. Therefore, my research aims at validating the most frequent used game design principle used in persuasive games for multi-actor decision-making: simulation. The simulation principle is defined as follows: *Players are provided with a mechanism to see the link between the cause and effect of their behaviour in the game and its link to reality.* In this research, the effect of the simulation principle on attitude change towards cooperation and information sharing will be measured.

Debriefing

Normally, after a game session, there would have been a debriefing in which I would explain the aim of the game and connect the concepts to the real world. However, as a debriefing can interfere with what you have learned or experienced during the game and thus with your attitudes, having a debriefing could have bias my research outcomes. But in short, the goal of the game was to provide you with insights about innovation processes and what is necessary for them to be successful: information sharing and cooperation. Although this may seems logical, in real life, this is not happening at all because actors are not aware of the necessity of these strategies. From the results of my research however, it seems like you have all understand this message luckily.

How did I try to validate the simulation principle

As I mentioned during the game session, I used an existing game (Mobinn), which aims at showing actors the importance of cooperating and sharing information, and adjusted it for my research. I ended up making three versions (sorry for lying to you Julian): a version where the simulation principle was present in each round, a version where the simulation principle was only present in one round and a version without the principle. You all played different versions of the game. Nevertheless, the goal of the game remained the same in all versions: to make truck platooning happen.

Assessing the attitude change

So why did I ask you to fill in 3 surveys? Well, I needed to know if your attitude towards cooperation and information changed after playing the game. Therefore, I needed to know you initial attitudes towards these strategies (survey 1), you post-game attitudes (survey 2) and your long-term attitudes (survey 3). With the latter, I tried to assess whether the game has led to a lasting attitude change, or if the attitude change was just a short-term thing. The other 4 strategies in the survey were 'dummy strategies' that were added to the survey to prevent that you would get biased and play with a certain strategy during the game.

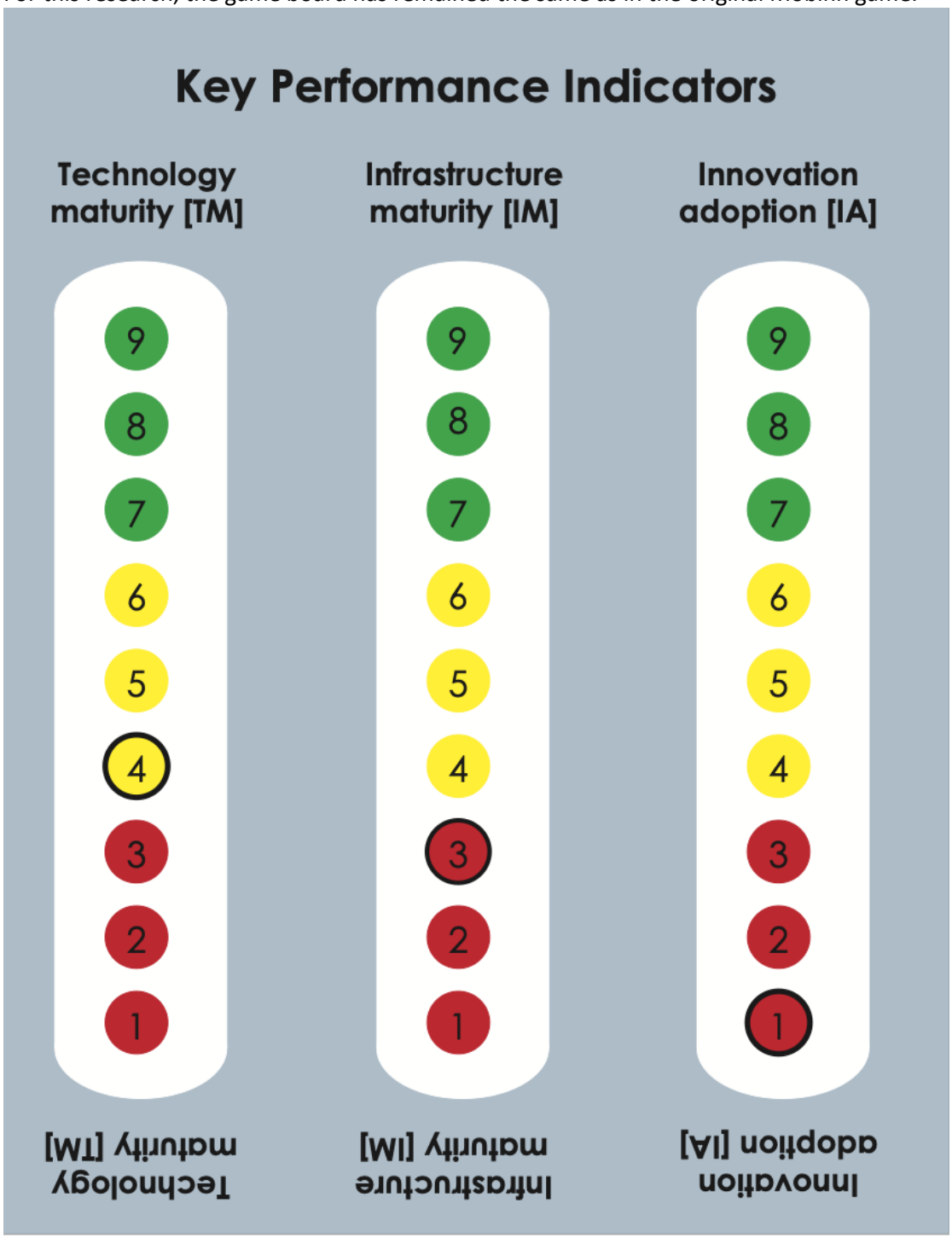
Why did you also measure our game experience?

