A usability evaluation of game-based approaches assessing risk and delayed gratification

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Abstract — This paper presents the usability evaluation of two games that are built upon existing experiments, assessing risk aversion and delayed gratification. The games were created in order to elicit players’ personality traits. The game scenarios were based on adapted validated experiments on cognitive psychology and behavioural economics. The purpose of these games is to enable the generation of predictive behavioural models, and thus design an adaptive and dynamic game promoting responsible energy consumption. Adapting the behaviour of energy consumers to follow environmentally friendly consumption patterns is a central challenge when seeking to address environmental concerns. To perform such adaptation, an understanding of an individual user’s traits can allow for customised solutions to be delivered, increasing the likelihood of impact. To assess the usability of the games, domain experts filled in two QUIS questionnaires. The results showed a broadly positive reception of the games’ usability; taking into account time, financial and other resources, though they also highlight some areas for future work. More broadly, knowledge generated has the potential to inform designs of similar games that adapt behavioural tasks to elicit an understanding of the user.

Keywords— Serious Games; Energy; Behavioural Economics; Risk Aversion; Patience; Delayed Gratification

I. INTRODUCTION

This paper presents the preliminary results of a usability evaluation of two games that aim to assess human behaviour (the "Risk" and "Patience" games). Research to date has pointed out the significance of examining the relationship between risk and patience, as they are correlated with cognitive ability and the prime years of economic decision making [15]. Risk and patience, in terms of delayed gratification, are considered to be important personality traits for the decision-making process, particularly in the case of economic models [15]. In economics applications, understanding individual degrees of risk aversion and impatience can allow prediction of a wide range of outcomes [15]. Thus, they are valuable elements of human behaviour to assess when seeking to predict people’s choices. However, before evaluating the games’ effectiveness as behavioural assessments, their usability aspect should be examined since they are interactive applications. The results from the QUIS questionnaires (for user interaction satisfaction) that were filled in by domain experts showed positive feedback regarding the game interface elements and the game play while pointed out issues that need to be addressed.

The key goal of this project is to create a synergy between the growing areas of behavioural economics and serious games, whilst examining how tasks used to elicit an understanding of users' traits might be translated to games, which exhibit a high degree of usability. The games represent an adaptation of behavioural tasks within an engaging environment, wherein game mechanics are employed in order to assess types of people.

The following section briefly describes the theories and the background on which these games are based and have a significant impact on the game design thus the usability of them. We then provide a description of the games followed by the presentation of the results and the interpretation of them. The ultimate goal of these gamified assessments is to ascertain their usefulness and the ways of using them as a baseline for predictive models. The final section concludes with avenues for future work, and the implications of the findings.

II. BACKGROUND

Whether or not consumers make decisions rationally regarding energy use has been an ongoing debate among researchers and other advocates [7]. However, it has been demonstrated that decisions related with energy consumption involve uncertainty, translated as risk, and counterbalance of future outcomes, associated with patience [42]. For instance, an accepted argument is that energy consumers use extreme discount rates when they make energy related choices (approximately 800%/year) [42]. Significant research addressing energy conservation has been conducted over the past thirty years, seeking to invent new ways of influencing people towards more environmentally friendly energy consumption patterns [18]. Influencing people to consume less energy, or to make energy demand more responsive in terms of time and space, can lead to significant impact towards facilitating climate policy with renewable energy [39]. Energy conservation and the transition away from traditional energy sources require individuals to think differently about their previous behaviour
towards energy consumption and energy policy. As a consequence, many people have difficulty in translating their environmental awareness into an environmentally friendly way of life [26].

In seeking to understand and influence energy behaviour, a first step is examining the components which formulate the decision making process. Empirical research on the factors that affect the way people make decisions and choices suggests that different types of people within different situations most often think the same way, which confirms the fact that “human beings have a common set of cognitive skills” [7]. Hence, even though preferences and behaviours vary between individuals, the distribution of preferences through a population is comparatively steady [32].

According to the above argument, games assessing behavioural attributes could enable us to develop predictive models about the factors that influence people, and categorize people according to their preferences. These predictive models will become a baseline for the development of a game, which employs behavioural theories in order to influence energy behaviour. Available evidence seems to suggest that Serious Games (SGs) may prove a useful tool, influencing people to change their behaviour towards energy consumption, having been effectively used in areas such as health and the military to train, teach, educate, or change behaviour [43]. Additionally, such games have shown value in stimulating complex problem solving to practice skills, whilst sustaining motivational benefits to maintaining behaviour [20]. Therefore, there is sufficient evidence supporting the notion that SGs can be applied to energy sector. There are numerous examples of games that have been designed in order to arise environmental awareness or even to “teach” individuals to consume less energy [20][13][36][12].

