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

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***Abstract*— 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. 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. Game experiments in the form of laboratory experiment were conducted to control for possible confounding variables. Three versions of an existing game were conceived in which the persuasive game design principle simulation was varied. A mixed methods approach was used in which both quantitative and qualitative measures were conducted to assess the effect of the persuasive game design principle simulation on attitude change. Based on current findings it cannot be confirmed nor denied that the persuasive game design principle has affected attitude change regarding cooperation and information sharing. Still, 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 which did not consist yet. Further research on the methodology is advised to validate its effect and for fine-tuning. Additionally, it is advised to conduct this research with a greater sample size in this future.**

Keywords—Persuasive games, persuasive game design principles, simulation, multi-actor decision-making

I. INTRODUCTION

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.

A relatively new tool for achieving attitude change 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.

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). The effects of persuasive game design principles have been studied in some notable research. 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.

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 knowledge regarding the persuasive effect of persuasive game design principles could be considered a serious knowledge gap in the persuasive game discipline and for conceiving persuasive games for multi-actor decision-making. In order to prevent the occurrence of ineffective and counterproductive games for multi-actor decision-making, which can be crucial instruments for innovation processes, the aim of this research is therefore to validate persuasive effect in isolation of the most frequent used persuasive game design principle for persuasive games in multi-actor decision-making which is the persuasive game design principle simulation. The persuasive game design principle simulation is defined as follows: *Players are provided with a mechanism to see the cause-and-effect linkage of their behaviour in the game and its link to reality.* This is perceived to bring new knowledge and understanding for the creation of persuasive games for multi-actor decision-making, both for persuasive game researchers and persuasive game designers.

The structure of this paper is as follows. In section 2, the theoretical framework is presented which forms the blueprint for this research. Section 3 presents the methodology and measurement instruments used for this research. The results of this research are presented in section 4. Finally, section 5 presents the conclusion, limitations, discussion and recommendations for future work.

II. THEORETICAL FRAMEWORK

Different types of theory and literature were assessed to analyse the persuasive power of the persuasive game design principle simulation from different points of view to form a theoretical base for this research. This was 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. Eventually, the Elaboration Likelihood Model of Persuasion (ELM) (Petty & Cacioppo, 1986) appeared to provide a complete overview of critical factors for processing a persuasive message that can be placed into the context of persuasive games. The model also provides constructs for understanding the relationship between the persuasive game design principle simulation and a lasting attitude change. Considering this, it was chosen to use this model as the theoretical base for the creation of the theoretical framework for this research. In this section, an

overview of the theory will be provided together with together with an explanation on how the persuasive game design principle simulation connects to the theory.

A. The Elaboration Likelihood Model of Persuasion

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).

Key factors for *motivation to process* 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).

B. 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 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:

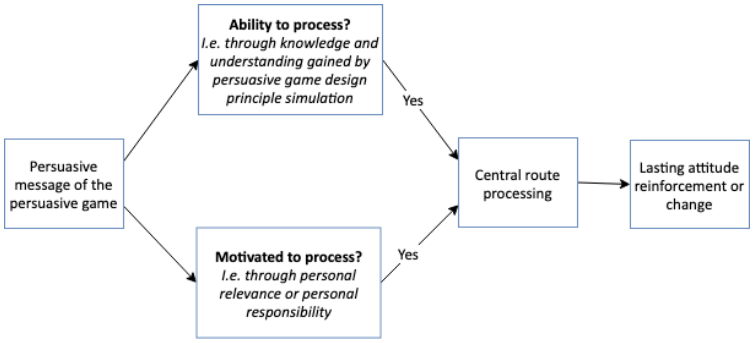

Fig. 1: Theoretical framework

C. *Implications*

There are a few implications that should be considered for this regarding the persuasive game design principle simulation. The first implication 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). Therefore, a risk a posed that the persuasive game design principle is applied wrongfully in this study, which could provide implications for observing the attitude change of interest. The second implication is that the ELM doe 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). It is assumed that the level of personal relevance could influence the outcome of the persuasion process. This implication will be controlled for by carefully selecting participants for the research that feel personally connected to the issue of realizing an innovation in the transportation domain. Finally, there is a change that the persuasive game design principle simulation will not result in an attitude change due to the occurrence of simulation denial. To assess whether simulation denial has occurred in this research and has acted as a possible barrier in this research, it will be assessed during the research to what extent they felt that the persuasive game was considered as a good representation of reality.