For this research, it was important that everything in all game sessions remained the same, except for the simulation principle. That also means that everything that is added to or removed from the game, could not interfere with your game experience. Therefore, I assessed if the game experience remained the same in all game versions.

Appendix D: Game play materials

D1: Game board

For this research, the game board has remained the same as in the original Mobinn game.



D2: Role cards

FREIGHT FORWARDER [FF]

You are Jasper, representative of the freight forwarder LEOFOROS Logistics B.V. Promoting sustainability and the reduction of CO2 emissions is one of the key performance indicators of your company. You have many different shippers as costumers and you want to keep them satisfied by offering "the greenest solutions" to them.

The issues that are particular of interest to you are:

- You want to be the first mover in "making truck platooning happen" by actively working with the community to achieve it and get clients and users on board
- You want to offer lower prices to your clients
- You are worried that truck platooning might increase the prices due to the additional equipment needed in order for it to be operational
- You are worried about the lack of EU regulations

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TRANSPORTER [T]

You are Lucas, representative of "METAFORA", a large company that delivers transport services in the Netherlands and across Europe. You are interested in using truck platooning technology to improve the services offered to your clients.

The issues that are particular of interest to you are:

- Possibility to form platoons with multiple transporters (multi-vender platoons), possibly with competing transporters
- Possibility to form platoons during the ride (on-the-fly/ dynamic platooning)
- Potential impact on logistical planning, waiting time and on and drivers that are not yet familiar with truck platooning
- The optimal payment scheme regarding compensation of other companies' trucks (for example when their truck is at the front of the platoon, it is exposed to more risks)
- The lack of regulations in favour of truck platooning by the EU side at the moment

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DEVELOPER [D]

You are Melissa, representative of the Original Equipment Manufacturer (OEM) "PROTOTIPO". Being really interested in the truck platooning concept, your company has already invested a large amount of money in R&D processes.

The issues that are particular of interest to you are:

- You aim at developing the technology before your competitors, still in the most cost-effective way. You really believe that the technology you develop is the best and it has to be the one that dominates the truck platooning market.
- Nevertheless, the lack of EU regulations at the moment in favour of truck platooning is a worrying factor for you.
- You also worry about potential compliance issues with EU standardization. What if you invest in developing a particular technology and after some time the EU decides to standardize another type of technology which is not compatible to your?
- You want to stand out by providing state-of-the-art technology that is safe and provides users with extra services

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POLICYMAKER [P]

You are Lisa, representative of the Dutch Ministry of Infrastructure and Water Management and in particular of the department responsible for executing policies with respect to Dutch highway infrastructure. Your Department is responsible for realizing and maintaining a safe and efficient infrastructure. Truck platooning is likely to have an impact on the physical infrastructure itself, but also potentially on the traffic flow.

