Will the winner learn it all?

A study on the effectiveness of a serious game on water-related issues in Vietnam

TUDelft

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A study on the effectiveness of a serious game about water related issues in Vietnam

By

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Preface

This thesis was executed within the project MK27 wlemeking.wikispaces.com/MK27 as part of the research program WLE Greater Mekong. With the support of GreenID, a local Vietnamese NGO and project partner, I was able to conduct a field study in a local community in Vietnam. I would like to thank them for their help and support during my time in Vietnam and after. Furthermore, I want to thank my committee members for their time and support during this research and the great feedback they have given me. Lastly, many thanks to Claire, Kathleen, Mom, Dad, and Tobias.

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Désirée Gautier
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Abstract

Vietnam these days is facing some major problems, such as a rapidly growing population which increase the pressure on the environment. Furthermore, fast urbanization which leads to concerns about urban planning and sufficient infrastructure. While the perception amongst the Vietnamese population prevails that the government is solely in charge in combating these problems, the population should take their own roles and responsibilities and perform pro-environmental behaviour to partly overcome the environmental degradation. This thesis addresses this problem by the means of introducing a serious game which addressed water-related issues. This game is tested, via a pre and post Likert scale based survey, in a local community in Vietnam. The game and surveys are based on the Theory of Planned Behaviour (Ajzen, 1991) which assumes that behaviour is related to multiple beliefs about one's own capacity, the socials norms and the expected outcome of a certain behaviour. The survey answers are analysed via statistical methods and these results show a significant different in answers to the pre and post surveys. This pilot study had a sample size of 120, therefore a confidence level of 80% was set indicating that no hard conclusion can be made but that an interesting research topic is founded.

1 Introduction

The introduction will focus on the social and scientific relevance of the research. The social relevance section gives an introduction about Vietnam and about its problems that form the basis for the research. As solution strategy, serious gaming is introduced. In the scientific relevance section serious gaming is further elaborated, examples are given, and it is reviewed how the effectiveness of a serious game is assessed. The theory of planned behaviour is introduced as theoretical background for the testing of the game.

1.1 Social relevance

In 2015, Vietnam's population was 93.4 million with an annual growth rate of 1.1% that year. Since 1975, the population in Vietnam has almost doubled. This growth, mainly in the cities, is a phenomenon of the current time in Vietnam's history (Albrecht, Hocquard, & Papin, 2010). Over the past decades, Vietnam has changed significantly: with the Doi Moi transformation in 1986, Vietnam has adopted a market-driven economy which induced economic growth. This market-driven economy reduced poverty, created more jobs, and improved people's life standards (Lam, 2012). The rapid economic growth has significantly increased the urban development and prompted urbanization. After the American/Vietnam War (1975–1986), the country had extreme economic difficulty and the urban development was practically non-existent during that period of war (Nguyen, Le, Tran, & Bryant, 2015). According to the World Bank report, the estimated urbanization rate in Vietnam is 3.4% per year, which is the highest in Southeast Asia (World Bank, 2011). Because of this rapid rate, various concerns have arisen about the sustainable development in Vietnam. Concerns of poor urban planning, environmental conditions, poor infrastructure, and high corruption are addressed by media and research. The common denominator of these concerns is that Vietnam has grown faster than its governance capacity (Nguyen, Le, Tran, & Bryant, 2015).

The increased pressure on the environment is of large influence on the country. In particular, on agriculture since a large part of Vietnam's population still depends on farming (Arndt, Tarp, & Thurlow, 2015). Although the northern part of Vietnam has a dense river network that supplies an abundant amount of water, there are some major challenges with regard to water management. Since Vietnam is a downstream country, the quality and quantity of the surface water is dependent of the upstream land. Therefore, uneven rainfall in both space and time can create water supply problems. Furthermore, the fast urbanization and intensification of agriculture leads to a rapid increase in water demand as well as severe pollution problems (Jolk, Greassidis, Jaschinski, Stolpe, & Zindler, 2010). Finally, the impact of climate change is already causing floods and rising sea levels. In addition to the polluting effects of the recent economic growth in the water, the increasing carbon emissions will only enhance the ecological threats the country is exposed to due to the use of fossil fuels (Lam, 2012).

The rapid development in Vietnam is also present in the Red River Basin which is situated in northern Vietnam. In the Red River Basin, mainly water resources are threatened by the rapid development., The land use changed and reservoir construction caused difficulties for the water delivery from the main river to the users due to this development. Climate change also decreased the water levels in the Red River (Quynh, 2015). The extensive mining in the Red River caused riverbank erosion which resulted in changes in river bed and a decrease of the water levels. A measurement recorded at Son Tay station indicated a decrease from 1.85m in 2006 to 1,5m in 2008 with a corresponding discharge of 1.200 m^3/s (Pham, Tran, Thi, Nong, & Rutten, 2016). The polluted discharges from the households and industrial practices into the river system are uncontrolled and therefore wellresulting in a bad water quality in Cau and Nhue - Day River (Hao, 2015). The pumping of groundwater is causing subsidence (Thu & Fredlund, 2000) and arsenic contamination of the drinking water resources (van

Green, et al., 2013) in greater Hanoi. This environmental degradation which is harmful and partly irreversible is a problem for both the inhabitants as well as the complete flora and fauna (Pham, Tran, Thi, Nong, & Rutten, 2016). A change of citizen behaviour could be an element of the solution to overcome part of this problem. A more pro-environmental behaviour could lead to decreases in water use, water pollution, and environmental degradation. This pro-environmental behaviour is needed since technical efficiency gains, resulting from water saving devices, are not sufficient enough and tend to be overtaken by the increase in consumption (Midden, Kaiser, & McCally, 2007). However, it is not an easy task to encourage substantive citizen participation (Handley & Howell-Moroney, 2010). To encourage civic participation, it is important to overcome major issues between citizens and authorities such as the conflicting interest, commitments, and knowledge (Yang & Callahan, 2007).

Specifically, for Vietnam, these issues are related to the fact that Vietnam has a communistic system. Since the independence in 1954, after the war with the French, north Vietnam's new leaders introduced communism as a quick way to modernize the country. For this purpose, communist used development principles such as state administration of the economy, a priority on heavy industry, and collectivization of agriculture. The responsibilities were divided into three levels, the state sector at the top, with the responsibility for administration, modern industry, communications, distribution, and urban social services. On the next level was the collective sector which consisted mainly of agricultural cooperatives, but also some industry and services. At the bottom was the individual sector consisting of family farms, petty traders, and small-scale businesses such as hairdressers. (Bryant, 1998) At this moment, Vietnam is still a country with one communist party that rules the country. A major problem that arises with this one party system is corruption. In a report from 2014 from Transparency international, it was stated that Vietnam was perceived to be one of the most corrupt countries in the world. It is common knowledge that public officials sell their influence and engage in nepotism. The problem seems to have worsened since the privatization of Vietnam's state-owned companies. This was the start for politicians and officials to appoint themselves and their families as directors. (Davies, 2015)

Due to the communist system and the total control of the government, the citizens lack a feeling of responsibility when it comes to environmental issues. However, land and water management are not solely the responsibility of the government. Citizens should take responsibility for their behaviour that influences the environment. Often pollution laws are not understood by citizens and citizens are they are therefore not aware of the effect of land use changes on their property. The capacity of the authorities to handle violations of the laws is inadequate. This results in a lack of compliance by citizens to follow the rules and regulations. (Minh Ly, 2012)

To overcome the lack of responsibility among the Vietnamese population, pro- environmental behaviour should be stimulated. Ngyten, Le, Tran & Bryant (2015) concluded that citizen participation is weaker in large cities than in small cities in Vietnam. Preforming a study in a local community with the intention to establish environmental behavioural change, would therefore most likely result in a better outcome than if one would do research in a large city. According to Carry and Hassell: "The change in behaviour is most likely to occur when as many as possible of these elements are present: Individuals have formed a strong positive attitude towards saving water, individuals believe that the advantages or positive outcomes outweigh the disadvantages or negative outcomes of saving water, individuals perceive more social (normative) pressure to conserve water than not to conserve water.'' (Cary & Hassall, 2007).

1.1.1 Strategy to change attitude and behaviour

In general, in order to raise awareness, policymakers aim for behavioural change of social norms and attitudes, which can be done via awareness campaigns. It is important to realize that raising awareness

is not merely done by achieving the specific goals set by policymakers. In that case one would ignore the initiatives by citizens' groups which are an important factor. It is recognized that there is a need for including communities in governmental and NGO-initiated programs, therefore awareness raising should be an interactive collaboration between different parties, each with their own roles and responsibilities. The traditional way of awareness campaigns is providing information and knowledge. The idea is that if one knows the effect of its own behaviour and realizes the impact of the effects, one would change its behavioural pattern. (Schaap & van Steenbergen, 2001) This is seen by some as a mistaken assumption, since simply knowing or caring more would not change a person's behaviour (McKenzie-Mohr & Schults, 2012). These traditional campaigns have been ineffective in encouraging the adoption of a more sustainable behaviour (Geller, 1981; McKenzie-Mohr D., 2011; Schultz, 2002). Another way of addressing the campaigns is by changing social norms, thus focussing on the subjective norm of the community (Schaap & van Steenbergen, 2001).

An example of a tool to design an awareness campaign is social marketing. According to Grier and Bryant (2005): ''Social marketing is the use of marketing to design and implement programs to promote socially beneficial behaviour change''. From the concept of social marketing, community-based social marketing (CBSM) is formed, with the goal to achieve broad sustainable behaviour in communities. ''Community-based social marketing (CBSM) is based on five steps: 1) Carefully selecting the behaviour(s) to be targeted; 2) Identifying the barriers and benefits associated with the selected behaviour(s); 3) Designing a strategy that utilizes behaviour-change tools to address these barriers and benefits; 4) Piloting the strategy with a small segment of a community; and, finally; 5) Evaluating the impact of the program once it has been broadly implemented.'' (McKenzie-Mohr & Schults, 2012).

According to McKenzie-Mohr & Schults (2012) different tools are useful for step 3, such as:
- Commitments: to enhance the responsibility
- Social diffusion: the idea that one adopts new behaviour if friends or family have already adopted that same behaviour.
- Goal setting: although goal setting on its own is not a success since most goals are rarely achieved, if one would combine it with implementation intentions the effectiveness of the goal setting rises.
- Social norms: refers to the accepted and common behaviour within a group, in other words what do others think and what do they approve of.
- Prompts: are needed to remind people to perform the desired behaviour by meaning of a visual or auditory aid.
- Incentives: refers to offering a reward for the behaviour.
- Feedback: essential for achieving the goal, so feedback mechanisms should be in place.
- Convenience: it should be convenient to perform a certain behaviour.

1.1.2 Serious gaming

An example that contains some of the previously mentioned points is serious gaming. In this thesis therefore, a serious board game is used as a tool to stimulate behavioural change. The focus is on testing serious gaming as a solution strategy for the lack of responsibility among the Vietnamese citizens. Serious gaming aims at altering a player's knowledge, attitude, or behaviour in the domain of the game (University of Twente, 2016). The games have the dual goal of entertaining and promoting behavioural change (Sakar, Georgiou, & de Azevedo Marques, 2015). In different fields, such as healthcare, the statement is made that serious gaming can be a tool to promote behavioural change (Arnab, Dunwell, & Debattista, 2013). Serious gaming is also used to enhance cultural change by concentrating on behavioural or attitude change with the purpose to raise awareness and empathy for cultural problems like genocide (Information Resources Management Association USA, 2015). These examples form the basic assumption that serious gaming can be used as a tool to change

behaviour. If the citizens of Vietnam would adopt a more sustainable behaviour when it comes to water use and pollution the environmental degradation can be partly overcome.

1.2 Scientific relevance

Serious gaming is further elaborated. The designing of a serious game is addressed and examples are given of serious gaming in relation to behavioural change. In order to test the game, a theoretical basis is formed and explained. At last, the knowledge gaps are stated and the research question formulated.

1.2.1 Serious gaming

At first sight, serious gaming seems to be a recent concept, nonetheless this is not the case. The concept of serious gaming, with a similar meaning currently used, seeming to originate from 1970. It was described by Clark Abt (1970) in his book ''Serious Games''. According to Abt (1970): ''Serious games have an explicit and carefully thought-out educational purpose and not intended to be played primarily for amusement''. This definition of a serious game makes no distinction in different types of serious gaming. Therefore, it is a broad term which include digital and non-digital games. However, recent literature about serious gaming shows that the concept tends to apply for digital serious games, in other words, computer based games. (Djaouti, Alvarez, Jessel, & Rampnoux, 2011)

A more recent definition of serious gaming is: ''Serious gaming involves the use of concepts and technologies derived from (computer) entertainment games for non-entertainment purposes such as research, policy and decision-making, training and learning.'' (TU Delft, 2016). Nowadays serious gaming is used for example by Deltares to train levee patrollers (Deltares, 2016) and the TUDelft developed the ''Tovertafel'', a serious game with the aim to prevent apathy by elderly with dementia (TU Delft, 2016). Serious gaming is a hot topic and the interest in using games for education, motivation, and changing behaviour is growing (Saywer, 2009).

There are different types of serious gaming, starting with digital and non-digital games. The digital games make use of computers; an example is Levee patrol from Deltares. Non-digital games can be in the form of card games, boards games, and role playing. The different types of serious games have different effects, strength, and weaknesses. A strength of a non-digital game in comparison with a digital game is the fact that a non-digital game has the emphasis on social contact. The players are playing the game at the same time in the same place. Non-digital games are easier to produce and less expensive than digital games. For a non-digital game, the players do not have to be comfortable with computers or other digital equipment (Nitin, 2014). Another advantage is that a non-serious game can be a standalone game. A board game for example can be given to citizens and they do not need anything else to play the game whenever they want. No further updating of the game, maintenance, or control is needed for the game to be usable.

1.2.2 Design serious game

The serious game used as starting point in this thesis has been designed prior to the start of this research and is based on Harteveld's theory (2011). Throughout the research, other theories such as the design, play and experience framework (Winn, 2009) are therefore not taken into consideration but are explained in the Discussion (chapter 4).

Serious game development is about finding the balance between play, meaning, and reality according to Hartveld (2011). These three factors can be seen as worlds which have to be in balance for a serious game to be effective. In Figure 1, the design space of the serious game is stated. The premise is that a serious game in which these worlds are in balance will result in a learning process. For example, a skill is learned. This learning process is what distinguishes a serious from a ''normal'' game. Although learning is the main goal, the balance between play, meaning and reality is the challenging part of

developing a serious game. First there is the world of reality. This means that the game should be a representation of the problem that is addressed. The goal of the world of reality is to indicate to the players what the problem is to create problem awareness. Also the personal effectiveness of the problem should be represented so that the players understand their involvement in the problem and the effects that will evolve from it. If the game is not realistic enough, people will not feel the responsibility to change because they cannot relate to the problem. Second, is the world of meaning. A game will be meaningful because the players will learn, however for the game to be meaningful beyond experience of playing is the challenge. The goal of this world is to learn something that is useful in the real world. The last world is the one of play. This world makes the game enjoyable. The role of the world is to engage people to play the game and to have fun. The play factor can work as a motivation to participants and gives the feeling that learning can be fun as well. These worlds together should make the game fun to play and achieve a problem solution that is relevant for the real world. (Harteveld, 2011, 22-23)
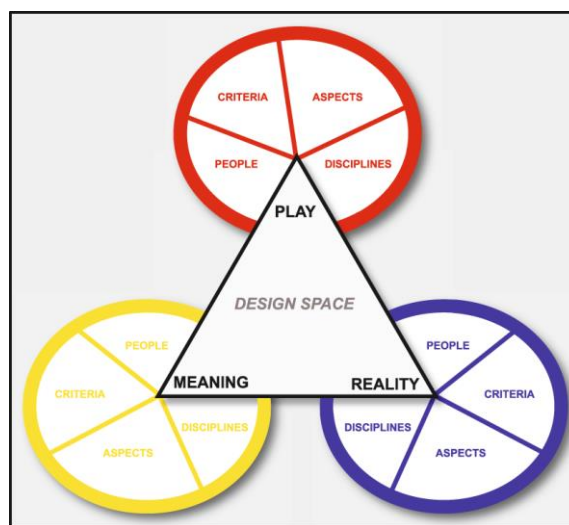

Figure 1 - The design space of triadic game design, in which the worlds of play. Meaning and reality should be in balance (Harteveld, 2011, 34)

1.2.3 Examples of serious gaming and behavioural change

Different serious games encourage behavioural change; a few examples are given to show how this is done. Firstly, a computer based game in which a participant manages a stretch of a river where they can build dikes, perform ecological measurements, and land-use-planning. There is a feedback mechanism that shows the effect on the river stretch of the taken measures. The effects are discussed and a new round of comments starts. The aim of this research was to examine the extent of convergence of perspectives of the participants. The convergence of perspective is a result of the interactive process of social learning. The conclusion from the research is that the convergence is largest during the session where the discussion of the perspectives was the main reason to change perspectives. So the game was most effective when discussion about one's views is enhanced. This results in change of perspective and convergence of those perspectives. (Van der Wal, de Kraker, Kroeze, Kirschner, & Valkering, 2016)

Secondly, a paper of Katsaliaki and Mustafee (2012) show that there are a lot of relevant serious games on the subject of sustainable development. Most of the games are in the online world, the oldest game that they present is from 1990 and each game gives the players different roles. One could be a farmer with the task to choose the best combination of plants or animals to preserve a prairie (game: Build a Prairie). In another game the player is the world's president and by funding projects

and granting subsidies, ecosystem issues can be tackled (game: Balance of the Planet). The result of the research was that most of the 35 selected and designated relevant games were on climate change management, followed by energy management, sustainable urban development, and ecosystem management. (Katsaliaki & Mustafee, 2012). This research shows that serious gaming is being used in various ways to enhance environmental awareness and can be used as a teaching and training tool for environmental issues.

