# Gamification in transport interventions: Another way to improve travel behavioural change

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## ABSTRACT

Gamification is dramatically transforming how behaviour change interventions are delivered in fields as diverse as health, physical activity, education, information studies and marketing. Most studies see gamification as a way of introducing gameful design (e.g., competition and social activity) into behavioural interventions. Gamification is often tied to using new digital technologies, especially smartphone apps and, although these might be enabling, there is no theoretical underpinning for making this a necessary condition. In comparison to other sectors, the design of gameful interventions in transport is under developed. Interventions that have or are introducing gamified designs include road safety and travel demand management initiatives and these have been shown to be more ongoingly successful than strategies which do not employ gameful designs. This paper explores gamification in the context of transport with the aim of proposing a framework for the design and implementation of gameful designs, providing a synthesis and critical appraisal of current practice. The proposed framework is underpinned by theoretical discussion and illustrated by case studies that have implemented some elements of gameful design. The framework is designed to lay the groundwork for greater implementation of gamified design in transport and mobility contexts to take advantage of the potential greater success in achieving travel behaviour change as well as highlighting how existing schemes could be improved and providing guidance for future research into gamification.

## 1. Introduction

Gamification is often defined as the use of game design elements in non-game contexts (Deterding, Dixon, et al., 2011:1). Gamification introduces competition and social activity into behavioural interventions so, for example, participants become "players" who can win individual or group rewards if they adjust their behaviour. The concept of gamification has been implemented in many fields including education (Denny, 2013; Foster, Sheridan, Irish, & Frost, 2012; Li, Grossman, & Fitzmaurice, 2012), marketing (Hamari & Lehdonvirta, 2010; Huotari & Hamari, 2017; Lucassen & Jansen, 2014) and health and wellness (Coombes & Jones, 2016; Cugelman, 2013). Within the transport field, the term gamification has only been in the field of aviation. The most obvious example is airline customers' loyalty programs (Dolnica, Grabler, Grun, & Kulnig, 2011; Gilbert, 1996; Liu & Yang, 2009; Yilmaz & Coskun, 2016) although under the definitions for gamification developed in the literature these would be seen as a simple incentive that is used to provoke certain behaviour without gameful design (this is

discussed in more depth below). Other examples can be found in attempts to reduce private car use, for example, the *Active School Travel* program in Brisbane, Australia, which uses class and school leaderboards to encourage sustainable travel and active transport in turn reducing air pollution and relieving congestion.

Most previous gamification studies in the literature pay attention to two dimensions: the development of a conceptual framework (Deterding, Dixon, et al., 2011; Deterding, Khaled, Nacke, & Dixon, 2011; Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011; Huotari & Hamari, 2017) and empirical case studies (Bittner & Shipper, 2014; Denny, 2013; Jones, Madden, & Wengreen, 2014; Nelson, 2012; Rey, Dixit, Ygnace, & Waller, 2016). As yet, there is no standard definition of gamification (Seaborn & Fels, 2015). Moreover, Blohm and Leimeister (2013), and Seaborn and Fels (2015) indicate that there are very few research studies that have explored the theories underpinning gamification, for example, the theory of self-determination (Deci & Ryan, 1985; Ryan & Deci, 2000a; Ryan, Rigby, & Przybylski, 2006) or intrinsic and extrinsic motivation (Ryan & Deci, 2000b; Zichermann & Linder,

2010). This suggests most empirical research has been designed and implemented with limited theoretical foundation. A more systematic development of the theory of gamification is needed to understand how to develop appropriate incentives, whether these incentives should be pecuniary or non-pecuniary and how gamification might be framed for the transport context so that interventions have a solid foundation of theory to underpin their design. This is the gap addressed by this paper.

In many cases, transport prices are not truly reflective of economic scarcity. The presence of externalities means that the market will over or under provide in terms of output. For example, the provision of free roads means that congestion can exist where there is a divergence between private and social costs. Often the first best solution is not socially or politically acceptable, for example the imposition of a tax in the case of congestion. Moreover, the first best solution may not be wholly successful as price is not the only driver of behaviour. As a result, transport operators, planners and policy makers are, as an alternative, seeking "softer" measures of changing travel behaviour. Gamification can help in creating an environment where these "softer" measures are more effective. Gamification approaches can be used to improve engagement, increase motivation and encourage participation in specific programs to engender travel behaviour change. The evidence is that gamification schemes in some transport areas could have significant behaviour change impacts at low cost although this evidence comes from stated preference experiments (Marcucci, Valerio, & Le Pira, 2016) or micro simulation exercises for metering traffic inflow to special traffic lanes (Olarte & Haghani, 2016) rather than real experiments. This current paper focuses providing a robust framework that can be used to underpin the development and implementation of gamified strategies to achieve travel behaviour change because the evidence points to gamified designs as being more successful.

The paper is structured as follows. First, a state of the art review of the literature is undertaken to establish concepts and to highlight research gaps. Second, the way in which theories of motivation and utility are explored with a view to understanding how they contribute to an understanding of the underpinning of gamification. The paper then turns to the way in which transport is primarily a derived demand and the impact of this on a framework for underpinning interventions with a gamified design. In each case, the theory is followed by a case study or case studies to show why the theory is needed and how it can be used. Thus the case studies show the design of the intervention in the context of the outlined theories with view to pinpointing areas for improvement. The penultimate section summarises the case studies before turning to the principal elements of a gamified intervention and the identification of avenues for further research.

## 2. What is special about gamification?

### 2.1. Game or gamification?

The term gamification still does not have a clear definition. Its concept is clearly derived from games, in which a range of descriptions and conceptual research can be found (Caillois, 2001; Crawford, 1984; Huizinga, 2000; Juul, 2003; Salen & Zimmerman, 2004). The definitions of games are diverse but have one central element in common: a game is engaging and voluntary. Caillois (2001) defines a game as "an activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity does not produce any goods of external value, and governed by rules" (Caillois, 2001; p. 4). Caillois (2001) also proposed a classification framework for gamification, which distinguishes between *paidia* and *ludus* as two kinds of activities. Whilst *paidia* (playing) refers to free-form, expressive and improvisational behaviour, *ludus* (gaming) characterises rule-based playing under pre-determined goals. For gamification, *paidia* and *ludus* are highly related, e.g., *paidia* can be added to *ludus*. The basketball game is a good example of paidia being added to ludus. The basketball game is governed by a series game rules, but players follow game rules intrinsically,

where intrinsic motivation refers to behaviour driven by internal-to-the-person rewards (Holbrook, 1999). Seaborn and Fels (2015) further conclude that gamification is an emerging strategy which has gained in acceptance because of the medium of digital games. Deterding et al. (Deterding, Dixon, et al., 2011; Deterding, Khaled, et al., 2011; Deterding, Sicart, et al., 2011) refer to gamification as the selective incorporation of game elements into an interactive system without having a fully-fledged game as the end product. The literature suggests that young adults and children do participate in gamified schemes, and this is reflected by the way in which gamification has been applied in the field of education (e.g., Erenli, 2013), health and wellness (e.g., Jones et al., 2014) and video games (e.g., Simões, Redondo, & Vilas, 2013). Even though solid evidence is yet be confirmed in a transport and mobility context, this literature suggests that children and young adults may be more susceptible to gamification, maybe because they are yet to be influenced by the need for self-support through earning or perhaps because reacting to the value of simple financial incentives is not yet part of their behaviour.

