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Research paper

Understanding the potential policy transfer of gamification schemes for behaviour change in public transport and road safety

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ABSTRACT

There is a long history in transport of implementing travel demand management (TDM) to manage users' behaviour. Recently, gamified interventions have been proposed as a better way to incentivise users to participate in TDM interventions. The concept of gamified design uses game design elements in non-game contexts. However, transport is complex and diverse and it is not clear whether gamified design is transferable between different transport applications such as increasing public transport use and improving road safety. The research question of this study is to investigate policy transfer effects of different gamified design applications. In order to explore this research question, this study designed two stated preference surveys with the same gamified design concepts but applied in two fields, including public transport with the aim to relieve congestion and for young drivers with the aim to improve road safety. Both surveys are held in Queensland, Australia. A multinomial logit modelling approach was used for both case studies. The marginal effect results were cross compared to draw out policy implications and potential policy transfer effects. The paper concludes that some users' attitudes and perceptions are transferrable, and gamified schemes are not particularly favoured. In particular, it is clear that irrespective of transport field, the design of a scheme for vehicle users must understand participants' intentions and that this is more important than capturing their beliefs.

1. Introduction

Transport planners, policy makers and operators are constantly searching for low-cost solutions to transport problems, such as peak hour congestion, peak loading and road safety. Travel demand management (TDM) has long been implemented in transport to manage users' behaviour, such as travel behaviour or driving behaviour (Gärling et al., 2002; Gärling & Schuitema, 2007; Meyer, 1999).

In order to motivate target users to change their behaviour, TDM schemes are typically presented as a package (Yen et al., 2019). In the early days, TDM was mainly used to decrease the demand for private vehicle use due to the presence of significant negative environmental impacts, such as congestion, noise, and air pollution (Gärling & Schuitema, 2007; Garling & Schuitema, 2007; Kitamura, Fujii, & Pas, 1997). Given the effectiveness of TDM in vehicle management, TDM has been implemented as a strategy package in multiple fields to address different travel behaviours, such as parking management (e.g., Petiot, 2004), traffic congestion relief (e.g., Logan, Nelson, Osbeck, Chapman, & Hastings, 2020), driving safety (e.g., Yen, Fu, & Chiou, 2022), public transport management (Yen et al., 2015; Yen, Mulley, Tseng, & Chiou, 2018). There are many types of TDM strategies. Gamified design has been widely used in non-game contexts, in the education field for example, because it has been viewed to be a more effective way to motivate behaviour change to achieve TDM goals. This paper aims to investigate the effect of gamified design in two transport fields, including public transport and young driver safety, to understand the potential policy transfer effect.

For public transport, peak hour traffic congestion and overloading problems are often the most pressing issues for urban transport agencies. The most common TDM strategy to address this issue is off-peak discounts. For example, in Brisbane, Australia, TransLink[1] has a "go card" electronic ticketing system for public transport. Go cards allow passengers to travel on all TransLink bus, train, ferry and tram services in South East Queensland (SEQ). There are two go card TDM strategies: an off-peak discount policy, in which trips in off-peak periods receive an additional 20% saving off the standard go card fare, and a volume rebate

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[1] TransLink is a division within the Department of Transport and Main Roads in Queensland with statewide responsibility for mass transit.

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policy, in which travellers who make eight paid journeys in a week (Monday to Sunday) travel for half price for the rest of the week.[2] These two fare policies have a price discrimination strategy but for different purposes of reducing peak-hour travel demand and at the same time encouraging public transport use. Similar policies are applied in cities worldwide. There is long-standing research on differential fare policies (Glaister, 1974) and on service frequency adjustments (Jansson, 1993), capacity improvements (Arnott et al., 1993) and their efficacy. However, some research concludes that traditional TDM strategies only influence users' behaviour with very limited effect. Yen et al. (2015) used go card data in Brisbane to evaluate the policy effects of the two TDM fare policies. They observed that, even with these two fare policies, there is still a "peak in the peak" travel pattern and suggested that traditional TDM strategies of an off-peak discount and volume rebate did not really have significant effects in this case.

To understand how to improve the efficacy of TDM strategies, recent studies have investigated how "attitudes" and "perceptions", collectively known as "soft factors", might increase the incentive for individuals to change their behaviour, especially their perceptions of the built environment (Aditjandra et al., 2012, 2013, 2015; Cao et al., 2007, 2009; Handy et al., 2005). The purpose of incorporating elements of attitudes and perceptions into TDM strategies is to make the strategies more attractive and acceptable, and thus effective. There is increasing literature that investigates the use of game elements in TDM strategies, known as gamification, often defined as the use of game design elements in non-game contexts (Deterding et al., 2011). The basic concept of gamification is to introduce composite elements and social activities into behavioural interventions so participants can become "players" by changing their behaviour and TDM policy goals can be achieved (Yen et al., 2019). Working real trials of gamification schemes can be found, such as INSINC in Singapore and Beat the street in the UK. More gamification schemes are still at the research stage. In this paper, the stated preference surveys present gamified or gaming elements to the specific contexts to respondents.

Previous studies have generally focused on two research areas in gamification: conceptual framework development (Deterding et al., 2011; Huotari & Hamari, 2017; Yen et al., 2019) and empirical case studies (Bittner & Shipper, 2014; Denny, 2013; Jones et al., 2014; Nelson, 2012; Rey et al., 2016). Yen et al. (2019) argued that before a gamification scheme is developed, several design perspectives should be addressed 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 interventions have a solid foundation of theory underpinning their design.

There are few cases of implementing gamified design in public transport and road safety fields. Singapore's INSINC program (https://insinc.sg/) can be viewed as one of the earliest trials of gamified design in public transport. This scheme has successfully shifted 7.49% peak demand for commuters in a six-month research pilot, which was launched on January 10, 2012. For road safety, several private insurance companies developed different gamified schemes (e.g., SDrive in Sydney in 2015). Some self-report results can be found. Take SDrive as an example reported "Over 3,000,000 safe kilometres have been travelled by users, with crashes in the region down by 25% and fatalities down by 20%[3]". These results beg the question as to whether gamified design is transferable between different transport applications. This is the central policy issue addressed by this paper starting from the position that policy design is transferrable between different transport fields not least as it is common for different transport fields to have the same or similar groups of users. For example, high school students may be public transport users while also learning to become safe vehicle drivers. In this case, in school catchment areas, public transport and young driver safety issues might be highly related since they have a similar target group. A clear research gap can be identified: this is to identify how transferable a similar or identical gamified design is to different contexts and/or for different participants?

Previous studies have found that young generations have higher acceptance of gamified design (Yen et al., 2019). In order to understand how gamified design can motivate behaviour change in transport field, the objective of this paper is to investigate the policy transfer effect for TDM schemes with gamified design in two areas: public transport and road safety. The study designs two gamification schemes with stated preference (SP) surveys, with applications to public transport to relieve congestion and for young drivers to improve road safety in Queensland, Australia. In order to achieve this research aim, a multinomial logit modelling approach is Thused to investigate participants' intention to participate in a gamified or incentive-based TDM scheme. Multinomial logit modelling is designed for the analysis of multiclass problems so as to predict the probabilities of a categorically distributed dependent variable that forms a set of independent variables (Greene, 2012). The study uses two different SP surveys that each have a different set of scheme choices that form the independent variables of a multinomial logit model. More detailed model and variable settings are introduced in section 4.