1.2.4 Serious games in Vietnam

At the moment, a group of scientists from the Netherlands (university of Wageningen) and from Vietnam (Can Tho University) are working together on the development of a serious game for sustainable shrimp farming. The research period is from March 2015 to March 2018 and at the moment nothing is yet published (Serious games for sustainable shrimp farming, sd). In Web of Science® only 8 publications are found with the query: serious gam*, refined by topic: Vietnam. None of the articles are about serious gaming. It seems that not a lot of research has been done in Vietnam in relation to serious gaming.

1.2.5 Quantification of effect serious game

At the moment, the testing of a serious game is primarily done by a pre-and post-game test session, indicating that a survey is conducted prior to and after the game is played. The main drawback is the lack of a methodological assessment of testing the effectiveness of a serious game. In most cases, the research is done with a test and control group. The control group learns the same content but via a different method, for example a lecture. The results of the survey of both groups are compared to each other and conclusions are drawn. This method gives the researchers the opportunity to compare the game impact with other learning methods. This method has been executed for the Icura game, a game focus is on learning about Japanese culture and etiquette. The analysis of this game is done with the use of the different levels of the Bloom's taxonomy, in which the levels are knowledge, attitude, and skills. The participants during the research were students from the Vienna University of Technology. The results of the game showed that in the pre-test 5.05 correct answers on average were given and in the post-test on average 10 correct answers were given. Therefore, the game was successful and the participants had learned about the Japanese culture and etiquette by playing the game. (Mortara, Catalano, Fiucci, & Derntl, 2013)

Another research shows the same way of pre and post testing of serious games. The serious game Zoom, which is used to train team cohesiveness, was translated to virtual a reality game. The effect of the serious game showed a significant positive effect on the participating teams. This was tested via an after game survey with the participants (Bozanta, Kutlu, Nowlan, & Shirmohammadi, 2016). Likewise, studies in other fields practice the same method of game testing. A research on a serious game about milk contamination tested the game with a structured questionnaire before and after the playing of the serious game. However, this survey was not based on a behavioural theory but created by themselves. After analysing the results with the Wilcoxon non-parametric test, an analysis of variance also called ANOVA, and the Chi-square test, the conclusion was that the game was able to change the player's perception about the risk associated with raw milk consumption (Crovato, et al., 2016). Overall, it seems that serious games are tested with questionnaires, mostly without a theoretical background, before and after playing the game. The results of the questionnaires are analysed with statistical methods and conclusions are drawn.

The lack of a clear consensus on how the effect of a serious game should be quantified is a challenging issue in need for a solution. In addition to testing of the game, this thesis is therefore used in order to create a starting point in finding a uniform approach. It seems logical to follow a behavioural theory as basis for testing of the game. Since it is not the scope of this thesis to find the perfect theory, a broad theory in terms of its applicability and frequent use is chosen (Knabe, 2012): the theory of

planned behaviour (Ajzen, 1991). This research can thus be used as a pilot study in order to give direction to the solution in creating consensus on this topic.

1.2.6 Theory of planned behaviour

In the social science literature, several models are available to describe the processes of behaviour. Fischbein and Ajzen (1991) published theory of planned behaviour (TPB). TPB is a successful model in the field of social sciences but there is no test that confirms that this model is ''better'' than others such as: Trans theoretical model (TTM) and the Health Action Process Approach (HAPA) (Schwarzer, 2007). The theory of planned behaviour, see Figure 2, explains how human behaviour results from different beliefs. In this theory, are three types of beliefs: behavioural, normative and control. Firstly, behavioural beliefs (BB) are the beliefs about the expected outcome of the behaviour. These beliefs lead to the attitude towards the behaviour (ATB). Here the behaviour is positively or negatively valued. Secondly, the normative beliefs (NB) refer to the beliefs about what the expectations are from important individuals or groups, like family or friends. These beliefs lead to the subjective norm (SN), the perceived social pressure one feels to engage or not in a certain behaviour. The last beliefs are the control beliefs (CB); these beliefs refer to the presence of factors that facilitate the behaviour. This leads to the perceived behavioural control (PBC) which refers to people's perception of their ability to perform a certain behaviour.

The three main components (purple, green and orange) of the theory together form the intention of the person to perform a certain behaviour. This intention can be positive or negative which may lead to the performance of the behaviour or not. But the intention is not the only factor that indicates if the behaviour is going to be performed or not, an external factor influences the behaviour as well. This external factor is the actual behavioural control (ABC), this says something about the skills, resources, and other prerequisites that are needed to perform the behaviour. (Ajzen, 1991)
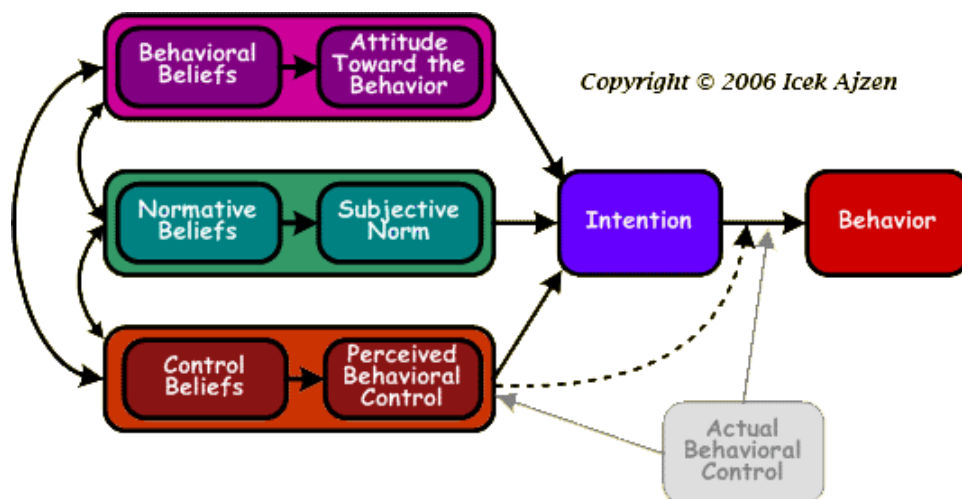
Figure 2 - The schematic visualisation of the Theory of Planned Behaviour by Icek Ajzen (2006)

The strengths and limitations of TPB:

The first major strength of the theory is how it is widely applied on all sorts of behaviour in varying contexts such as health communication and environmental concerns (Knabe, 2012). The TPB is a simple theory, this simplicity is a quality of theories associated with strength and the utility of a theory (Reynolds, 1971). The number of citations, that is in Web of Science® of the original paper of Ajzen and Fisbein, is 12,443 times. Although the understanding of the theory is specific per scientist, the

amount of citations is a strong indicator of its acceptance in the field (Reynolds, 1971). Another strength is the omission of external variables such as emotions or environmental conditions. This is done since for different situations different variables are needed and this cannot be generalized (Ajzen & Fishbein, 1980). Nevertheless, the TPB has been criticized for this (Conner & Armitage, 1998). A limitation is that the TPB is based on the assumption that all behaviour is rational, however humans do not always behave based on rational thinking (Knabe, 2012).

Another limitation is that according to the model of TPB, behaviour follows from the intention, PBC and ABC. PBC is the individual's perception of how to perform, which can be seen as a continuum with easily executed behaviour at one side and needed resources, like skills, on the other side. The relation between the intention and behaviour indicates that people tend to engage in behaviour they intend to do. However, the relationship is more complex than is stated in the model (Conner & Armitage, 1998). The past behaviour of a person is not taken into consideration in the TPB but it is argued that behaviour is determined by past behaviour rather than only cognition (Sutton, 1994). Demographic factors are also not incorporated in the TPB, although they could have an indirect effect.

1.2.7 Environmental behavioural change and theory of planned behaviour

Different studies (Kantola, Syme, & Campbell, 1982; Syme & Nancarrow, 1992) tested Ajzen and Fishbein's model and found it useful for explaining intention about conserving water. The model is also used for predicting consumer responses to water supply systems (Porter, Leviston, Nancarrow, Po, & Syme, 2005). Nevertheless, a rising problem in this area is the relation between pro-environmental attitudes and pro-environmental behaviour. The question here is, does pro-environmental attitude lead towards pro-environmental behaviour? It has been determined that the link between attitudes that households have towards the use of a resource and the actions they take to change their behaviour is weak. This is already an area of long-standing study. Heberlein and Black (1981) agreed that pro-environmental behaviours are based on pro-environmental attitudes, while Sharma, Kivlin and Fliegal (1975) questioned whether environmental pollution concerns of the public were sufficient to lead to action to stop this kind of behaviour. An early review by O'Riordan (1976) also concluded a weak link between environmental attitudes and behaviour. In a review of Stern and Oskamp (1987), they concluded there was evidence of positive relationships between environmental attitudes and environmentally protective behaviours. Jackson (2005) stated that if there is the possibility to recycle but it is not an obligation, the correlation between pro-environmental attitude and recycling behaviour is the strongest. In other words, when the intention is already present and not forced upon the attitude leads to behaviour.

The field has different views on the matter and it is still a broadly researched area. Nevertheless, there are some similarities too. For example, the most effective strategies for changing attitudes are: set specific goals, agree on what the is desired behaviour and generate positive self-talk (anything said to oneself for encouragement or motivation). However, no single strategy determines a wide spread attitude change towards water conservation behaviours (Cary & Hassall, 2007). Since there is no clear consensus on the relationship between attitudes and behavioural change, for this thesis the assumption is that the relation is positive. The idea is that if the attitude towards environmental behaviour is changed, the behavioural change will follow. In this thesis this is done by the means of the theory of planned behaviour. The TPB has proven to be successful in explaining different types of pro-environmental behaviour such as the using unbleached paper, reducing meat consumption, using energy-saving lightbulb, turning off the water while brushing the teeth (Hardland, Staats, & Wilke, 1999), and general pro-environmental behaviour (Kaiser & Gutscher, 2003).

1.3 Knowledge gap

Hardly any research is done in Vietnam when it comes to serious gaming. This research is filling that gap. According to the literature, is seems that there are different strategies to enhance behavioural change and serious gaming could be a tool to achieve that goal. In Vietnam, the environmental degradation is a large problem and citizen's behaviour could partly prevent this from becoming worse. At the moment, the behaviour of the citizens of Vietnam is helping the degradation rather than preventing it. Examples show that serious gaming could be a tool to enhance environmental awareness and change behaviour. In this thesis all of the above is combined, a research will be conducted to test the effect of a serious game with the aim to enhance environmental behaviour in Vietnam.

Currently, no methodological assessment of testing serious games is determined by the field, therefore testing is merely done by pre-and post-testing via questionnaires mostly without any theoretical base and analysed with statistical methods. This thesis will therefore use a behavioural theory as basis for the game and the survey. The survey will be taken before and after the playing of the game and analysed with different statistical methods to see if there is a significant change. For the thesis, a serious game will be designed and tested. After the testing, questionnaire applicability will be evaluated and recommendations will be given in order to improve the game. The overall goals of the game are firstly to be a standalone game and reach as many citizens as possible. Secondly, to create awareness about a sustainable environment. Lastly, change behaviour to a more sustainable one to achieve a decrease of the degradation of the land of Vietnam.

This leads to the following research question: Can serious games be used to change behaviour towards water resources in a local community in Vietnam?

2 Method and materials

This chapter will focus on the materials used: the game and the survey. It explains how they were developed, tested and used. The research is conducted in a local community in Vietnam in cooperation with a local NGO (GreenID). The relation between the TPB and the used materials will be elaborated and hypothesis, to be tested, stated.

2.1 A Walk Around the Lake

For the research, the serious game "A Walk Around" the lake was designed. It is a board game, Figure 3. The goal of the game is to end up with the cleanest lake. As can be seen on the board, both teams (the participants are either a household or small business owner) have a deck of cards with lake colours (see Figure 4) laying in the middle of the board. Via correct answering of the questions a cleaner lake card can be put on top, at the end of the game the person with the cleanest card on the lake wins.

Figure 3 - The board lay-out of the serious game A Walk Around the Lake

Figure 4 - Grading for the lake colours. From very dirty brown with only trash to clear clean blue water with aquatic life. These cards form the lake of the participants; the goal of the game is to end with the cleanest card.

The game is played with two teams of two participants each. One team will start counter clockwise and the other team clockwise. The randomly picked starting team will role a dice and move their totem the corresponding number in the indicated direction. There are three different locations the totem can end up:

Trees, households and business: The players will have to answers a question, if the answer is correct their lake card will become a colour cleaner. If the answer is wrong the lake becomes one colour dirtier and the players will have to do the corresponding action that is on the question card. An example is shown in Figure 5, which is question 1 of the game.

> 1. How long do you need to cook water before it has drinking water quality (in minutes)?
>   All answers above 1 minute are correct
>   *Explanation of right answer:* The World Health Organization advised that you should bring the water to boil and keep it rolling for 1 minute. Boiling is sufficient to inactivate bacteria and viruses.
>
>   *Action:* After playing this serious game you have to tell at least three persons about how long you have to cook water. Tell us who these three persons will be, why you choose them and what you will tell them.

Figure 5 - Questions 1 of the serious game. This question is an open question with the answer in green and the corresponding explanation and action.

Benches: while sitting on the bench the players will get a tip&fact card. These cards have a tip and fact about a specific subject, the idea is that the players can implement these tips and facts into their daily life. The fact will give insight in the rising problems in Vietnam and the tip will give a handle on how to reduce one's part in this problem. Also the lake of the team becomes one colour cleaner since they have learned something to improve the water quality. See Figure 6 for an example of a tip&fact.

> *Fact:* The Ocean is filled with plastics, every day 12.000 tons of plastic end up in the ocean this amount would fill up 52 trucks.
> *Tip:* Do not throw your plastic into the water system but bring it to the garbage collector.

Figure 6 - An example of a tip&fact card from the game

Trash bin: The players had some bad luck and they have to take a mistake card – There are different cards with actions one has to do after they hit the trash bin. See Figure 7 for an example of a mistake.

> Your water was not cooked long enough and therefore it had not yet the quality of drinking water. Now you have to cook it again. Stay one round to cook the water.

Figure 7 - An example of a mistake card of the game

Since the game board is round, the game can be played until the question cards are finished or a specific time limit can be set. Appendix A is the complete game, including questions, tips & facts, mistakes and the game explanation.

2.1.1 Game design process

The first serious game design was a combination of the results from different game designs during the NUFFIC-NICHE workshop ''Innovative water learning games for Vietnam'' Hanoi, August 2015. During a five-day training, with 19 participants from the MK27 project, five different serious games were designed (Koole-Loois, Rutten, & de Waele, 2015). The participants had the freedom to create any type of serious game, which had the aim to learn the players something about water. During the

workshop, the game design had three phases. First the analyse phase which resulted in document with requirement for the game design. The second phase was the designing of the game based on the document. The last phase was the testing and redesigning of the game. The latter phase is an iterative process until the game design is finish. The five resulting game from the workshop were board game, however after the workshop they were not yet finished and could not be directly used. Therefore, de Waele (2015) combined these game and made the first version of the game ''A Walk Around the Lake'' in cooperation with GreenID. The game has the intention to teach the citizens of Hanoi about their behaviour and what the influences of this behaviour are on the water system.

The iterative process of testing and redesigning of the game was started again. The game was firstly tested with two Dutch students who were working on the MK27 project and two staff members from GreenID. The first main remark was that the aim of the game was not clear. The proposed solution was to include personal background information; this was done in the introduction text which is told prior to the start of the game. Secondly the game was tested seven times with citizens in Hanoi from ages between 21 and 50. The testing showed that citizens considered the game as a childish activity and therefore it was difficult to encourage them to play it. In contrast, the players thought they had learned something from playing the game and they got more excited during the playing of the game. They also feel no responsibility for the maintaining of the water quality in the lakes of Hanoi but see that as a governmental task (de Waele, 2015). The remark about the childishness of the game was not further addresses in the game, it is common that participant associate gaming with children although the game is designed for adults. The latter comment, about the government responsibility, is addressed in the introduction text as well. The introduction text frames the idea upon the participants that they all have their part in the responsibility for water saving, water pollution and environmental degradation.

After the adjustments from the first rounds of tests, the game was tested at the VACI (Vietnam wAter Cooperation Initiative) conference on the 19th and 20th of October 2015. During the conference the main feedback was that the game took too long and that explanation of the right answer was too extensive. The game was played for 10 minutes but the start-up and explanation of the game took almost 15 minutes. The participants found that the questions were too easy and that they were too Hanoi specific, since not every participant was from Hanoi the reality part of the game was not completely clear to them. Another remark that was made was that the topics of the questions were too broad, it was advised to choose a small set of topics and relate multiple questions to that topic. The game was also tested at a conference WLE Forum Water and Food in Cambodia (21, 22 and 23th of October 2015), the main remarks from there were that the game was too complicated with many rules. Therefor it took a long time to play it so people could not keep their attention to the game.

2.1.2 Changes
After the testing phases at the two conferences the game design was changed, the remarks were taken into consideration and the game rules were simplified and the introduction text was shortened. Since for the field part of this research a local community was chosen, the content of the game was also changed to make it suitable for the community citizens. After consultation with the GreenID staff, the main problems in the local community determined. Four main problems could be addressed and were converted into topics of the game; water use (WU), water quality (WQ), water pollution (WP) and environmental behaviour (EB). Therefore, the content of the questions was changed to address these four problems. Because during the testing phase a remark was that there were to many topics for the questions, only four topics were chosen. In this way, the topics had repetition among the questions. In this case there was consistency overall and by the use of repetition a basic learning principle (Weibell, 2011) was applied. In Table 1 the changes between the game design of de Waele and the design for this research are summarized.

Table 1 – An overview of the changes made during the redesign of the serious game. Shown in the left column the first version from de Waele and in the right column the version for this research.

First version	Final version for research
Tips and facts were separated	Tips and facts are on the same card and related to each other. The tip gives a practical solution on how to convert the fact into daily life. Important aspect of a serious game is that it relates to reality (Harteveld, 2011)
Mistakes are not related to problems	Mistakes are related to problems to increase the coherence of the game (Harteveld, 2011)
Household and small business questions	One deck of questions for all the players to make the game more manageable.
Single players	Team based game, so the players can learn from each other (McMahon, 2012)
English and Vietnamese texts on 1 card	Only Vietnamese to resize the cards to make the card more manageable.
	Simplified rules, according to the players of the first version the game rules were too complicated.
	The second team can answer the question if the first team got the answer wrong, this is done to keep everyone's attention during the game.
	Address both positive and negative points (van Duijvenvoorde, Zanolie, Rombouts, Raijmakers, & Crone, 2009)
	Multiple choice and open questions, this to support multiple ways of thinking about the questions. A multiple choice answer already gives a direction were the answers should be found, an open question does not. Here the team member has to debate about the right answers.

