THE EFFECTS OF GAMIFICATION ON DRIVER BEHAVIOR: AN EXAMPLE FROM A FREE FLOAT CARSHARING SERVICE

Research in Progress

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Abstract

It has been argued that information systems have the potential to support the pursuit of becoming more environmentally sustainable. The majority of studies in green IS has been focused on investigating the organizational level. Accordingly, the proportion of studies pertaining to green IS used by individuals in comparison has been neglected and only recently garnered more interest in research. Thus, to add to this increasing interest field, our research aims at expanding the knowledge of green IS on an individual's level by examining how a gamified information system can change customers' behavior towards an improved level of personal environmental sustainability. More specifically we are proposing an international field experiment in cooperation with a leading carsharing service to study whether the application of gamification during car rides can lead to effects which decrease CO_2 emission caused by driving behavior of individual drivers. Furthermore, we suggest the application of Self-Determination Theory to explain behavioral change induced by gamification.

Keywords: Green IS, Gamification, Behavior Change, CO_2 Emission

Introduction

In recent years a broad variety of actions have been taken and regulations have been implemented to address the issue of environmental sustainability on various levels of society. Particularly the reduction of greenhouse gases such as CO_2 has attracted attention from policy makers and enterprises (e.g., Dedrick, 2010; Corbett, 2013). For example, Germany's Federal Government has pledged to reduce the country's CO_2 emissions by 40% (compared to the emission level in 1990) by the year 2020 through investing 2.6 billion EUR every year until then and through implementing strategies to increase energy efficiency and transitioning to regenerative energy resources (Federal Government of Germany, 2014).

A major part of the efforts to reduce CO_2 emission is addressing the emissions caused by road traffic. Although automobile manufacturers have started to build more environmentally friendly cars, which emit less CO_2 (JATO, 2014), still traffic and transportation are a major cause for CO_2 emission. For the year 2011 the International Energy Agency estimated that transportation was responsible for 22.3% of worldwide CO_2 emissions, ranking it the second largest source of CO_2 emissions after electricity and heat production (IEA, 2013). Furthermore, motorized individual transportation alone contributed 58.3% to the CO_2 emission caused by traffic in 2013 in Germany (Statista, 2014).

Information systems have been shown to facilitate and enable the reduction of CO_2 emissions in an organizational context (e.g., Watson et al., 2010b; Corbett, 2013; Marett et al., 2013; Seidel et al., 2013) and with the reduction of CO_2 emission being also addressed by the government and the automobile industry, the consequent next step now is to also involve individuals and engage them in the endeavor of sustainability. However, research on green information systems has been mostly focusing on organizations and businesses, as shown by literature reviews by Elliot (2011) and Loeser (2012). In comparison, the application of green information systems on an individual level and particularly research examining individuals' motivation to act sustainably are scarce. Only in recent years has the individual level gained more attention in research. Exemplary papers include Dedrick (2010), who calls for research on individual behavior in an sustainability context, because individual behavior can be the starting point for a host of decisions (e.g., in organizations). Other individual level studies look at the effects of a persuasive system on residential energy consumption (Graml et al., 2011), how different types of feedback can positively influence the energy consumption of individuals (Loock et al., 2011) or how IT can help consumers in overcoming challenges regarding green consumption decisions (Zhang, 2012).

For our research we apply the definition of green information systems of Melville (2010) and Chen et al. (2008), i.e., we consider an information system to be "green" or sustainable if it enables or facilitates processes or practices which lead to improved environmental performance, eco-efficiency, eco-equity or eco-effectiveness. As for gamification, we will adopt the following definition: Gamification is the use of game design elements (such as rewarding points or badges and visualization of progress towards a certain goal) in a non-game context to intrinsically motivate and alter an user's behavior towards a more preferred outcome (Deterding et al., 2011; Blohm and Leimeister, 2013). We are particularly looking at gamification as a motivational tool, as it has been shown to be effective in changing user behavior for the better in diverse contexts such as learning (Simões et al., 2013) or service marketing (Huotari and Hamari, 2012) and because gamification can be viewed as promising paradigm to drive user engagement (Kankanhalli et al., 2012).