To employ its entertaining characteristics alongside cues that target a specific behaviour, a SG should employ insights from behavioural economics and psychology, as they have significant influence. Researchers have considered incorporating behavioural theories into games to inform their design, as they have been perceived as a powerful medium for behavioural change and learning [17]. For example, Baranowski et al. (2010) examined the use of socio-cognitive theory in the design of a SG for health related behaviour change. Based on the Elaboration Likelihood Model, which suggests that attitude, motivation and ability enhance the possibility of a message being immersed in people’s minds, Baranowski et al. implemented story characters designed to be persuasive [5][38]. Inoculation Theory, by comparison, intends to identify the possible threats to the fulfilment of the ultimate goal while social cognitive theory helps people to learn by seeing others replicate the behaviours [45][4]. The above-mentioned theories, along with Self-determination Theory, stress the importance of feedback when trying to change behaviour during the process of play [11].

Further research on behaviour change explored the potential of using cognitive models during gameplay [46]. The Emergent Dialogue approach suggests that behaviour change does not arise as a result of the available information, but from participation in activities that explore environmental issues [3].

Emergent Dialogue is not only focused on individual behaviour, but also operates on a collective level on which most of the important changes occur, such as energy and transportation infrastructure [3]. Similarly, the Procedural Rhetoric Model examines players' behaviour, based on the notion that the activities are more influential than then the information layered on top of them [3]. Taking into consideration these proposed cognitive models and behavioural theories, many similarities and consistencies exist: hence, the approach put forward by this paper in developing an SG for the energy sector envisages the incorporation of elements of multiple theories to create a game experience facilitating behavioural engagement.

A. Influencing Behaviour and Decision-Making

Identifying the factors that influence peoples' decisions on environmental issues, such as extensive energy consumption, is amongst the foremost challenges for social and behavioural scientists [8]. One of the main reasons is that environmental decisions involve an aggregation of behavioural drivers [8]; A potentially fruitful line of investigation here is the field of Behavioural Economics, which provides insights into how people evaluate options and make decisions. Given that the energy efficiency gap (“energy paradox”) exists with potential explanations such as market failure, behavioural effects (discount probability), and modelling flaws (overstating benefits and costs of energy efficiency), energy consumption becomes an ideal arena for exploring the decision making process [22][49]. Various behavioural drivers influence many of these explanations: Some of the most profound are aversion to risk, delay discounting on decision taking (preference for immediate lower rewards to later bigger ones), and the heterogeneity of preferences within the population [49]. Risk aversion and discount probability, amongst other effects of human behaviour (messenger, incentives, norms, defaults, salience, priming, affect, commitment and ego), are reflected by the MINDSPACE framework [14], which aims to bring together the most robust effects and understand human decisions. Therefore, the implementation of these effects and behavioural theories into the game play provide the potential of better results on influencing people’s behaviour.

The act of changing and influencing human behaviour has been an integral part of policies applied in the areas of finance and environment. Behavioural Economists have drawn their attention to the reasons that people make decisions by using insights from psychology. In comparison with traditional economics, which posits that people behave rationally, this new wave of behavioural science reflects evidence suggesting people do not think perfectly rationally even in cases in which the information given to them is accurate. Tversky and Kahneman (1974) concur that either naïve or sophisticated individuals violate at least some principles of rational choice in particular situations [5][6]. With reference to their research, a new trend of literature began, examining how people take decisions, and what makes them behave irrationally. These alternative economic models sometimes provide better predictive models than traditional economics [39]. According to these models, there are two approaches of influencing behaviour, differentiated by the operating brain ‘system’ they target; ‘System 1’ is automatic, unconscious uncontrolled and
fast, while ‘System 2’ is reflective, rule based and slow [48]. The most common approach that policy makers use consists of programmes that target “changing minds” through incentives and information, commonly referred to as the “cognitive model”. Hence, people analyse the information that is given to them and act accordingly (System 2). However, people often behave irrationally, because of environmental external factors [14]. In this project, we propose to shift from “mind” to the “context” as indicated by an increasing agreement among behavioural economists that people’s behaviour is substantially guided by dynamics associated with the context or the circumstances they are facing at the moment (‘System 1’)[48].

In broader terms, the focus is on the environment within which the person acts, and not in the cognition behind it. According to the Theory of Planned Behaviour (Ajzen 1985), an extension of the Theory of Reasoned Action, there are some factors that affect “the individual’s intention to perform a given action” [3].