In Table 2 an overview of the deviation of topics in comparison with the content of the serious game is given. During the design phase of the game for this thesis, a balance between the different topics was made to overcome that one topic is important than another. In Table 2 also the link between the game and the TPB is made, since all the components of the game relate to a specific part of the TPB.

Table 2 – An overview of the content of the game (questions, tips&facts and mistakes) related to the TPB and the different topics addressed in the game. The different topics are environmental behaviour (EB), water quality (WQ), water use (WU) and water pollution (WP).

Question	Topic	Theory	Question	Topic	Theory
1	WQ	BB/NB	9	EB	BB/NB
2	WU	BB/NB	10	WQ	BB/NB
3	WU	BB/NB	11	WU	BB/NB
4	WU	BB/NB	12	WP	BB/NB
5	WU	BB/NB	13	WQ	BB/NB
6	EB	BB/NB	14	WQ	BB/NB
7	WQ	BB/NB	15	WP	BB/NB
8	WP	BB/NB			

Question	Topic	Theory	Question	Topic	Theory
1	WQ	NB/CB	9	EB	NB/CB
2	WU	BB/CB	10	WQ	BB/NB
3	WU	BB/CB	11	WU	NB/CB
4	WU	BB/CB	12	WP	NB/CB
5	WU	BB/CB	13	WQ	NB/CB
6	EB	CB	14	WQ	BB/CB
7	WQ	NB/CB	15	WP	NB/CB
8	WP	-			

Tip&Fact	Topic	Theory	Tip&Fact	Topic	Theory
1	EB	BB	5	WP	BB
2	EB	BB	6	WQ	BB
3	EB	BB	7	WQ	BB
4	WP	BB			

Mistake	Topic	Theory	Mistake	Topic	Theory
1	WQ	BB	5	WQ	BB
2	EB	BB	6	WP	BB
3	WQ	BB	7	WU	BB
4	WU	BB	8	WP	BB

2.2 Model

For this research the TPB was used, Figure 8 is shows how the TPB relates to the serious game and the survey. The serious game affects the behavioural, normative and control beliefs and the behaviour. The survey, about those same constructs, tested if the game was effective. It was assumed that the component in the boxes relate to each other, so the behaviour beliefs correspond with the attitude towards behaviour. Therefore, only the beliefs were addressed in the survey and the serious game. The same idea holds for the intention, it was assumed that the beliefs lead to intention and the intention lead to behaviour, therefore only the behaviour is addressed and not the intention. In the TPB, the actual behavioural control is the component that indicates if the needed skills, resources and other requirements are in place to perform the behaviour.
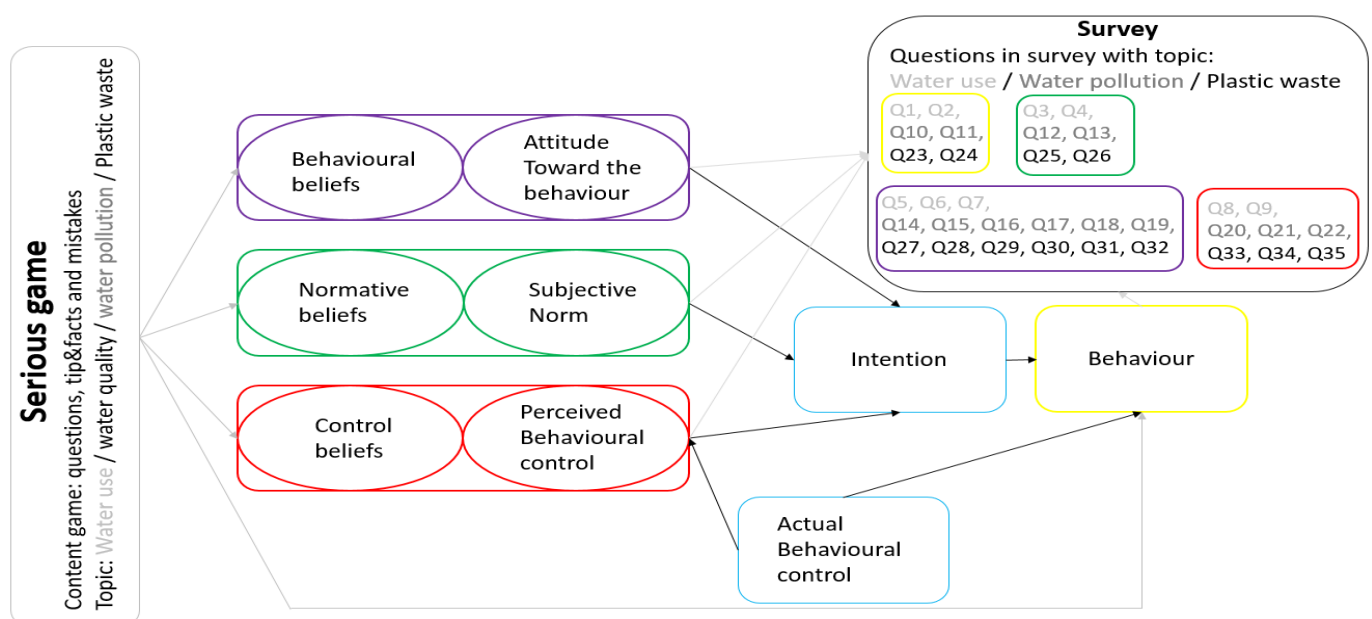

Figure 8 - Model of how the TPB related to the survey and the serious game.

This is hard to determine, since these component are person specific and difficult to indicate if one measured the right component. Even for the person, it can be hard to determine if they have a certain skill or not and if the level of the skill is sufficient.

The main assumption was that serious gaming is an effective way to change human behaviour. This assumption is stated in literature, elaborated in the introduction, and via analysis of a pre and post-game survey tested on its justifiability. In order to test the effectiveness of the serious game, different sub assumptions were made and translated to hypotheses. These hypotheses are tested, to see if it can be accepted that the game is of influence on the behavioural belief (these beliefs refer to the expected outcome of the behaviour (Ajzen,1991)). Since the facts and tips show how a certain behaviour (the tip) can have influence on a certain outcome (the fact) it seems justifiable that this will influence the behavioural beliefs. For example, (fact & tip no. 7):

> Fact: The Ocean is filled with plastics, every day 12.000 tons of plastic end up in the ocean this amount would fill up 52 trucks.
> Tip: Do not throw your plastic into the water system but bring it to the garbage collector.

This stimulates the players to bring their plastic waste to the garbage collector, since this will help to decrease the amount of plastic waste that ends up in the ocean every day. All the facts and tips have the same construction and they all influence the behavioural beliefs. To measure these behavioural beliefs, different questions in the survey address this (questions 5 to 7, 14 to 19 and 27 to 32). The expectation is that after playing the game the participants will have different opinions about the behavioural beliefs, they will probably agree more with the statements since they know better which kind of behaviour leads to which result. This will lead to a higher answer on the Likert-scale, if this were the case it would seem that the game has a positive effect on the behavioural beliefs.

The second assumption was that the game will also have an influence on the normative beliefs (refers to the expectation of important individuals or groups (Ajzen, 1991)). In the game, some of the actions (one has to take an action if the question is answered wrong) are related to the social group of the participant, like (action with question no. 1):

> Action: After playing this serious game you have to tell at least three persons about how long you have to cook water before you can use it. Tell us who these three persons will be, why you choose them and what you will tell them.

Other examples of actions are: one has to tell the other players how you can improve your behaviour or tell what you have learned during the game. A goal of the game was to show the players what correct behaviour is, this is done through feedback on the questions and with the tips and facts. Since neighbours, family and friends also play the game, the assumption was that during the game one will get insight in the ideas of others about the topics that are addressed in the game. This would have a positive influence on the normative beliefs, since friends and family now know what good behaviour is. Since one would like to be appreciated by friends and family when performing the behaviour and therefore tend to perform the showed correct behaviour.

The third assumption was that the game will influence the control beliefs (beliefs that refer to the presence of factors that facilitate the behaviour (Ajzen, 1991)), since the actions during the game show how other likeminded perform a certain behaviour this might indicate that one would also be able to perform that behaviour. For example, (action with question no. 12):

> Action: Tell us how you can reduce your share in the water pollution. (Example: take a short shower, turn of the tap while tooth brushing.)

This way the other players learn about different options how to perform a certain behaviour. Since we assumed that the community is a group of likeminded people, the stories of the players will have an influence on the control beliefs of the others. Depending on how the actions are performed during the game, the game can have a positive influence on the control beliefs. This positive effect could be that participants get ideas on how to perform a certain behaviour. The assumption was that the tip&fact will have a positive influence on the control beliefs. These facts and tips were tested with a group of Vietnamese and they thought the tips were executable. Although the Vietnamese that were questioned are living in Hanoi, some of them had a background of growing up in a local Vietnamese village and could therefore asses if the tips were realistic to execute or not.

The fourth assumption was that the game has also a positive influence on the behaviour, partly under the influence of the beliefs, since according to the TPB the beliefs lead to behaviour, and because of the feedback system in the questions. The players get an explanation about the questions after answering it, this will show what the correct behaviour concerns water related problems and why that is the case. In the questions not only the possible improvements are addressed but also some already good executed behaviour is shown. This to address the positive and negative feedback towards the behaviour executed in the local community.

These assumptions combined give the justifiable assumption the TPB is an effective predictor of behaviour. If the analysis of the survey shows a corresponding change in the beliefs and the behaviour it could be plausible that the TPB is a good indicator and appropriate for this research. If the results are positive, it could indicate that there is a positive change in the beliefs and the behaviour due to the playing of the serious game. These assumptions are related to the following hypothesis.

General hypotheses:
> *In the second survey the answers about BB are higher than in the first survey.*
> *In the second survey the answers about NB are higher than in the first survey.*
> *In the second survey the answers about CB are higher than in the first survey.*
> *In the second survey the answers about B are higher than in the first survey.*
> *If BB, CB and NB have a positive change than B has also a positive change.*

Another set of hypothesis are based on the demographic factors that are taken into consideration during the survey. These demographic factors in relation to the surveys answers are analysed to see if the game is sensitive to these factors, the assumption is that the survey is a correct way of testing the serious game. The demographic factors that are taken into account are: gender, age, educational level, income level, number of people in the household and the day of the research. These factors are tested to give insight in how the game can be improved. Hopefully the game has the same effect on citizens without considering their demographic factor, since this would mean that the game is broadly applicable. When the game is not sensitive to demographic factors it would work for every person in the same way. These demographic factors are taken into account in the following hypothesis:

Demographical hypotheses:
> *Gender has no influence on NB, BB, CB and B.*
> *Income level has no influence on NB, BB, CB and B.*
> *The game day has no influence on NB, BB, CB and B.*
> *The number of people in the household has no influence on NB, BB, CB and B.*
> *Age has no influence on NB, BB, CB and B.*

2.3 Survey

Following to Ajzen, when making a survey to measure components from the TPB, a survey with a 7 options Likert scale is used (Fishbein & Ajzen, 2010; Ajzen, Sample TPB Questionnaire, 2016). The Likert-based scale is widely used in studies; however, the method is subjected to social desirability in answering. Anonymity could reduce the social pressure and therefore partly overcome the social desirable answers, therefore it is important that the survey is anonymous (Simply Psychology, 2016). Since for this research it was desired to address as much citizens as possible, an amount of 400 to 500 participants was set as goal. Since the rule with survey is that for one variable an amount of 10 participants is needed, the survey can hold around 40 questions maximum (Poletiek, 2015). Different studies show that the use of the TPB coincide with the use of a Likert scale (Kantola, Syme, & Campbell, 1982; Syme & Nancarrow, 1992; Sainsbury & Mullan, 2011).

Since the basis of the beliefs in the TPB is influenced by variables such as emotions, character traits, intelligence, value, age, sex, education, knowledge, experience, income level and race ((Ajzen, Attitudes, Personality and Behaviour (Second Edition), 2005), these questions should be addressed in the survey. For this study the demographic questions in the survey are about: gender, education, income level and number of people in the household. The other variables are hard to measure and compare, for this reason they are not stated as demographic questions and are not considered during the research.

Constructing survey is a difficult and time-consuming process since multiple design loops should be done. Since the complete constructing of a new validated survey would not be possible during this research, validated questions from others researches are used (Kilic & Dervisoglu, 2013; Sainsbury & Mullan, 2011; Ajzen I., 2013; Chu & Chiu, 2003). The content of the survey is consistent with the content of the game, so the different topics of the game are also the topics of the survey. Since the survey is testing the TPB, the constructs of TPB are included in the survey.

The questions from the other researches are reformulated to make them usable for this survey, the reformulation in this case is to change the topic of the questions. In Appendix B the complete survey can be found and the original validated questions with the changes marked. The validated questions found in articles, all show questions about a specific topic. Since the topics of the game are quit broad, a specific subject per topic is chosen for the survey questions. The water use topic for example, addressed water saving, amount of water used and water recycling. One of these is chosen to be addressed in the survey. For this, the clearest and most appealing subject is used in order to ensure that the participants understand the survey content. This to make the survey a manageable length so that the survey will not take too long to fill in. These specific topics are:

> *Water use – water saving*
> *Water pollution – dumping waste water on the street*
> *Environmental behaviour – recycling plastic*

For the water quality topic, no specific subject was chosen because there seems a strong relation between water use, water pollution and water quality (since water pollution influences the water quality and the type of water used depends on the quality). Since the knowledge about water quality was low in the local community (and also at GreenID), no specific numbers about the water quality are found. But in general people use ''safe'' (bottled or cooked) water for drinking and they always cook their water before using it. Without this topic the survey has already 35 questions, thus in order to keep the survey of a decent length the removal of this topic is desired.

2.3.1 Testing survey

The first survey was in English and consisted of 60 questions. The testing of the survey was done by five Dutch students from different background such as Dutch language, water management and offshore engineering. They tested the English survey content and the time it took to fill it in. They found that the survey was too long, and some questions were not clear. Since the survey will be conducted in a local community and the participants are voluntarily filling in the survey, the aim is to make the fill in time of the survey around ten minutes. After this first testing phase, different questions such as the difficult ones are erased to enhance the comprehensibility and reduce the fill in time. In the survey, multiple questions address the same construct. This is done to check the overall answering consistency over the constructs. Therefore, it was possible to erase the difficult questions, since multiple other questions were still addressing the constructs.

After the changes the survey was tested by staff from GreenID and the supervisors from the TU Delft. They also had some remarks about clearness of the questions and therefore these were revised to make it understandable. The second step was the translation of the survey to Vietnamese, this was done by a staff member of GreenID. Since the Vietnamese language is much longer than English a part of the introduction text had to be erased otherwise this would take too long to explain before the game. Non-English speaking staff from GreenID tested the survey at this point, the non-English speaking staff was chosen so they would not be biased by the English origin of the survey. The survey took on average 10.5 minutes to fill in and it was completely understood by the test participants. The last test was done by 15 Vietnamese student who had no further explanation about the survey background, again the average fill in time was around 10 minutes and no major remarks were made.

2.3.2 Survey layout

The survey used for the field research is stated below, in appendix B the original questions from the references can be found with the made changes.