- You face a really challenging dilemma: should you wait for the EU to develop regulations regarding truck platooning first and then act accordingly and align with them? Or should you be a frontrunner to keep Netherlands innovative and successful (with all the risks involved for pioneers)? You are afraid of either acting too early or acting too late.

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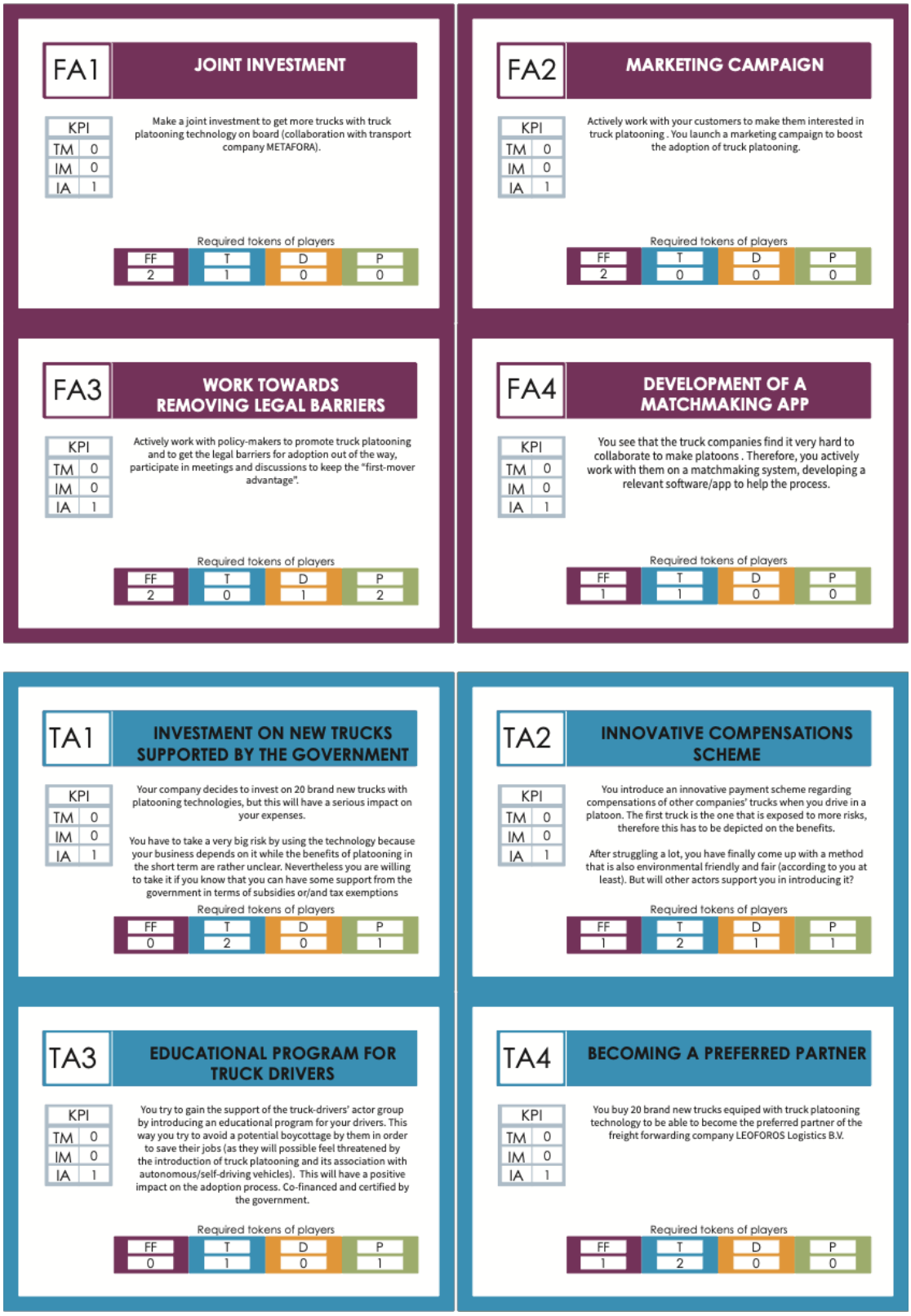
D3: Action cards