The paper is structured as follows: the next section provides the literature context to understand TDM in the transport field and policy transfer and how it can be measured and assessed. This discussion is followed by the introduction of the survey design for improving public transport use and road safety, and the study area. Then, the methodology used in this paper is outlined before providing results and interpretation. Policy transfer effects are discussed next. Finally, the paper concludes with policy implications.

2. Literature review

2.1. Travel demand management

There is a long history of TDM being implemented to manage transport users' behaviour. Since the 1970s, TDM policy has been used in the United States at the federal and local levels to accommodate increasing travel demand within the existing urban transport system (Meyer, 1999). In Australia, public transport patronage is expected to double by 2031 (relative to 2006 levels) (Department of Transport and Main Roads, 2011), especially during peak travel periods (e.g., 7–9 am). Furthermore, "avoidable" social costs of traffic congestion for the eight Australian capital cities were approximately A$16.5 billion in 2015, having increased from A$12.8 billion in 2010 (Bureau of Infrastructure Transport and Regional Economics, 2015). To relieve peak congestion problems, TDM is used to move people more efficiently and reduce congestion, by shifting demand from peak to off-peak times. Several TDM strategies have been widely used to manage transport users' behaviour. and widely reported in the decade from 2000. This paper uses the framework proposed by Ison and Rye (2008) and summarised in Table 1 which gives four types of TDM measures aimed at influencing travel behaviour: economics, land use, substitution of communications for travel, and regulation.

The discussion of examples has focused on TDM in public transport. However, other areas in transport also use TDM to influence behaviour, such as road safety. A typical example is young driver safety which has long been a significant concern in road safety (Scott-Parker, 2015). Many policy initiatives and strategies have been proposed to improve young driver safety, such as young driver education training programs (Senserrick, 2007). Despite a number of policy initiatives, young drivers remain disproportionately represented in road accident deaths in Australia (Scott-Parker, 2015; Scott-Parker et al., 2015). Similar to TDM strategies in public transport, the purpose of these young driver policy

[2] TransLink go card user guide: https://translink.com.au/tickets-and-fares/fares-and-zones/discounts-and-ways-to-save/go-frequently-then-go-for-half.

[3] https://www.brisbanekids.com.au/using-phone-actually-make-safer-driver-s-drive-samsung/.

Table 1
TDM measures.

Type	Measures
Economics	• Fuel tax • Parking charges • Public transport subsidisation • Road pricing
Land use	• Land use and transport strategy such as car free developments • Park-and-ride facilities
Substitution of communications for travel	• Teleworking • E-shopping
Regulation	• Parking controls • Pedestrianised zones

Source: Adapted from Ison and Rye (2008).

initiatives and strategies is to change behaviour to meet a policy goal, which is safer driving behaviour. Public transport use and road safety behaviour may be considered very different areas. This argument is the starting point of this research: could TDM policies be transferred to different areas potentially given the policies may have the same target groups? The following section reviews previous literature on policy transfer to understand how to address behaviour issues while designing a policy tool.

2.2. Policy transfer for TDM

The concept of policy transfer is well-known. One definition by Dolowitz and Marsh (1996) defined policy transfer as 'a process in which knowledge about policies, administrative arrangements, institutions etc. In one time and/or place is used in the development of policies, administrative arrangements and institutions in another time and/or place' (p. 344). Indeed, most previous literature has discussed policy transfer by comparing policy impacts for different regions or countries to see if policy transfer happens (Bray et al., 2011; Olsen & Fearnley, 2014; Stead et al., 2008). Irrespective of how to measure policy transfer, it is clear that policy transfer can easily be influenced by different factors, such as the political situation, globalisation and governance structure. Marsden and Stead (2011) reviewed previous literature on policy transfer in transport. They concluded that policy transfer effects are highly influenced by the political process but, in general, policy transfer did happen, especially for those areas (e.g., European countries) with higher-level community support or belief that policy solutions are working. It is interesting to note that policy transfer has been widely discussed for a similar type of policy with similar goals. For example, Bray et al. (2011) used Australia as a case study to understand policy transferability. One of the findings was state governments in Australia tend to have similar transport policies for highly similar transport issues, such as traffic congestion. One reason for this policy transfer is that similar policy can avoid the need for justification of a particular approach or evidence and justification of it is already available.

Instead of focusing on spatial transfer of policy, Black and Schreffler (2010) investigated the effect of policy transfer from the aspect of integration planning, which integrates the policy needed to form sustainable urban transport strategies. They identified the importance of taking motivation into account when proposing TDM strategies since individuals tend to have permanent behaviour change if they have been motivated intrinsically rather than extrinsically. Behaviour analysis has played a key role in justifying why a particular TDM strategy worked or not. For some TDM transport policies that have been implemented in different transport fields but with the same design concepts, how behaviour change might be with the same gamified design? This is one of the research questions we aim to investigate. We have used the gamification concept to design two strategies for public transport and young driver behaviour change. We investigate whether potential policy transfer exists in this context.

2.3. Gamification in transport

TDM has long been implemented in transport to manage users' behaviour. Most examples aim to reduce private car use (Garling & Schuitema, 2007; Meyer, 1999; Taylor, 2007) or encourage more sustainable transport modes such as active transport, public transport or clean and green vehicles (Batur & Koç, 2017). However, decision makers and scholars are still looking for more effective TDM strategies. This suggests that current TDM strategies might work but we can do better. Recently, the very popular concept of "gamification" has been introduced in TDM as a design principle to create more fun, joyful or addictive elements in TDM strategy to improve engagement with participants. Gamification is defined as the "use of game design elements in non-game contexts" (Deterding et al., 2011). There are a few successful case studies in transport that have adopted gamified design. Examples include the UK's "Beat the Street" initiative that targeted active transport users to walk and cycle for health benefits or Singapore's INSINC program that is a gamified scheme to shift public transport demand from peak to off-peak shoulder times (Pluntke & Prabhakar, 2013). Gamification has attracted much attention.

The gamification concept can be adopted in different transport fields. From previous successful case studies, gamified design has been treated as one of the successful elements. In this case, gamification design might have one characteristic, policy transfer. For example, if policymakers design one "leader board point collection" gamified scheme for public transport users, policy transfer could occur if this game is then used for active transport or road safety users. The research question for this issue might be whether the same gamification content works for different contexts. In this paper, we use case studies in public transport and road safety (i.e., young driver safety) in SEQ, Australia, to explore whether attitudes and perceptions about gamified schemes are similar in two different proposed applications amongst the same target age group.

3. Survey design and case study

3.1. Survey design

As mentioned earlier, this study designedtwo applications to understand policy transfer of gamified design. Two stated preference surveys were designed, including public transport (PT) survey and young driver (YD) survey, respectively. Each survey included four main sections (i.e., the current behaviour; the gamification scheme preference; perception and attitude; and basic socio-demographic characteristics).

The current behaviour section was used to understand participants' original travel or driving behaviour and choice to use as a baseline to evaluate behaviour change. For the PT survey, general trip characteristics were asked, such as travel frequency, travel time and trip purpose. For the YD survey, the Driver Behaviour Questionnaire (DBQ) was used to measure the driving behaviour of young drivers including negligence of potential risk, violations and errors and lapses (Bener et al., 2007; Mesken et al., 2002; Ulleberg & Rundmo, 2003; Westerman & Haigney, 2000) with a 6-point Likert scale (ranging from "never" to "nearly all the time", as shown in Table A1 in Appendix). Since the PT and YD surveys focused on different current behaviour, comparison of current behaviour between the two surveys is not included in this paper.