Water use
[Behaviour]
1.   I do my best in to save water[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
2.   I save water[1].
        Never: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Always
[Normative beliefs]
3.   If my family would expect me to save water, this expectation is important to me[2].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
4.   If my neighbours would expect me to save water, this expectation is important to me[2].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
[Behavioural beliefs]
5.   If I save water I will contribute to the decrease of water shortage. This water shortage is important to me[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
6.   If I save water I will contribute to the decrease of the effect of drought. This decrease of drought is important to me[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
7.   If I save water I will be protecting the environment. This environment is important to me[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
[Control beliefs]
8.   If people around me take my warnings concerning water saving into consideration this it would make my water saving easier[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
9.   If I have had the financial means to save water, it would make my water saving easier[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
Water pollution
[Behaviour]
10.   I dump my waste water on the street[1].
        Never: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Always
11.   I do my best not to dump my waste water on the street[1].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
[Normative beliefs]
12.   My family thinks that I should not discharge my waste water on the street[3].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
13.   My neighbours think that I should not discharging my waste water on the street[3].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
[Behavioural beliefs]
14.   I will benefit (health) from not discharging my waste water on the street[4].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
15.   Benefiting (health) from not discharging my waste water on the street is an *extremely unimportant/extremely important* decision factor affecting my recycling behaviour[4].
        Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
16.   I feel I accomplish something important from not discharging my waste water on the street[4].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
17.   Accomplishing something important from not discharging my waste water on the street is an *extremely unimportant/extremely important* decision factor effecting my recycling behaviour[4].
        Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
18.   I will help to reduce environmental pollution by not discharging my waste water on the street[4].
        Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
19.   Helping to reduce environmental pollution is an *extremely unimportant/ extremely important* decision factor affecting my discharging behaviour[4].
        Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important

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[1] (Kilic & Dervisoglu, 2013)
[2] (Sainsbury & Mullan, 2011)
[3] (Ajzen I. , 2013)
[4] (Chu & Chiu, 2003)

[Control beliefs]
20.   I know what kind of water can be discharged on the street[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
21.   Knowing what kind of water can be discharged on the street is an *extremely unimportant / extremely important* decision factor affecting my discharging behaviour[5].
       Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
22.   Discharging my waste water on the street is convenient[5] .
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

Plastic waste

[Behaviour]
23.   I recycle my plastic[6].
       Never: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Always
24.   I do my best to recycle my plastic[6].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

[Normative beliefs]
25.   My family thinks that I should recycle my plastic waste[7].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
26.   My neighbours think that I should recycle my plastic waste[7].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

[Behavioural beliefs]
27.   I will benefit (health) from recycling my plastic waste[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
28.   Benefitting (health) from recycling my plastic waste is an *extremely unimportant/extremely important* decision factor affecting my recycling behaviour[5].
       Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
29.   I feel I accomplish something important from recycling my plastic waste[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
30.   Feeling I accomplish something important from recycling my plastic waste is an *extremely unimportant/extremely important* decision factor effecting my recycling behaviour[5].
       Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
31.   I will help to reduce environmental pollution by recycling my plastic waste[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
32.   Helping to reduce environmental pollution is an *extremely unimportant/ extremely important* decision factor affecting my recycling behaviour[5].
       Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important

[Control beliefs]
33.   I know how to recycle my plastic waste effectively[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree
34.   Knowing how to recycle my plastic waste effectively is an *extremely unimportant / extremely important* decision factor affecting my recycling behaviour[5] .
       Extremely unimportant: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Extremely important
35.   Recycling my plastic waste is convenient[5].
       Strongly disagree: 1 : 2 : 3 : 4 : 5 : 6 : 7 : Strongly agree

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[5] (Chu & Chiu, 2003)

[6] (Kilic & Dervisoglu, 2013)

[7] (Ajzen I. , 2013)
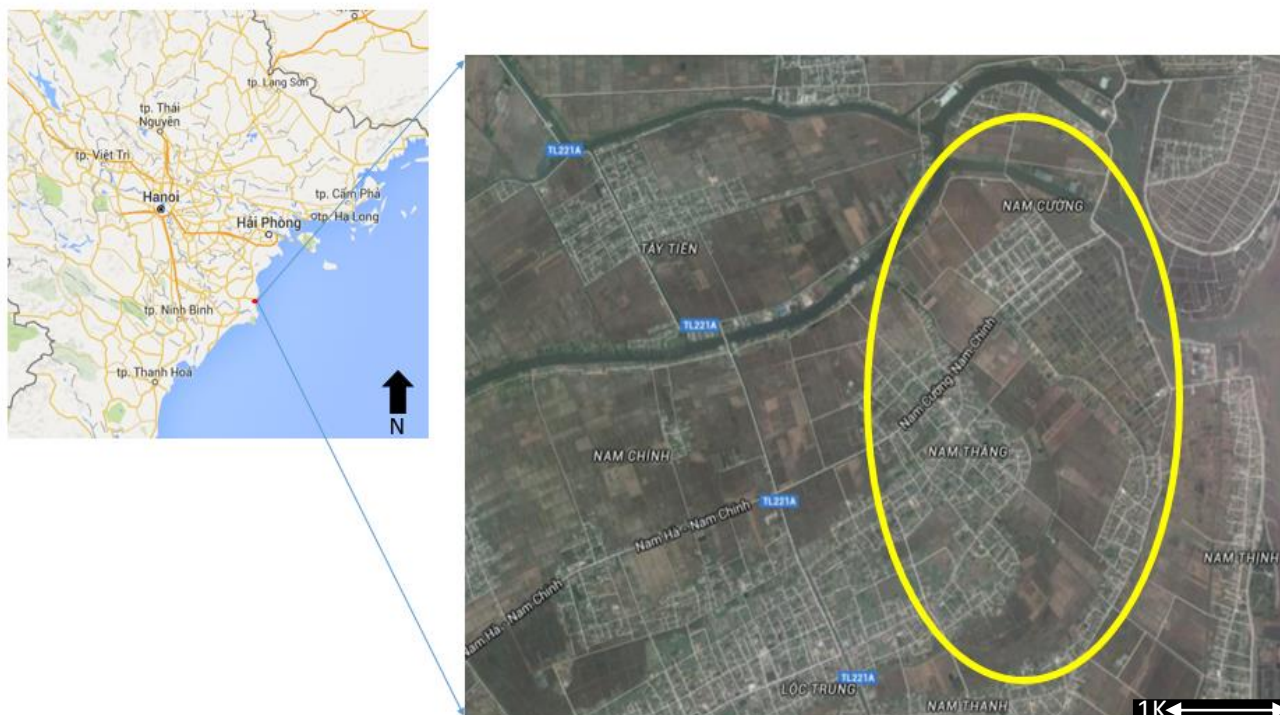
2.4 Site description

Figure 9 - Location of the local community Nam Cuong, Vietnam

This research was conducted in a small local community, see Figure 9 for the location. This community is one of the communities that GreenID is working with, they are participating in sustainable local energy planning. In the community, a local energy team (LET) was set up, that were working for GreenID. They gather information for GreenID and help them conduct research. GreenID provided some general information about the community; the community consists of 3 villages and the population is 3500 with 855 households. In a research done by GreenID in September and October 2012, 340 households were interviewed. They found that the average family had four members per household. In 2011 GreenID estimated an average income of 80 million VND per household per year which is equal to 3,202 euro, this results in 267 euro per month per household.

In 2016, 50.6% of the Vietnamese population is female (United Nations Department of Economic and Social Affairs: Population Division, 2016), the average amount of children per female is two and the life expectancy at birth is 75.6 for the population of Vietnam (World Bank, 2016). Vietnam is designated by the World Bank (2016) as a lower middle income economy.

2.5 Research set up

The research was set up for 400-500 participants and would last 10 days. The LET member would be trained to become game instructor. The games would be played in the community house and multiple game could be started simultaneously. At the start of the game round the staff from GreenID would execute the survey and explain what was going to happen, after this the games would be played. At the end of the game a general debriefing would take place to get feedback on the game and to make

the link between the game and real life. After two months the LET member would contact the participants and provide them with the second survey.

During the research however, the weather was terrible, according to the staff from GreenID. The temperature was around 4 to 6 degrees Celsius and it was raining constantly. Therefore, the participants could not come to the community house, so the staff of GreenID went to the houses. Since the town board could not provide 10 research days anymore, the amount of days was set back to 3. Hereby, only 165 participants could be researched since no more time was available. The general debrief at the end has taken place but has not be recorded due to a misunderstanding. Therefore, no information is available about the feedback of the participants on the game. The LET member provided the second survey after two months by looking up the participants at their houses, since not everyone could be found or was available to fill in the research, only 120 participants that did the game filled in the second survey.

2.6 Analysis methods

Different statistical analyses are used to analyse the results; they will be explained below. These analyses are done in SPSS®.

2.6.1 Test for normal distribution

It is important to test the normality of the distribution of the answers, since most standard statistical methods are based on the assumption that the data that is used is normally distributed. If this is not the case these methods cannot be used. According to the Shapiro-Wilk test, a test to determine the level of normality, none of the questions is normally distributed: for all the questions the significance is 0.000. A significance level lower than 0.05 indicates that the distribution is significantly different from a normal distributed data set. Since the data is not normally distributed, the use of a mean value with standard deviation gives a distorted view. Therefore, the median is used, since this is a more robust measure and can be used with skewed data.

One way of addressing normality is by visual inspection of the data. This is however time consuming and difficult to analyse, since it is hard to determine what the exact boundary is of normality. Therefore, a statistical test as the Shapiro-Wilk test can be used. A disadvantage of statistical analysis for normality is however the sensitivity of the test, it could be not sensitive enough for small sample sizes or over sensitive for large sample sizes. Therefore, a correct interpretation of the results must be made and the significant level should be taken into account. Since the significant level for this research is, for all the data, 0.000 it seems justifiable to determine the data distribution as non-normal. This is supported by visual inspection of the data.

The Shapiro-Wilk test used the formula:

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

In which the ''a'' variable consists of information about normal distributed data. Hereby the formula determines whether a distribution is different from a normal distribution. ''W'' represent the correlation between the data distribution and a normal distribution. A ''W'' value of 1 indicates a perfectly normal distribution. (Shapiro & Wilk, 1965)

2.6.2 Non-parametric test

Since the data from this research does not have a normal distribution the use of non-parametric analyse methods have to be used. Since the data for survey 1 and survey 2 is from the same group of participants, the data sets are related and therefore the statistical analysis for correlated data must be used.

Paired sample sign test

The first non-parametric test that was used for the analyse, is the Wilcoxon Signed-Rank test. This test is the non-parametric equivalent to the depended t-test. This test is used to compare two data sets that come from the same set of participants. There are three assumptions which must be met before using the Wilcoxon test. The first; the depended variable should be measured on an ordinal or continuous level. A Likert scale variable is an example of an ordinal measured one. Therefore, for this research, that assumption is met. The second assumption, holds that both data set that are being compared come from the same group of participants. This assumption is met as well. The last assumption is that the distribution of the difference in the data sets is symmetrical in shape. However, after visual inspection of the data this assumption could not be met. Therefore, the paired sample sign test is needed to analyse the data. (Leard statistics, sd)

The paired sample sign test evaluates the two data set, in this research the pre- and post-survey. The answers of the participants from the pre- and post-test form a pair, it is evaluated if there is a difference between the pairs. If there is not, this is stated as ties. If the post survey is greater than the pre survey this is designated as positive difference and vice versa a negative difference. The total amount of differences is denoted as ''n'' (without taking the ties into consideration) and the amount of the least frequent sign by ''S''. If for example in a question 8 people answered higher this corresponds with 8+, if 9 people answered lower this results in 9- and 5 people answered the same. This would result in a ''n'' of 17 and a ''S'' of 8. The ''n'' and ''S'' value is used in the following formula:

$$Z = \frac{S - np}{\sqrt{np(1-p)}} \ (with \ p = \frac{1}{2})$$

The ''S'' value is compared to the ''Z'' value, if the former is greater than the latter the null hypothesis, that the + and − signs are equal or the population means are equal, is met. If vice versa the null hypothesis is rejected. Along with the ''Z'' value, a probability value significant level is determined, based on this value the null hypothesis can be rejected or retained. If this level is 0.05 or below than the null hypothesis should be rejected. The rejecting of the null hypothesis indicates that there is a significant difference between the first and the second survey. (Statistics solutions, sd)

Kruskal-Wallis test

The Kruskal-Wallis test is the non-parametric equivalent of the one-way ANOVA and is used to determine if there is a difference between two or more groups in a data set. For this research this method is used to determine the difference in that data amongst the demographical factors. In other words, is there a difference between for example the age groups in answering the survey questions. This method does not test the difference between the surveys, as is the case with the sign test, but only amongst the groups. The Kruskal-Wallis test does not indicate which groups differ from each other but rejects the null hypothesis if two or more groups in the category have a significant different distribution. The null hypothesis holds that the groups come from an identical population. In other words, there is no difference between the answering distribution among the groups. Three assumptions are related to the use of the Kruskal-Wallis test; samples must come from the same population, no individual can appear in multiple groups and the measurements should have an ordinal scale. For this research all the assumptions are met.

For this method the data is, per group, sorted in ascending order and a rank is assigned. The ranks are summed (value "T") and the Kruskal-Wallis test statistic is computed by using the following formula:

$$H = \frac{12}{n(n+1)} \sum \frac{T^2}{n} - 3(n-1)$$

$$with \text{ "}n\text{" } as \text{ } total \text{ } number \text{ } of \text{ } oberservation \text{ } in \text{ } all \text{ } groups$$

Since the Kruskal-Wallis test is approximately a chi square distribution with a k-1 degrees of freedom and n_i which should be greater than 5. The "H" value is compared with this critical chi-square value and thereby it is determined if the null hypothesis can be rejected or not. It the "H" is larger than the critical chi-square the null hypothesis is rejected and it can be concluded that the groups have significant different answering distributions. (Statistics solutions, sd)

2.6.3 Cronbach's alpha

To determine the internal consistency of the survey the Cronbach's alpha value is determined. This is commonly used to determine if multiple Likert scale questions measure the same construct. For example, if one has five Likert scale questions about feeling happy, the Cronbach's alpha can determine whether these five questions indeed measure the construct of feeling happy. (Leard statistics, sd) Questions with a Cronbach's alpha with a value of 0.7 can be identified as reliable consistent (Tilburg University, sd). The Cronbach's alpha is determined via the following formula:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

$$with \text{ } n = number \text{ } of \text{ } items \text{ } tested$$
$$\bar{c} = averge \text{ } inter - item \text{ } covarience \text{ } among \text{ } the \text{ } items$$
$$\bar{v} = average \text{ } varience$$

This states that the Cronbach's alpha is depended on the covariance and variance between the tested items. (Institute for digital research and education, sd)

2.6.4 Factor analysis

The results of the Cronbach's alpha were used in the factor analysis. The questions that have a sufficient number for the Cronbach's alpha were taken as one construct. Their averages were used as the new values for the combined questions. Factor analysis is used to determine the variability in the data and to find underlying factors that explain this variance. For this research it was expected that the underlying variables are either the construct of the TPB or the topics addressed in the survey. Although it would be logical if the topics addressed are the underlying factors instead of the TPB construct, since it is likely that participant's beliefs and behaviour is constant over a certain topic. If the constructs of the TPB would be the underlying factors this would indicate that the beliefs are constant over different topics, which seems unlikely. For example, the social pressure about water use could be different than about plastic waste. This would indicate that the normative beliefs are different in those topics and therefore are unlikely to pop up as factors.

3 Results

In the results different statistical analysis are used to give insight in the data and the hypotheses are tested. First the characteristics of the participants are described. Secondly the general hypotheses are tested. Thirdly the demographic hypotheses are tested. At last the survey is analysed to determine if the use of this is justifiable. In this chapter the results are described and a preliminary elaboration is given. More thorough interpretations are discussed in the next chapter.
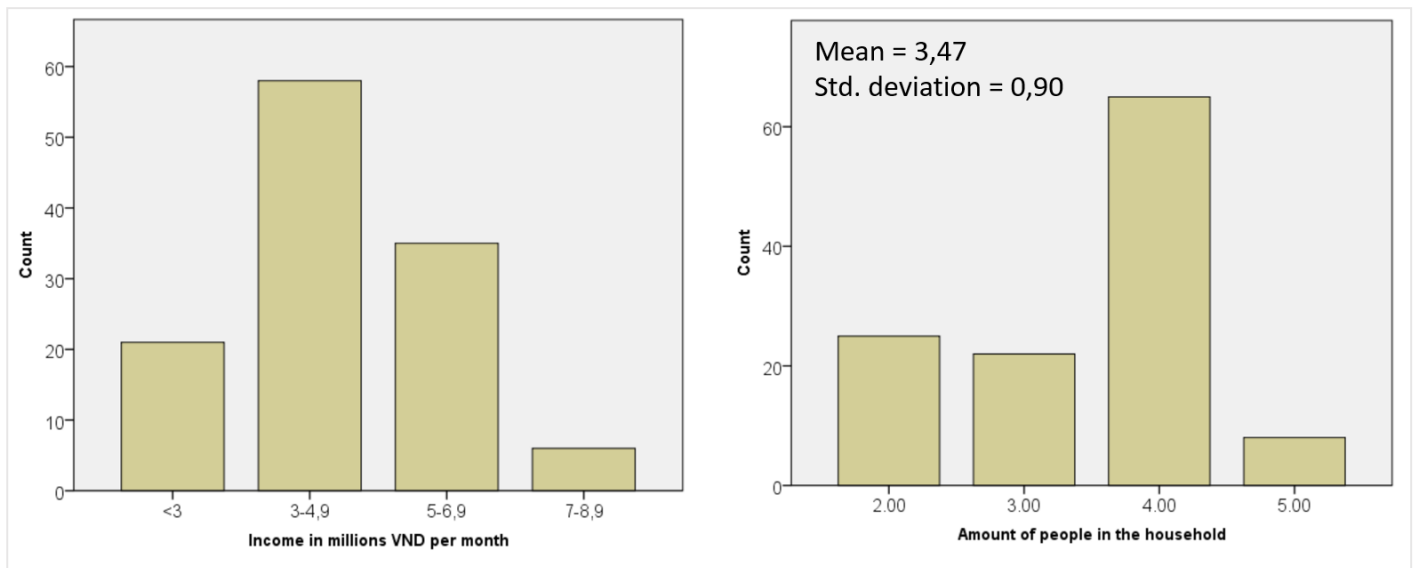
3.1 Participant characteristics

Figure 10 - 10 – On the left side the income levels (per month) of the participants are shown, 3 million VND which corresponds with approximately 120 euro. On the right side the distribution of the amount of people in the households of the participants are shown.

120 participants were studied, from which 68 were female. The field study took 3 days, there were 51 participants on the first day, 21 participants on the second day and 48 participants on the third day. The average age of the participants was 49.6 years with a standard deviation of 11.6 and a minimum of 28 and maximum of 78. The income level distribution is shown in Figure 9 on the left hand side, on the right hand side the distribution from the amount of people in the household is shown. These income levels correspond to the levels that GreenID found in their study.