DA1 INTRODUCTION OF BRAND NEW TECHNOLOGY

KPI	
TM	2
IM	0
IA	1

Pilot research studies from companies in the US show that there is great potential to further improve the communication technologies that you are currently developing. You would like to be a frontrunner and bring this brand new technology to Europe. Therefore you are willing to invest more on R&D to achieve it, but this will require support from the government and from the private sector.

Required tokens of players

FF	T	D	P
0	1	2	2

DA2 JOINT DEVELOPMENT OF TECHNOLOGY WITH COMPETITORS

KPI	
TM	1
IM	0
IA	1

Your company realizes that you can develop in a more cost-efficient way if you develop the technology in a more cooperative rather than a competitive way with the rest of OEMs. The business case of truck platooning will increase its chances to be successful if trucks equipped with technology from different OEMs can form dynamic platoons on their way. You start promoting an initiative for cooperation.

Required tokens of players

FF	T	D	P
0	0	3	1

DA3 INCREASE SAFETY TO PREVENT HACKERS ATTACK

KPI	
TM	1
IM	0
IA	1

You decide to invest a large amount of money in increasing the safety mechanisms of the technology you develop against cyber-attacks from hackers. By doing so, the freight forwarder and transporters will also be able to offer a more secure environment to their clients. However, this means that the prices for investing in the technology and for offering their services might increase.

Required tokens of players

FF	T	D	P
0	1	2	0

DA4 PROVISION OF ADDITIONAL SERVICES

KPI	
TM	0
IM	0
IA	1

You introduce additional services for the truck companies, freight forwarders and government in terms of providing trucking tracing information, information about successful platoons, fuel savings etc.

Required tokens of players

FF	T	D	P
1	1	2	1

PA1 LARGE INVESTMENT ON PHYSICAL INFRASTRUCTURE

KPI	
TM	0
IM	1
IA	0

The government decided to invest a large amount of money in order to boost the truck platooning development in the Netherlands based on updating road infrastructure on main traffic arteries. A huge project is on its way to be implemented but it requires co – financing from OEMs and transporting companies to ensure they are on board for this ambitious plan.

Required tokens of players

FF	T	D	P
0	2	2	3

PA2 DEVELOPMENT OF A TEST LABORATORY

KPI	
TM	0
IM	1
IA	1

The Ministry decided to create a large test laboratory to facilitate pilot experiments around truck platooning technology. The location is decided and works can start immediately if the private sector agrees in participating by partially co-financing the lab's development.

Required tokens of players

FF	T	D	P
1	1	2	2

PA3 INTRODUCTION OF NEW LEGISLATION

KPI	
TM	0
IM	1
IA	0

The government decided that Netherlands should lead the way among EU countries and "make truck platooning happen". A new legislation is introduced that lowers the minimum legal driving distance between two trucks in the Dutch highways, so that platoons can be formed; this can act as a motivation for the private sector to invest more on the truck platooning concept.