3.1.1. The gamification scheme preference

This section used a stated preference design to investigate participants' preferences for several designed schemes. The survey design principle for both surveys was the same. Taguchi's Orthogonal Arrays design ($L_{12}(2^{11})$) was used to construct 12 different scenarios for each survey. Table 2 shows the gamified design elements. For both surveys, there was a "not join" option if participants preferred not to change their behaviour by joining one of the designed schemes. The PT survey had four choice alternatives including "not join" and the YD survey had five alternatives including "not join". Table 3 shows one out of 12 scenarios

Table 2
Design of intervention schemes.

PT survey					
Scheme type	Gamification	Add-on game	Off-peak discount	Not join	
Prize type	Cash; non-cash		–	–	
Reward type	Withdraw; Guarantee reward prize		–	–	
Players	Personal play; Team play		–	–	
Prize/ discount[a]	Withdraw: $500; $1000 Guarantee reward: $5; $10	Withdraw: $1–$500; $500–$1000 Guarantee reward: $1–$5; $5–$10	20%; 50%	–	
YD survey					
Scheme type	**Gamification**	**Start-up bonus**	**Insurance**	**License**	**Not join**
Prize type	Cash; non-cash		–	–	–
Reward type	Withdraw; Guarantee reward prize		–	–	–
Players	Personal play; Team play		–	–	–
Prize/ discount[a]	Withdraw: $100; $500 Guarantee reward: $10; $50		30%; 50%	50%; 100%	–

[a] Prizes in Australian dollars (AUD).

Table 3
Sample choice question for PT survey and YD survey.

PT survey: If you had a choice of the following schemes which ONE would you prefer?				
Please select one scheme	Prize Type	Play Method	Players	Prize/ Discount
☐ Gamification	Cash	Raffle	Personal play	$500
☐ Add-On Game	Cash	Guarantee Reward	Team play	$10
☐ Off Peak Discount	–	–	–	50%
☐ Not Join	–	–	–	–
YD survey: If you had a choice of the following schemes which ONE would you prefer?				
Please select one scheme	Prize Type	Play Method	Players	Prize/ Discount
☐ Start-up Bonus	Cash	Raffle	Personal play	$100
☐ Gamification	Cash	Raffle	Personal play	$100
☐ Insurance discount	–	Guarantee Reward	Personal Play	30%
☐ Licence fee discount	–	Guarantee Reward	Personal Play	50%
☐ Not join	–	–	–	–

for PT survey and YD survey, respectively. Alternatives can be separated into two categories: gamified schemes and traditional TDM schemes. The alternatives with game elements (e.g., point collection to win a prize) are classified as gamified schemes, including the "gamification" and "add-on game" schemes in the PT survey and the "start-up bonus" and "gamification" schemes in the YD survey. "Off-peak discount" in the PT survey and the "Insurance" and "License" schemes in the YD survey are traditional TDM type schemes. Each scheme had four characteristics: the prize type, reward type, players, and prize or discount amounts (Table 3). Each scheme had a careful explanation. Taking the gamification scheme as an example the explanation was: 'Gamification Scheme: You will be awarded 5 or 20 points if you travel during off-peak hours. After you accumulate a certain amount of points, you can redeem them for guaranteed prizes or a raffle ticket to go into a draw to win a better prize. This scheme can be played as an individual or a team game.' Since the design concepts are similar for both surveys, the following sections introduce the scheme characteristics.

3.1.1.1. Gamified schemes

3.1.1.1.1. Gamification scheme: PT and YD surveys. Participants were informed that they would receive points (e.g., 20 points) every time they performed the wanted behaviour, which was travelling in off-peak hours for the PT survey and demonstrating safe driving behaviour for the YD survey. When participants collected enough points (e.g., 100 points), they could use those points to redeem either cash or non-cash prizes. Participants could also choose to have a guaranteed reward prize or a raffle-like prize by redeeming a raffle ticket to possibly win a bigger prize. Participants could choose to join the scheme as a "personal game" or a "team play". The design concept of the gamification scheme is a baseline and a simple game.

3.1.1.1.2. Start-up bonus scheme: YD survey. Only the YD survey had this scheme as one of the gamified schemes. This scheme had the same design as a gamification scheme with all four scheme characteristics. The only difference was the way that participants collected the points. Participants were given start-up points (e.g., 100 points) at the beginning of the game. Once participants displayed unwanted behaviour (i.e., risky driving behaviour), punishment points (e.g., 100 points) were deducted. At the end of the scheme period, participants could use their remaining points to redeem prizes, in the same process as the gamification scheme. The purpose of this scheme was to understand the effect of a punishment avoidance type scheme since people keener to avoid a loss than make a gain.

3.1.1.1.3. Add-on game scheme: PT survey. This type of gamified scheme was only in the PT survey. This scheme also had the same four scheme characteristics of gamification. The difference was in the reward redeeming process. Participants were informed that they could take the points requent used travel mode (i.e., private vehicle, walk, bicycle, bus, motorcycle, taxi, light rail or heavy rail), travel time of day, travel duration per day, travel frequency (number of travel days per week), travel cost per week, trip purpose and travel areas (postcode of origin and destination). The YD survey collected the same socio-demographic characteristics. In contrast to the PT survey, the YD survey collected driving characteristics, such as license type (i.e., Learner license, P1 provisional license, P2 provisional license and Open license),[4] vehicle type, road usage (i.e., motorway, main road, local street) and driving area (i.e., Greater Brisbane, large regional city or area, small regional town, or rural or remote area). To control the influence of the basic profile for each participant, different socio-demographics are used for the PT and YD models.

3.1.2. Perception and attitude

Behaviour theory studies how individuals act the way they do. In the case of gamification, the schemes are usually applied through some types of technology, for example, mobile applications (Castellanos, 2016; Kazhamiakin et al., 2015). With transport moving into the digital

[4] https://www.qld.gov.au/transport/licensing/driver-licensing/applying.

age, the Technology Acceptance Model (TAM) (Davis et al., 1989) can be a useful tool to monitor the adoption of new measures. There will always be multiple factors behind a person's decision to adopt a new technology (or game in this case). The TAM states that there are two primary factors influencing an individual's intention to use new technology: perceived usefulness and perceived ease of use. For example, someone who perceives a digital game as too difficult to play or a waste of time will be unlikely to want to adopt this technology, while another one who perceives a digital game as providing needed mental stimulation and as easy to learn will be more likely to use digital games. Fig. 1 shows the basic structure of TAM model that proposed by Davis et al. (1989).

In the TAM model, perceived usefulness and perceived ease of use are affected by different external variables, mediated by a person's attitude. This attitude in turn affects the person's behavioural intention, which determines whether the person will be willing to use a certain piece of technology or not. Moon and Kim (2001) stated that to increase the external validity of TAM, it is necessary to further explore the nature and specific influences of technological and usage–context factors that may alter the user's acceptance. Therefore, four external variables are included in the model of this paper, resulting in an "extended" TAM model. The following are the definition of the factors included in this extended TAM in this paper.