3.2 Normality

As can be seen in Figure 11, the distribution among the questions is either U shaped- or folded - normal. The consequence of non-normally distributed data is that one should use non-parametric statistics to analyse the data. In contrast to the standard statistical methods the non-parametric ones do not have the constraints of normally distributed data.
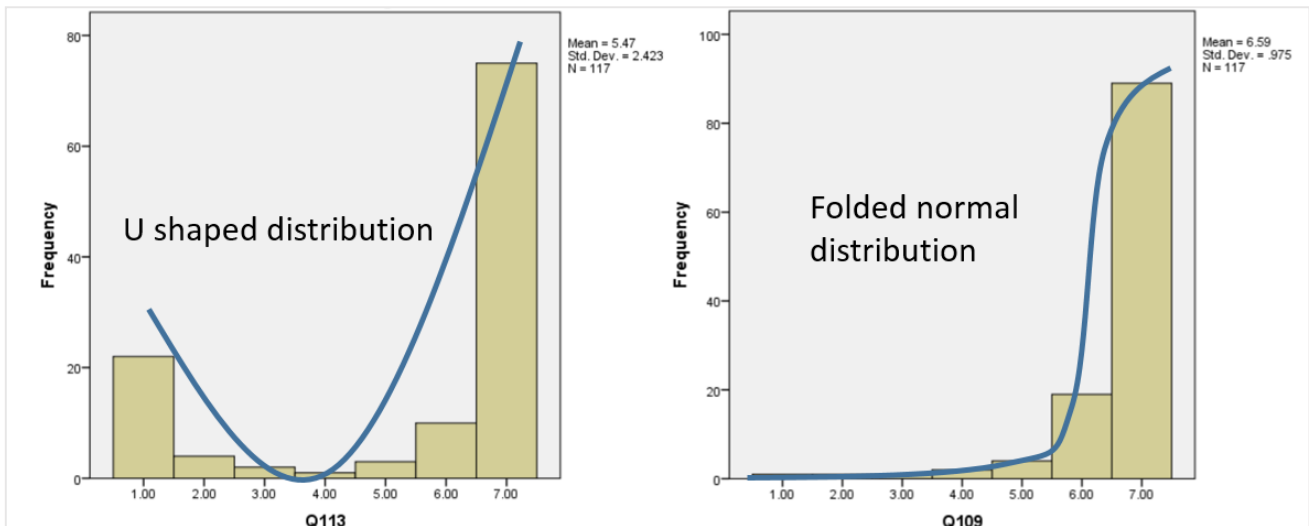
Figure 11 - Distribution among questions two different questions, which shows the different distribution forms

3.3 General hypotheses

The general hypotheses, given in section 2.2, are tested and the median answers of the whole group of participants on survey 1 and 2 are shown in Figure 12. The red boxes show the questions where the median answers of the questions differ between survey 1 and 2.
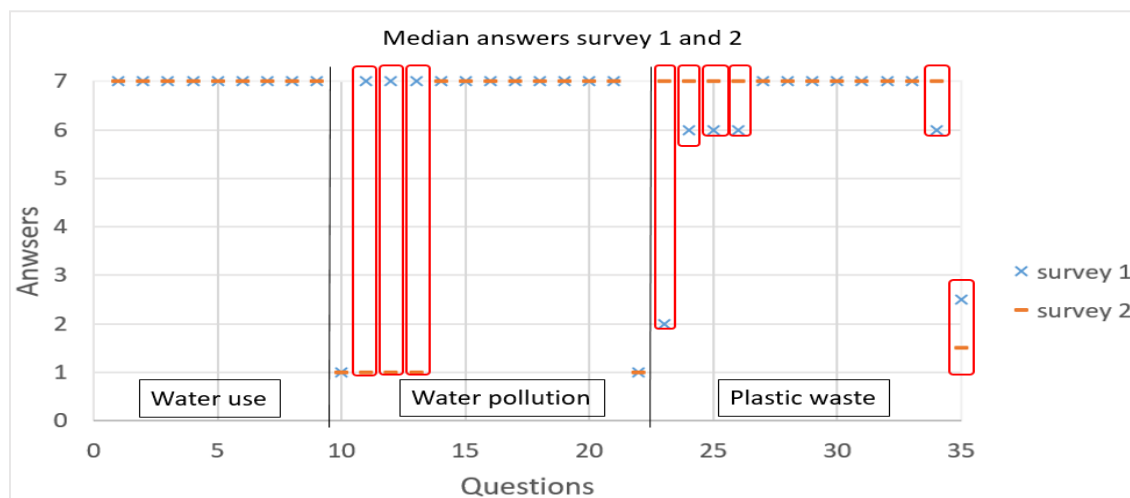

Figure 12 - The median answers of survey 1 and survey 2

Several striking observations can be made: questions 11,12,13 and 35 shift from a very positive answer in survey 1 to the complete opposite in survey 2, were the goal of the game was to stimulate the contradicting. Questions 23,24,25,26 and 34 on the other hand do show a positive shift.

To go into more detail, Table 3 is created were the significant difference between the surveys are tested, using the Sign Test. The observations from Figure 12 are clearly visible in this table as well. The yellow cells of questions 11,12,13 and 35 corresponds with a negative difference. The blue cells in questions 23,24,25,26 and 34 show a positive difference. In addition, two more blue cells can be observed, in questions 20 and 21. The rest of the questions show green cells, which indicates that the majority of the people have answered the same in both surveys. Those who answer differently for these questions tend to answer more positive instead of negative. Lastly, the red cells indicate a significance number above 0.05, which indicates that these questions show no significant change.

Table 3 – The paired sample sign test results. The green cells correspond with the answers were the majority of participants answers the same in survey 1 and 2. The red cells show the questions with a to high sig.2 value, these questions show no significant change. The blue numbers indicate the questions in which the amount of positive difference was higher than the negative. The yellow numbers indicate the questions in which the amount of negative difference was higher than the positive.

	Ties	Negative difference	Positive difference	Sig. 2		Ties	Negative difference	Positive difference	Sig. 2
Q201 - Q101	79	6	35	0.000	Q219 - Q119	66	26	28	0.892
Q202 - Q102	73	27	20	0.381	Q220 - Q120	46	26	47	0.019
Q203 - Q103	83	9	28	0.003	Q221 - Q121	41	34	45	0.261
Q204 - Q104	86	8	26	0.004	Q222 - Q122	63	48	9	0.000
Q205 - Q105	96	3	21	0.000	Q223 - Q123	22	18	80	0.000
Q206 - Q106	92	6	22	0.005	Q224 - Q124	39	7	74	0.000
Q207 - Q107	102	2	16	0.001	Q225 - Q125	43	7	70	0.000
Q208 - Q108	84	8	28	0.002	Q226 - Q126	47	11	62	0.000
Q209 - Q109	67	29	24	0.583	Q227 - Q127	60	11	49	0.000
Q210 - Q110	75	38	7	0.000	Q228 - Q128	55	15	50	0.000
Q211 - Q111	45	56	19	0.000	Q229 - Q129	67	5	48	0.000
Q212 - Q112	43	64	13	0.000	Q230 - Q130	63	17	39	0.005
Q213 - Q113	43	63	14	0.000	Q231 - Q131	66	48	6	0.000
Q214 - Q114	74	15	31	0.027	Q232 - Q132	53	23	44	0.015
Q215 - Q115	60	38	21	0.037	Q233 - Q133	59	5	56	0.000
Q216 - Q116	89	4	27	0.000	Q234 - Q134	44	16	59	0.000
Q217 - Q117	67	26	27	1.000	Q235 - Q135	42	44	34	0.308
Q218 - Q118	91	4	25	0.000					

24 from 35 questions	4 from 35 questions	7 from 35 questions

3.4 Demographical hypotheses

To test the influence of the demographic factors, a Kruskal-Wallis test is used. In order to do so, the demographical hypothesis, mentioned in section 2.2, are tested. In Table 4 the distinction between the different subsets are made and the amount of participants in the subsets are shown.

Table 4 - Demographic factors with their subsets and amount of participants per subset

Factor	Subsets	# participants	Factor	Subsets	# participants
Gender	Male	52	**People in the**	2	25
	Female	68	**household**	3	22
Income level	<3	21		4	65
	3 – 4.9	58		5	8
	5 – 6.9	35	**Age groups**	26-35	14
	7 – 8.9	6		36-45	37
Research day	26/01/2016	51		46-55	31
	27/01/2016	21		56-65	27
	28/01-2016	48		66-75	9
				>75	2

In Table 5 the results are shown from the Kruskal-Wallis test, only the results where a significant difference among the subsets is found is shown. These results however do not indicate between which subsets this significant difference is. In general, there are more significant differences observed in the second survey than in the first. The table shows that the subgroups within day number, income, people in the household and age show more significant difference among the groups in survey 2 compared to survey 1. Gender on the other hand shows the opposite. This indicates that the different subgroups within the demographic factors change differently over time. In general sense, more difference between the subgroups is found in survey 2.

Table 5 – The numbers indicate a significant different amongst the subsets of the demographic factor, according to the Kruskal-Wallis test. The empty cells indicate that no significant difference was found.

Survey 1	Day number	Gender	Income	People in the household	age	Survey 2	Day number	Gender	Income	People in the household	age
Q1						Q1	0.015				
Q2						Q2	0.000		0.007		0.022
Q3						Q3	0.039		0.015		
Q4						Q4			0.047		
Q5						Q5					0.029
Q6						Q6	0.041				
Q7						Q7					
Q8						Q8			0.031		
Q9		0.002				Q9	0.000		0.039		
Q10	0.017					Q10					
Q11						Q11	0.000				
Q12						Q12	0.000		0.024		
Q13	0.001					Q13	0.000		0.015		
Q14						Q14					0.018
Q15		0.004				Q15	0.000	0.045	0.018		
Q16						Q16					
Q17						Q17	0.000	0.042	0.011		
Q18						Q18					
Q19						Q19	0.000		0.008		
Q20	0.036					Q20	0.002			0.029	0.036
Q21						Q21	0.005			0.030	
Q22			0.022			Q22					
Q23		0.002				Q23	0.000				
Q24						Q24					
Q25		0.029				Q25					0.048
Q26						Q26					0.020
Q27		0.045				Q27				0.002	0.000
Q28						Q28	0.001		0.032		
Q29		0.028				Q29					0.026
Q30						Q30	0.002		0.032		0.042
Q31						Q31					0.017
Q32		0.026				Q32	0.000		0.013		
Q33	0.009					Q33				0.015	0.002
Q34	0.017					Q34	0.000		0.042		
Q35		0.003				Q35	0.000				

In the remaining of this section the results found in Table 5 are illuminated chronologically. The graphics show the median answers of the according subgroups, on the left hand side for survey 1 and on the right hand side for survey 2. In the text the most remarkable observations are given, together with a first interpretation.

Day number

In Figure 13, the difference in median answers between the subsets of the research day are shown. In the second survey the answers of the 26th of January coincide with the answers of the 28th. It seems that the significant difference is between these two and the 27th of January. In survey 2, the 26th and the 28th answered only the most extreme answers of 1 and 7, where the participants of the 27th have more differences in answering. The former two subsets are more positive than the latter, indicating that the research day is of influence on the effect of the game. During these research days the surrounding factors like weather were not recorded. Even though it is known that the weather in fact was fairly bad during the period of these research days, it is not known which day exactly was worse than the other. Therefore, the influence of the weather could not be determined. Furthermore, it was not reported which game leader explained the game in which research day, therefore it could not be analysed what the influence was of a certain explanation of the game in comparison with answers of the game It seems plausible however that the way the game is explained could be of influence on the effectiveness of the game.
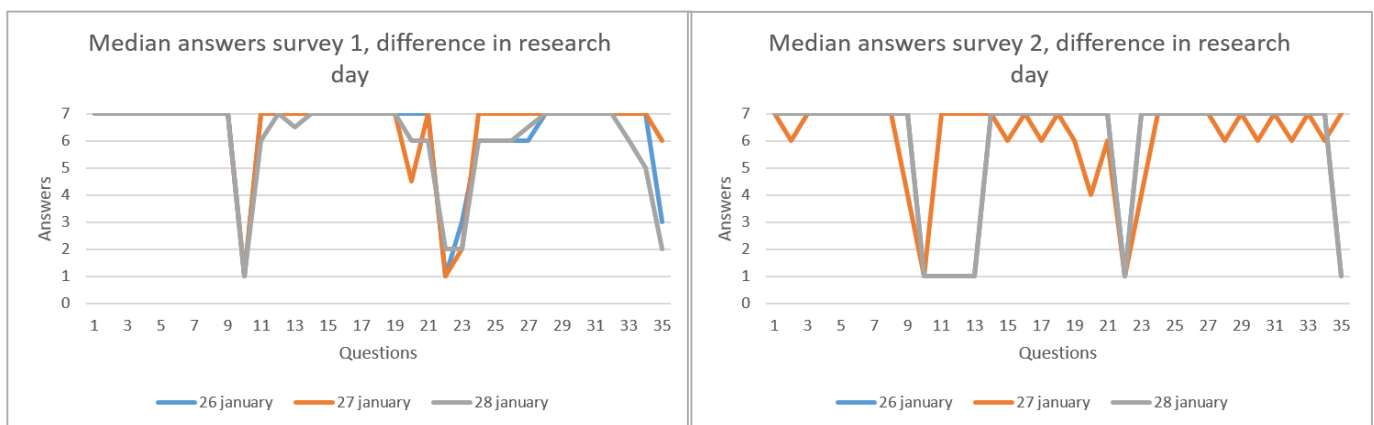

Figure 13 - On the left the medians answers of survey 1, on the right the median answers of survey 2 with the difference in research day.

Gender

If the subset groups are evaluated by gender, the difference between males and females is mostly to be found in survey 1 (Figure 14). Survey 2 on the other hand only shows two questions (11 and 35) in which there is a difference in median. These questions do not correspond to the two questions from survey 2 in which there is a significant difference according to the Wilcoxon test, as is shown in table 4 (15 and 17). However, the significance levels are on the limit of what is accepted (a value lower than .05), which indicates that the significant difference is questionable. It seems that the game has brought males and females closer together in their beliefs about- and behaviour towards water pollution, water use and plastic waste. From Figure 14 it can be seen that the only difference in medians exist when females score higher than males. This indicates that the game is more effective on males, although this view could be influenced by the fact that the females already gave the highest possible answer as a median.
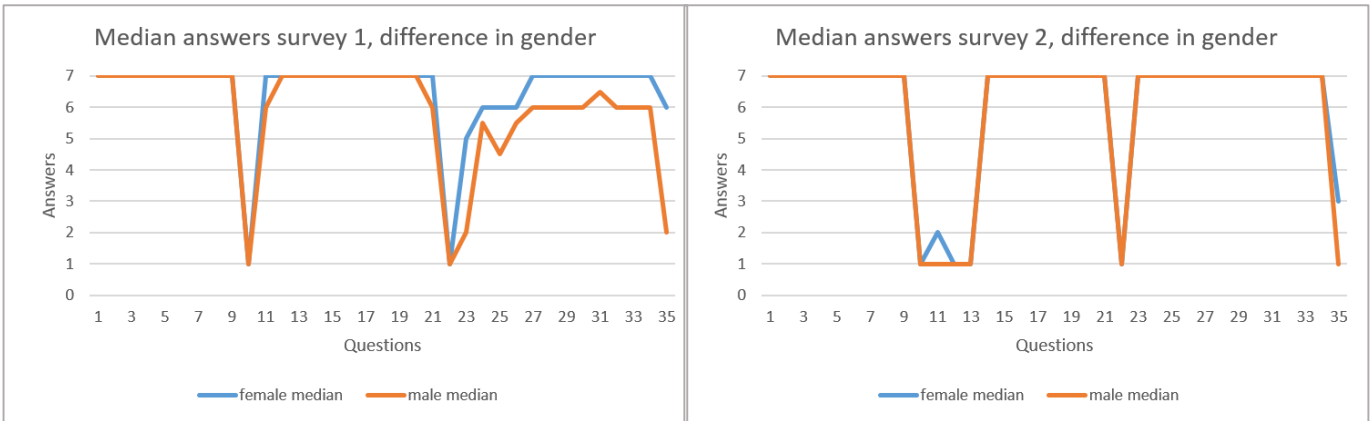
Figure 14 - On the left the medians answers of survey 1, on the right the median answers of survey 2 with the difference in gender

Income

In Figure 15, the difference in median of the answers of the income level subsets are shown. According to the Kruskal-Wallis test in survey 1, only question 22 has a clearly visible significant difference. However, the majority of questions from survey 2 show a significant difference. Here the subset of <3 and 3-4.9 M VND coincide with the line of 7-8,9 M VND, so the significant difference is clearly between the 5-6,9 subset and the others. In general, the other subsets give the extreme answers of 1 or 7 and the 5-6,9 group often has 6 as a median. Noticeable here is that significant differences are mostly found in the questions in the form '' an important decision factor affecting my recycling behaviour''. It seems that although the participants within the 5-6.9 subset feel they do something good and they extremely agree with a statement, by answering with a 7. But with questions about the importance as a decision factor not the maximum score of 7 is given. The link why this is done in combination with a certain income however is hard to make.

Figure 15 - On the left the medians answers of survey 1, on the right the median answers of survey 2 with the difference in income level.

People in the household

In Figure 16, the median answers are shown for the subsets of the amount of people in the household. As stated in table 5, none of the questions from survey 1 and only 4 questions (20,21,27 and 33) from survey 2 show a significant difference. In Figure 15 it can be seen that the median in those questions only different for question 21. For the second survey the groups 2, 3 and 4 all follow the same path and only 5 is very different. However, since the subset of 5 people in the household only applies to 8 participants, the comparison between 2,3,4 and 5 is hard to make. At last for 2,3 or 4 people in the household it seems that there is hardly any trend visible: the game effect seems not sensitive to the amount of people in the household. These results would coincide with the design of the game, which had the intention to aim for the same effect without being influenced by the amount of people in the household. This would indicate that the game is usable for all different kinds of family compositions.
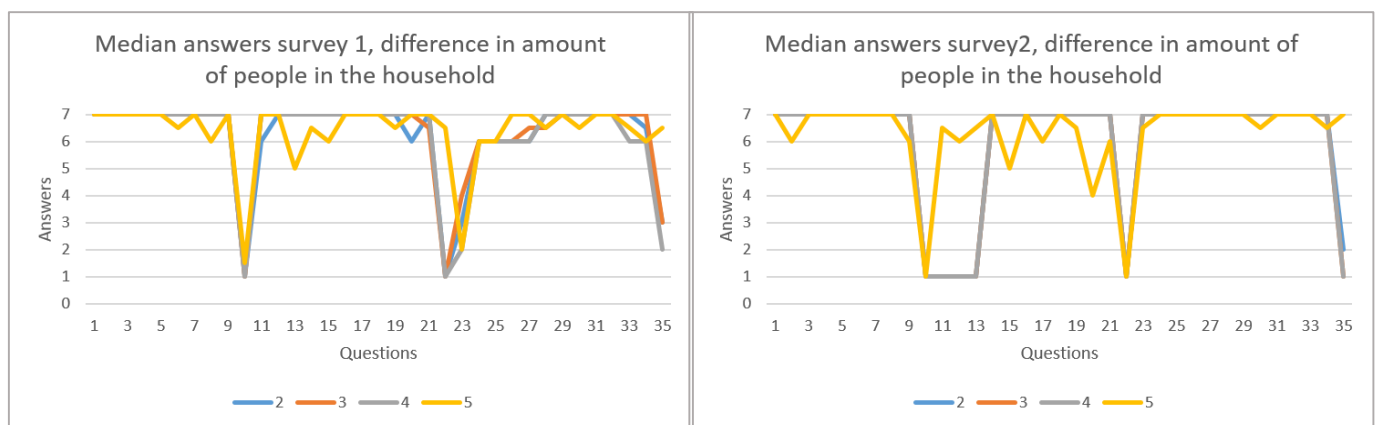

Figure 16 - On the left the medians answers of survey 1, on the right the median answers of survey 2 with the difference in amount of people in the household.