Attitude, subjective norms and perceived control over the specific behaviour are found to predict individual’s intentions with an interesting level of accuracy. These intentions, alongside perceived behavioural control, can increase the predictive power of the deliverable behaviour. Hence, the theory suggests targeting attitude, instead of simply “teaching” behaviour. The application of TPB to a particular subject area such as energy provides a pool of information, which can become useful either to understand specific behaviours or to implement interventions [3]. Consistent with the theory, the different factors that induce an individual in order to adopt a specific behaviour could be predicted and encourage a desirable behaviour.

A focus of current work is identifying the uncountable factors that affect human behaviour, and understanding the contexts where are defined. Two of the most significant insights gained so far are people’s tendency to “discount the future”, and people’s tolerance towards a sure loss or a riskier decision [14][23]. These two personality traits are examined in the project reported on by this paper, since they are considered to be closely connected with the model of decision-making in residential energy use [49].

B. Patience-Time related Discount Rates

In order to explain people’s tendency to discount the future, Behavioural Economics proposes “hyperbolic discounting”, which refers to the impact of higher discount rates for shorter time horizons or lower discount rates for longer time horizons [27]. Evidence shows that individuals are farsighted when costs and benefits happen in the future; however, if people have time varying discount rates, the way individuals think changes. For instance, people may prefer to get £120 in 31 days than £110 in 30 days, but also prefer £110 today rather than £120 tomorrow. The latter event, indicating preference for immediate smaller rewards compared to larger future ones, was first discussed by Rotter (1954) in the context of “delay gratification” [41]. Self-control problems or the way we discount the future are central to behavioural science. Taking into account patience’s impact on wealth in addition to its relation to impulsive behaviour, it is unsurprising that delay discounting has attracted interest from behavioural economists, psychologists and neuroscientists [25][30]. Time Delay Discounting is considered an indicator of impulsive behaviour and typically is referred to as the preference of a very quick but low value reinforcement (reward), over a delayed reinforcement of high value [19]. Research on delayed discounting has found that it can be predictive for the tendency of drug use [29]. Furthermore, discounting the future is considered to be one of the main barriers of energy conservation, since benefits build up over a long time whilst costs related to them are immediate and substantial in some instances, such as the installation of insulation on a property [47]. Research evidence examining individual willingness to trade-off today’s energy consumption for the future, via a constant discount rate, reveals that people do not make decisions in time-consistent way [49]. In broader terms, when every cost or benefit is immediate, people can become farsighted, and this is reflected in their advance planning [10]. The natural predisposition to concentrate on the present, and the aversion to adopting energy efficiency habits coupled with the human tendency to discount future energy savings, could prevent people from acting responsibly [47]. Behavioural experiments on delay discounting have sought to measure preferences between taking a smaller reward immediately compared to waiting for a specific time for a bigger reward.

Behavioural economics seeks to understand social phenomena such as whether individuals become addicted to cigarettes, drugs, or alcohol; how much money they (under) save, and why people prefer not to spend money now in order to save energy and money in the future, using models of discount probability. The same models are used in order to explain the energy conservation gap, which shows that even though people want to behave environmentally, sometimes they procrastinate or lack the discipline to do it immediately, and due to the fact that the results of energy saving are not instantly obvious, they postpone their behaviour [39].

C. Risk Aversion

Available evidence suggests that utility models are insufficient to describe individuals’ chosen behaviours in many situations. This has lead to search for other variables that affect the decision making process [50]. The procedure of decision-making involving risk refers to choices that have probability distributions over the possible outcomes, equivalent to lotteries. Therefore, the outcome is only probabilistically known at the time that one takes the decision [50]. As a result, the significance of understanding such decisions at a corporate and social level is vital to explain the role of risk. Risk tolerance is pervasive in everyday people’s decisions, including gameplay, and plays an important role in their economic life. Consequently, understanding individuals perception towards risk is linked to the prediction of human’s behaviour [44]. Economists have long known that people tend to be risk averse: the mathematician Daniel Bernoulli firstly observed it (1738). The differences that people show towards resolving decisions that involve risk and uncertainty are often perceived as differences of risk attitude. According to prospect theory, [34] people under-weigh outcomes that that are probable compared to outcomes that are obtained with uncertainty. In the context of energy conservation, consumers tend to be risk averse with respect to gains, and risk-seeking with respect to losses. Hence, the prospect of a loss is much greater than that from a gain [23]. Reasons examined by prior research include the lack of
information, or fluctuations in energy prices, since the “new” energy saving technologies involve a higher risk compared to the traditional ones [16]. Therefore, to commend a risk approach in order to assess risk, premises various factors, the perception of benefits and risks, in addition to a steady element that reflects an individual’s tendency to favour a choice that one perceives as risky option [49]. In the following section, a simple lottery game is presented based on an adaptation of Multiple Choice Lottery Task [21] a validated behavioural task inferring the degree of risk aversion. This is combined with a game derived from the understanding of patience presented in the previous section to provide tools seeking to assess "risky" and "patient" behaviour amongst players.