- Perceived ease of use refers to the extent to which an individual believes that using a particular system is free of effort (Davis et al., 1989);
- Perceived usefulness refers to the extent to which an individual believes that using a particular system would improve work performance (Davis et al., 1989);
- Attitudes toward the behaviour refer to an individual's favorable or unfavorable response to a particular behaviour (Ajzen & Fishbein, 2005);
- Behavioural intentions refer to the belief that an individual will in fact perform a certain behaviour (Ajzen & Fishbein, 2005);
- Social norm (also known as subjective norms) refers to an individual's reaction to social preferences on performing a particular behaviour (Cheon et al., 2012);
- Perceived Cohesion: the extent to which individual group members feel "stuck to," or a part of, particular social groups (Bollen & Hoyle, 1990);
- Perceived Enjoyment: Based on the definition of perceived enjoyment from Davis et al. (1992). It is the extent to which an activity is perceived to be enjoyable in its own right."
- Perceived Security: Security encompasses three dimensions: reliability, safety and privacy (Nui Polatoglu & Ekin, 2001). For this research, perceived security is defined as the extent to which an individual believes that using a piece of technology satisfies these three dimensions.

In the gamification related literature, TAM is widely used in conjunction with numerical analysis methods to capture users' perceptions and attitudes that have been used to understand policy transfer effects. In the Appendix, Table A2 shows survey questions which form the empirical basis to this paper where all items measured on six-point Likert scales ranging from 1 "strongly disagree" to 6 "strongly agree". Further, Table A3 shows Cronbach's alpha coefficient to measure the internal consistency for each perception and attitude. The results indicate reliability of most perceptions and attitudes are of an acceptance level.

3.2. Study areas and two stated preference surveys

The case studies are two surveys (i.e., PT survey and YD survey) in Queensland, Australia, designed to improve the understanding of participants' intentions to participate in transport gamification schemes. Table 4 lists the survey details.

Each survey had four sections: current behaviour (i.e., travel behaviour or driving behaviour), gamification scheme preference, perceptions and attitudes, and basic socio-demographic characteristics. The PT survey is delivered in the Gold Coast, Queensland, Australia along the newly built Gold Coast Light Rail. An intercept survey method was used since the main target group is public transport users. The survey was delivered by a trained interviewer who used a tablet as the survey tool and asked the questions to participants. This survey approach can allow participants to understand the survey context better since the trained interviewer can explain when necessary. In the YD survey, young drivers are the target group and a professional panel provider was used with respondents coming from the whole of Queensland, Australia. In order to make two surveys comparable, this study uses participants' age as the selection criterion. The setting of the surveys can allow us to understand policy transfer effects of TDM with gamified design not just in different contexts (i.e., public transport and driving safety) but also in different study areas (i.e., Queensland and Gold Coast). Basic statistics analysis is reported in the following section.

3.3. Descriptive statistics

Table 5 provides descriptive statistics for both surveys that have relatively different target groups. Without presetting a quota, the PT survey had an equal split between two genders, but females were over represented in the YD survey. Educational level also varied. Participants in the PT survey had higher education (i.e., more than 60% of participants had a Bachelor degree or higher) than in the YD survey (i.e., around 20% of participants had a Bachelor degree or higher). This is likely due to the target groups for each survey. By definition, the YD survey was designed for young drivers aged 16–24 years. As a result, the YD survey had younger participants, with an average age of 19.83. The

Table 4
Summary of the two surveys.

Item	Public Transport (PT) survey	Young Driver (YD) survey
Location	Gold Coast, Queensland	Queensland
Survey method	Intercept survey	Panel provider
Sample	90	485
Survey time	2018	2016
Target group	Transport users along Gold Coast Light Rail Stations	Young drivers aged 16–24 years

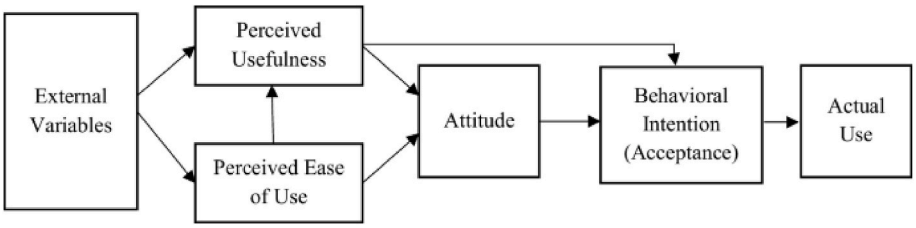

Fig. 1. Technology acceptance model (Source: Davis (1989)).

Table 5
Descriptive statistics for the PT and YD surveys.

PT survey		YD survey	
Variables	%	Variables	%
Socio-demographic variables		Socio-demographic variables	
Gender		Gender	
Male	50.00	Male	30.00
Female	50.00	Female	70.00
Average age of respondents	25.30	Average age of respondents	19.83
Educational level		Educational level	
High School	17.80	High School	60.80
Certificate/Diploma	18.90	Certificate/Diploma	20.40
Bachelor Degree	46.70	Bachelor Degree	16.20
Master's Degree	15.60	Master's Degree	1.60
PhD Degree	1.10	PhD Degree	1.00
Trip characteristics		Driving characteristics	
Travel mode		License type	
Car	30.00	Learner license	36.4
Walk	6.70	P1 provisional license	18
Bicycle	1.10	P2 provisional license	14.4
Bus	18.90	Open license	31.2
Motorcycle	1.10	Vehicle type	
Taxi	2.20	Car	97.80
Tram	34.40	Motorcycle	1.20
Train	5.60	Moped	0.60
Trip purpose		Heavy vehicle	0.20
Education	38.90	Other	0.20
Leisure	12.20	Road usage	
Work	48.90	Motoway	30.80
Average travel duration per trip (minutes)	29.50	Main road	65.20
Average travel days per week (days)	5.20	Local street	54.00
Average travel cost per week (A$)	29.60	Driving area	
		Greater Brisbane	54.40
		Large regional city or area	29.80
		Small regional town	13.20
		Rural or remote area	2.60
		Average vehicle number in the household	3.13
		Average passengers in the vehicle	2.16
		Average driving time (hour) per week	5.20
		Average driving distance (km) per week	115.70

PT survey did not have this pre-selection of participants and the participants' average age was 25.3.

The PT survey collected trip characteristics. Most participants used public transport modes (i.e., bus, tram and train) with only around 30% of participants using private modes. This might be due to the selection of survey areas that were located around major public transport corridor and stations such as the Gold Coast Light Rail. Other than that, most participants travelled for work and education purposes with average travel time around 30 min one way.

In the YD survey, driving characteristics were surveyed. Generally, participants were equally represented among different license types (i.e., learner, provisional and open license). Almost all participants used car as their major vehicle type. Around half of the participants used their vehicle on main roads and local streets in Greater Brisbane.

Table 6 shows summary details of the variables used in the multinomial logit models that are introduced in Section 4. During the modelling process, all variables were considered but, due to space limitations, Table 4 only reports information for significant variables. Some variables specifically addressed in Table 5 only appeared in either the PT or YD survey, while other variables were obtained from both surveys.

Table 6
Summary of the model variables.