Our research contributes to green IS research by examining whether information systems can support individuals in pursuing environmentally friendly goals such as reducing one's own carbon footprint. For this, we investigate the effects of a gamified information system aiming at reducing CO_2 emissions by inducing a more environmentally friendly driving behavior. Through collecting and analyzing data from a field experiment with a carsharing company we address the following research questions:

RQ1: Which effects does gamification aimed at sustainability have on driving behavior?

RQ2: Are these effects persistent or to which extent do they vanish over time?

The remainder of this paper is structured as follows: First, we review the extent to which gamification has been addressed in the IS discipline. Afterwards, we position our research project in an existing framework in the green IS area and then introduce our proposed field experiment. At the end of this research-in-progress paper we present an outlook on how we plan to analyze the findings and possible contributions.

1 Gamification in the IS Discipline

Although gamification has been practiced and applied by companies for several years and in various contexts, e.g., for education (Khan Academy, 2014) or health and fitness (Nike, 2014), this phenomenon has remained mostly in the shadows for academia until recent years. A systematic literature review conducted within the IS discipline (including the Senior Scholars' Basket of Eight and Proceedings of ICIS, ECIS, AMCIS and HICSS) has shown that the term "gamification" was mentioned the first time only three years ago in four IS conference proceedings (Hallerstede et al., 2012; Li et al., 2012; Romero et al., 2012; Schulze et al., 2012). Table 1 shows that since then a total of 42 articles were published in the above mentioned outlets containing the word gamification. The fact that more than a third of these papers are in an early research stage (research-in-progress) also indicates that gamification has only started to attract interest in the IS discipline. For a full list of all papers refer to appendix 1.

Outlet *Year*	EJIS	ISJ	ISR	JAIS	JIT	JMIS	JSIS	MISQ	AMCIS	ECIS	HICSS	ICIS
2012	-	-	-	-	-	-	-	-	1	1	0	2
2013	-	-	1	-	-	-	-	-	3	3	4	2
2014	-	-	-	-	-	-	-	-	3	8	8	6
Sum	-	-	1	-	-	-	-	-	7	12	12	10

Table 1. Number of papers containing the term "gamification" in searched outlets

Our literature review also showed that the majority of these papers so far have not looked at gamification as a new motivational phenomenon worthy of sole investigation but rather addressed or used gamification merely as minor matter or as a means to an end. However, we also found exceptions to this, i.e., papers which discuss gamification explicitly in distinct contexts: In the area of education Wu and Wang (2014) investigated the positive effects of gamification in an mobile education environment and Romero et al. (2012) hint at the potential of game based learning; the papers of Hamari and Koivisto (2013) and Pletikosa Cvijikj et al. (2014) address the area of fitness and health by describing how gamified information systems can help in the treatment of obese patients and how gamification can foster social motivation to do physical exercise. Other authors discuss pointification as a game element which can affect user behavior on social networking sites (Sjöklint et al., 2013) or hint at the benefits of a gamified knowledge management systems with regard to better experience and knowledge sharing (Schacht et al., 2014). Table 2 shows an overview over full research papers which examine the use of gamification explicitly and indicates the involved game design elements as well as the context in which gamification was embedded.