III. Methodology

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 was to design a methodology that allows for evaluating the effect of the persuasive game design principle simulation on attitude change towards cooperation in isolation. Expert interviews were conducted with researchers at the Delft University of Technology together with a literature review for the design of a methodology that allows for evaluating the effect of the persuasive game design principle in isolation.

It was chosen to carry out a mixed methods research approach. This approach refers to gathering, analysing and combining quantitative and qualitative data within a single research (Creswell & Clark, 2007, p. 2). For this research, it was assumed that using a single quantitative or qualitative method would not be sufficient due to the biases and limitations that occur when using a single quantitative method. This is also the rationale behind the mixed methods research approach (Greene, Caracelli & Graham, 1989).

The main instrument that is 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. The Mobinn game created by researchers at the faculty of Technology, Policy and Management at the Delft University of Technology was selected for this research. This game focuses on the realization of transportation innovations and aims at conveying the persuasive message that innovations cannot be implemented unless actors are willing to interact with each other and cooperate. The game 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 create different versions in which the presence of the principle is varied to observe its effect when present in different extents.

To be able to measure the pure effect of the persuasive game design principle simulation, it was chosen to conduct game experiments in the form of laboratory experiment in which the environment was controlled or standardized. Possible confounding variables such as game experience, game elements, other persuasive game design principles and participant characteristics were identified and standardized to be able to evaluate the effect of the persuasive game design principle simulation in isolation. The research design is discussed below.

A. *Design of persuasive game versions*

For varying the persuasive game design principle simulation, the timing strategy was used which is a strategy for providing feedback (Brookhart, 2017, p.5). In this research, this refers to varying how of often the persuasive game design principle simulation occurs. Three game versions of the existing persuasive game Mobinn were created: a version in which the principle is present in every round (simulation version), a version in which the principle is present only in one round (in-between version) and a version in which it is not present at all (no simulation version). Original elements of the Mobinn game were maintained as much as possible. Other than the persuasive game design principle, all elements were kept constant.

B. *Quantitative measurements*

Direct attitude measurements were chosen to assess attitudes for the quantitative measurements as it appears to be the most reliable for measuring attitudes in a game setting and are the most frequently used. Four 9-point semantic differential scales proposed by Petty & Cacioppo (1984) were used to measure attitudes towards a psychological object that can be summed into one index. Participants were presented a scenario and were asked to assess their thought towards applying different strategies among which cooperation and information sharing in the presented scenario. Additional strategies were added to prevent participants from getting the impression that the research was focusing on these two constructs and would adjust their

answers and game-play accordingly. Participants were asked to assess the strategies along the following scales: good/bad, beneficial/harmful, foolish/wise, and unfavourable/favourable.

C. Qualitative measurements

Qualitative measurements were conducted by performing semi-structured interviews. Based on the theoretical framework for this research, themes and questions were prepared as a basic guideline. The questions were 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.

Predetermined questions were not literally asked to maintain an informal setting during the interview. All questions were asked as open questions. No direct questions were asked regarding whether the persuasive game design principle simulation has lead to attitude change to prevent that any biases from the researcher will occur. Instead, participants were asked what game elements or parts of the game affected them the most during the game-play.

D. Participants

Twenty students from the Delft University of Technology participated in the research. 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 students were randomly allocated to game versions and received drinks and snacks during the game play. Six students agreed to participate in the interviews, of which two of each game version.