The concept of gamification has brought together many disciplines and professionals, including game designers, psychologists, sociologists, computer engineers and others (Mora, Riera, Gonzalez, & Arnedo-Moreno, 2015). Most empirical studies adopt their definitions from Deterding, Dixon, et al. (2011) but, in addition to this, there is a body of literature that categorises gamification schemes. Mora et al. (2015) split current studies according to a three-dimension perspective according to their background (academic/non-academic); scope (complete gamification processes or focussing only on a specific part or step) and approach (applicable to a wide spectrum of environments [generic] or designed for a specific business context). Huotari and Hamari (2017) categorise previous research into three levels of contribution: research informing games as systems; research identifying game characteristics but not necessarily of relevance to all games (such as rules, variables and uncertain outcomes); and research exclusive to understanding games. This categorisation is useful in terms of developing a theoretical framework to understand how gamification works and how it can contribute to better soft policies in transport.

### 2.2. Incentive or gamification?

Both incentives and gamification can be used to make travel demand management strategies form part of transport policy or to otherwise improve the take up of travel behavioural change. Incentives are used to provoke change in, or maintain certain behaviour. However; it is important to be able to distinguish between a 'simple' incentive and an incentive which is part of a gamified framework. As mentioned earlier, the most obvious example of a simple incentive is the airlines' customer loyalty programs' where points are allocated for travel. Incentives are often adopted as part of a travel demand management (TDM) instrument where rewards are provided for travel behaviour change (e.g., off-peak fare discount for public transport). 'Simple' incentive programs are characterised by financial rewards or economic benefit or some form of concession that is known fully in advance. 'Simple' incentives can deliver extrinsic motivation where individuals are motivated to a behaviour simply to earn a reward (for example, travelling only on a particular carrier even if this delivers more expensive or longer journeys, just to keep gathering loyalty points with that airline) or to avoid some negative consequences.

Incentives that promote intrinsic rather than extrinsic motivation are viewed as better because they promote behaviour where activity is undertaken because it is personally rewarding or carried out for its own sake. 'Simple' incentives can detract from an individual's desire to undertake an activity simply because they find it interesting or rewarding and so can be detrimental to intrinsic motivations, autonomy, and creativity (Deci, Koestner, & Ryan, 1999; Hamari, 2013). Kohn (1999) showed that for some incentive programs pleasure is not additive and that rewards can backfire (Groh, 2012). Lepper, Greeme, and Nisbett

(1973) demonstrated these effects when finding that if children are paid for drawing, as an incentive, they will draw more pictures but with lower quality and, very worryingly, when the incentive is ceased the children will not like to draw as much as they did before. Lepper et al. (1973) called this an 'overjustification' effect where intrinsic motivation is shifted towards the less desirable extrinsic motivation. It is for this reason that gamified interventions must aim to promote intrinsic motivation.

Gamification needs to provide more than the 'simple' incentive where the outcome for the player is always known at the start. With a gamification framework, the outcome may not be known in advance although, of course, the rules of the game need to be well specified. In proposing a gamification framework, some finesse is required as the aim must be to go beyond the intrinsic value of the 'simple' incentive via a suitable intrinsic motivation design that has three innate requirements: relatedness, competence, and autonomy (Deci et al., 1999; Hamari, 2013). A lottery-based gamification scheme, for example, harnesses intrinsic motivation because it keeps participants who opt-in voluntarily (autonomy) to play together (relatedness) for a small number of big prizes (competence). Separately from a lottery, other programs encourage participants to team up or introduce the game that requires teams to be set up in advance, where participants ('players') group together as a collective or peer group (a 'team'), and then make specific trips or behaviour that meets the transport agency's preferences (such as travelling outside peak hour) for higher rewards than playing as a single player. For teaming up, the participants may have their collective number of game points increased or be able to redeem team only rewards. The design of a "team game" introduces *social connectedness* components which have been shown to provide a stronger incentive to participants to change their behaviour. Introducing game elements into an otherwise 'simple' incentive structure is useful for a transport agency responsible for rewards since the outcome and cost becomes certain and the gameful design provides greater interest for participants who face uncertain outcomes.

This section has set out some definitions and characteristics of gamification. However, it has not defined specific game elements nor has it explored how an individual is motivated by gameful design. The next section discusses the theory of gamification to fill this research gap.

## 3. The theory underpinning gamification

The supporting theory for gamification (the application of game design elements to non-game contexts) is not well established in the literature despite the large amount of attention its application has received recently. Success with gamification involves determining which games are preferred by individuals, how schemes may be organised and what the effects are likely to be. In this context, where gamification is used as part of a policy instrument design, designers place gamification as the mediating link between identifying the objective or the motivation for change and the achievement of the behaviour change as shown by Fig. 1.

There are, of course, different types of players and game types. In the case of public transport, players could be classified by trip purpose to commuting, education, leisure and game types could be off-peak fare discounts and/or volume rebates. The matching of players to game type is an essential element of gameful design since it influences how well the gamified scheme can achieves its policy goal or goals.

The central element of a game is that it should be engaging and voluntary. Two strands of theory have a bearing on this: motivational theory points to how to engage and encourage participation and how people respond to specific stimuli to achieve the behaviour change. This

is discussed next. The following section looks at the underpinning of behaviour drivers in terms of utility theory. These together are providing a framework for looking at gamification in transport in the following sections.

### 3.1. Motivation theory

The starting point for gamification, or for a game, is the motivation of an intervention which requires participants to be motivated to change behaviour. To be motivated means to be moved to do something (Ryan & Deci, 2000a). Motivation theories distinguish between intrinsic (motivation originating from internal forces) and extrinsic motivation (motivation driven by external forces). Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation refers to doing something because it leads to a separable outcome (for example, external rewards such as monetary incentives) (Calder & Staw, 1975; Davis, Bagozzi, & Warshaw, 1992; Hennessey & Amabile, 2005; Ryan & Deci, 2000a; Scott, Farh, & Podaskoff, 1988).

Gamification typically uses both psychologically-orientated and design-oriented elements in combination. Significant effort is required in the game design phase, using psychological factors of a "gameful experience" such as mastery, achievement, autonomy, flow, suspense, competence, relatedness, etc. (Huotari & Hamari, 2017). Baranowski, Buday, Thompson, and Baranowski (2008) and Miller, Cafazzo, and Seto (2014) identify several approaches which are used to capture these factors which are intended to amplify intrinsic motivation. These include:

- *leader boards* that rank individual users and peer-group progress and achievements, creating competition;
- a *points system* to inform users of their levels and to reward progress and continue engagement;
- *rewards*, either real or virtual, achieved by reaching certain milestones;
- *challenges and quests* motivating users to continue engaging; and,
- *social connectedness and peer pressure* through team challenges and/or the sharing of information via social media.

In terms of design, game elements applied in a gamification context should be mostly aimed at extrinsic motivation unless the aim is to solely to motivate the individual to play a game. For example, a gameful design whereby participants collect points by changing their mobility habits may lead to participants changing their travel behaviour simply to benefit from the game elements (in this case collecting points), not because they want to change their travel behaviour per se. However, if participants keep the new mobility habits when the incentives of the game (in this case collecting points) have been removed then this will be because they perceive quality improvements as a result of their new travel behaviour. In this case the game elements have motivated participants intrinsically as well. In other words, game design can extrinsically motivate a new behaviour but it cannot guarantee to extrinsically motivate participants intrinsically so as to keep the new behaviour.