Completed research paper	Title	Context	Game design elements
Halavais et al. (2014)	Badges of Friendship: Social Influence and Badge Acquisition on Stack Overflow	Learning	Badges
Hamari and Koivisto (2013)	Social motivations to use gamification: An empirical study of gamifying exercise	Fitness/health	Team building
Melville (2010)	Crowd-Sourced Peer Feedback (CPF) for Learning Community Engagement: Results and Reflections from a Pilot Study	Learning	Badges, feedback (progress)

Pletikosa Cvijikj et al. (2014)	Health information systems for obesity prevention and treatment of children and adolescents	Fitness/health	Achievements, badges, goal setting
Romero et al. (2012)	Learning through playing for or against each other? Promoting collaborative learning in digital game based learning	Education/learning	Team building, competitition
Schacht et al. (2014)	The project world-gamification in project knowledge managenet	Knowledge management	Achievements, pointification, levels
Sjöklint et al. (2013)	Numerical representations and user behaviour in social networking sites: Towards a multi-theoretical research framework	User engagement	Pointification
Wu and Wang (2014)	Understanding the Effects of Mobile Gamification on Learning Performance	Education/learning	Pointification leaderboards

Table 2. Full research papers in searched outlets addressing aspects of gamification

Only two papers put gamification at the center stage of their research: Thiebes et al. (2014) explicitly look into gamification mechanics and dynamics and how they can lead to behavioral change, while Codish and Ravid (2014) approach this topic more from a user perspective by investigating how different personality types perceive and react to gamification.

Interestingly, through our literature we did not find any articles describing the application of gamification for the higher purpose of environmental sustainability, despite the potential it offers to intrinsically motivate (Ryan and Deci, 2000a) people to act more environmentally friendly. Thus, our proposed research project would be the first to take advantage of the first insights on gamification and to apply these to a sustainability context within the IS discipline.

2 Theoretical Foundation

For our research project we apply the Energy Informatics Framework proposed by Watson et al. (2010a), as this framework has been shown to aptly embrace the setting of automobiles and traffic (Watson et al., 2010a; 2010b). More specifically, the Energy Informatics Framework describes any energy management system which consumes energy and consists of three different components which are connected or integrated in an information system: a flow network, a sensor network, and sensitized objects (Watson et al., 2010a). Applied to the setting of our research project the energy (resource) consumed is fuel and the goal is to minimize this consumption. Besides higher energy efficiency, less fuel consumption would also lead to the environmental goal of less CO_2 emissions. Roads and streets in any given region or city constitute the flow network, in which automobiles are embedded as sensitized objects which in turn are equipped with various telematics sensors to measure and evaluate the performance of each single automobile. Using the framework gives us the opportunity to systematically address different questions related to each of the components of the Energy Informatics Framework (information system, flow network, sensor network, sensitized objects) from different perspectives (e.g., company/supplier view, consumer view). Such questions can relate to the type and granularity of information which companies have to collect and how this information has to be provided to customers in order for them to manage their energy efficiency (Watson et al., 2010a).

Or put in other words: The role of the information system here is to collect the data provided by the sensors as well as to process and visualize this data to inform, for example, drivers about their driving behavior and fuel consumption, respectively. According to Watson et al. (2010a; 2010b) having

information about one's energy consumption (here also the CO_2 emission caused) should enable and facilitate decisions and behavior which lead to a more efficient and thus more sustainable consumption.

Upon conducting the field experiment depicted in the following session, we will apply a theory that addresses behavioral change. As we believe that the application of gamification will intrinsically motivate customers to drive more environmentally friendly, Self-Determination Theory (Ryan and Deci, 2000b) could be applied to explain the behavioral change. Self-Determination Theory is particularly suitable for two reasons: First, a customer's decision to act environmentally sustainable can be considered to be self-determined, especially when this decision was made in a gamified context. This fits well in the spectrum of motivated behaviors suggested by the Self-Determination Theory, which posits a person's behavior can range from being self-determined, i.e., intrinsically motivated, to various levels of controlled behavior, i.e, extrinisically motivated (Ryan and Deci, 2000b). This also reflects, why Self-Determination Theory (e.g., Wati and Koo, 2012; Wunderlich et al., 2013a; 2013b) or its sub-theories, e.g., Organismic Integration Theory (Wunderlich et al., 2012), have been used in previous green IS research. Secondly, the three constructs Self-Determination Theory uses to explain intrinsic motivation can be easily connected to gamification:

- *Autonomy*, which is the need to control one's own life or to make free decisions (Deci and Ryan, 2000) is highly relatable to gamification, as the decision to start, to continue and to end playing a game is solely up to the customer and thus completely based on voluntariness.
- *Competence,* which is the need to be effective and to know that one is or can become capable of solving a problem at hand (Deci and Ryan, 2000). Gamification can accommodate this need by providing stimulating (i.e., not too difficult but also not too simple) challenges and providing feedback which acknowledges success or points out potential to improve.
- *Relatedness,* which is the need to interact with others or to connect and identify with a meaning or goal (Deci and Ryan, 2000). In gamified contexts, customers get the opportunity to compete with others or work together in teams to achieve goals, which serve a higher purpose or overlap with personal goals.

3 Field Experiment and Data Collection

To collect the necessary data we cooperate with a car sharing company. This company operates a free floating car renting company in numerous cities worldwide and can be considered as one of the market leaders in this business. As opposed to traditional car rental services, upon registering as a customer, drivers are not required to come to a fixed renting station first to start renting a car. Instead, customers are able to use their mobile communication devices (e.g., smartphones) to locate one of usually hundreds of available cars, which are spread throughout the city, and start the renting period at any location and drive to their desired location. At the end of the rent, customers may leave the car at any place in the city and do not have to return the car to a specific station (thus the free floating car sharing system).

As soon as a customer starts to drive the car, internal telematics sensors start measure numerous indicators which eventually are summarized in three numerical scores ranging from 1 (bad) to 100 (good):

1. *Acceleration*: Measures how slowly and smoothly a customer is driving. If the customer is accelerating unnecessary or often, this will increase fuel consumption and thus also CO_2 emission.

2. *Cruising*: Evaluates the driving style in terms of calmness and consistency. If the driver frequently alternates between speeding and braking, the score worsens indicating inefficient fuel consumption and hence higher CO_2 emission.
3. *Deceleration*: Assesses the foresight and consciousness with which a customer drives. The more often a car is coasting (e.g., downhill or towards a red traffic light) instead of using the breaks, the better this score gets. This indicates a preserving consumption of fuel and thus less CO_2 emission.

Taking these three measurement as indicators for CO2 emission makes sense as tailpipe emission rates of pollutants such as carbon dioxide have been shown to be sensitive to vehicle speed (Bokare and Maurya, 2013) and researchers have established a linear relationship between CO2 emission of a vehicle and the speed and acceleration/deceleration of the vehicle (Oduro et al., 2013).

For each of the three measurement scores are computed and depicted in real time on the cars' on-board displays. In addition to this, each numerical value is also represented as a colorful, "living" tree which changes its appearance according to the driving behavior and value: The better the value is, the "healthier" the respective tree becomes and in its final (preferred) stage all three trees are blooming, with animals living in them and a rainbow appearing in the background. In the opposite case, when the driving behavior is not fuel efficient, the customer will receive low scores and thus gets to see leafless, bleak trees with dark rain clouds in the background in the worst case. Furthermore, a fourth score, which is the arithmetic mean of the other three scores, is also displayed for a quick assessment of the overall driving style.

By using pointification (the four values) and the illustration of trees (progress visualization and immediate feedback on goal achievement) as game design elements, each drive is gamified. The apparent goal is to encourage each customer to play this mini-game while driving and encouraging everyone to achieve a perfect score (all scores equal 100 points) which implies an environmentally friendly driving behavior.

To investigate whether gamification does have an effect on driving behavior we will collect data in several cities from different countries. For each city, we will determine two random customer groups. For the first group (control group) the cars will be set up in such a way that customers will not be able to see or play the "tree game"; however, the scores will still be computed and reported internally. For this group we expect the scores to settle down on a low to mid-range level and to stay at this level throughout the experiment.