Required tokens of players

FF	T	D	P
1	1	1	3

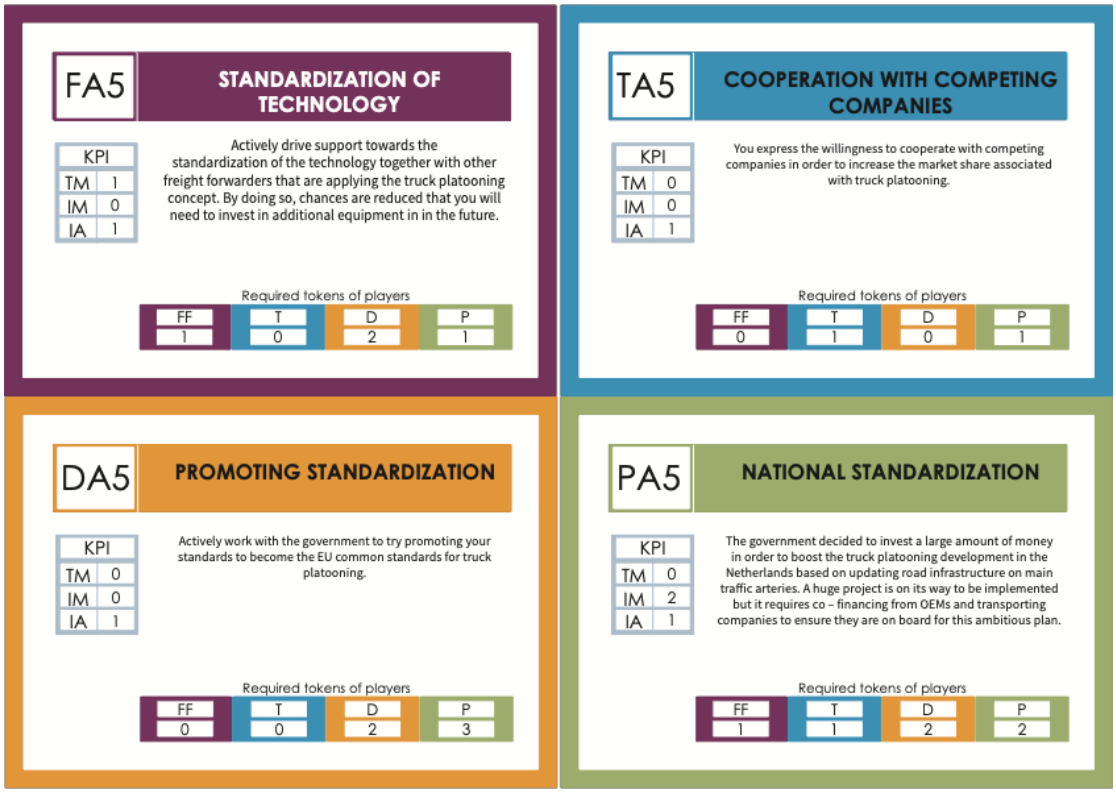
PA4 PROVISION OF INCENTIVES

KPI	
TM	0
IM	0
IA	1

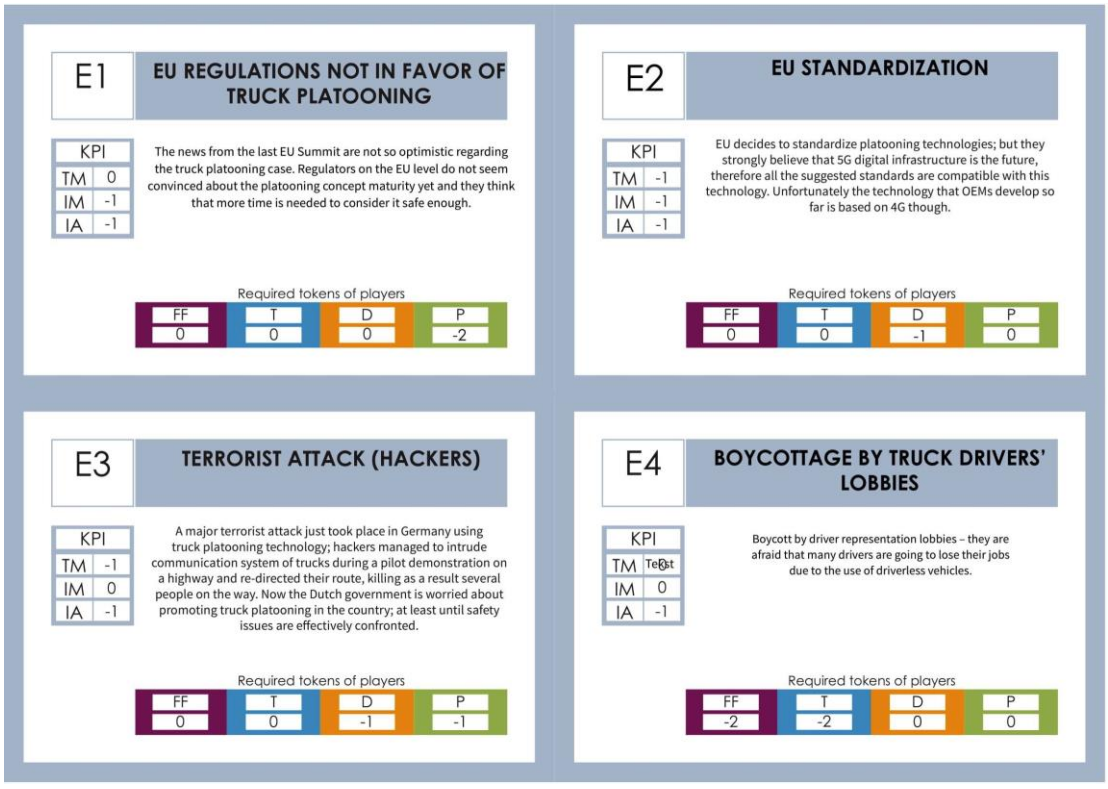
The government decided to provide some incentives to the companies that are involved in truck platooning, such as tax and toll reductions, as a reward for the reduction of CO2 emissions.

Required tokens of players

FF	T	D	P
1	1	1	3



D4: External event cards (Event cards)



D5: Simulation cards

Simulation cards for simulation version

The innovation adoption has **remained at /reached (again)** its lowest level. Several actors in the transportation sector are not willing to use truck platooning yet because they don't see the advantages and they have no incentives to use it. Due to your inability as a group of decision-makers to promote the technology and get the innovation adoption to the required level together, there is no prospect yet of truck platooning being adopted by future users. The prospect of reducing CO2 emissions, fuel use, increasing traffic safety and traffic flow is low.	The innovation adoption is getting to the required level, probably due to your ability as a group of decision-makers to make decisions together effectively. Several actors in the transportation sector are warming up to the idea of using truck platooning. You are one step closer at making truck platooning happen, which would allow for less CO2 emissions, traffic congestion, traffic accidents and fuel use. But there is still work that needs to be done to get the innovation adoption to the required level together.	Making decisions effectively together as a group of decision-makers has resulted in the innovation adoption reaching the required level for realizing truck platooning. Truck platooning is being widely accepted in the transportation sector and will probably be widely used when truck platooning is realized. When the infrastructure maturity and technology maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.