Age

In Figure 17 the median answers are shown, divided among the age groups. Although the significant numbers from the Kruskal-Wallis test show that there are no significant differences in answers given in survey 1, the median answers of the subsets show the opposite. What is not visible in the second survey in Figure 17, is that the lowest three sub groups answered the same as the subset of above 75 (with an exception of the last question). The significant difference is mostly attributed to the difference between the 66-75 subset and the other groups. Since the subset of 66-75 only consist of 9 participants, the influence of answers given by the individual participants on the median is high. In this case neither the median nor the average gives a good example of the group, since it is so small in comparison to the rest. Even so, among the other subsets it seems that the participants do not have a significant difference in answers before or after the game.
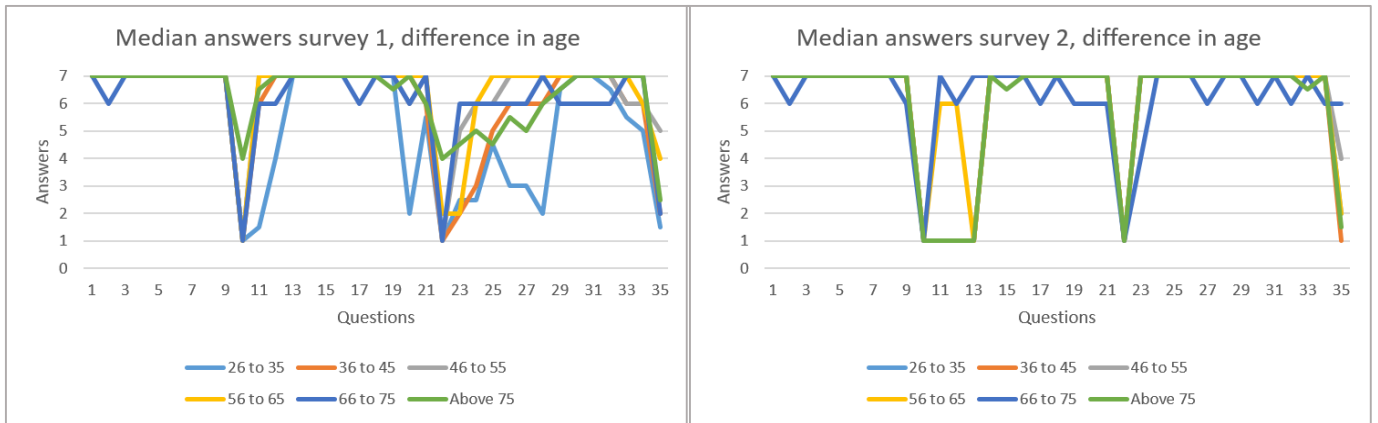
Figure 17 - On the left the medians answers of survey 1, on the right the median answers of survey 2 with the difference in age groups.

3.5 The Survey

Although the questions of the survey are validated questions from other researches, the survey was tested with statistical analysis to examine whether the survey was valid for this research. The first thing that was analysed was the internal consistency of the survey, for which the determining of the Cronbach's alpha is used. The Cronbach's alpha indicates if questions address the same construct, results shown in Table 6. In other words: do they measure the same and can they be combined to one construct. Since the survey is built around 3 topics (water use, water pollution and plastic waste), with four constructs from TPB (B, BB, CB and NB) it could be analysed what the Cronbach's alphas are of the TPB constructs. In table 6 the Cronbach's alpha results are shown; the green number indicate a sufficient level of consistency (a Cronbach's alpha of 0.7 or higher).

Table 6 - The number for the Cronbach's alpha per construct of the TPB. On the left are the questions of survey 1 and on the right of survey 2. The green cells indicate a Cronbach's alpha that indicates a sufficient high number, so internal consistency can be concluded. The Cronbach's alpha is determined per constructs of the TPB, so for the behaviour, normative beliefs, control beliefs and behavioural beliefs questions.

Q101	0.550	Q114		Q127			Q201	0.216	Q214		Q227	
Q102		Q115		Q128			Q202		Q215		Q228	
Q103	0.442	Q116	0.860	Q129	0.936		Q203	0.905	Q216	0.616	Q229	0.812
Q104		Q117		Q130			Q204		Q217		Q230	
Q105	0.605	Q118		Q131			Q205	0.655	Q218		Q231	
Q106		Q119		Q132			Q206		Q219		Q232	
Q107		Q120		Q133			Q207		Q220		Q233	
Q108	0.286	Q121	0.644	Q134	0.776		Q208	-0.135	Q221	0.128	Q234	-0.437
Q109		Q122		Q135			Q209		Q222		Q235	
Q110	0.327	Q123	0.853				Q210	0.223	Q223	0.657		
Q111		Q124					Q211		Q224			
Q112	0.859	Q125	0.966				Q212	0.954	Q225	0.762		
Q113		Q126					Q213		Q226			

Although the questions from survey 1 show a sufficient consistency within 6 from the 12 constructs, the survey questions from survey 2 show a different picture. The internal consistency of the latter had only 4 constructs with a score higher than 0.7 and 5 constructs in the zone with a value lower than

0.3, which indicates hardly any consistency. Since the questions in the surveys were the same and they are used on the same group of participants, this result is striking: it indicates that the participants answered more consistently in the first survey than in the second.

With the results of the Cronbach's alpha a factor analysis was performed, in order to determine the variability in the data and to find underlying factors that explain this variance. The results are shown in table 7 and 8, respectively for the first and second survey. It can be seen that the colours are grouped more in survey 1 compared to survey 2, which indicates that the factor analysis from survey 1 shows a better distinction of the topics of the survey. This means that the underlying factors that explain the variety in answers can be explained by the topics of the survey, which makes sense since the survey is build up around these topics. The TPB constructs measure the different beliefs about these topics, the B, NB, CB and BB questions however have the same overall topic. Therefore, it is logical that these topics are the underlying factors and that they come up during the factor analysis.

Table 7 - **The factor analysis of the first survey, the green cells correspond to the plastic waste questions in the survey, the blue cells to the water pollution questions and the yellow cells to the water use questions. The pink coloured cell indicate the corresponding TPB constructs of the questions.**

FACTOR 1	23.92%		FACTOR 2	17.03%		FACTOR 3	8.53%		FACTOR 4	7.19%	
mean127-132	.875	BB	Q108	.803	CB	Q120	.602	CB	Q109	.508	CB
mean125-126	.839	NB	Q106	.715	BB	mean114-119	.443	BB	Q102	.460	B
mean133-135	.781	CB	Q105	.688	BB	Q106	.360	BB	Q101	.455	B
mean123-124	.772	B	Q103	.666	NB	mean112-113	.352	NB	Q110	.347	B
mean112-113	.657	NB	Q107	.622	BB	Q122	.337	CB	Q122	.328	CB
Q111	.654	B	Q104	.477	NB	Q110	.279	B	Q121	.314	CB
Q120	.545	CB	Q109	.451	CB	Q121	.230	CB	Q107	.137	BB
Q121	.490	CB	Q101	.446	B	Q108	.179	CB	Q104	.075	NB
Q122	.473	CB	Q102	.444	B	Q104	.072	NB	mean114-119	.028	BB
mean114-119	.450	BB	mean114-119	.146	BB	Q103	.013	NB	Q103	.018	NB
Q110	.439	B	Q111	.034	B	Q107	.005	BB	Q120	-.015	CB
Q102	.257	B	mean133-135	.002	CB	Q111	-.053	B	Q111	-.093	B
Q104	.104	NB	mean123-124	-.001	B	Q105	-.158	BB	mean125-126	-.136	NB
Q109	.068	CB	mean125-126	-.012	NB	Q101	-.167	B	mean133-135	-.145	CB
Q101	.056	B	Q122	-.014	CB	Q102	-.205	B	mean127-132	-.153	BB
Q103	.050	NB	mean112-113	-.028	NB	mean127-132	-.220	BB	mean123-124	-.175	B
Q106	-.015	BB	Q120	-.029	CB	Q109	-.267	CB	mean112-113	-.195	NB
Q107	-.031	BB	mean127-132	-.031	BB	mean133-135	-.278	CB	Q105	-.264	BB
Q108	-.043	CB	Q121	-.044	CB	mean125-126	-.346	NB	Q106	-.269	BB
Q105	-.064	BB	Q110	-.302	B	mean123-124	-.444	B	Q108	-.356	CB

The factor analysis of the second survey shows a more deviated picture: a clear trend is not seen. The different constructs of the TPB can also be seen in the tables, but these constructs show no trend in the factor analysis.

Table 8 - The factor analysis of the second survey, the green cells correspond to the plastic waste questions in the survey, the blue cells to the water pollution questions and the yellow cells to the water use questions. The pink coloured cell indicate the corresponding TPB constructs of the questions.

FACTOR 1	29.86%		FACTOR 2	19.38%		FACTOR 3	9.41%		FACTOR 4	7.91%	
Q223	.871	B	Q235	.592	CB	Q201	.597	B	Q218	.846	BB
Q224	.730	B	Q205	.582	BB	Q222	.597	CB	Q219	.613	BB
mean227-232	.681	BB	Q224	.539	B	mean203-204	.548	NB	Q217	.603	BB
Q205	.670	BB	Q233	.497	CB	Q206	.436	BB	Q206	.495	BB
Q233	.655	CB	mean225-226	.494	NB	Q233	.384	CB	Q211	.216	B
Q208	.589	CB	mean212-213	.486	NB	Q207	.373	BB	mean212-213	.210	NB
Q217	.582	BB	Q208	.471	CB	Q205	.207	BB	Q235	.201	CB
Q234	.555	CB	Q216	.449	BB	Q210	.076	B	Q216	.057	BB
Q216	.536	BB	Q211	.442	B	Q202	.075	B	Q205	.024	BB
Q201	.521	B	Q207	.328	BB	Q220	.068	CB	Q209	.005	CB
mean225-226	.514	NB	Q201	.277	B	Q215	.067	BB	Q207	.002	BB
Q219	.488	BB	Q206	.260	BB	Q217	.027	BB	mean203-204	-.007	NB
Q202	.473	B	mean203-204	.219	NB	Q223	-.023	B	Q223	-.013	B
mean203-204	.457	NB	mean227-232	.172	BB	Q235	-.027	CB	Q233	-.015	CB
Q209	.452	CB	Q214	.145	BB	Q234	-.035	CB	Q214	-.017	BB
Q220	.365	CB	Q218	-.122	BB	Q208	-.036	CB	Q224	-.018	B
Q215	.364	BB	Q223	-.172	B	Q219	-.044	BB	Q210	-.035	B
Q206	.325	BB	Q234	-.200	CB	Q211	-.049	B	mean225-226	-.043	NB
Q218	.307	BB	Q221	-.208	CB	Q218	-.083	BB	Q221	-.068	CB
Q207	.277	BB	Q222	-.276	CB	mean212-213	-.084	NB	Q222	-.082	CB
Q221	.257	CB	Q220	-.481	CB	Q209	-.108	CB	Q215	-.107	BB
Q214	.162	BB	Q217	-.484	BB	Q216	-.205	BB	mean227-232	-.117	BB
Q222	-.224	CB	Q202	-.555	B	Q224	-.228	B	Q234	-.148	CB
Q235	-.620	CB	Q219	-.567	BB	Q221	-.400	CB	Q208	-.166	CB
Q211	-.733	B	Q210	-.610	B	Q214	-.406	BB	Q201	-.204	B
Q210	-.735	B	Q209	-.647	CB	mean225-226	-.441	NB	Q202	-.241	B
mean212-213	-.768	NB	Q215	-.684	BB	mean227-232	-.581	BB	Q220	-.334	CB

4 Discussion

The aim of the discussion is to assess the strengths and weaknesses of the methodology. The discussion consists of the influence is of the sample size, Likert scale, the participants involved in the research, the use of a control group, and the cultural influence in this kind of research. Furthermore, the results are interpreted and serious gaming is analysed. Recommendations for the game and further research are given. The TPB is discussed and other options for theories are evaluated to determine if they would be applicable as well. Finally, variables that were not included in this research, but could have been relevant, will be discussed.

4.1 Sample size

The sample size is one of the most important factors in this research. In the introduction, it was stated that 400 to 500 participants were needed for this research, but in the end there were 120 participants. The question that rises: is this sample enough for the results to be significant? In other words, do the results of the 120 participants say something useful about the rest of the village. In social science there are different ways to determine the sample size. For example, a rule thumb is stating that the sample size should be at the least 10% of the population researched (Bullen, 2016). For this research the population of the local community is 3500, indicating a sample size of at least 350 participants is needed. Another way of addressing the sample size is by means of a sample size calculation formula. This formula (Creative Research systems, 2016) works with the assumption that the question can be answered by two only options. Within this formula there is a factor built in which assesses the expected outcome of the question. In cases of an unknown factor 0.5 is used since this corresponds with a probability of outcomes when only two options are given. Due to the fact that in this research a Likert scale with multiple options is used, this formula can therefore not be implemented. However, the sample size calculated via this formula creates the lower boundary of the size of the sample that is needed. Whenever there are more answering options the sample size will increase. (Hut, 2016) Therefore, the formula is used in order to find this lower boundary condition, which had an outcome of a sample size of 347. This number however depends on the chosen confidence interval (usually this is 5%) and the confidence level (usually this is 95%). If one would decrease the confidence level, conclusions with more uncertainties are created but a smaller sample size is required. According to Sauro (2015) a confidence level of 80% is sufficient for an exploratory research. This corresponds with a sample size of 107 participants. This research therefore is accepted as exploratory research since 120 people participated. Since significant results are observed, a potential for further research is found due to the exploratory nature of the research. In order to draw a conclusion from this research, with respect to the entire community, a larger sample size is needed.

4.2 Results

In this section the results of the general hypothesis as well as the demographical factors are discussed. The results are interpreted and recommendation are given to improve the game.

General hypotheses

In general, the participants have answered either the same as- or a higher value in survey 2 compared to survey 1. This is not seen in the median answers since the majority of participants gave extreme answers in the surveys, but is a result from the paired sign test. Remarkable is that behaviour questions 9,22 and 35 all have a high negative difference indicating that more participants answered lower in the second survey than higher compared to survey 1 (although in Q35 this difference is not significant). If question 9 and 22 are analysed this is an expected outcome;

> Q9.   If I had the financial means to save water, it would make my water saving easier.
> Q22.   Discharging my waste water on the street is convenient.

For question 9, the negative difference shows that part of the participants thinks that financial means are not making water saving easier. This would be in line with the game where the examples that are given to save water have no relation with financial means. In other words, the answers could indicate that the participants found other measures to save water without spending money. Question 22 indicates that a negative difference expresses the idea that discharging water on the street is less convenient than before the game. This could be the results of the addressed problems in the game in relation to water pollution. The participants could have the idea that other ways of discharging water are more convenient and better for the environment than discharging on the street.

Striking are the questions 11, 12 and 13, which all have a high negative difference count indicating a lower answering in survey 2 compared to survey 1. The questions related to these numbers are the following:

Q11.   I do my best not to dump my waste water on the street.
Q12.   My family thinks that I should not discharge my waste water on the street.
Q13.   My neighbours think that I should not discharging my waste water on the
        street.

Questions 12 and 13 indicate that the expectation of family and neighbours has changed between the first and second survey. It seems that the social surrounding of the participants gives the participants the feeling that they should discharge their waste water on the street. This result is not in line with the other normative questions which do not show this trend. This could be because of the formulation of this questions. Questions 12 and 13 were written in the negative form, which might be confusing for the participant. For the water use- and plastic waste section, the participants give a higher answer for the normative questions. This inconsistency within the normative questions could support the idea that the questions were not clear enough. This could be an indicator why these questions are answered in a different way. However, the entire water pollution question part (Q10 to Q22) is written in the negative form. It is remarkable that only two of those questions are answered in this way.

In general, it seems that the hypotheses will hold, with the exception of a part of the water pollution section. Participants answer positively in the second survey and these differences are statistically significant. This means that an effect is observed when comparing the pre and post-game surveys. These effects can be a results of the game, however since a control group is not used, this statement cannot be solidified. In section 4.5, the usage of a control group and the influence of different biases will be discussed. However, it seems unlikely that the observed differences in the survey are just purely coincidental, since in general, the participants have answered the same or higher. This indicates that an interesting research topic is found, but in further research a control group needs to be incorporated in the research for comparison.

In this thesis, the post survey was taken two months after the game day. It would however be interesting to see what the effect of the game would be a year later. Of interest would be, is the effect lasting or do the participants fall back into their old behaviour and will they answer the same as in the post-game survey? The results of these questions could give more insight on the effect of the game and how to set up a strategy to achieve a long term effect.

Demographical hypotheses

The analyse of the demographic factors show some interesting points. If the results from the Kruskall-Wallis test are evaluated, it is clear that in general the second survey shows more difference amongst the subgroups (day number, gender, income, people in the household, and age) than the first survey. This could indicate that the different subgroups changed differently over time. That could be

influenced by the game. Noticeable is that in survey 1 the factor research day shows significant differences among the subgroups in five different questions. This is striking since this was before they had played the game. This might indicate that the research surroundings, like weather, are of influence on the given answers in the first survey. For the subgroups of gender, a large amount of questions shows significant differences. This indicates that females and males have different perspectives about the topics addressed in the survey. The income level (with the exception of one question), the amount of people in the household, and age have no influence on the distribution of answers given in survey 1. This indicates that within the group of participants the same beliefs and behaviours arise, without being influenced by income, age, or the amount of people in the household.

For the second survey, more differences between the subgroups are observed. These differences could be a result of the gameplay, however as was mentioned earlier, no hard conclusion can be drawn since a control group is not used. Some possible explanations are given in this section. For the day number subgroups, a large number of questions shows differences. This could be due to the influence of weather or the interactions between participants. Since every game is played with different participants, a participant can learn something new from those they play the game with. The observed and mentioned differences between the income subgroups is striking, but a direct logical explanation cannot be found. However, it might be explained by the fact that only a small group is tested and the mean value of the group is used. Therefore, the influence of outliers is larger. The fact that the age of the participants seems not to be of influence on the effect of the game is noteworthy, since in the first stages of the designing of the game, an often stated comment was that the game was childish. This result shows that however childish the game may feel to participants; it has the same effect on different age groups.