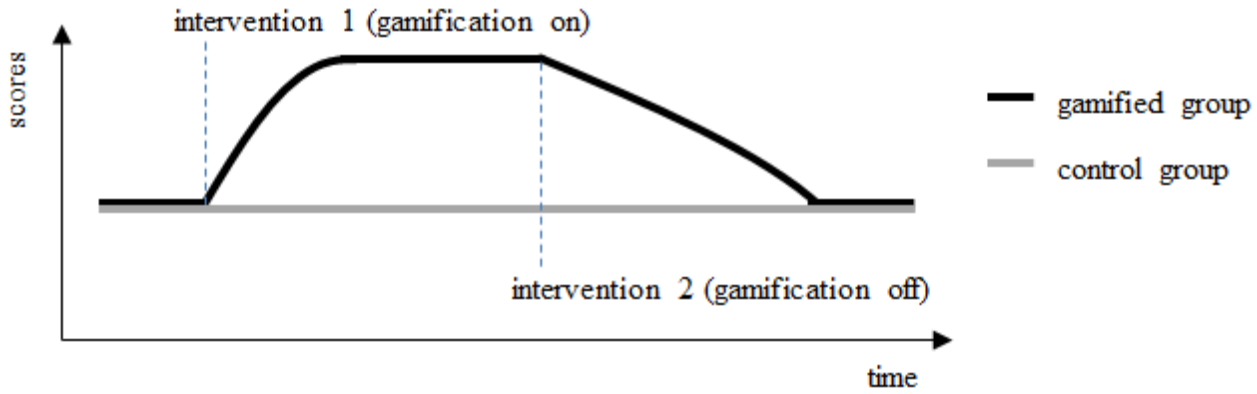

Figure 1. Expected change of scores (driving behavior) due to gamification

The second group (gamified group) will be manipulated in terms of availability of the game: Similar to the control group, the gamified group will start out renting and driving cars which will not engage them in the game. After we have established a base line – we expect both groups to generate similar scores at the beginning of the experiment –, the game will be activated (intervention 1) for this group giving the customers the possibility to play the game. Here we expect to see positive effects on driving behavior as soon as gamification is involved, i.e., the scores will improve and settle on a higher level when compared to the scores of the control group. Again, after a certain period of time, gamification will be switched off again (intervention 2) for the second, gamified group in order to see whether the effects of gamification on the drivers' behavior are persistent, i.e., scores remain on the same level, or waning over time, i.e., scores are worsening or returning back to the level when no gamification was applied.

Figure 1 shows how we expect the application and consequently the deactivation of gamification to affect the scores and thus drivers' behavior.

4 Contribution

Irrespective of the findings, our research project offers contributions which are twofold. First, it expands our knowledge on how information systems can further support in overcoming the society's grand challenge of becoming more sustainable, especially on the level of individuals. Secondly, it offers the possibility to further investigate the potential and effects of gamification in a sustainability context and across countries, which not only offers insights on the persistence of gamification effects but also whether effects may vary depending on cultural backgrounds.

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Appendix

Full list of IS papers containing the term "gamification"

Outlet	Authors	Publication Year	Type of Paper	Title
Information Systems Research	Nandhakumar et al.	2013	Full paper	From knowing it to "getting it": Envisioning Practices in computer games development
Americas Conference on Information Systems	Crowley et al.	2013	RIP	Decision support using linked, social, and sensor data
	Hallerstede et al.	2012	Full paper	Design and Management of Web-Based Innovation Communities: A Lifecycle Approach
	Kaleta et al.	2014	RIP	Achieving Business Goals with Gamification: An Informational and Motivational Perspective
	Küpper et al.	2014	Full paper	Features for Social CRM Technology–An Organizational Perspective
	Roth et al.	2013	Full paper	Facilitating conflict resolution of models for automated enterprise architecture documentation
	Shang and Lin	2013	RIP	An Understanding of the Impact of Gamification on Purchase Intentions
	Wu and Wang	2014	Full paper	Understanding the Effects of Mobile Gamification on Learning Performance
European Conference on Information Systems	Codish and Ravid	2014	Full paper	Personality based gamification: How different personalities perceive gamification
	Feldmann et al.	2014	Full paper	Using serious games for idea assessment in service innovation
	Füller et al.	2014	Full paper	Web-based customer integration for product design: The role of hedonic vs utilitarian customer experience
	Hamari and Koivisto	2013	Full paper	Social motivations to use gamification: an empirical study of gamifying exercise
	Ononiwu and Brown	2013	Full paper	Theorisation In Critical Realist Is Research And Its Implications On Structure And Agency Interplay: A Morphogenetic Approach
	Pletikosa Cvijikj et al.	2014	Full paper	Health information system for obesity prevention and treatment of children and adolescents
	Romero et al.	2012	Full paper	Learning through playing for or against each other? Promoting collaborative learning in digital game based learning