Variables	Description			
Dependent variable				
Scheme choice	Scheme choice for each participant			
Independent variable				
Socio-demographic variables				
Gender_Male	= 1 if male; = 0 if female			
PT Survey: Travel characteristics				
Actual cost	Travel cost per week in Australian dollars			
Travel duration	Trip travel time for the most frequent trip in minute(s)			
Travel day	Travel day(s) per week			
Trip purpose for the most frequent trip				
Education	= 1 if education related trip; = 0 otherwise			
Work	= 1 if work related trip; = 0 otherwise			
Leisure	Compare base			
YD Survey: Driving areas				
Small regional town	= 1 if main driving area is in small regional town; = 0 otherwise			
Rural or remote area	= 1 if main driving area is in rural or remote area; = 0 otherwise			
Perceptions and attitudes interaction terms				
	Trip purposes		Travel modes2	
Perceptions and attitudes	Education	Work	Public transport3	Private vehicle
Social norms	Edu_SN1	Work_SN	PT_SN	PV_SN
Perceived ease of use	Edu_EU	Work_EU	PT_EU	PV_EU
Perceived cohesion	Edu_C	Work_C	PT_C	PV_C
Perceived enjoyment	Edu_EN	Work_EN	PT_EN	PV_EN
Perceived usefulness	Edu_US	Work_US	PT_US	PV_US
Attitude toward playing a gamified scheme	Edu_AT	Work_AT	PT_AT	PV_AT
Behavioural intentions	Edu_BI	Work_BI	PT_BI	PV_BI
Perceived security	Edu_SE	Work_SE	PT_SE	PV_SE

1 Taking "Edu_SN" as an example, variable description is " = social norm points for a participant with education trip purpose; = 0 otherwise".
2 The most frequent used travel mode.
3 Public transport modes include bus, rail and light rail.

4. Method and model results

4.1. Method

The multinomial logit modelling approach was used to investigate participants' intention to participate in a gamified or incentive-based TDM scheme, especially the influence of participants' perceptions and attitudes. Equation (1) shows the multinomial logit model form.

$$Choice_i = \omega + \sum_{j=1}^{m} \beta_j z_{j_i} + \varepsilon_i \quad (1)$$

where $Choice_i$ indicated an individual's choice set that is different for the PT survey and YD survey. For the PT survey, $Choice_i$ is shown as follows:

(1) Add-on game; (2) gamification; (3) off-peak discount; and (4) not join.

For the YD survey, $Choice_i$ is shown as follows:

(1) Start-up bonus; (2) gamification; (3) insurance fee discount; (4) driver license fee discount; and (5) not join.

Where z_{j_i} denotes the demographic and scheme perception and attitude variables $j \ldots m$; and ε_i is the error term. The scheme perception and attitude variables are the TAM variables: social norms, perceived ease of use, perceived cohesion, perceived enjoyment, perceived usefulness, perceived attitude toward playing a gamified scheme, perceived behaviour intentions to play a gamified scheme, and perceived security. The multinomial logit model allows unique associations between different choice options to be disentangled from the perceptions and attitudes.

4.2. Model results for the PT survey

The PT survey had 90 valid responses and each participant

independently chose a scheme four times. Therefore there were a total of 360 observations. However, we only used the 212 observations from respondents aged 16–24 years to run the model to be able to compare with the results from the YD survey. Table 7 shows the model results for the PT survey with only the young adults' samples. The overall model fit is acceptable with a pseudo R-square of 0.33 and a p-value of 0.00 for the intercept only model, relative to the final model.

Average marginal effects are reported for model results. The results are interpreted as the probability of choosing a specific outcome (e.g., "(1) Add-on game") compared to "(4) Not join"; for a one-unit of discrete change in the independent variable. For example, as shown in column 1, individuals who travel for education purpose were 30.71% more likely to choose "(1) Add-on game" than they were to choose "(4) Not join"; compared to individuals who were travelling for other trip purposes. This result is statistically significant at the 1% level. Variables are included in the model if they are significant for at least one scheme.

In the PT model results, generally, most variables show the same impact across schemes but with a different scale. For example, males were less likely to choose any gamified and traditional TDM scheme than females due to the negative coefficient for all three schemes. However, model results revealed that "(3) Off-peak discount" is the least favoured scheme for males due to the smallest coefficient. Similar results can be found for travel characteristics. If participants travel for education and work purposes, they had a higher chance of joining one of the schemes than of choosing "(4) not join" due to positive coefficients. Travel cost shows the same pattern that participants with higher travel costs were more likely to choose one of the schemes than "(4) not join". On the contrary, travel duration and travel days a week show opposite results that participants with longer average trip duration or travelling more days a week were less likely to choose to join one of the schemes than "(4) not join".

We now focus on the perception and attitude variables that interact with trip purposes (i.e., travel for education purpose or work purpose) and travel modes (i.e., public transport or private car as the main travel mode). We first examine those who travel for education purpose. This group of travellers had the same perception of "social norms". A one-unit increase in "social norms" was associated with a higher likelihood of participating in one of the schemes, compared with choosing "(4) not join". For the other perception items, a slightly different impact can be found. For "perceived ease of use", the results show a conflicting view of two gamified schemes. With a one-unit increase in "perceived ease of use", travellers were more likely to choose "(2) gamification" (36.76%) and less likely to choose "(1) Add-on game" (−5.06%). Travellers had a similar view of "(3) Off-peak discount" as they do for "(1) Add-on game" but with a stronger view (−10.98%). For "perceived enjoyment", it is obvious that travellers preferred a traditional TDM scheme over gamified schemes giving a positive coefficient for a traditional TDM scheme and a negative coefficient for gamified schemes. In terms of "perceived usefulness", users with higher "perceived usefulness" were more likely to join "(1) Add-on game" scheme (4.02%) but less likely to join a "(2) Gamification" scheme (−26.55%) and an "(3) Off-peak discount" scheme (−6.8%). As to "perceived security", a higher perception of security by travellers had a higher chance of joining one of the gamified schemes but a lower chance of joining an "(3) Off-peak discount" scheme.

Next, the results for those who travel for work purpose are discussed. This group of travellers had a consistent view across all schemes. To be precise, users were more likely to participate in one of the schemes if they had lower "perceived cohesion" and "perceived enjoyment" but higher "perceived usefulness" and "perceived security".

Those who use public transport as their main mode had a significant and consistent positive viewpoint for "perceived enjoyment", "attitude toward playing a gamified scheme" and "perceived security". This indicates if public transport users had higher perceptions of these three variables, they had a higher chance of joining one of the three schemes. On the contrary, "social norms" had a negative coefficient for all three schemes. If public transport users perceived higher for "social norms", they had a lower chance of joining one of the schemes. There were also

Table 7
Public transport model results (16–24 year old respondents).