E. Game session procedure

On three consecutive days, game sessions were conducted for the three game versions. All game sessions were conducted from 2 PM to 3 PM to maintain standardization of the environment. For all game versions, two game sessions were conducted, except for the no simulation version. This was due to the lack of participants.

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

After the game play, the post-game attitude measurements were conducted using an analog survey. Afterwards, the students who agreed to participate in the interviews were interviewed. The interviews were 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 were asked to fill in the survey again to be able to assess whether there was a lasting attitude change. Again, the online survey tool LimeSurvey was used. Finally, participants were sent an email containing the debriefing of the game and an explanation of the research. It was chosen to do the debriefing at the end of the research instead of the game sessions because the insights provided during the debriefing could also cause for an attitude change to occur (Williams & Williams, 2007). Participants were allowed to ask questions regarding the game sessions and research.

IV. Results

A. Quantitative measurements

1) Initial attitudes

Considering that this study deals with very small sample sizes, non-parametric tests were selected to assess attitude changes and to assess difference between groups. Results showed that the initial attitude towards cooperation and information sharing in the different groups differed from each other. 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).

Due to the differences in initial attitude towards cooperation, comparing attitude reinforcements between the groups was difficult. Furthermore, the initial attitude towards cooperation were 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 was therefore expected that the attitude towards cooperation could be only reinforce to a small amount which may not be detectable by statistical tests.

Finally, 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).

2) Short-term attitudes

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 0.01 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.

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.

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.

3) 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. 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. This indicates that there was a lasting attitude reinforcement/change for the in between group.

4) Reflection on quantitative results

The quantitative 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. Fig. 2 and Fig. 3 present boxplots of the initial, short-term and long-term attitudes towards cooperation and information sharing per group.

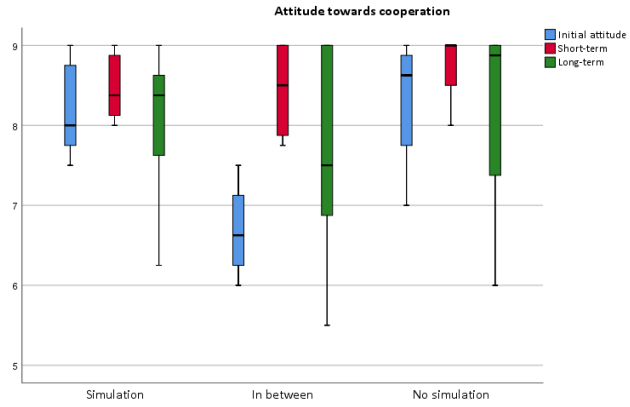

Fig. 2: Attitude changers towards cooperation

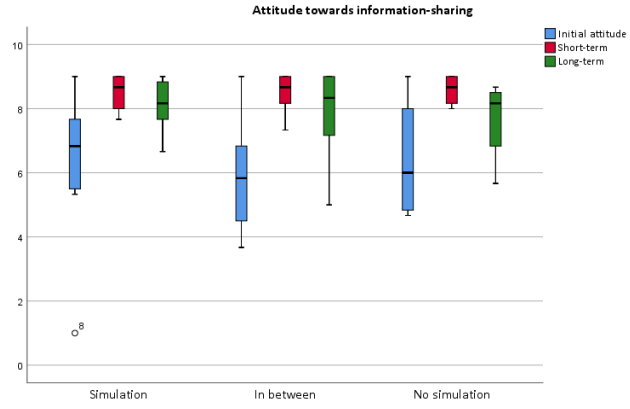

Fig. 3: Attitude changes towards information sharing

B. *Qualitative results*

1) General insights

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. 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

C. Explanations for attitude change towards cooperating and information sharing by interviewees

1) 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. For both interviewees, no new groundbreaking 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.

2) 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.

3) 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

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. 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.

4) 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). 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 section 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.

5) 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 leads 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.

6) 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 section 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.

7) 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 were 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.