4.3 Control group

In social science the use of a control group is often used to evaluate the effectiveness of a taken measure. A control group is a group of participants that are undergoing the same pre- and post-test as the test group, without having the intervention in between. If the test group shows significant differences, they can be compared with the control group in order to see if they also show these significant differences. If this is not the case, it seems that the taken measure is the base for the significant change. It is critical for the control group to have the same composition as the test group. (Dehue, 2005)

The aim of this research was to create an overall awareness in the local community, which was done by encouraging the participants to talk about the game with their friends and family. The game even contained actions that encourage this behaviour. As an example, the action from question 1 is given:

> *After playing this serious game you have to tell at least three persons about how long you have to cook water. Tell us who these three persons will be, why you choose them, and what you will tell them.*

This was done because the idea was that awareness was raised partially by discussion amongst the inhabitants of the local community. Another reason for this approach was the fact that not everybody in the community could participate, so the more people that would change their behaviour the better. Therefore, the whole population could benefit from the game without everyone having to participate. Since the assumption was that the participants would talk to the rest of the local community, a control group could not be set up. The control group would have been influenced by the discussion of the game within the local community and therefore the results of the control group would be biased. Although this decision would greatly influence the conclusions that can be drawn from this research, the control group would probably even be biased if these kinds of actions were not in the game. It is

impossible to control the conversations in the local community and although it was encouraged to talk about the game, this probably would have occurred anyway. This outcome is also not measurable, so the influence of the participants in the local community would always be an uncertainty. The use of a control group in another community could have been done, but this was not feasible during this research. Unfortunately, without a control group it cannot be determined if the seen effect in the survey answers were caused by the serious game or by something else. The significant effects that were seen in the 120 participants could be an effect that may have occurred had they not played the game. No certain conclusion can be drawn to support the claim that the difference was due to the game playing.

4.4 Biases

The problem with conducting research on people is the presence of the effect of many different biases. In this section, some of these biases that were assumed to be present during this research are elaborated. It is important to mention is that the actual effect of these phenomena is not measured and therefore it is not possible to give the size of the influence. If a control group was used the assumption can be made that both the control group as the research group have the same biases. The difference between the groups is than not under the influence of biases and would give a clear insight on the changes.

Response-shift bias
Different problems arise when the validity of the answers of the researched group is analysed. ''A problem, referred to as "response-shift bias," where participants overestimate their behaviours on the pre-survey and underestimate their behaviours on the post-survey due to a change in frame of reference.'' (Raidl, et al., 2004). This effect indicates that participants' views can shift over time, after filling in the first survey one may re-evaluate its own behaviour. Maybe the participant in question comes to the conclusion that he filled in the wrong answer. If this would be the case, in the next survey he would most likely fill in an answer corresponding to the behaviour he evaluated. The difference in the answer in the first and second survey could therefore either indicate an influence of the measure that was taken, or it could indicate a shift in the view of the participant. (Howard, 1980)

Stated versus revealed preferences
Such a response bias cannot be avoided, therefore one should preferably also examine the actual affected behaviour caused by this measure. In this research, for instance, one could measure whether after the game less water is used, less garbage is dumped on the street or in the water, or if more plastic is reused. This is referred to, as stated versus revealed preferences. In other words, a person might have certain preferences (as stated in, for example, a survey), but in real life his behaviour shows other preferences (revealed). To see this effect, one should indicate which revealed preferences are measurable. One should measure these effects and compare them with the stated preferences from the survey. In this research this was not done, mainly because this takes a lot of time and sufficient measuring devices should be in place. On top of that, one should measure during a certain time so see a trend in the recycling behaviour to be able to make a clear conclusion about what the revealed preference is.

Volunteer bias
Another problem that affects the results of the research is the so called volunteer bias, which applies to this research as well. The volunteer bias is the bias than comes from the fact that the participants are voluntarily willing to participate in a study. There are differences between people who want to participate in a study and those who do not. It seems that volunteers have a tendency to come from a higher social status, have higher intelligence, are searching for approval, and have the tendency to be less authoritarian. Furthermore, when people are interested in the topic that is researched, they

tend to volunteer more often than those who do no find it interesting. From the former group it is expected that they evaluate on a positive level. If participants are forced to join a study this could also negatively influence their results, since they could be bored or inactively participating. (Heiman, 2002)

Cultural bias
''Cultural bias involves a prejudice or highlighted distinction in viewpoint that suggest a preference of one culture over another'' (Yingst, 2011). It has been found in research (Chen, Lee, & Stevenson, 1995) that Japanese and Chinese are more likely to choose the midpoint answer on a Likert scale compared to Americans. According to Lee, Jones, Mineyama and Zhang (2000) the cultural bias indeed influences the responses to a Likert scale type survey. They found that Japanese and Chinese respondents answered the midpoint more frequently than the American respondents, but only on items that involved the expression of a positive feeling. There is no clear consensus on why this difference occurs between cultures.

One explanation could be given by comparing two cultural orientations: individualism and collectivism. It is suggested that the response style of avoiding extreme answers fits the cultural norms of a person living in a collectivist culture. These cultures are associated with greater emphasis on interpersonal harmony and less on individuals (Triandis, et al., 2001). A study (Johnson, Kulesa, Cho, & Shavitt, 2005) also indicates that cultures with high scores on masculinity and power distance were more likely to answer the extremes. Based on the dimension of Hofstede, Vietnam has a high power distance, indicating that people accept a hierarchical order in which challenges to the leadership are not well-received. On the masculinity rating, Vietnam scores only 40 out of 100 points, indicating that it is a feminine society. These societies have the focus on ''working in order to live'' and conflicts are solved by compromise and negotiation (Hofstede, 2016). This high power distance score corresponds with extreme answers given by the participants in this research. This however is conflicting with research which shows that Asians, in general, tend to answer middle options instead of extremes. Also, the feminine society should indicate a more reserved way of answering than is shown in this thesis. A reason why the participants have given such extreme answers is not clear, however Vietnam's high power distance score could be an influential factor.

A last cultural bias within this research is the fact that I have a totally different culture than those in the research area. Although the design of both the game and the survey is checked by the Vietnamese, it is subjected to my European view, which could affect ones' interpretation. In order to minimize these effects, it is important to work closely together with the locals and to invest in gaining knowledge in the culture. It is therefore advised to design such a game or survey in cooperation with local consultants and to be open-minded to their cultural beliefs.

Summarizing this section, the effectiveness of a taken measure is hard to determine, since vast amounts of parameters influence the measurements. One should consider and determine the influence of these parameters and try to avoid as many biases as possible. Of course, a completely bias free research group is impossible and therefore the results are always subjected to uncertainties.

4.5 Survey
In this section different aspects of the survey are discussed. The use of the Likert scale is examined first, followed by the consistency of the survey based on the Cronbach's alpha and factor analysis.

Likert scale
When one would like to know a participant's attitude (''a person's feeling towards and evaluation of some object or event'' (UC Davis, 2016)), the most straightforward way to do that is to ask someone about what their attitude is. Since a person's attitude is related to social acceptance it would however

be likely that a person would give social desirable answers. Therefore, other ways of measuring attitude are required. These attitude measurements can be done in two different ways; directly or indirectly. Indirect measurement is a measurement where the problem of socially desirable answering is avoided. This is done by either having the participants unaware of what is measured, or by measuring something they cannot intentionally influence (like a heartbeat) (Simply Psychology, 2016). These tests are mostly time consuming and intensive and therefore are not appropriate for this kind of study.

The Likert scale as well as the semantic differential are both forms of direct measurements. The latter gives a participant the option to choose a point on a 7-point scale in between two opposite words, for example:

$$Active - 1 - 2 - 3 - 4 - 5 - 6 - 7 - Passive$$

In general, this technique is used to assess the intensity and the direction of the attitude. Limitation of this technique is that the participants should have a sufficient knowledge of language, since a clear distinction between the words has to be made (UC Davis, 2016). For the local community, it is known that the level of education is not that high and a clear identification of the language level is hard to determine. Therefore, this does not seem an appropriate way of testing them. If, from further research, it could be concluded that a semantic differential research method is possible, the pros and cons between this method and the Likert scale should be examined to determine the most efficient one.

Consistency and quality
The results of the Cronbach's alpha analysis indicate that the first survey has a sufficient consistency, since the value for alpha was above 0.7 in more than half of the survey. Since it was done at the start of the research, before anything was explained and before the game was played, this survey shows a neutral view of the participants. With the second survey it could be the case that participants are trying to remember what they answered the first time and therefore are inconsistent in answering the questions. The consistency of the survey can be interpreted as a quality measurement as well: if the survey is consistent, the questions that are supposed to address the same, indeed do so.

The factor analysis gave insight on the quality of the survey as well, since one would expect the underlying factors to be the topics that are addressed. The survey is built up from the different TPB constructs and is grouped per topic. Therefore, it is logical that these topics are the underlying factors and would show up during the factor analysis. This was indeed the result from the factor analysis, although only from survey 1 and not from survey 2. It can be concluded that the different TPB constructs in the survey indeed measure the same topics in survey 1. Since the results of the factor analysis are linked to that of the Cronbach's alpha, the same explanation could be given for the missing trend in survey 2.

4.6 Serious gaming

Serious gaming is a relatively new field where no clear consensus is found on its definition and on testing its effectiveness. After evaluating this research, I formed the definition of a serious game as: a game in which the participants learn something valuable which can be used in life. I therefore would consider games as Monopoly or Risk serious games too. Although it seems that they were not designed as such, the user does learn something while playing them. Monopoly gives insight in investing, buying, and mortgage and Risk shows the topography of the world and can enhance the discussion about war. Harteveld (2011) states that a serious game should be designed according to his triadic game design theory. I however think that good serious games were already designed before his theory was created, which indicates that good game design theories already existed. Although different game design strategies are present, this was not addressed in this thesis. The focus was on testing serious

games. I would encourage further research to include ''normal'' game design theories too. According to me, serious games should be merely seen as a game type.

Besides Harteveld's theory, another framework is: the serious game design, play and experience framework by Winn (2009). This framework states that the designer can only make a prototype but cannot test the game. Therefore, the prototype should be tested within the research group. The framework is based on 5 aspects: learning, storytelling, game play, user experience, and technology. These aspects give structure and a process to guide the design of the game. A game can be designed by defining the experience goals, designing the game and prototype, play-testing, and iterating this process. (Winn, 2009)

In retrospect, this is what broadly was done in the design of this research's game. During the workshop, the design goals were set and a prototype was made. While this prototype was tested with Vietnamese, the test was not with the Vietnamese people from the local community. According to Winn, this would be preferential, but unfortunately this could not be realized. In general, the designing cycle exists of investigating, designing, creating, and testing in a loop. It is logical that retrospectively it can be found that the framework of Winn is partly applied, since it is close to the design cycle.

4.7 Design recommendations

Even though no hard conclusion can be made that the game influenced the player since a control group is not used, the game shows significant changes amongst the participants and therefore some design recommendations can be made. The negative difference from the paired sample sign test had the highest number in the water pollution part. The water pollution questions in the game should therefore be evaluated to see if they are clear enough. Even more questions could be added to address the important points around water pollution like the effect on the environment, influence on human health, and how the participants are contributing to the problems. Furthermore, the plastic waste part shows the most positive differences. Indicating that a large group of participants learned something from this part. It could be the case that the plastic waste part was quite new and therefore interesting to the participants. For other topics of the game, one should look for new kind of topics that are currently a threat to the water resources, like global warming. Therefore, an important factor to incorporate in further research is to ask feedback on the game. Questions that can address this are: did you like the topics that were addressed as well as are the topics new or have you thought about those before?

4.8 Theory of Planned Behaviour

During this research only part of the constructs of the TPB were tested. The reason for this was that the survey length should be as short as possible. However, different topics had to be addressed to test the overall effectiveness of the game. It was assumed that the TPB was a sufficient theory for this study and that it works as shown by Ajzen. In order to keep the survey small, only the first beliefs and the behaviour are addressed, since it is assumed that the beliefs via several steps lead to behaviour. However, this resulted in a survey of only part of the TPB and therefore a data set that was not complete in synchronization was constructed. Afterwards it could not be analysed whether or not the given answers would correspond with the complete TPB. Via structural equation modelling (SEM, (Hox & Bechger)) it would be possible, based on the results of the research, to analyse whether the TPB fits the results and therefore was the correct theory to use. Since not all the constructs of the TPB are considered during this research, an analysis with SEM is not possible. This measure could therefore not be used in order to determine whether the TPB is adequate for this research. However, according to literature stated in the introduction, the use of TPB seems relevant.

4.9 Other theories

Different models such as the norm activation model, the Health Action Process Approach (HAPA), and the transtheoretical model are also used to describe behavioural changes. These theories are described and are evaluated whether they are suitable for this type of research and therefore should have been taken into consideration when performing this research.

''The norm activation model (NAM) (Schwartz, 1977) is a vested model that explains altruistic and environmentally friendly behaviour'' (Onwezen, Antonides, & Bartels, 2013). The study of Onwezen, Antonides and Bartels (2013) found different explanations in literature on what the association is of anticipated pride and guilt in the NAM. However, the functions of the different proposed emotions have rarely been tested. Their study tried to fill this knowledge gap by assuming that anticipated pride and guilt would lead to behaviour that corresponds with personal norms. Preliminary evidence led them to conclude that anticipated pride and guilt indeed has a mediating effect of a person's norm of behaviour. Their study shows that the NAM is still subjected to a lot of research and not fully understood. Web of Science® shows only 372 results when the query 'norm activation model' is used, which indicates that more research has to be done. Since the TPB is a well-known accepted model and this research is mainly focused on the effectiveness of a serious game not on the functioning of a model, the usage of the TPB surpasses the NAM.

The health action process approach (HAPA), named in the introduction as another model to describe the processes of behaviour, is an approach used to model health related behaviours. It holds some of the same constructs as TPB, such as perceived self-efficacy. This indicates the level of one's belief of its own capacity to perform a certain task and it is similar to the perceived behavioural control in the TPB. HAPA is a recently developed approach by Schwarzer (2007) and therefore it is not yet widely used. Sutton (2008) states that HAPA is similar to the TPB and could therefore be used as an alternative for the latter, however research to compare these two models should support this assumption and be undertaken. Since the HAPA has yet no clear position amongst the other theories, it is hard to estimate whether or not it is usable for this thesis.

In the theories used to address behaviour, a distinction can be made between social cognition models (TPB, HAPA and NAM) and stage models. The dominant model amongst the stage models is the transtheoretical model (Prochaska & Velicer, 1997). The stage models assume that behavioural changes are movements through different stages. With every stage, different requirements are needed to move on to the next stage (Sutton S., 2002). Although the difference between these types of models is quite clear, an overall consensus on the different applications cannot be found.

In general, it seems that the field of behavioural science has a wide range of models that describe behaviour and even new models are still being developed. On the one hand, this can be viewed as a field rich of conceptual and theoretical development. On the other hand, this makes it difficult to see the general overview of the body of knowledge. It would be beneficial if there would be a clearer definition of models, standardized measurements, and more empirical comparisons between models. (Sutton S., 2002)

Munro, Lewin, Swart and Volmink (2007) conclude that because of the variety of studies clear evidence could not be found for the support of a model in the field of adherence behaviour (''The extent to which the patients follow the instruction they are given for prescribed treatments'' (Munro, Lewin, Swart, & Volmink, 2007)). This indicates that researchers are overwhelmed by the available theories, which show fragmented and often contradicting evidence. Furthermore, the question arises of the applicability of these theories beyond the context in which they are developed. (Munro, Lewin, Swart, & Volmink, 2007)

Different theories all have their own strengths and limitations, which could partly be overcome by using combinations. By doing so, one would combine different theories and concepts in order to design a research specific theoretical framework. A downside to this approach however is that ideal combinations are project specific and not general. Hence the lack of consensus in game testing mentioned in section 1.2 will remain.

4.10 Missed variables

During this thesis, the questions on the behaviour of the participants were indirect and only gave a result on how the participants viewed their own behaviour. It would have been preferable to have data about the actual behaviour of the participants. An example of this is the amount of water they use or how many times they dump their waste water onto the street. With this data, a better comparison between participants could have been made based on the same scale. This would partially overcome the response bias and the stated versus revealed preferences could be indicated more properly.

The demographical factors are used to determine whether the game has a different effect on different kind of participants. Looking back, some other variables, apart from the researched ones, would be informative as well. For example, the amount of children that live in the household. During this research the amount of people in the household is known, however this does not state anything about the composition of the family. When three people live together in a household, this would not necessarily mean that this family contains a father, mother, and child. However, for this game it would have been interesting to know if people with children are differently affected by the game than participants without children, since the game tries to focus on the effect of environmental behaviour on the next generations. Furthermore, a clear overview of the professions of the participants could indicate whether participants that are in contact with the environmental problems (for example, a farmer) would undergo a different effect than other participants.

Another missed variable is the rating of the game and the survey. It was not asked from the participants to indicate what they thought of the game and the survey, therefore it could not be concluded whether the survey was understood by the participants. Although the survey used validated questions and was tested beforehand, it would be preferable if feedback from the participants was given in order to conclude whether the survey was competent for this research.

5 Conclusion

During this research, the following question was stated: can serious games be used to change behaviour on water resources in a local community in Vietnam? A serious game about water related-issues in Vietnam was designed and tested via a Likert scale based pre- and post-survey. A group of 120 participants joined the research. Their answers to the survey were analysed via non-parametric statistical methods.

The sample size used in this study showed to be sufficient for an exploratory research. Since significant results were observed a potential for further research is found. However, the confidence level of 80% is not sufficient to draw conclusion with respect to the entire community. In order to be able to do so a larger sample size is needed. In addition, a control group is needed in order to compare the results and to indicate whether differences are found between this group and the research group.