Variables	(1) Add-on game		(2) Gamification		(3) Off-peak discount	
	Marginal Effect	P value	Marginal Effect	P value	Marginal Effect	P value
Socio-demographic variables						
Gender_Male	−0.1045	0.00	−0.0791	0.00	−0.2175	0.00
Travel characteristics						
Education purpose	0.3071	0.00	0.2301	0.00	1.0838	0.00
Work purpose	0.3377	0.00	0.1669	0.00	0.4954	0.00
Actual cost	0.0056	0.00	0.0046	0.00	0.0071	0.00
Average trip duration	−0.0001	0.00	−0.0049	0.00	−0.0027	0.00
Travel days a week	−0.0468	0.00	−0.0705	0.00	−0.0515	0.00
Perception of schemes						
Edu_SN	0.0986	0.00	0.0706	0.01	0.0500	0.01
Edu_EU	−0.0506	0.05	0.3676	0.00	−0.1098	0.04
Edu_EN	−0.2353	0.01	−0.1686	0.01	0.0609	0.03
Edu_US	0.0402	0.01	−0.2655	0.00	−0.0068	0.01
Edu_SE	0.0118	0.02	0.0406	0.02	−0.1774	0.00
Work_C	−0.3810	0.00	−0.6852	0.00	−0.7724	0.00
Work_EN	−0.3844	0.00	−0.3544	0.00	−0.5693	0.00
Work_US	0.3818	0.00	0.5918	0.00	1.0095	0.00
Work_SE	0.2331	0.00	0.3639	0.00	0.2381	0.00
PT_SN	−0.1489	0.00	−0.1718	0.00	−0.2027	0.00
PT_EN	0.2664	0.00	0.2173	0.00	0.1423	0.00
PT_US	−0.1765	0.01	0.1227	0.05	−0.2540	0.01
PT_AT	0.0863	0.00	0.2648	0.00	0.5155	0.00
PT_BI	0.0051	0.00	−0.4068	0.00	−0.4049	0.00
PT_SE	0.0561	0.00	0.0564	0.00	0.2978	0.00
PV_US	−0.2845	0.00	−0.2072	0.00	−0.2428	0.00
PV_BI	0.3633	0.00	0.2726	0.00	0.2922	0.00
Summary statistics						
Observations	212.00					
Chi square test statistic	Chi square (69) = 312.79					
p-value	0.00					
Pesudo R2	0.33					

some inconsistent perceptions. For "perceived usefulness", public transport users with higher "perceived usefulness" were more likely to join the "(2) Gamification" scheme but less likely to join the other two schemes. For "behavioural intentions", different from "perceived usefulness", users with higher "behavioural intentions" had a higher chance of joining the "(1) add-on game" scheme but a lower chance of joining the other two schemes.

Finally, those who use private vehicle as their main mode again had a consistent viewpoint across the three schemes. Private vehicle users were more likely to join one of the schemes if they had lower "perceived usefulness" and higher "behavioural intentions".

4.3. Model results for the YD survey

We surveyed 500 young drivers and each of them independently chose a scheme three times. With 485 valid samples, there were 1455 observations in the model. Table 8 shows model results for the YD survey. The overall model fit is acceptable with a pseudo R-square of 0.036 and a p-value of 0.00 for the intercept only model, relative to the final model.

Similar to the PT model results, average marginal effects are reported in Table 8. Again, the results are interpreted as the probability of reporting a specific outcome (e.g., (1) "Start-up bonus scheme") compared to "(5) Not join" a scheme; for a one-unit of discrete change in the independent variable. For example, as shown in column 1 "(1) Start-up bonus", individuals from rural or remote areas were 4.44% more likely to choose "(1) Start-up bonus" than they were to choose "(5) Not join"; compared to individuals who were not from rural or remote areas. This result was statistically significant at the 3% level.

In the PT model, most schemes had similar impacts for particular variables (e.g., participants would be less likely to choose one of the schemes if they are males). Unlike the PT model, the YD model had some more diverse results. An example was participants from small regional towns. They were more likely to choose gamified schemes (i.e., "(1) Start-up bonus" and "(2) Gamification") but were less likely to join traditional TDM schemes (i.e., "(3) Insurance discount" and "(4) License fee discount"). Overall, variables tended not to have the same impacts on choice of schemes in the YD model. Therefore, model results are reported on scheme base.

For "(1) Start-up bonus" scheme, column 1 reports the results of the likelihood of an individual choosing it. Only variables with at least 10% significance are discussed. Young drivers from small regional towns and rural or remote areas were 4.55% and 4.44% more likely to choose "(1) Start-up bonus" than they were to choose "(5) Not join", respectively, compared to drivers who were not from those two areas. For perceptions of schemes, like the PT model, perception variables also interact with travel demographics (e.g., trip purposes, travel modes). For education purpose trips, it appears that a one-unit increase in an individual's "perceived cohesion" and "perceived security" is associated with a 0.27% and 0.96% lower likelihood of participating in the "(1) Start-up bonus" scheme. Similar results can be found for "perceived cohesion" for work purpose trips with 2.98% lower likelihood. On the contrary, "behavioural intentions to play a gamified scheme" was associated with a 2.95% higher likelihood of participation. Somewhat differently, private vehicle users had a higher likelihood of joining a scheme with stronger "perceived cohesion". Conversely, they would have a lower likelihood of joining with stronger "perceived enjoyment" and "perceived usefulness".

Column 2 reports results for the likelihood of participating in the "(2) Gamification" scheme. The results indicate that male were 1.47% more likely to choose "(2) Gamification" than they were to choose "(5) = Not join". Similar to the "(1) Start-up bonus" scheme results, participants from small regional towns had a higher likelihood of joining (4.64%). However, participants from rural or remote areas had an opposite and stronger viewpoint regarding joining this scheme (−14.6%). In terms of perceptions, for those who travel for education purpose, higher "perceived cohesion" reduced the likelihood (−0.63%) of being part of the scheme but higher "perceived security" actually had a higher likelihood of joining (0.69%). Furthermore, for those who travel for work purpose, higher "perceived cohesion" increased the chance (0.69%) of participating in the scheme but not for "behavioural intentions to play a gamified scheme" which was associated with lower likelihood of joining (−6.69%). This is totally opposite compared to the results for the "(1) Start-up bonus" scheme. Participants who drive tended to have a lower likelihood of being part of the scheme if they had higher "perceived enjoyment" (−2.71%) and "Perceived usefulness" (−3.25%) but lower "perceived cohesion" (1.23%).

The results for "(3) Insurance discount" are reported in column 3. Males preferred this scheme even more (7.03%) than the "(2) Gamification" scheme (1.47%). Further, participants from both small regional towns and rural or remote areas had lower chance of joining this scheme compared to those who were not from these areas. Those who travel for education purpose tended to have a higher likelihood of joining the scheme if they had higher "perceived cohesion" (1.99%) and lower "perceived security" (−0.86%). Those who travel for work purpose had the results for "(3) Insurance discount" scheme that higher "perceived cohesion" was associated with a lower likelihood (−11.47%) of joining the scheme but higher "behavioural intentions to play a gamified

Table 8
Young driver model results.

Variables	(1) Start-up bonus		(2) Gamification		(3) Insurance discount		(4) License fee discount	
	Marginal Effect	P-value	Marginal Effect	P-value	Marginal Effect	P-value	Marginal Effect	P-value
Socio-demographic variables								
Gender_Male	−0.0465	0.18	0.0147	0.10	0.0703	0.03	−0.0429	0.10
Small regional town	0.0455	0.02	0.0464	0.05	−0.1112	0.00	−0.0225	0.01
Rural or remote area	0.0444	0.03	−0.1406	0.01	−0.1018	0.02	0.1356	0.05
Perception of schemes								
Edu_C	−0.0027	0.00	−0.0063	0.00	0.0199	0.00	−0.0284	0.00
Edu_SE	−0.0096	0.01	0.0069	0.01	−0.0086	0.01	0.0222	0.00
Work_C	−0.0298	0.01	0.0690	0.04	−0.1147	0.00	0.0199	0.01
Work_BI	0.0295	0.02	−0.0669	0.05	0.1190	0.01	−0.0045	0.03
Car_EN	−0.0394	0.00	−0.0271	0.00	0.0391	0.03	0.0237	0.02
Car_C	0.0450	0.00	0.0123	0.00	0.0071	0.00	−0.0265	0.00
Car_US	−0.0512	0.01	−0.0325	0.02	0.0031	0.07	0.0603	0.20
Car_AT	0.0384	0.32	0.0552	0.61	−0.1016	0.03	−0.0088	0.15
Car_BI	−0.0141	0.24	−0.0150	0.30	0.0595	0.05	−0.0219	0.23
Summary statistics								
Observations	1455							
Chi square test statistic	Chi square (48) = 148.62							
p-value	0.00							
Pesudo R2	0.036							

scheme" was associated with a higher likelihood (11.9%). For car users, all significant perceptions items were associated with positive probability of joining the scheme with the only exception of "attitude toward playing a gamified scheme" with a negative likelihood.