V. Conclusion, disscusiion and limiations

A. 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.

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 that were 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.

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.

B. Limitations

1) 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.

2) 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.

3) 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.

4) 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.

C. Discussion

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.

D. Future research recommendations

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.

References

[1] Abt, C. C. (1987). *Serious games*. Lanham, MD: University press of America.

[2] Bitner, M. J., & Obermiller, C. (1985). The elaboration likelihood model: Limitations and extensions in marketing. *Advances in Consumer Research, 12,* 420-425.

[3] Bogost, I. (2007). *Persuasive games: The expressive power of videogames*. London, England: The MIT Press Cambridge.

[4] Bogost, I. (2008). *Unit operations: An approach to videogame criticism*. London, England: The MIT Press Cambridge.

[5] Brookhart, S. M. (2017). *How to give effective feedback to your students*. Alexandria, VA: ASCD.

[6] Cialdini, R. B. (2001). Influence: Science and Practice. *Journal of Marketing Research, 23* (3), 305-306. doi: 10.2307/3151490

[7] Cohen, A. R., Stotland, E., & Wolfe, D. M. (1955). An experimental investigation of need for cognition. *The Journal of Abnormal and Social Psychology*, *51*(2), 291.

[8] Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research.* Thousand Oaks, CA: Sage Publications.

[9] De Bruijn, H., & Herder, P. M. (2009). System and actor perspectives on sociotechnical systems. *IEEE Transactions on systems, man, and cybernetics-part A: Systems and Humans*, *39*(5), 981-992.

[10] De la Hera Conde-Pumpido, T. (2013). A Conceptual Model for the Study of Persuasive Games. In *DiGRA Conference*.

[11] Deterding, S., Canossa, A., Harteveld, C., Cooper, S., Nacke, L. E., & Whitson, J. R. (2015). Gamifying research: Strategies, opportunities, challenges, ethics. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 2421-2424). New York, NY: ACM.

[12] Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational evaluation and policy analysis, 11*(3), 255-274.

[13] Howard, D. J. (1997). Familiar phrases as peripheral persuasion cues. Journal of Experimental Social Psychology, 33(3), 231-243.

[14] Kaptein, M., De Ruyter, B., Markopoulos, P., & Aarts, E. (2012). Adaptive persuasive systems: a study of tailored persuasive text messages to reduce snacking. *ACM Transactions on Interactive Intelligent Systems (TiiS)*, *2*(2), 10.

[15] Kono, T & Kagami, K. (2015). An Institutional Approach to the Creation of Innovation Ecosystems and the Role of Law. *Penn State Journal of Law & International Affairs, 4*(1), 167 - 185.

[16] Kors, M., Van der Spek, E. D., & Schouten, B. A. (2015). A Foundation for the Persuasive Gameplay Experience. In *Proceedings of the 10th Foundations of Digital Games Conference (FDG '15)*.

[17] Kurapati, S., Freese, M., Kourounioti, I., Lukosch, H. K., Bekebrede, G., Smit, T., ... van Veen, L. (2018). Attitude measurement with board games in transportation nodes. In *Simulation gaming - Applications for sustainable cities and smart infrastructures: 48th International Simulation and Gaming Association Conference, ISAGA 2017, Revised Selected Papers* (Vol. 10825 LNCS, pp. 148-157). (Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)). Springer Verlag. doi: 10.1007/978-3-319-91902-7_15

[18] Laczniak, R. N., Muchling, D. D., & Carlson, L. (1991). Effects of motiation and ability on ad-induced cognitive processing. In *R. Holman (Ed.), Proceedings of the 1991 conference of the American Academy of Adverting* (pp. 81-87). New York, NY: D'Arcy Masius Bention & Bowles.

[19] Mitusch, K. (2006). Non-commitment in performance evaluation and the problem of information distortions. *Journal of Economic Behavior & Organization*, *60*(4), 507-525.