III. GAME DESIGN & USABILITY ANALYSIS
This section describes the details of the games' designs as well as the method of usability evaluation used. Building on the theories presented in the previous section, each game seeks to replicate validated methods for assessing levels of "patient" or "risky" behaviour in a game-based fashion, allowing the player to accumulate reward through various strategies. The long-term goal is to provide a means for eliciting these characteristics from players, to create an adaptive gameplay experience that responds to an understanding of the most appropriate behavioural influencers for a given player.

A. Patience game
The patience game ("Mansion") is designed to assess the patience of the player in terms of delayed gratification. In humans, the capacity for patience is closely related to addictive behaviour and IQ [9]. Experiments with rodents, for example, have shown those with a predisposition for faster discount choice to be increasingly sensitive to drug acquisition self-administration [37]. It involves a T-maze and two choices of reward; one immediate and one after an adjustable delay [35]. The experiment reported by this paper is based on a behavioural task originally used with rodents in a physical maze, with digital game elements used to enhance engagement on-task amongst humans and replace the physical maze with a virtual equivalent. A T-maze was developed as a part of an old mansion where the player should choose between taking one path leading to a low reward; versus the other path with a delayed, larger, reward. The low and the high reward are counterbalanced between left and right corridor in order to avoid order effects. This game aims to target general public and elicit people according to their patience towards immediate low value to delayed high value rewards in a certain time. The 3D environment was designed in 3DS Max and the game was developed in the Unity Game Engine. It uses mixed media within a web-based 3D environment, and relies on collection of coins, which leads the player to a gradual increase of level where the delay and the reward is escalated accordingly. At the end of the game, the participants should fill in their details, which help us to correlate the results of the two games. Movements and decisions of the players, including which corridor they choose, are captured during play and as soon as the player decides to quit or to finish the game, data are sent to a web form and stored. These data include the movements of the players and their details (name & e-mail), as well as informed consent. The capturing of participant details is not only useful for the correlation of the results but also for creating a pool of e-mails (participants) that will be used for future experiments.

B. Risk Game
The game measuring the risk tolerance of people is based, as mentioned before, in an adaptation of a Lottery Multiple Choice Test [21]. In this particular game participants in the experiment are invited to discover their risk tolerance. This choice based game is grounded on the Prospect Theory [23] and the certainty effect. According to the latter people tend to overbalance outcomes that are certain compared to outcomes that are probable. The Risk game was developed to target all the ages above 18 and it demands limited gamer skills. It is also web-based in a 2D environment with a cartoonish design. The graphics were designed in Photoshop and the game engine employed is Unity, for consistence with the game for patience. Players are presented with two options in order to gain more points. The options are divided between one ‘risky’ option the roulette where are equal possibilities either to win more or to lose more, whereas the ‘safe’ option involves a fixed number. The game provides 20 pairs of options and the level of risk is increasing as the levels are progressing. Another important feature of that game is that as long as you are gaining more points you move from a very small house to a bigger one. It has the intention of representing the emotion of ownership (i.e. you
do not risk so easily to lose your house). Since risk tolerance is an attribute that is more accurately examined with real rewards not monetary, we tried to relate the lotteries with something that is important for the majority of the public. Moreover, according to the theory that losses loom larger than gains, we hypothesize that people might show difficulty in taking risks and losing their already-gained house [23]. Players have the opportunity to take their decision in their own time as there is no timer at the present version but there is a future potential to add it in order to explore how people react towards risky decisions under pressure. As described in the case of the Patience game, participant’s movements are tracked in this game as well. Their choices (card & roulette) are recorded while playing and sent again to a web form.

It appears from the wider game based research that there are few games assessing human attributes and even fewer that are used instead of behavioural tasks. Risk and Patience tried to combine the engaging environment of a game environment and the serious procedure of a behavioural task. This is aligned with the objectives of the general research in order to establish a new area of games that are used for assessing behavioural attributes.