Motivation theory appears helpful as a starting point for gamification schemes, with intrinsic motivation producing greater satisfaction for participants in changing their behaviour than extrinsic motivation. However, more research is needed to validate the relationship between intrinsic and extrinsic motivation and in particular to inform as to how to design and/or measure intrinsic motivation via extrinsic motivators. The following case study "*Beat the Street*" is used to show how the

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┌──────────────┐      ┌──────────────┐      ┌──────────────────┐
│ Motivation for│ ───▶ │ Gamification │ ───▶ │   Achieving      │
│    Change     │      │              │      │ Behaviour Change │
└──────────────┘      └──────────────┘      └──────────────────┘
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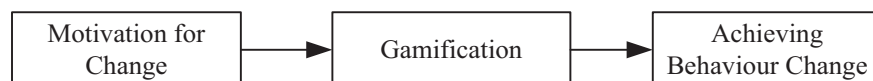
**Fig. 1.** Gamification procedure.

relationship between extrinsic motivation and intrinsic motivation provides on-going travel behaviour change.

### 3.1.1. Case Study 1: active travel - Beat the Street

The "*Beat the Street*[1]" initiative is an active travel scheme in Reading, UK. The "*Beat the Street*" initiative turns the whole town into a game where people earn points as they walk, cycle and run around (Intelligent Health, 2017). In 2016, more than 300,000 people participated in this initiative.

What motivates individuals to participate in this scheme? The design of the scheme shows there are two major design elements making this scheme successful which are embodied the selection of participants and the experience of participation.

"*Beat the Street*" targeted children's physical activity and was designed to encourage participants to walk and cycle in their neighbourhoods by linking walk-tracing technology to a reward scheme. Innovative systems combining Radio Frequency IDentification (RFID) with electronic readers were placed throughout the city for participants to 'tag-on' to record that they have undertaken travel at specific places, at specific times, as incentivised by the game. These readers provided advantages over the cheaper alternative of using a smartphone app. First, participants receive immediate confirmation of their 'reward' by a signal of flashing lights and buzzing and the immediacy of this is an important part of the gamification framework. Second, readers become social objects where multiple users congregate, ensuring interaction with other participants. Reward points are competed for by the groups or teams and/or individuals.

The trial in Reading started with the junior school. Each child was given several devices/cards to allow other family members to play the game as well. This meant that the game among children in the school could generate the "peer pressure" on the one hand and, on the other hand, the game among the family stimulated the "family pressure" to encourage family member(s) to play more for or play with the participating child so generating social connectedness. After a period of time when the benefits of the greater active lifestyle is more apparent, the game becomes self-sustaining with better health for the players and with the players getting to know each other.

The expected longer term outcome is that the "*Beat the Street*" will lead to long term behaviour change and benefit health (Coombes & Jones, 2016). There is already evidence of success with "*Beat the Street*" participants showing sustained behaviour change (Intelligent Health, 2016) from which Fig. 2 is taken. This shows that "*Beat the Street*" increased physical activity in the first phase of the game (2014) and that one year later, people had become even more active showing the gamification scheme had activated intrinsic motivation to achieve long term behaviour change.

### 3.2. Utility theory

As identified above (Fig. 1), gamification is a mediator between motivations for an intervention and the achievement of behaviour change. Individual behaviour is all about personal preference and choice and decision making serves as the foundation on which utility theory rests (Fishburn, 1970).

The literature on different utility theories have developed over time from the neoclassical approach of utility maximization, through expected utility theory to the more recent prospect theory. Utility theory has been much expanded in fields, outside transport and mobility to more closely relate it to observed behaviour. However, extending utility theory in transport and mobility fields is more problematic because of the spatial and temporal contexts.

Expected utility theory grew out of a need to understand risky behaviour which is not explained by the neoclassical framework and
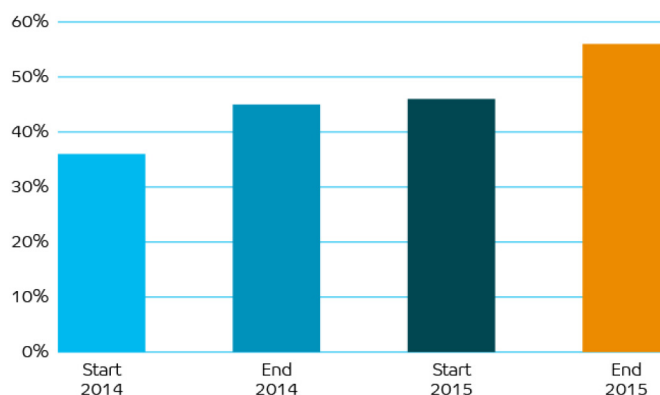


**Fig. 2.** The percentage of participants who reached the UK government's target for physical activity of 150 min a week in Reading over 2014–2015. Source: Intelligent Health (2016).

covers risk and uncertainty (Kahneman & Tversky, 1979), how a person's sense of self affects decisions (Akerlof & Kranton, 2000) and the impact of non-consumed goods in the utility function (Loewenstein, 1999). The evidence shows that individuals are not good at estimating unlikely events and may overestimate an unlikely positive gain such as with a lottery or underestimate the possibility of failure of a project important to them showing an asymmetry in behaviour towards gains and losses (Rieger & Wang, 2006). This seems particularly true when people need to make decisions about uncertain prospects which have small probabilities of occurrence or small prospects.

As neoclassical and expected utility theories have struggled to really explain behaviour, the seminal paper introducing prospect theory by Kahneman and Tversky (1979) and extended by Tversky and Kahneman (1992) is a descriptive approach to explaining behaviour, in contrast to the optimization or normative approaches that preceded it. This theory appears to be better at explaining how gamified schemes might work since prospect theory suggests that individuals make decisions based on the possible value of gains and losses rather on what actually happens in the final outcome and that the decisions are made following a number of 'rules' or heuristics. The heuristics underpin the framing process which determines equivalent outcomes which are then defined as either gains or losses by the individual, depending on their chosen reference point. It relates to utility theory because the individual behaves as if a utility has been computed for each of the outcomes with the highest utility outcome being chosen. Individuals typically find losses more unpleasant than they find gains good so the value function that passes through a reference point (shown in Fig. 3 as the origin) is asymmetric - it is steeper for losses than for gains. Of course, there is no single value function as the heuristics mean that different individuals will have different reference points and therefore make different decisions. The way in which prospect theory describes individual behaviour suggests that it is a good theory for underpinning the development of personal behaviour choice within gamification schemes and this is demonstrated in the case study which follows.

### 3.2.1. Case Study 2: public transport - INSINC

The Singaporean *INSINC* program[2] introduced in 2012 a gamified approach in a six month trial to try to shift travelers out of the peak period to resolve capacity issues. Additional incentives were provided to users who find 'friends' to join them providing social connectedness. This section shows how prospect theory can be used to explain the successful results of the *INSINC* program in terms of two important design elements, the reward type and the social connectedness (the importance of social connectedness was discussed in Section 3.1).
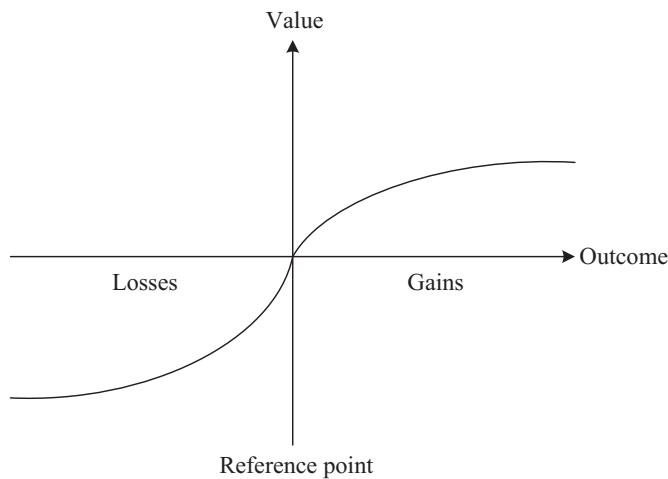
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Value



**Fig. 3.** Value function of CPT.

*INSINC* provides two reward types, including random, raffle-like rewards (e.g., lotteries), and personalised offers (e.g., guaranteed rewards that can be redeemed by the points that participants collect through the game). Around 87.6% of participants preferred the raffle option over certain payment (Pluntke & Prabhakar, 2013). Prospect theory describes why this might be so. Participants are framing the equivalent outcomes and then choosing relative to a personal reference point. For 87.6% of participants choosing raffle option they are behaving as though this is for them a higher utility outcome based on potential rewards rather than final outcomes. The remaining participants, the minority, would in prospect theory terms be using different heuristics, identifying a different reference point, reflected in a different value function where the guaranteed option is better. For game designers the skill is how to set the rewards so that gaming appeals to participants – clearly achieved in the *INSINC* program.