[20] O'Keefe, D. J. (2002). *Persuasion: Theory and research* (Vol. 2). Sage.

[21] O'Keefe, D. J. (2008). Elaboration likelihood model. In W. Donsbach (Ed.), *International encyclopedia of communication* (Vol. 4, pp. 1475 - 1480). Oxford, England: Wiley-Blackwell.

[22] Oinas-Kukkonen, H. (2010, June). Behavior change support systems: A research model and agenda. In *International Conference on Persuasive Technology* (pp. 4-14). Berlin, Heidelberg: Springer.

[23] Orji, R. (2016, April). Persuasion and Culture: Individualism-Collectivism and Susceptibility to Influence Strategies. In *Proceedings of the International Workshop on Personalization in Persuasive Technology (PPT'16)*. Salzburg, Austria, 30–39.

[24] Orji, R., Nacke, L. E., & Di Marco, C. (2017, May). Towards personality-driven persuasive health games and gamified systems. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 1015-1027). New York, NY: ACM.

[25] Orji, R., Tondello, G. F., & Nacke, L. E. (2018, April). Personalizing persuasive strategies in gameful systems to gamification user types. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (p. 435). New York, NY: ACM.

[26] Orji, R., Vassileva, J., & Mandryk, R. L. (2014). Modeling the efficacy of persuasive strategies for different gamer types in serious games for health. *User Modeling and User-Adapted Interaction*, *24*(5), 453-498.

[27] Petty, R. E., & Cacioppo, J. T. (1984). The effects of involvement on responses to argument quantity and quality: Central and peripheral routes to persuasion. *Journal of Personality and Social Psychology, 46*, 69-81. doi: 10.1037/0022-3514.46.1.69

[28] Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In *Communication and persuasion* (pp. 1-24). Springer, New York, NY.

[29] Petty, R. E., & Duane, T. (1999). The elaboration likelihood model: Current status and controversies. In Chaiken, S. & Trope, Y (Eds.), *Dual-process Theories in Social Psychology*. (pp. 41-72). New York, NY: Guilford Press.

[30] Ramaprasad, A. (1983). On the definition of feedback. *Behavioral science*, *28*(1), 4-13.

[31] Schrier, K. (2017). Designing Games for Moral Learning and Knowledge Building. Games and Culture, XX(X), 1-38. doi: 10.1177/1555412017711514

[32] Siriaraya, P., Visch, V., Vermeeren, A., & Bas, M. (2018). A cookbook method for Persuasive Game Design. *International Journal of Serious Games, 5*(1), 37-71.

[33] Toma, C., & Butera, F. (2009). Hidden profiles and concealed information: Strategic information sharing and use in group decision making. *Personality and Social Psychology Bulletin*, *35*(6), 793-806.

[34] Vegt, N., Visch, V., Vermeeren, A., & de Ridder, H. (2016). Player experiences and behaviours in a multiplayer game: Designing game rules to change interdependent behaviour. *Int. J. Serious Games, 3*(4), 69–85.

[35] Visch, V. T., Vegt, N. J. H., Anderiesen, H., & Van der Kooij, K. (2013). Persuasive Game Design: A model and its definitions. In *CHI 2013: Workshop Designing Gamification: Creating Gameful and Playful Experiences, Paris, France, 27 April-2 May 2013*

[36] Vargas, J. A., García-Mundo, L., Genero, M., & Piattini, M. (2014). A systematic mapping study on serious game quality. Paper presented at the CEUR Workshop Proceedings, 1196, 52-57.

[37] Williams, R. H., & Williams, A. J. (2007). In pursuit of peace: Attitudinal and behavioral change with simulations and Multiple Identification Theory. *Simulation & Gaming, 38(4)*, 453-471.

[38] Wittenbaum, G. M., Hollingshead, A. B., & Botero, I. C. (2004). From cooperative to motivated information sharing in groups: Moving beyond the hidden profile paradigm. *Communication Monographs*, *71*(3), 286-310.