	Schacht et al.	2014	Full paper	The project world-gamification in project knowledge management
	Sjöklint et al.	2013	Full paper	Numerical Representations And User Behaviour In Social Networking Sites: Towards A Multi-Theoretical Research Framework
	Sørensen and Landau	2014	Full paper	We've got 99 problems, but a phone ain't one: Mobile ICT and academic agility in information systems research
	Thiebes et al.	2014	Full paper	Gamifiying information systems - a synthesis of gamification mechanics and dynamics
	Zogaj and Bretschneider	2014	Full paper	Analyizing governance mechanisms for crowdsourcing information systems: A multiple case analysis
Hawaii International Conference on System Sciences	Brigham et al.	2014	Full paper	A Tailoring Algorithm to Optimize Behavior Change
	Brigham et al.	2013	Full paper	Lessons from an Online Stop-Smoking Intervention: Adaptations for Mobile Implementation
	Crowston and Prestopnik	2013	Full paper	Motivation and data quality in a citizen science game: A design science evaluation
	Halavais et al., 2014	2014	Full paper	Badges of Friendship: Social Influence and Badge Acquisition on Stack Overflow
	Hamari et al.	2014	Full paper	Does Gamification work? A literature review of empirical studies on gamification
	Hughes et al., 2014)	2014	Full paper	User-Rank: Generic Query Optimization for Participatory Social Applications
	Melville	2014	Full paper	Crowd-Sourced Peer Feedback (CPF) for Learning Community Engagement: Results and Reflections from a Pilot Study
	Pflanzl and Vossen	2014	Full paper	Challenges of Social Business Process Management
	Prpic and Shukla	2013	Full paper	The Contours of Crowd Capability
	Prpic and Shukla	2013	Full paper	The theory of crowd capital
	Tootell et al.	2014	Full paper	Generation Alpha at the intersection of technology, play and motivation
	Yoda et al.	2013	Full paper	Stage-Based mHealth Communication Interventions for HPV Education
International Conference on Information Systems	Burleson et al.	2014	RIP	The Same, Yet Different: Using Hedonic Systems in Utilitarian Settings
	He et al.	2014	RIP	Towards Understanding IT Value Co-creation in Crowdsourcing: the Multiple

				Stakeholders' Perspective
	Kankanhalli et al.	2013	RIP	Gamification: A New Paradigm for Online User Engagement
	Kari and Makkonen	2014	Full paper	Explaining the Usage Intentions of Exergames
	Lenarcic	2014	RIP	Use the Difficulty through Schwierigkeit: Antiusability as Value-driven Design
	Li et al.	2012	RIP	Quantifying the Impact of Badges on User Engagement in Online Q&A Communities
	Mutter and Kundisch	2014	Full paper	Behavioral Mechanisms Prompted by Badges: The Goal-Gradient Hypothesis
	Schulze et al.	2012	RIP	Workers' task choice in crowdsourcing and human computation markets
	Teh et al.	2013	RIP	Can Work Be Fun? Improving Task Motivation and Help-Seeking Through Game Mechanics
	Wahle et al.	2014	RIP	Towards the Design of Evidence-based Mental Health Information Systems: A Preliminary Literature Review