Last but not least, column 4 reports results for the "(4) License fee discount" scheme. It is interesting to note that like the "(1) Start-up bonus" scheme, females preferred the "(4) License fee discount" scheme and they were 4.29% more likely to join the fee discount scheme. Those from small regional towns were less likely (−2.25%) to join the scheme. Differently, those from rural or remote area were more likely (13.56%) to join the scheme. Regarding perceptions, for trip purpose, the results for "(4) License fee discount" scheme were the same as the "Gamification" scheme but with a larger value for education trip purpose and a smaller value for work trip purpose. Furthermore, car drivers were more likely to be part of the scheme if they had higher "perceived enjoyment" (2.37%) and lower "perceived cohesion" (−2.65%).

5. Policy transfer

Policy transfer is the process of transferring knowledge gained from policies in one political setting to develop another policy in another political setting (Dolowitz & Marsh, 1996). However, this study extends this definition to explore not only different geographical settings but similar designs of gamified schemes in different settings. This study compares two surveys and two models, one on public transport and the other on young drivers. Those two surveys were designed with the same concepts, including the same perception design and similar stated preference design for the schemes. The analysis reporting marginal effects allows a comparison between the two models.

From Tables 7 and 8, it is clear that not all perception variables are significant in both models. We discuss how transferrable the gamified schemes and/or traditional TDM schemes are for those variables that are significant in both models. Table 9 shows the likelihood of participation in schemes for both the PT and YD surveys for variables that are significant in both models. There are only four perception variables that are significant for both models (at least one scheme in each model), including "Edu_SE (perceived security for education purpose)", "Work_C (perceived cohesion for work purpose)", "PV_US (perceived usefulness for private vehicle user)" and "PV_BI (Behavioural intentions for private vehicle user)". This indicates that different transport users might have similar or contrasting perceptions for those schemes. Each variable is discussed in turn in the following sections.

The variable "Edu_SE (perceived security for education purpose)" was significant for all schemes across the two models. For gamified schemes (i.e., "(1) Add-on game" and "(2) Gamification" in the PT survey and "(1) Start-up bonus" and "(2) Gamification" in the YD survey), if the confidentiality of the schemes can be guaranteed, in general, transport users who travel for education trip purpose were more likely to opt in to a gamified scheme. This might indicate that gamified schemes are more attractive to young adults (i.e., 16–24 years old) who are also students. One might challenge that "(1) Start-up bonus" in the YD model has a negative coefficient. However, this is not a serious issue since the coefficient is very small (−0.96%). For traditional TDM schemes (i.e., "(3) Off-peak discount" in the PT survey and "(3) Insurance discount" and "(4) License fee discount" in the YD survey), in general, a negative likelihood relationship holds for "perceived security" and participation in these schemes. This is somewhat consistent with the results for gamified schemes that are relatively new design concepts and it is not unexpected that security is a major concern. In contrast, traditional TDM schemes have existed for some time and do not have any issues or incidents related to security. We may summarise that users have higher confidence in traditional TDM schemes over newly designed gamified schemes.

For the "Work_C (perceived cohesion for work purpose)" variable, there are some interesting insights. "Perceived cohesion" is usually viewed as one of the most important social interaction items for those who travel for work (Geurs & Van Wee, 2004). In line with previous literature and not unexpected, "Perceived cohesion" is only significant to those who travel for work purpose. Those users generally have low intention of joining one of the schemes if they have higher "perceived cohesion". This is particularly obvious for the PT survey. This might be because Australia has very high car mode share and public transport is not an attractive mode with either gamified strategies or traditional TDM strategies.

Further, asymmetry intention can be found in the results of the YD survey. For gamified schemes, users who travel for work purpose would prefer a reward type game (i.e., a gamification scheme where users earn points for wanted behaviour) than a punishment avoiding game (i.e., a start-up bonus scheme where users are given certain points in the beginning and points are deducted for unwanted behaviour). As for traditional TDM schemes, users in this group with higher "perceived cohesion" had a higher intention of joining a license fee discount scheme but lower to join an insurance discount scheme. NRMA Insurance (2001) reported that around 80% of vehicles are insured with comprehensive insurance in Australian capital cities and the proportion may be lower in other areas. Australia is a low population density country, especially in rural or remote areas. This suggests a low exposure rate to potential vehicle related incidents or policy enforcement. As a result, an insurance scheme is not the most attractive scheme given users might not insure at all since they might think they do not need it. At the other end of the spectrum, if people want to drive, they need to have a driver license. The need for a driver license makes the license fee discount scheme much more attractive for this group of users with higher "perceived cohesion".

"PV_US (perceived usefulness for private vehicle user)" is another variable that was significant in both surveys. Similar to "Work_C″, this variable had a negative sign for all schemes in both models, except for the insurance discount scheme in the YD survey. This indicates that private vehicle users with higher "perceived usefulness" have lower preference for either gamified or traditional TDM schemes. For PT schemes, the same reason for "Work_C″ can be applied to this result. In a highly car dominated country, private vehicle users might perceive the schemes that are designed for public transport use are not very useful. As for YD schemes, it is clear that private vehicle users prefer to join an insurance discount scheme over gamified schemes if they have higher "perceived usefulness".

Last but not least, "PV_BI (Behavioural intentions for private vehicle user)" is significant for all PT schemes but only significant for the

Table 9
The likelihood of participation in schemes for the PT and YD surveys.

Perceptions	PT survey			YD survey			
	(1) Add-on game	(2) Gamification	(3) Off-peak discount	(1) Start-up bonus	(2) Gamification	(3) Insurance discount	(4) License fee discount
Edu_SE	+	+	(−)	(−)	+	(−)	+
Work_C	(−)	(−)	(−)	(−)	+	(−)	+
PV_US	(−)	(−)	(−)	(−)	(−)	+	
PV_BI	+	+	+			+	

Note: Only significant variables are marked. For insignificant variables, the cell is blank. "+" and "(−)" mean the coefficient of variable is positive and negative, respectively. "+"/"(−)" also indicate a particular perception is associated with higher/lower likelihood of participating in the scheme.

insurance discount scheme in the YD model, with stronger behavioural intentions linked to adopting those schemes. Together with the "PV_US" variable, for private vehicle users, those two variables revealed contradictory links between an individual's stated behaviour intentions as opposed to their perceptions of usefulness of a scheme. These contradictory results highlight a discord between beliefs (i.e., perceived usefulness) and intentions (i.e., behavioural intention). With this result in mind, when designing or proposing a scheme for vehicle users, understanding participants' intentions is more important than capturing their beliefs.

6. Discussion and conclusions

Gamification schemes have attracted increasing attention in transport in recent years. This study investigated the policy transfer effects of TDM strategies with a gamified design and traditional TDM design in two transport fields: increasing public transport use and improving young driver safety. We conducted two separate stated preference surveys with the same design concept for TDM schemes. We built two multinominal logit models for the two surveys to understand participants' perceptions. We further evaluated policy transfer effects by understanding the difference of perceptions across the proposed gamified schemes and traditional TDM schemes.