The *INSINC* program was judged as a success with the trial shifting 7.49% of peak demand. Indeed the success seems to be the combination of the two design features: social connectedness created by allowing 'friends' to join and the way in which rewards were enhanced by the presence of these friends.

### 3.3. Gamification in transport

Transport is characterised as a derived demand as transport is demanded to allow consumption at the destination e.g., work, study or leisure activity. An effective gamification scheme in the transport field needs to consider how to incorporate transport as a derived demand.

Fig. 4 illustrates how the derived nature of demand for transport affects the design of gamification. For the direct demand of goods and services such as services provided within a club, a gamified framework can be designed to be orientated around their consumption. However, in the context of changing travel behaviour, gamification can be designed either to impact on the derived demand itself and/or the end point activity for which transport is demanded.

In practice therefore, policy makers have choices in the implementation of gamification in the transport context. A gameful design to enhance an intervention in the transport arena where a derived demand is present can either target the activities that generate the travel behaviour (i.e., the undertaking of the travel to consume activity at the destination) or find some way of gaming transport as part of a bundle of 'goods' including the goods or services being consumed at the end of the travel. For example, if traffic congestion relief is the goal of policy makers, there can be two different designs. First, a gamification scheme could be designed for public transport to substitute for an individual driving their private car; in this case the game elements would need to focus on all variables that relate to travel behaviour, e.g., travel cost,

travel time, travel modes. On the other hand, the gamification scheme could be designed to work with the bundle of travel and the consumption of goods/services at the end of travel; the game structure could then be framed around using public transport as access, e.g., to a football match, bundled with a football match ticket giving, for example, an entry into a lottery for a cash prize/tickets for the next match. In both cases gamification is providing the incentive for providing a public transport experience as an alternative to the private car for car users which have in practice been shown to be successful in achieving change (Abou-Zeid & Fujii, 2016; Ben-Elia & Ettema, 2011).

Gamification in general requires opt-in action by the individual as a fundamental requirement for participation but physical participation sometimes is not necessary for a pure game. An example of a non-physical game component, some social network platforms, such as LinkedIn, provides a progress bar and affirmatory messages as people enter key personal details. They do this in order to increase the perceived value of filling in all the details, making use of progress-related psychological tendencies (Huotari & Hamari, 2017). Gamification in transport is different because travel is an embodied experience requiring participants to opt-in and physically 'play' by changing their personal travel. Research has not yet identified how the need for physical participation changes either a person's experience of a game, or whether games may change the lived experience and cultural geography of travel but as more transport gamified applications are put in place, this will become more apparent.

The next section brings together the discussions above to provide a framework for the design of gamified interventions in the transport domain. This is illustrated by reference to case studies of gamified interventions.

## 4. Proposed gamification framework

Fig. 5 shows the proposed gamification framework. This extends Fig. 1 by showing the links between the base theories of motivation and utility and gamification. Motivation theory, including intrinsic and extrinsic motivation, helps to provide the underpinning for the design of a gamification scheme with prospect theory being used to understand the way in which participants make decisions that change behaviour. Finally, every designed framework should have a feedback mechanism, where the evaluation of behaviour can revise the motivational design, in order to better create incentives for individuals to achieve policy goals. In summary, Fig. 5 shows the starting point of a gamification scheme design would be "Motivation for Change". After all, to be motivated means to be moved to do something (Ryan & Deci, 2000a). Therefore, motivation theory is used to identify suitable intrinsic or extrinsic motivations as inputs to the gamification design. On the other side of the diagram, utility theory is added as an input to evaluate behaviour change under the derived demand for transport.

To illustrate how this framework relates to practical examples, two case studies are presented to show this framework working in practice.

### 4.1.1. Case Study 3: active travel - PASTA project

The EU-funded project *PASTA* (Physical Activity Through Sustainable Transport Approaches)[3] provides an illustration of the first part of the framework (i.e., from motivation for change to gamification). The *PASTA* project promotes active mobility (walking and cycling). Instead of doing a direct trial as in *Beat the Street*, discussed above, *PASTA* focused on identifying a set of objectives and identifying participant opinions. The *PASTA* project had three phases, including identifying the indicator set, workshops & interviews with stakeholders, and finally a survey in seven EU cities. The purpose of identifying the
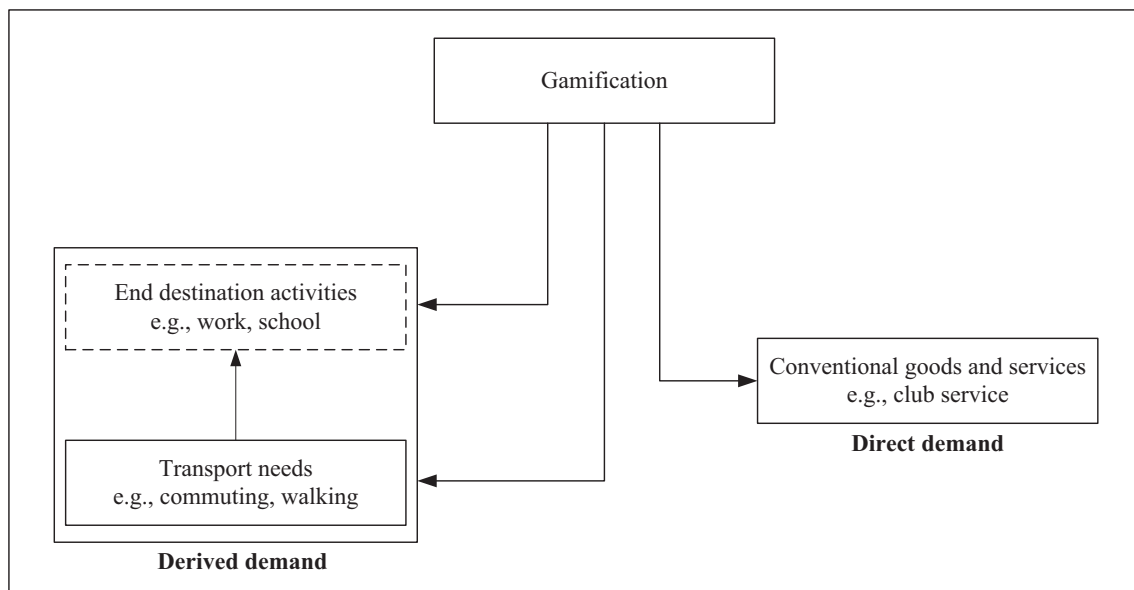
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[3] http://www.pastaproject.eu/home/.