![Fig. 3: Risk Game Interface](image)

D. Usability Analysis

Usability issues are very important for games since they require constant interaction. QUIS (Questionnaire for User Interaction Satisfaction) is a validated method for assessing the usability evaluation of the games. It consists of 6 parts of questions regarding the interface, the usability and the multimedia featured in the games. The first section includes questions that are focusing on the background of the users, i.e. it checks the computer systems that are most familiar with.

The second section of the questionnaire focuses on the overall reactions of the users to the system. Participants can express how they feel playing the games in terms of semantic bipolar differentiated expression (i.e. opposing expressions). In part 3 the GUI of each game is tested such as the readability of displayed characters, windows layout etc. In the fourth part of the questionnaire, the participants share their opinion regarding how easy or encouraging is to learn the Interface of the game. In the fifth part of the questionnaire, the questions are about the system speed and reliability. The sixth part of the questionnaire is about the multimedia content in games. The multimedia content includes the images inside the virtual application, the movies, the sound and the nature of the colours. This content enhances the user’s experience and adds depth to the game.

IV. METHODOLOGY

The approach described here focuses on the expert’s evaluation of the games from a usability standpoint. Ten Computer Scientists from Coventry University’s Serious Game Institute were invited to take part in the user interface evaluation for each game. After they played the games, they were asked to fill in two QUIS questionnaires (one for each game). At the end, participants had the opportunity to fill in their comments regarding what could be improved in the games.

QUIS questionnaire was employed in order to determine if the behavioural approach of the game scenario had a negative or positive effect on the usability aspects of the games. It measured the overall system satisfaction with the facet of interface. The subjects were asked to respond to the questionnaire after having played both games. They participated without offering any incentives in order to respond to survey or to play the games. This project focuses more on the System 1 reactions, hence the participants were given enough time and space without help from the researcher instructor in order not to bias the result.

On average most of the Computer Scientists were between the age of 18 to 33. All the qualitative data (the answers of the QUIS) were collected and were content analysed in order to evaluate the user interface of games. Given the nature of the data (Likert-scale) an independent t-Test was utilized to analyse the performance in both games. Whilst the sample size precludes a definitive outcome from such a test, the results described in the next section reflect a positive overall consensus on usability amongst experts.

V. RESULTS AND DISCUSSION

As described in the previous section, only domain experts participated. The lowest Likert-mean is 5.7, whereas the highest mean value is 7.65. In a 9-scale Likert scale and taking into account the relative high values people most often give in questionnaire like surveys, the result in this evaluation show a good level of usability of the interface, but also highlight some improvements to be made.

In particular, the interface for both of games had been considered easy enough: satisfying but a “bit dull” and rigid. Moreover, the characters in Patience game were coherent but in Risk game, there were some difficulties, as the text seemed to be a bit small. The learnability of interface was much easier in the Risk game compared to Patience game, this can be explained by the fact that the latter needs gaming skills (use of keyboard along with the mouse), hence is more difficult to operate. Multimedia in both games was commented as good in quality.

Some of the participant’s comments for Risk game were: “System was quick and easy to play” & “Colours/sound good and clear”. Similarly participants commented for Patience game as well: “System very clear, it looks really nice”, “Great games”.
However, there was also feedback about the experience of using first person interface and helped us to identify the disadvantages and ways these could be improved. In particular, some of the participants found it difficult to manipulate the keyboard along with the mouse especially if they were lacking gaming experience. This feature should definitely be enhanced in order this game to serve its purpose. In addition to that even though they responded positively regarding the atmosphere of the game, they found it hard to move around because of the poor lightning.

The overall feedback showed that respondents enjoyed games and the general usability evaluation had fairly positive results.

VI. CONCLUSION

The games of Risk and Patience are a prototypical attempt to assess types of people according to their behaviour inside the game. This paper presented results of two QUIS questionnaires, filled in by ten Computer Scientists. As this project is currently a work in progress, the results on this evaluation reflect only the usability aspects of the games. The games try to measure two traits that are notoriously difficult to capture in small-scale experiments and no matter the quality of them there is always the possibility to misinterpret the results. However, this attempt is still an important step towards leveraging games that incorporate Behavioural Economics and psychology. Comments by domain experts suggest that it is possible to use them.

Taking into account the above limitations and challenges, the possibilities of these games with solid theoretical basis, create promising avenue for using them as behavioural tasks. The aim is to engage people with game play and to have an immediate but also validated assess of behaviour. At the same time, it will provide valuable insights on design and background of such games.

VII. ACKNOWLEDGMENTS

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Table 1: Descriptive Statistics of all Sections – Risk Game

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