The infrastructure has reached its lowest level, meaning that the Dutch roads are not ready for truck platooning at all. Both legal and physical changes are still needed to enable truck platooning. Due to your inability as a group of decision-makers to facilitate these changes effectively together, there is no prospect yet that truck platooning will be realized soon in the Netherlands. Reaching goals regarding reducing CO2 emissions, traffic congestions, traffic accidents and fuel use still seem far away.	The infrastructure maturity is not yet at the required level. Some legislation and physical changes have been proposed or implemented to get the Dutch roads ready for truck platooning. However, you as a group of decision-makers still have a long way to go together when it comes to effectively making decisions to get the current infrastructure ready for truck platooning, which would benefit the economy and the environment.	Making decisions effectively together as a group of decision-makers has resulted in the infrastructure maturity to reach its required level. The Dutch roads are ready for truck platooning. When the innovation adoption and technology maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.
The technology maturity has reached its lowest level, meaning that the technology enabling truck platooning is not ready for the future at all. There are safety, standardization and efficiency issues. Due to your inability as a group of decision-makers to improve the technology and get the technology maturity to the required level together, there is no prospect yet of realizing truck platooning. Reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seem far away.	The technology maturity is not yet at the required level. The safety and technical efficiency are improving, but there is still work that needs to be done by you as a group of decision-makers to get the technology maturity to the required level together. You are getting closer at making truck platooning happen, which would reduce the current fuel use, CO2 emission levels, traffic congestion and traffic accidents.	Making decisions effectively together as a group of decision-makers has resulted in the technology maturity to reach its required level. The technology that enables truck platooning is safe and ready to make truck platooning happen in the Netherlands. When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.