In this study, perceptions were interacted with trip purpose (i.e., education or work trip purpose) and travel mode (i.e., public transport or private vehicle). Therefore, a more in-depth analysis can be observed. Only four perception variables were significant for both the PT and YD models: "Edu_SE (perceived security for education purpose)", "Work_C (perceived cohesion for work purpose)", "PV_US (perceived usefulness for private vehicle user)" and "PV_BI (Behavioural intentions for private vehicle user)". These four variables were used to discuss the policy transfer effect. Generally, users who travel for education purpose were more willing to join gamified schemes in both applications as long as security is not an issue. Further, in terms of gamified design, a rewarding earning design was more popular than a punishment avoiding design.

Moreover, due to the nature of the survey context with low population density and a highly car dominated environment, public transport related schemes, whether gamified or traditional TDM schemes, are not attractive for workers with strong social interaction (i.e., high "perceived cohesion") and private vehicle users with higher perception of usefulness. The same group of users might have the same views for gamified schemes for public transport schemes. However, for private vehicle users, there are contradictory links between their behavioural intentions and beliefs. This could imply that young adults might choose to place greater confidence in their stated behavioural intentions as opposed to their beliefs.

By understanding the target audience's perceptions of schemes to change behaviour, policy makers and planners can better design effective gamified schemes or improve existing TDM schemes. The results of this study allow us to understand the perceptions of particular user groups, in this case, young adults. Developing a better profile of target groups should help design better scheme strategies. For example, if we want to design a public transport scheme for university students to solve a parking issue on campus, a gamification scheme might be worth pursuing with extra effort to secure the confidential information of users.

Even though this study has provided some interesting findings, it has limitations, indicating areas for future research. We conducted two surveys with different sets of participants, although of similar age. This might not be able to capture and compare the effect of policy transfer precisely. It is recommended the same participants are surveyed about different schemes in different fields. Further, following the discussion above, it is worth identifying the profile of target groups and cross comparing with the model results of this study to gain more insights into designing a behavioural change scheme. This study used a multinomial logit modelling approach to understand participants' perceptions across different schemes. There are still many aspects of gamified schemes worth investigating, such as personal game or team game design. Different modelling approaches, such as discrete choice modelling, can be applied to evaluate the important characteristics of gamified design.

CRediT authorship contribution statement

Barbara T.H. Yen: Methodology, Conceptualization, Writing – original draft, Revision of the manuscript. **Corinne Mulley:** Conceptualization, Writing – original draft, Revision of the manuscript. **Gerardo Meza:** Modelling, Data collection.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A1
Driver Behaviour Questionnaire (DBQ) variables and item descriptions (Source: Ambrey and Yen (2018)).

Variables* and item descriptions
Negligence of potential risk
During early night or dawn, what was your frequency of not using the headlight?
While turning, what was your frequency of not using the turning signal?
Violations
Drive especially close to the car in front as a signal to its driver to go faster or get out of the way
Cross a signalised intersection knowing that the traffic lights have already turned red
Disregard the speed limits late at night or early in the morning
Disregard the speed limits on a motorway
Strongly dislike a particular class of road user and indicate your hostility by whatever means you can
Become impatient with a slow driver in the outer lane and overtake on the inside (left) lane
Get involved with unofficial 'races' with other drivers
Errors
Attempt to overtake someone that you hadn't noticed to be signalling a left/right turn
Miss 'Give Way' signs and narrowly avoid colliding with traffic having right of way
Fail to notice that pedestrians are crossing when turning into a side street from a main road

(*continued on next page*)

Table A1 (*continued*)

Variables* and item descriptions
Queuing to turn right/left onto a main road, you pay such close attention to the mainstream of traffic that you nearly hit the car in front
On turning right/left nearly hit a bicycle rider or motorcyclist who has come up on your inside
Fail to check your rear-view mirror before pulling out or changing lanes, etc
Lapses
Are in the wrong lane when approaching a roundabout or an intersection
Misread the signs and exit from the roundabout on the wrong road
Forget where you left your car in the car park
Attempt to drive away from the traffic lights
Switch on one thing, such as headlights, when you meant to switch on something else, such as wipers

*All items measured on six point Likert scales ranging from 1 "never" to 6 "nearly all the time."

Table A2
Technology acceptance model (TAM) variables and item descriptions

Variables and item descriptions*
Social norms
I want to participate in this scheme because my classmate(s) is/are participating
I want to participate in this scheme because my colleague(s) is/are participating
I want to participate in this scheme because my friend(s) is/are participating
Perceived ease of use
Learning to participate in this scheme will be easy for me
It will be easy to participate in this scheme
It will be easy for me to be skillful in this scheme
Perceived cohesion
I believe I will fit in well with the scheme
I believe I will like the other participants in this scheme
In general, I believe the participants in this scheme will act as a union
Perceived enjoyment
Participating in this scheme will be enjoyable
Participating in this scheme will be thrilling
Overall, participating in this scheme will be entertaining
Perceived usefulness
I believe this scheme applies to me
I believe I should participate in this scheme
I believe I have nothing to gain from this scheme*
Attitude toward playing a gamified scheme
I will like participating in this scheme
I feel good about participating in this scheme
In general, I will have positive feelings towards this scheme
Behavioural intentions
It will be worth playing in such schemes
I will actively be involved in such schemes in the future
I have intentions to participate in this scheme again
Perceived security
I am confident that the private information I provide with the scheme will be secured
I believe that inappropriate parties may deliberately view the information I provide with this scheme*
I believe that the information I provide in this scheme will be secured

*All items measured on six-point Likert scales ranging from 1 “strongly disagree” to 6 “strongly agree”.
**Recoded.

Table A3
Cronbach’s alpha coefficient for each perception and attitude

PT survey					
Measure	Number of items	Perception (P) or Attitude (A)	Mean (range 1–6)	S.D.	Cronbach’s alpha
Social norms	3	A	3.15	4.60	0.93
Perceived ease of use	3	P	4.52	1.63	0.90
Perceived cohesion	3	P	4.22	2.09	0.88
Perceived enjoyment	3	P	4.16	1.67	0.92
Perceived usefulness	3	A	4.18	2.72	0.92
Attitude toward playing a gamified scheme	3	A	4.39	1.23	0.95
Behavioural intentions	3	P	4.27	1.74	0.92
Perceived security	3	A	4.04	1.35	0.93
YD survey					
Measure	Number of items	Perception (P) or Attitude (A)	Mean (range 1–6)	S.D.	Cronbach’s alpha
Social norms	3	A	3.61	1.66	0.92
Perceived ease of use	3	P	4.62	1.11	0.89
Perceived cohesion	3	P	4.40	1.11	0.86
Perceived enjoyment	2	P	4.24	1.10	0.86

(*continued on next page*)

Table A3 (*continued*)

PT survey					
Measure	Number of items	Perception (P) or Attitude (A)	Mean (range 1–6)	S.D.	Cronbach's alpha
Perceived usefulness	3	A	4.03	1.35	0.54
Attitude toward playing a gamified scheme	2	A	4.33	1.06	0.89
Behavioural intentions	2	P	4.36	1.09	0.87
Perceived security	2	A	3.89	1.22	0.17*

* This might be due to having only two items in the scale measuring a participant's perception of security.

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