**Fig. 4.** Gamification on direct and/or derived demand products and services.
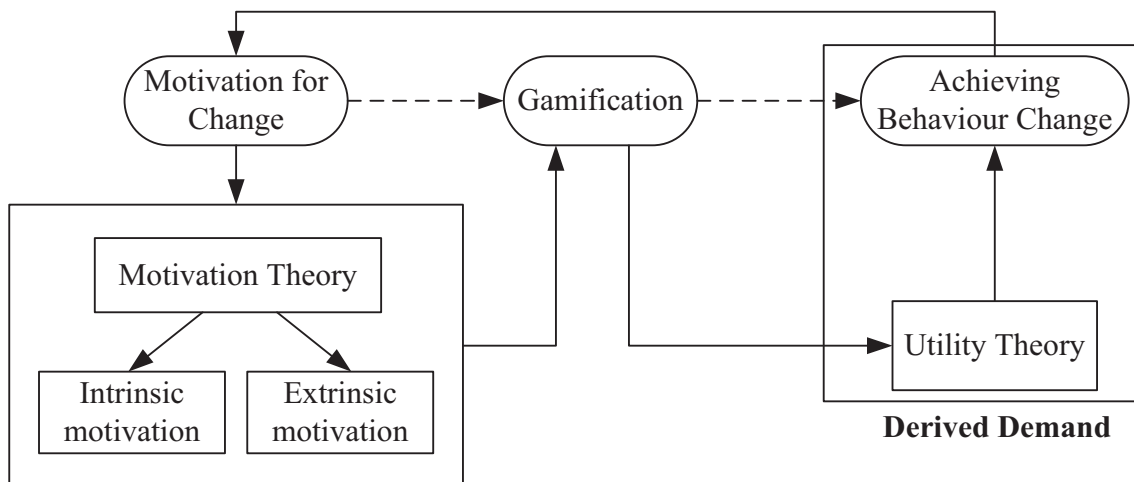


**Fig. 5.** Proposed theoretical framework for gamification in transport.
Note: ------► refers to elements presented in Fig. 1

indicator set was to provide a consistent and common standard to evaluate active mobility initiatives. The second third phases of the project aim to find out which initiatives would be best suited for both the project and its participants. In other words, these latter two phases are trying to find which initiatives will motivate participants best and this is the first part of the proposed theoretical framework in Fig. 5. As the project has not released the deliberations to identify the set of motivations cannot be reviewed but it is clear that the first stage of gamification design was undertaken.

*4.1.2. Case Study 4: road safety - S-Drive*
S-Drive is a program that was developed in 2014 by Samsung and Leo Burnett in Sydney to incentivise young drivers to have safer driving behaviour. S-Drive was directly tied to smartphone use since the program designers believed this to be the strongest connection point to the young driver.[4] S-Drive awarded points for staying below the speed limit and not using a phone whilst driving as well as introducing a "social component" of "Drive Team" for participants to team up with three

friends to earn team only rewards through a chosen social media platform such as Facebook thus introducing social connectedness.
Fig. 6 maps the S-Drive to the framework of Fig. 5. The desired behaviour change in S-Drive is for young drivers to drive more safely. Fig. 5 shows three components to the proposed theoretical framework, including motivation for change, gamification and achieving behaviour change. For the first component, "motivation for change", the S-drive program pre-determined each scheme element, such as the award types or game rules. For the second component of "gamification", the game rules (i.e., point collecting for desired behaviour) and the implementation technology (i.e., smart phone app) are also pre-determined by the scheme. For the third component, achieving behaviour change, the S-Drive program introduced a social component to the game that allowed participants to team up with self-selected friends to play the game. This social effect needs to be considered in the behaviour change analysis, especially in the adoption of an analysis using utility. Unfortunately, the, S-Drive program does not report much in the way of specific project results but only states the general results as "The S-Drive app is already working where it has been piloted in the Hunter region, New South Wales. So far, there are 4500 active users and over 25,000 rewards have been redeemed. Over 3,000,000 safe kilometres

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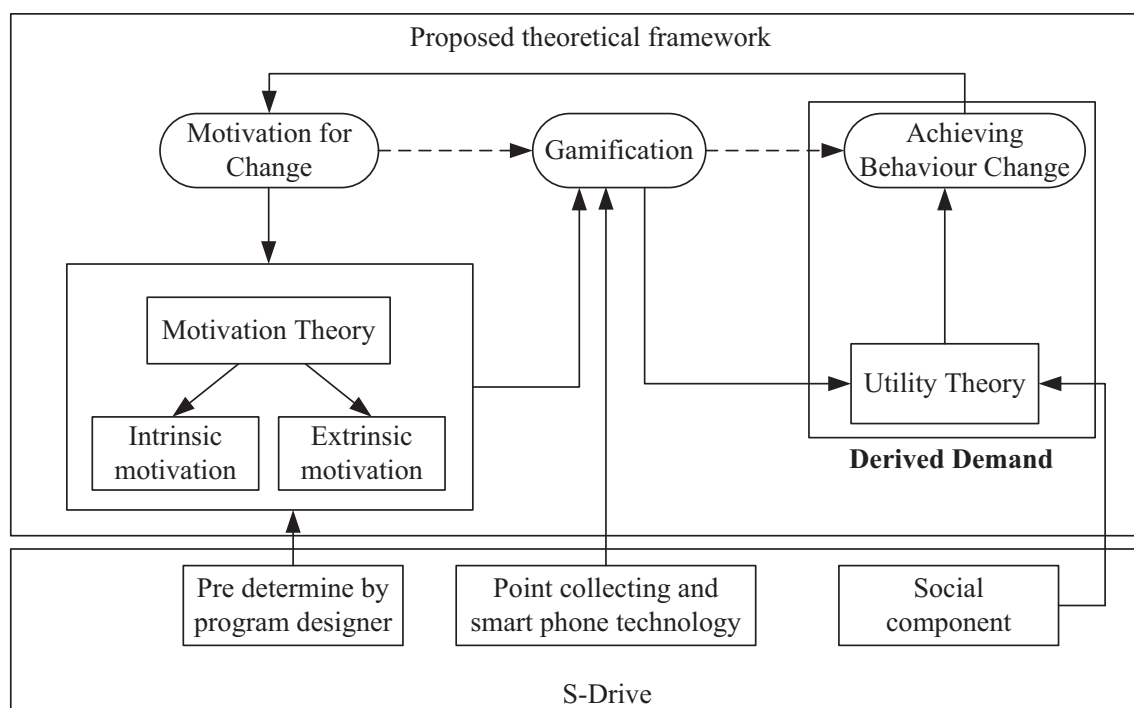[4] https://www.leoburnett.com.au/Sydney/Case-Studies/samsung-s-drive.

Fig. 6. S-Drive in proposed gamification framework.

have been travelled by users, with crashes in the region down by 25% and fatalities down by 20%. This has resulted in the region's death toll from car accidents dropping to the lowest it has been since 1936!"[4]. These statements do not reveal what behaviour change has actually been achieved and with what theory the results are analysed and a simple statement reporting accident rate change cannot guarantee that the program is effective. The S-drive project would fit more clearly into the framework of Fig. 5 if the design was known to consider aspects of motivation theory to identify how to better motivate the participants as this would give a clearer link for the motivation change and outcome. In addition, a behaviour change analysis is needed for a better evaluation of the program and to identify to what extent it meets the framework identified in Fig. 5.