The innovation adoption is **still/again** at its lowest level. Several actors still don't see the advantages of using truck platooning. As a group of decision-makers, you have not yet succeeded together at providing them with incentives for using truck platooning. The prospects of making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation are low.	The innovation adoption **has remained/ is again** at the intermediary level. You as a group were not yet able to make decisions effectively together to take actions in order to get all actors in the transportation sector on board with the idea of using truck platooning. But you are getting closer at making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able **to keep/get** the innovation adoption at the required level again**.** When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions provide society with the environmental and economic benefits that are linked to this innovation.
The infrastructure maturity is **still/again** at its lowest level. You as a group were not able to make not yet able make decisions effectively together in order to take measures to get the Dutch roads ready for truck platooning. Realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	The infrastructure maturity is **has remained/is again** at the intermediary level. You as a group were not yet able to make decisions effectively together to take measures that are necessary to get the Dutch roads ready for truck platooning. But you are getting closer at making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able **to keep/get** the infrastructure maturity at the required level again**.** When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions provide society with the environmental and economic benefits that are linked to this innovation.
The technology maturity is **still/again** at its lowest level again. You as a group were not yet able make decisions effectively together in order to be able to take measures to improve the technology. Realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	The technology maturity **is again/has remained** at the intermediary level. You as a group were not yet able to make decisions effectively together in order to get the technology for truck platooning fully ready for use. You are almost able to get the technology maturity to the required level. This would mean that you are one step closer to make truck platooning happen and provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able to keep the technology for truck platooning safe and workable. When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.

The innovation adoption is at **still/again** at its lowest level. As a group of decision-makers, you have not yet succeeded at providing actors with incentives for using truck platooning even slightly. Realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	You as a group were **still/again** not able to make decisions effectively together to take actions in order to get all actors in the transportation sector on board with the idea of using truck platooning. But you are getting closer at making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able **to keep/get** the innovation adoption at the required level again**.** When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions provide society with the environmental and economic benefits that are linked to this innovation.
The infrastructure maturity is **still/again** at its lowest level. You were still not able to make decisions effectively together in order to take measures to get the Dutch roads ready for truck platooning even slightly. The prospects of making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation are low.	You as a group were **still/again** not yet able to make decisions effectively together to take measures that are necessary to get the Dutch roads ready for truck platooning. But you are getting closer at making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision as a group has made you able **to keep/get** the infrastructure maturity at the required level again**.** When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions provide society with the environmental and economic benefits that are linked to this innovation.
The technology maturity is **still/again** at its lowest level. You were still not able to make decisions effectively together in order to be able to take measures to improve the technology even slightly. Realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	You as a group were **still/again** not yet able to make decisions effectively together in order to get the technology for truck platooning fully ready for use. But you are almost able to get the technology maturity to the required level. This would mean that you are one step closer to make truck platooning happen and provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able **to keep/get** the technology for truck platooning safe and workable. When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.