Biases, such as stated versus revealed preferences and cultural influences, seem to be of importance for the results. To minimize the former of these biases is to measure the actual behaviour of the participants in order to indicate whether or not his or her behaviour corresponds to the answers given in the survey.

Before any real conclusions can be drawn, which can e.g. be used to improve the game, the mentioned points need to be addressed first.

An effort was made in addressing the lack of a clear consensus on how to assess the effect of a serious game by using a theoretical background. The survey showed sufficient results in consistency and factor analyse. The use of the TPB seemed relevant and gave guidance throughout the research. Other theories can be used as well, even a combination of theories would be preferential.

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Appendix A – the serious game

A Game explanation

The purpose of this game is to give information about water pollution and how you can prevent this in your daily live. We live in a world that is constantly changing, this means that we can always learn new things. This game will focus on water, since water is everywhere and a daily necessity. Water is the most important life source on the planet, but if we misuse the resources it can give major problems. Together we can prevent major issues from occurring if we all participate and preserve the water quality. This will not only benefit your own life but also that of all the generations to come.

So today we will discuss how we can prevent water pollution seen in rivers and water underground. From this you will benefit, your children will benefit, and future generations will benefit because everyone needs safe drinking water. If we all participate we can make a change and improve our resources.

Now I will tell you how we are going to play the game. The game is played by rolling the dice to move your totem.

There are 3 different types of steps:

1. Trees, households and business: questions. If you answer correctly your lake will become a colour cleaner but if you answer wrong your lake will become a colour dirtier and you will have to do an action.
2. Benches: while sitting on the bench you will get a tip or a fact. You can implement this tips and facts into your daily life.
3. Trash bin: mistakes - you will have a problem when you jump into this box. Follow the instructions.

The game will be finished after 15 minutes. The person with the bluest lake at this time will be the winner. The rest of the explanation is on the rule card.

Rules

Throw 1 or 4 → 1 step
Throw 2 or 5 → 2 steps
Throw 3 or 6 → 3 steps

Player 1 (Yellow) start in the left direction.
Player 2 (Red) start in the right direction.

Tree, Houses, Businesses → general question
- Correct answer, your lake becomes one colour cleaner.
- Wrong answer, your lake becomes one colour dirtier and you have to do an action.
  - The other team can try to answer the question as well, if they know the correct answer their lake becomes cleaner, if they answer incorrect the lake becomes one colour dirtier but they do not need to do an action.

Bench → Facts & Tips
You get a fact or tip with useful information, your lake becomes one colour cleaner.

Trash bin → Mistake
You have done something wrong, the card will show what will happen now.

The game is finished after 15 minutes. The player with the bluest lake is the winner of the game.

Facts and tips

1. Fact: In 2010 two million tons of waste got dispose into water every day in the world. This is 0.3 kg per person every day and this results in 110 kg per year per person.[8]
   Tip: Try to reduce the amount of waste you produce. For example, make all your waste as small as possible and try reuse everything that is possible.

2. Fact: Vietnam has an increase in urbanization, industrialization and population since 1990. Between 1970 and 2015 the Vietnamese population is more than doubled [9]. This increase resulted in an increase of chemical waste from for example soaps.[10]
   Tip: Use face wash, toothpaste and other washing products without "polypropylene" or polyethylene". Use products with cocoa beans or apricot shells for example instead. This are natural scrubs, who are biodegradable.

3. Fact: Worldwide, only 1% of plastic is recycled.[11]
   Tip: Try to reuse the plastic bags and bottles you have or take a plastic bag with you when you go shopping.

4. Fact: The Ocean is filled with plastics, every day 12.000 tons of plastic end up in the ocean this amount would fill up 52 trucks.
   Tip: Do not throw your plastic into the water system but bring it to the garbage collector.

5. Fact: There are 39 million motorbikes in Vietnam, together they use 22.608.000 litres oil per day. This is an average of half a litre per motorbike per day. [12]
   Tip: Think about the bigger picture. You may think that a little oil leak on your car or motor isn't a big problem. However, the oil from thousands or millions of cars and motors with oil leaks adds up quickly and soon you're looking at a cumulative oil spill far worse than any oil tanker crash. You can't fix all the oil leaks in the world, but you can fix yours.

6. Fact: Vietnam has a dense river network with 2360 rivers but unfortunate the water quality is not always sufficient for human use for example because of the amount of plastics in the water. This is due to the rapid economic development since this results in more waste production which is dumped untreated into the open water. [13]
   Tip: Always check the water quality, if you are not sure about the quality than you should cook the water before drinking it.

7. Fact: This community is near the sea; this means that the water quality is depending of the upstream land.
   Tip: Always check the water quality, if you are not sure about the quality than you should cook the water before drinking it.

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Mistakes

1. You swam and got ill because of the bad water quality. You have to stay one round to get better.
2. You were too late with putting your garbage outside, now it will stand all night on the street. The next morning when the garbage collectors will pick it up, your garbage bag is opened by rats. Your garbage has spread all over the street. It is difficult to collect it all again. You have polluted the road. The colour of your card goes one step back.
3. You throw your food leftovers in the lake. This has a bad influence on the water quality because of the increase in nutrients in the water. The water will have algae bloom and more parasites are in the water. The colour of your card goes one step back.
4. Your water was not cooked long enough and therefore it had not yet the quality of drinking water. Now you have to cook it again. Stay one round to cook the water.
5. Your rainwater tank was not covered and now you have a lot of mosquitoes. Stay one round to go neighbours to get some water and hide for the mosquitoes.
6. You were cleaning your bike with a lot of soap, your neighbours told you that this is not good for the ground water quality. The colour of your card goes one step back because you polluted the groundwater.
7. You boiled your water without a cover on the pan, the cooking takes a lot more time now, stay one round to wait for the water to be boiled.
8. Your motor has an oil leakage, this has a bad influence on the water and this resulted in a decrease in water quality. The colour goes one step back.

Questions

1. How long do you need to cook water before it has drinking water quality (in minutes)?
    - All answers above 1 minute are correct
        - The World Health Organization advised that you should bring the water to boil and keep it rolling for 1 minute. Boiling is sufficient to inactivate bacteria and viruses. (http://www.who.int/water_sanitation_health/dwq/Boiling_water_01_15.pdf)
        - Action: After playing this serious game you have to tell at least three persons about how long you have to cook water. Tell us who these three persons will be, why you choose them and what you will tell them.

2. Can you eat cucumber without washing it, why?
    - Yes, even without pealing the skin off
    - No, you always have to wash the cucumber
    - Yes, but only if you peal the skin of
        - When growing vegetables pesticides are used to protect the vegetables from being eaten by insects. These pesticides are harmful for humans when you eat them. The outside skin of the vegetable however protects the inside of the vegetable for being contaminated with pesticides. So if you peal the skin of you do not need to wash the vegetable before. Vegetables which do not have a skin to peal of (like spinach) you need to wash before you eat them because of the pesticide that are on it.
        - Action: Name 2 vegetables which you do have to wash before eating them (Example: Morning glory).

3. Can you eat a mandarin without washing it?
    - Yes
    - No
        - The skin of the fruits will keep all the bacteria out; therefore, you can eat the fruits without washing it when you peal the skin off. Always look if the skin is intact because when it is broken bacteria could have entered the inside.
        - Action: Name 2 fruits which you do not have to wash before eating them (Example: Banana).

4. For what can you use rainwater directly?
    - Drinking, washing vegetables/fruit and washing clothes
    - Washing clothes, washing dishes and drinking
    - Washing the motorbike, washing clothes and watering the plants.
        - Rainwater is of a too low quality for drinking water for humans but for washing clothes and motorbikes it is fine. Remember that for washing your motorbike you do not need chemicals, water and a sponge will do the trick.

- Action: Tell use for what you use rainwater directly and have you learned a new option for which you can your rainwater?

5. What can you do with the water in with you have washed your vegetables?
- o Washing dishes
- o Wash your clothes
- o Washing motorbike
- o Water the plants
- o Use for drinking
  - The answer is correct if one green answer is named.
  - From this you can learn how you can reuse water. For different kind of activities, you need different qualities of water always try to reuse the water for an activity that needs a lesser quality. You cannot use the water for washing the dished because the water is contaminating with pesticides. If you wash your dishes the pesticides will end up on your dished and unto your food.
  - Action: Tell us how you are going to re-use water now you know you can re-use water?

6. How long will it take for plastic bottle to decompose in the environment (in years)? (Cho, 2012)
  - It will take 450 years for a plastic bottle to decompose in the environment. So every answer above this is correct. (http://des.nh.gov/organization/divisions/water/wmb/coastal/trash/documents/marine_debris.pdf)
  - Action: Tell us how you can reduce your waste. (Example: I will only use eco bags, I will make my garbage as small as possible, if I make the plastic bottles flat they need less space in the trash bin so less plastic, I will stop using plastic water bottles.)

7. What are the signs of a low water quality (name 2)?
- o Algae bloom
- o Hardly any water plants
- o Smelly water
- o No fish or dead fish
- o Blue colour of the water
- o Brown, green or red colour
  - The answer is correct if 2 correct points are named.
  - Water with this kind of features can be toxic, you should not drink this water but also not swim in it because it can infect your skin. This water needs to be cooked first and filtered if there are plants in it.

8. Which of the following products include micro plastics (micro plastics are pieces of plastic smaller than 5 mm) (name 3)?
- o Soaps
- o Shampoo
- o Toothpaste

- o Clothes
- o Paint
- o Water bottle
- o Fish
- o Polyester
  - The answer is correct if 3 correct points are named.
  - Micro plastics are small parts of plastic, as small as ant. Actually everything in the list contains micro plastics, these micro plastics spread through the whole water system for example if plastics bottles are thrown in the water. The fishes in the sea will eat the micro plastics that are in the water, this is the way that micro plastics enter the food chain. Try to reduce the products which contain micro plastics.
  - Tell us something you did what had a bad influence for the environment. Why it this bad for the environment? (Example: I throw my empty can into the lake, it takes 80-200 years to compose.)

9. How much land of Vietnam is covered with forest (in %)?
  - An answer between 30% and 50 % is correct.
  - 40 % of Vietnam is covered with forest but this is decreasing. Since 1990 Vietnam is experiencing a rapid economic growth more forest is harvested. The forest is import for the environment so it is important to plant new trees and plants. You can also help the environment by getting more plants and trees around your house for the water to filter through the ground and it will be then added to the groundwater.
  - Action: Tell us something you did what had a good influence on the environment. Why is this good for the environment? (Example: I reduced my plastic bottle, through reducing my bottle I produce less plastic waste or I have planted trees next to my house.)

10. What are the advantages of covering your rainwater tank (name 2)?
  - o No mosquito's growth
  - o No dirt that can enter the tank
  - o No animals can enter the tank
  - o The water will get a better quality
  - o The heat of the sun will purify the water
    - The answer is correct if 2 points are named.
    - Action: Tell us if your rainwater tank is covered, explain why it is or is not.

11. How much water does an average Vietnamese in a village just like yours use per day (in litres)?
  - An answer between 90 and 110 litres per day per person is correct.
  - The average water use is 100 litres per person per day, due to increasing population and development the water demand will rise in the coming years. The estimation is that in 2025 the average water use will be 120 litres per person per day. (http://www.wpro.who.int/vietnam/topics/water_sanitation/watsan_sector_report_vietnam_2011.pdf)

- ▪ Action: Tell us a how you can reduce your water consumption. (Example: take a short shower, turn of the tap while tooth brushing.)

12. In what way is polluted water affecting your life?
- o It causes; less fish in the waters.
- o It causes; more fish but less clean drinking water.
- o It causes; less fish, less clean drinking water and you will be ill more often.
    - ▪ Many fishes die because of the pollution, also the ground water quality will decrease so it has no longer drinking water quality. Moreover, the risk of diseases increases with contaminated water, you could have more diarrhoea for example.
    - ▪ Action: Tell us a how you can reduce your share in the water pollution. (Example: take a short shower, turn of the tap while tooth brushing.)

13. What are the consequences of micro plastics (plastic pieces smaller than 5 mm) in the water?
- o Micro plastics do not really have consequences; they will float in the water so it is easy to remove them.
- o Micro plastic in the water will enter the food chain, this means that the fishes you eat might contain micro plastics and in this way they will get into your body.
- o The lake looks dirty because of the micro plastics; this is not a nice view.
    - ▪ Micro plastics are plastics smaller than 5 mm. They end up in the water due to the use plastics (like water bottles and plastics bags), soaps and paint for example through the water they will end up in the human food chain. Since micro plastics will not degrade over time there is a growing concern how to deal with these plastics. Reducing plastics will help.
    - ▪ Action: Tell us a how you can reduce your plastic consumption. (Example: Example: reuse a plastic bag.)

14. Through how many countries is the Red River flowing?
- o 2, this is the only correct answer.
    - ▪ The Red River only flows through China and Vietnam. Since this community is at the end of the river system the water quality is depending on what has happened upstream.
    - ▪ Action: Tell us what type of water you use for drinking water and if you add a treatment step before drinking it.

15. How much plastic ended up in the ocean in 2010 due to Vietnam (in million kg)?
- o 455 million kg. All the answers between 400 and 500 million kg are correct.
    - ▪ Vietnam is with this contribution on the 4th place of most plastic dumping country. This can be avoided if you do not throw your plastic on the ground or in the water.

- Action: Tell us how you can reduce your amount of plastic waste.

Appendix B – Survey

In black is the original text from the reference and the green text is changed in order to ensure that the survey can be used for this research.

Water use

[Behaviour]
1.   I do my best in saving water[14]
2.   I save water[1]

[Normative beliefs]
3.   My neighbours expect me to save water. ~~x t~~ The expectation of these ~~principle~~ neighbours is important to me[15]
4.   My family expect me to save water. The expectation of my family is important to me

[Behavioural beliefs]
If I save water
5.   I will contribute to the ~~lessening~~ decrease of water shortage ~~x~~ . This ~~gain of their~~ water shortage is important for me[1]
6.   I will contribute to the ~~lessening~~ decrease of the effect of draught ~~x~~ . This ~~gain of theirs~~ decrease of draught is important to me[1]
7.   I would be protecting the environment ~~x.~~ This ~~gain of theirs~~ environment is important to me[1]

[Control beliefs]
8.   If people around me take my warnings concerning water saving into consideration ~~x~~ it ~~this~~ would make my water saving easier[1]
9.   If ~~My family's~~ I had the financial means ~~are sufficient~~ to save water ~~buy water saving goods (such as washing machine or dish washer) x this~~ it would make my water saving easier[1]

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[14] (Kilic & Dervisoglu, 2013)
[15] (Sainsbury & Mullan, 2011)

Water pollution

[Behaviour]
10.   I do my best in saving water[16]

        I do my best in not dumping my waste water on the street
11.   I save water[3]

        I dump my waste water on the street

[Normative beliefs]
12.   My ~~classmate's~~ neighbours think that I should not discharging my waste water on the street ~~attend the meeting of this class on a regular basis~~[17]
13.   My family thinks that I should not discharge my waste water on the street[4]

[Behavioural beliefs]
14.   I will benefit (~~money~~ health) from ~~recycling my garbage~~ not discharging my waste water on the street[18]
15.   Benefiting ~~Whether or not I benefit~~ (~~money~~ health) from ~~recycling my garbage~~ not discharging my waste water on the street is an extremely unimportant/extremely important decision factor affecting my recycling behaviour[5]
16.   I feel I accomplish something important from ~~recycling my garbage~~ not discharging my waste water on the street[5]
17.   Accomplishing ~~Whether or not I feel I accomplish~~ something important from ~~recycling my garbage~~ not discharging my waste water on the street is ~~not~~ an extremely unimportant/extremely important decision factor effecting my recycling behaviour[5]
18.   I will help to reduce environmental pollution by ~~recycling my garbage~~ not discharging my waste water on the street[5]
19.   Helping to reduce environmental pollution is an *extremely unimportant/ extremely important* decision factor affecting my ~~recycling~~ discharging behaviour[5]

[Control beliefs]
20.   I know what kind of water can be discharged on the street ~~is to be recycled~~[5]
21.   Knowing what ~~is to be recycled~~ kind of water can be discharged on the street is an extremely unimportant / extremely important decision factor affecting my recycling behaviour[5]
22.   ~~Recycling my garbage~~ Discharging my waste water on the street is convenient[5]

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[16] (Kilic & Dervisoglu, 2013)
[17] (Ajzen, 2013)
[18] (Chu & Chiu, 2003)

Environmental behaviour

[Behaviour]
23. ~~I save water~~[19]
    I recycle my plastic
24. ~~I do my best in saving water~~[6]
    I do my best to recycle my plastic

[Normative beliefs]
25. My ~~classmate's~~ family thinks that I should recycle my plastic waste ~~attend the meeting of this class on a regular basis~~[20]
26. My ~~classmate's~~ neighbours think that I should recycle my plastic waste ~~attend the meeting of this class on a regular basis~~[7]

[Behavioural beliefs]

27. I will benefit (~~money~~ health) from recycling my ~~garbage~~ plastic waste[21]
28. Benefiting ~~Whether or not I benefit~~ (~~money~~ health) from recycling my plastic waste ~~garbage~~ is an extremely unimportant/extremely important decision factor affecting my recycling behaviour[8]
29. I feel I accomplish something important from recycling my plastic waste ~~garbage~~[8]
30. Accomplishing ~~Whether or not I feel I accomplish~~ something important from recycling my plastic waste ~~garbage~~ is not extremely unimportant/extremely important decision factor effecting my recycling behaviour[8]
31. I will help to reduce environmental pollution by recycling my plastic waste ~~garbage~~[8]
32. Helping to reduce environmental pollution is an *extremely unimportant/ extremely important* decision factor affecting my recycling behaviour[8]

[Control beliefs]

33. I know how to recycle my ~~garbage~~ plastic waste effectively[8]
34. Knowing how to recycle my ~~garbage~~ plastic waste effective is an extremely unimportant / extremely important decision factor affecting my recycling behaviour[8]
35. Recycling my ~~garbage~~ plastic waste is convenient[8]

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[19] (Kilic & Dervisoglu, 2013)
[20] (Ajzen, 2013)
[21] (Chu & Chiu, 2003)