In the gamification design stage, the S-Drive adopted a smartphone as the major tool to allow young drivers to play the game seeing this as the connection to young drivers. The choice of platform to implement the scheme must be carefully addressed in the design stage in order to link to motivational constructs. The S-Drive, like the *INSINC* program, discussed above, introduced social connectedness to create peer support and enhance behaviour change. However, the framework suggests that an improved program would include a feedback loop which the final part of the framework identifies as being necessary to promote long-term sustainability of outcomes.

*4.1.3. Case Study 5: active travel*

Gamified design has been used in the health field to transform people's health and physical activity levels. This section examines three key examples to look at design against the framework presented in Fig. 5 and to highlight where further action might enhance travel behaviour change (Table 1).

The *Beat the Street* initiative is discussed in Section 3.1 and is not discussed further here. This section focuses on another active travel initiative: the *Active School Travel Program* run by Brisbane City Council (BCC) in Queensland, Australia. This program has successfully converted 35% of single-family car trips to participating schools to an active and healthy transport mode (Brisbane City Council, 2016). Similarly, the Department of Transport and Main Roads *Healthy Active*

*School Travel* (HAST) program has been built on similar previous programs to deliver a set of gamified interventions across other Queensland local governments. For the gamification stage, non-pecuniary "leaderboards" rewards are used to introduce one of very important game elements of competence.

A series of previous studies based on children's and parent's self-reported behaviour change have noted the efficacy of these programs and they have been praised for also encouraging children's independent mobility, and not just physical activity (i.e., Deloitte Australia, 2015; Moghtaderi, Dodson, & Burke, 2012). Separate from any self-report data, and contrary to national trends, the Queensland Household Travel Survey revealed a significant drop in the number of children who were driven to school by private car between 2007 and 2009. Car travel declined by 11% (64% to 53%) during the period of mass roll-out of these school interventions (Department of Transport and Main Roads, 2012), which suggests that these programs have had strong system-wide efficacy in changing travel behaviours.

Analysing these case studies shows the links to the framework of Fig. 5. The motivations for change are clear with the intention of increasing more active travel and reducing car access to school. As with the S-Drive case study, the gamified design elements are pre-determined without any information as to whether motivational theory was considered and the outcomes might have been even better if some pre-trial analysis, such as the workshop, interview or survey in *PASTA* project, had been introduced or, given that this is an on-going program, could be introduced to enhance future travel behaviour change. In addition, after-program monitoring to provide information for the feedback mechanism (from behaviour change achievement to motivation to change) is not part of the planned intervention but could still be implemented to allow the game framework to be modified to better target or motivate specific groups of people.

**5. Summary of case studies**

Although here are few case studies in the transport and mobility fields of a gamified branded approach, there are interventions which have used a gamified approach to achieve behaviour change. This

**Table 1**
Examples of gamification (trial) programs in active travel.

| Program name | Year(s) | Department/country | Contents | Gamified design |
|---|---|---|---|---|
| Brisbane City Active School Travel Program (AST) | 2004–current | Brisbane City Council, Queensland, Australia | Tailored program (using school travel planning) targeting primary school students and parents to leave the car at home and walk, cycle, scooter, carpool or take public transport to school; delivered via local government to a rolling sub-set of schools annually; low technology | Competition between children, classrooms, years and schools; leaderboards compiled and reported at all competition levels; low-cost rewards like stickers. |
| Healthy Active School Travel (HAST) | 2011–2014 | Department of Transport and Main Roads, Queensland, Australia | Tailored program differing slightly across participating local governments; rolling sub-set of schools; targets sustainable and active travel mode shift; low technology. | Competition between children, classrooms, years and schools; leaderboards compiled and reported at all competition levels; low-cost rewards like stickers. |
| Beat the Street | 2014–2015 | Reading, UK[a] | Encourages communities to undertake increased physical activity | Players organised into teams; players and groups accrue points as they travel, progressing towards fun targets; low-cost or ephemeral rewards. |

[a] Beat the Street was initially trialled in the city of Reading, UK and has been implemented across neighbourhoods in London, UK; New York, USA; Shanghai, China; and Vancouver; Canada (Coombes & Jones, 2016).

section summarises cases in three areas of transport and mobility discussed in this paper of active transport, public transport and road safety with the listed studies presented in Table 2.

Other than the *PASTA* project, all other interventions and/or projects in Table 2 share the same pre-design characteristics. If we link the case in public transport (*INSINC*) to the proposed framework (Fig. 5), there are some interesting findings. First, the game rules and rewards. Such as raffle-like rewards or lottery-based game were predetermined. Being pre-determined it cannot be known whether these game rules or rewards are those which can motivate the participant the best. This is why it is important to explore participants' preferences before finalising the game design, as with the *PASTA* project. Second, in terms of behaviour measurement, the *INSINC* scheme uses risk as one of its game elements without taking account of the way individuals may exhibit different risk profiles. Without taking the "risk attitude" into account means that the final evaluation might be biased.

Unlike the *INSINC* case in public transport, the cases in active travel do not use "risk" in the "leader boards" game design to introduce the very important game element of competence. Mapping the active travel case studies to the framework of Fig. 5, the issue of how to further motivate participants is clear. These cases appear very successful, especially for *Beat the Street* program where longer term effects are observed after the program is finished. In the other words, whilst the motivations might have been extrinsically designed, participants have been motivated intrinsically as a result of finding quality in their new travel behaviour.

In terms of road safety, most of gameful interventions are tied to and delivered via new digital technologies, normally a smart phone app. Apps may be particularly useful to interact with the young learner or inexperienced driver cohort to incentivise safe driving behaviour, but efficacy is not yet fully understood, especially regarding gameful design. Very little evaluation is in the public domain, if undertaken at all. Commercial sensitivity prevents much information being available to the research community and this leaves transport agencies uncertain as to what they should be looking for or how they should proceed. More research is necessary to understand the critical elements that work to better motivate participants in this context.

Gamified interventions could also be used to target recidivist driver behaviour for other groups than the predominantly learner or young drivers. For example as an add-on or alternative option to licence demerit points or suspensions. As in other areas of transport policy, creative use of a gamified approach is likely to produce a litany of approaches, with their limitations identified over time and with successful elements being codified for more standardised use.

This summary shows that investigating these cases, which have some element of gameful design, against the framework of this paper shown in Fig. 5 provides a benchmark for better implementation of gamified design in transport and mobility contexts. The process of summary has highlighted how existing schemes are deficient and how these could be improved as well as providing guidance for future research into gamification. In particular, interventions in the transport and mobility context appear particularly weak on the feedback function because evaluation is rarely explicit in identifying how much of the behaviour change is made by the target group of the intervention.

## 6. Discussion and conclusions

Gamification has already seen some success in the transport field. The *INSINC* program in Singapore shifted 7.49% peak demand to off-peak periods. The important questions confronting transport agencies are not if and how gamification works, but where it may be useful, what the limitations may be and how to design successful interventions. This is especially important as more is understood about the end results than the causal pathway to achieving these results. This paper provides key starting points and a framework for designing gamified approaches, grounded in motivation and utility theory.