As a group of decision-makers, you have not succeeded at providing actors with incentives for using truck platooning to get the innovation adoption to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have not succeeded at providing actors with incentives for using truck platooning to get the innovation adoption to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have together succeeded at providing actors with incentives for using truck platooning to get the innovation adoption to the required level. When the innovation adoption and infrastructure maturity are also at the same level, you as a group have succeeded at making truck platooning happen and provide society with the environmental and economic benefits that are linked to this innovation.
As a group of decision-makers, you have not been able to make decisions effectively together in order to take measures to get the Dutch roads ready for truck platooning and get the infrastructure maturity to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have not been able to make decisions effectively together in order to take measures to get the Dutch roads ready for truck platooning and get the infrastructure maturity to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have succeeded at to making decisions effectively together in order to take measures to get the Dutch roads ready for truck platooning and to get the infrastructure maturity to the required level. When the innovation adoption and infrastructure maturity are also at the same level, you as a group have succeeded at making truck platooning happen and provide society with the environmental and economic benefits that are linked to this innovation.
As a group of decision-makers, you have not been able to make decisions effectively together in order to be able to take measures to improve the technology and get the technology maturity to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have not been able to make decisions effectively together in order to be able to take measures to improve the technology and get the technology maturity to the required level. You have not succeeded in realizing truck platooning, and thereby reducing CO2 emissions, traffic congestion, traffic accidents and fuel use still seems far away.	As a group of decision-makers, you have succeeded at making decisions effectively together in order to be able to take measures to improve the technology for truck platooning and to get the technology maturity to the required level. When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.

Simulation cards for in between version

The innovation adoption is at its lowest level. Several actors in the transportation sector are not willing to use truck platooning yet because they don't see the advantages and they have no incentives to use it. Due to your inability as a group of decision-makers to promote the technology and get the innovation adoption to the required level together, there is no prospect yet of truck platooning being adopted by future users. The prospect of reducing CO2 emissions, fuel use, increasing traffic safety and traffic flow is low.	The innovation adoption is at the intermediary level. You as a group were not yet able to make decisions effectively together to take actions in order to get all actors in the transportation sector on board with the idea of using truck platooning. But you are getting closer at making truck platooning happen and thereby provide society with the environmental and economic benefits that are linked to this innovation.	Making decisions effectively together as a group of decision-makers has resulted in the innovation adoption reaching the required level for realizing truck platooning. Truck platooning is being widely accepted in the transportation sector and will probably be widely used when truck platooning is realized if the innovation adoption will remain at this level. When the infrastructure maturity and technology maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.
The infrastructure has is at its lowest level, meaning that the Dutch roads are not ready for truck platooning at all. Both legal and physical changes are still needed to enable truck platooning. Due to your inability as a group of decision-makers to facilitate these changes effectively together, there is no prospect yet that truck platooning will be realized soon in the Netherlands. Reaching goals regarding reducing CO2 emissions, traffic congestions, traffic accidents and fuel use still seem far away.	The infrastructure maturity is at the intermediary level. You as a group were not yet able to make decisions effectively together to take measures that are necessary to get the Dutch roads ready for truck platooning. You are getting closer to making truck platooning happen, which would allow for less CO2 emissions, traffic congestion, traffic accidents and fuel use. But there is still work that needs to be done to get the infrastructure maturity to the required level together.	Making decisions effectively together as a group of decision-makers has resulted in the infrastructure maturity to reach its required level. If the infrastructure maturity remains at this level, the Dutch roads are guaranteed ready for truck platooning. When the innovation adoption and technology maturity get at the same level, you as a group will be able to realize truck platooning and reduce CO2 emissions, traffic congestion, traffic accidents and fuel use.
The technology maturity has reached its lowest level, meaning that the technology enabling truck platooning is not ready for the future at all. There are safety, standardization and efficiency issues. Due to your inability as a group of decision-makers to improve the technology and get the technology maturity to the required level together, there is no prospect yet of realizing truck platooning. You are still far away from reducing CO2 emissions, traffic congestion, traffic accidents and fuel use.	The technology maturity is at the intermediary level. You as a group were not yet able to make decisions effectively in order to get the technology for truck platooning fully ready for use. You are almost able to get the technology maturity to the required level. This would mean that you are one step closer to make truck platooning happen and provide society with the environmental and economic benefits that are linked to this innovation.	Effectively making decision together as a group has made you able to get the technology for truck platooning safe and workable. If the technology maturity remains at this level, the technology that enables truck platooning will be safe and ready to make truck platooning happen in the Netherlands. When the innovation adoption and infrastructure maturity get at the same level, you as a group will be able to realize truck platooning and thereby provide society with the environmental and economic benefits that are linked to this innovation.