**Table 2**
Examples of travel behaviour change programs with gamification elements in the transport and mobility fields.

| Field | Scheme name | Country | Reward type | Content |
|---|---|---|---|---|
| Public transport | INSINC (2012) | Singapore | Monetary | A project that manages peak demand by incentivising commuters to travel off-peak. |
| Active transport | Active School Travel (2004–current) | Australia | Non-monetary | Tailored program (using school travel planning) targeting primary school students and parents to leave the car at home and walk, cycle, scooter, carpool or take public transport to school; delivered via local government to a rolling sub-set of schools annually; low technology |
| | Healthy Active Travel (2011–2014) | Australia | Non-monetary | Tailored program differing slightly across participating local governments; rolling sub-set of schools; targets sustainable and active travel mode shift; low technology. |
| | Beat the Street (2014–2015) | UK | Non-monetary | Encourages communities to undertake increased physical activity |
| | PASTA (2013–current) | EU | – | The PASTA project aims to show how promoting active mobility (i.e. walking and cycling) can lead to a healthier, more physically active population. |
| Road safety | S-Drive (2014) | Australia | Non-monetary | By installing the S-Drive app on a smartphone and driving safely, participants can earn points that can be used to redeem rewards. |
| | GAMETUNED (2011) | UK | Monetary | A car insurance premium scheme to encourage drivers to have safer driving behaviour. |
| | Pay-As-You-Drive vehicle insurance (2005) | Dutch | Monetary | Insurance premiums are directly based on a multitude of risk factors, including driving volume (mileage) and style (e.g. speed, acceleration, deceleration), as well as other factors (e.g. time of driving) (Bolderdijk, Knockaert, Steg, & Verhoef, 2011). |
| | Return insurance premium scheme (2002) | Norway | Monetary | The participants in this intervention received a 'starting bonus' in an account; for each minute that they drove faster than the limit, an amount was deducted from this starting bonus; at the end of the month the participant received the remaining amount of the bonus. |
| | SmartDrive (current) | New Zealand | Monetary | By using the SmartDriver app, drivers can save up to 20% on car insurance. |

How to motivate participants is an essential part of any gamification framework. Motivation can come internally (intrinsic to the individual) or be created by external 'push' or rewards (extrinsic motivation). A well-designed gamification program should harness intrinsic motivations that are created and measured via extrinsic motivations. How to define and identify critical motivation is a key element which in many interventions, as shown above, are not based on understanding the participants motivations. The *PASTA* project as an example, conducted several workshops & interviews as well as undertaking a survey in seven EU cities so as to understand what stakeholders/policy makers can offer and what participants want as a way of understanding how participants can be motivated.

The cases described above show there are several ways to amplify the intrinsic value. Some interventions (e.g., *INSINC*) use monetary incentives. Whilst monetary incentives are not necessarily bad, Zichermann (2011) argues that monetary incentives can reduce participants' sense of intrinsic desire and so these need to be carefully designed if they are not to reduce the performance of a gamified approach. In other words, monetary incentives do motivate people with a significant impact but once the monetary incentives stop, participants tend to move back to their original behaviour suggesting that monetary based games work more on extrinsic motivation which is less likely to translate to lasting behaviour change. On the other hand, the few studies that adopted non-cash incentives (for example leader board competitions and prizes in the *Active School Travel* program) have found that they can increase intrinsic motivation so longer-term effects are observed. This is also seen with the *Beat the Street* program. How to design intrinsic motivation by using extrinsic motivators is a critical area in gameful design, including the determination of whether monetary or non-monetary incentives should be adopted. Separately, the role of social connectedness needs to be better understood although it is clear that interventions that provide this appear to amplify the intrinsic motivation. Research in understanding how to provide greater intrinsic motivation is progressing with theoretical investigations (Marcucci et al., 2016 or Olarte & Haghani, 2016) or practical applications such as with the *PASTA* project but more is required in the area of social connectedness.

In this paper, gamification has been discussed as being a supportive way to meet policy goals. However, care must be taken to ensure a positive outcome. For example, *Strava*[5] provides a social network for active travelers but the service can, through encouraging racing via

leader boards, inadvertently encourage cyclists to ride unsafely on particular street networks. It is clear that technology developments will help to provide a gamified future and there are already many privately developed apps that are supportive and those which include user information, such as *Moovit* which could be harnessed to provide gamification.

Whilst gamification can be a powerful tool to change participants' behaviour, little discussion has been given to who pays for the incentives, especially when it comes to monetary rewards. If schemes are shown to be effective and outcomes can be tied to public transport operator business travel plans, or agency operational plans, then gamification and the incentives used in such schemes may be underwritten through savings. However, in areas such as road safety, it is likely savings will accrue to other agencies (e.g., health, insurance) rather than among licensing or road authorities. As such, it does seem inevitable that public agencies will need to invest in gamified approaches as policy instruments in much the same way in which current TDM schemes are funded. The advantage of a gamified framework with a set cap on incentives is, however, that the funding outcome is at least certain for the funder, if not for the players.

Gamification is a rapidly growing field and a limitation of this paper is that new interventions may not have been captured. Moreover, the framework provided needs to be tested by reference to new trials and pilot schemes. Low-cost trials can help identify which motivations and/or games are preferable, how schemes may be organised, who should run them, what should be the target group, how the heterogeneity of individuals can be managed within a gamified program and in what way and what is possible – and what is not possible – to achieve. Lessons learned can fine-tune the transport interventions for optimal results in full scale implementation.

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[5] https://www.strava.com/.

# References

Abou-Zeid, M., & Fujii, S. (2016). Travel satisfaction effects of changes in public transport usage. *Transportation, 43*(2), 301–314.

Akerlof, G. A., & Kranton, R. E. (2000). Economics and identity. *The Quarterly Journal of Economics, 115*, 715–753.

Baranowski, T., Buday, R., Thompson, D. I., & Baranowski, J. (2008). Playing for real: Video games and stories for health-related behaviour change. *American Journal of Preventive Medicine, 34*, 74–82.

Ben-Elia, E., & Ettema, D. (2011). Changing commuters' behavior using rewards: A study of rush-hour avoidance. *Transportation Research Part F: Traffic Psychology and Behaviour, 14*(5), 354–368.

Bittner, J. V., & Shipper, J. (2014). Motivational effects and age differences of gamification in product advertising. *Journal of Consumer Marketing, 31*, 391–400.

Blohm, I., & Leimeister, J. M. (2013). Gamification: Design of IT-based enhancing services for motivational support and behavioral change. *Business & Information Systems Engineering, 5*, 275–278.

Bolderdijk, J. W., Knockaert, J., Steg, E. M., & Verhoef, E. T. (2011). Effects of pay-as-you-drive vehicle insurance on young drivers' speed choice: Results of a Dutch field experiment. *Accident Analysis & Prevention, 43*(3), 1181–1186.

Brisbane City Council (2016). Active School Travel Program. http://www.brisbane.qld. gov.au/traffic-transport/public-transport/school-transport/active-school-travel-program, Accessed date: 17 March 2016.

Caillois, R. (2001). *Man, play and games.* Urbana, Chicago: University of Illinois Press.

Calder, B. J., & Staw, B. M. (1975). Self-perception of intrinsic and extrinsic motivation. *Journal of Personality and Social Psychology, 31*, 599–603.

Coombes, E., & Jones, A. (2016). Gamification of active travel to school: A pilot evaluation of the Beat the Street physical activity intervention. *Health & Place, 39*, 62–69.

Crawford, C. (1984). *The art of computer game design.* Berkeley, CA: McGraw-Hill/Osborne Media.

Cugelman, B. (2013). Gamification: What it is and why it matters to digital health behaviour change developers. *Journal of Medical Internet Research Serious Games, 1*, e3.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology, 22*, 1111–1132.

Deci, E. J., & Ryan, R. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*, 109–134.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*, 627–668.

Deloitte Australia (2015). *Evaluation of Healthy Active School Travel (HAST) initiative summative report: June 2015.* Brisbane, Australia: Deloitte Touche Tohmatsu Limited.

Denny, P. (2013). The effect of virtual achievements on student engagement. *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 763–772). .

Department of Transport and Main Roads (2012). *Travel in South-East Queensland: An analysis of travel data from 1992 to 2009.*

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". *Proceedings of the 15th International Academic MindTrek conference: Envisioning future media environments* (pp. 9–15). Tampere, Finland: ACM.

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). Gamification: toward a definition. *Proceedings of the CHI 2011 gamification workshop proceedings. Presented at CHI 2011.* Vancouver, BC: ACM.

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification: Using game-design elements in non-gaming contexts. *Proceedings of the 2011 annual conference extended abstracts on human factors in computing systems* (pp. 2425–2428). Vancouver, BC: ACM.

Dolnica, S., Grabler, K., Grun, B., & Kulnig, A. (2011). Key drivers of airline loyalty. *Tourism Management, 32*, 1020–1026.

Erenli, K. (2013). The impact of gamification-recommending education scenarios. *International Journal of Emerging Technologies in Learning (iJET), 8*, 15–21.

Fishburn, P. C. (1970). *Utility theory for decision making. No. RAC-R-105.* McLean VA: Research Analysis Corp.

Foster, J. A., Sheridan, P. K., Irish, R., & Frost, G. S. (2012). Gamification as strategy for promoting deeper investigation in a reverse engineering activity. *Proceedings of the 2012 American Society for Engineering Education conference* (pp. AC2012–AC5456). .

Gilbert, D. C. (1996). Relationship marketing and airline loyalty schemes. *Tourism Management, 17*, 575–582.

Groh, F. (2012). Gamification: state of the art definition and utilization. *Proceedings of the 4th seminar on research trends in media informatics*.

Hamari, J. (2013). Transforming homo economics into Homo Ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. *Electronic Commerce Research and Applications, 12*, 236–245.

Hamari, J., & Lehdonvirta (2010). Game design as marketing: How game mechanics create demand for virtual goods. *International Journal of Business Science and Applied Management, 5*, 14–29.

Hennessey, B. A., & Amabile, T. M. (2005). Extrinsic and intrinsic motivation. *Blackwell Encyclopedic Dictionary of Organizational Behavior, 1*, 3–23.

Holbrook, M. B. (1999). *Consumer value: A framework for analysis and research.* Psychology Press.

Huizinga, J. (2000). *Homo Ludens: A study of the play-element in culture.* London, UK: Routledge.

Huotari, K., & Hamari, J. (2017). A definition for gamification: Anchoring gamification in the service marketing literature. *Electronic Markets,* 1–11.

Intelligent Health (2016). Intelligent Health: Evidence. http://www.intelligenthealth.co. uk/evidence/, Accessed date: 16 March 2016.

Intelligent Health (2017). Intelligent Health: Evidence. https://www.beatthestreet.me/ UserPortal/Default, Accessed date: 25 May 2017.

Jones, B. A., Madden, G. J., & Wengreen, H. J. (2014). The FIT game: Preliminary evaluation of a gamification approach to increasing fruit and vegetable consumption in school. *Preventive Medicine, 68*, 76–79.

Juul, J. (2003). The game, the player, the world: Looking for a heart of gameness. *Level up: Digital games research proceedings. Presented at the level up: Digital games research conference* (pp. 30–45). Utrecht: Utrecht University.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*, 263–292.

Kohn, A. (1999). *Punished by rewards: The trouble with gold stars, incentive plans, A's, praise, and other bribes.* Houghton Mifflin Co.

Lepper, M., Greeme, D., & Nisbett, R. (1973). Understanding children's intrinsic interest with extrinsic reward: A test of the "overjustification" hypothesis. *Journal of Personality and Social Psychology, 28*, 129–137.

Li, W., Grossman, T., & Fitzmaurice, G. (2012). GamiCAD: A gamified tutorial system for first time AutoCAD users. *Proceedings of the 25th annual ACM symposium on user interface software and technology* (pp. 103–112). .

Liu, Y., & Yang, R. (2009). Competing loyalty programs: Impact of market saturation, market share, and category expandability. *Journal of Marketing, 73*(1), 93–108.

Loewenstein, G. (1999). *Because it is there: The challenge of mountaineering… for utility theory.* 315–343 (Kyklos52.3).

Lucassen, G., & Jansen, S. (2014). Gamification in consumer marketing - future or fallacy? *Procedia - Social and Behaviour Sciences, 148*, 194–202.

Marcucci, E., Valerio, G., & Le Pira, M. (2016). Gamification design, stakeholder engagement and behavior change in urban freight transport. *Proceedings of the world congress in transport research, Shanghai*.

Miller, A. S., Cafazzo, J. A., & Seto, E. (2014). A game plan: Gamification design principles in mHealth applications for chronic disease management. *Health Informatics Journal.* https://doi.org/10.1177/1460458214537511.

Moghtaderi, F., Dodson, J., & Burke, M. (2012). A systematic review of children's travel behaviour change programs in Australia. *35th Australasian transport research forum proceedings.* Australia: WA Department of Transport.

Mora, A., Riera, D., Gonzalez, C., & Arnedo-Moreno, J. (2015). A literature review of gamification design frameworks. *Proceedings of 7th international conference on games and virtual worlds for serious applications (VS-games)* (pp. 1–8). .

Nelson, M. J. (2012). Soviet and American precursors to the gamification of work. *Proceedings of the 16th International Academic MindTrek conference. Presented at MindTrek'12* (pp. 23–26). ACM.

Olarte, R., & Haghani, A. (2016). Introducing and testing a game-theoretic model for a lottery-based metering system in Minneapolis, United States. *Proceedings of the world congress in transport research, Shanghai*.

Pluntke, C., & Prabhakar, B. (2013). *INSINC: A platform for managing peak demand in public transit. JOURNEYS, Land Transport Authority Academy of Singapore, Journeys, September 2013*.

Rey, D., Dixit, V. V., Ygnace, J. L., & Waller, S. T. (2016). An endogenous lottery-based incentive mechanism to promote off-peak usage in congested transit system. *Transport Policy, 46*, 46–55.

Rieger, M. O., & Wang, M. (2006). Cumulative prospect theory and the St. Petersburg paradox. *Economic Theory, 28*, 665–679.

Ryan, R. M., & Deci, E. (2000b). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54–67.

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.

Ryan, R. M., Rigby, C., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30*, 344–360.

Salen, K., & Zimmerman, E. (2004). *Rules of play.* Cambridge, MA: MIT Press.

Scott, W. E., Farh, J., & Podaskoff, P. M. (1988). The effects of "intrinsic" and "extrinsic" reinforcement contingencies on task behavior. *Organizational Behavior and Human Decision Processes, 41*, 402–425.

Seaborn, K., & Fels, D. (2015). Gamification in theory and action: A survey. *International Journal of Human-Computer Studies, 74*, 14–31.

Simões, J., Redondo, R. D., & Vilas, A. F. (2013). A social gamification framework for a K-6 learning platform. *Computers in Human Behavior, 29*, 345–353.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*, 297–323.

Yilmaz, H., & Coskun, I. O. (2016). *New toy of marketing communication in tourism: Gamification. e-Consumers in the era of new tourism, managing the Asian Century.* Springer53–71.

Zichermann, G. (2011). *Intrinsic and extrinsic motivation in gamification [WWW document].* Gamification Co. URL: http://www.gamification.co/2011/10/27/intrinsic-and-extrinsic-motivation-in-gamification/, Accessed date: 4 July 2016.

Zichermann, G., & Linder, J. (2010). *Game-based marketing: Inspire customer loyalty through rewards, challenges, and contests.* Hoboken, NJ: Wiley.