

OTDK Thesis

2025

SZÉCHENYI ISTVÁN UNIVERSITY
KAUTZ GYULA FACULTY OF BUSINESS AND ECONOMICS



**NUDGING SZEREPE A BIZTONSÁGOS VEZETÉSI SZOKÁSOK
KIALAKÍTÁSÁBAN:
Z GENERÁCIÓS JÁRMŰVEZETŐK VIZSGÁLATA**

**HOW NUDGING SHAPES SAFE DRIVING HABITS:
EVIDENCE FROM GENERATION Z DRIVERS**

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Manuscript finalised on: January 10, 2025

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INTRODUCTION

Road traffic accidents are among the most common causes of death today, as approximately 1.19 million people fall victim to road traffic crashes each year, and they also constitute the leading causes of death for children and young adults aged 5–29 years (WHO, 2023a).

The impact, however, is not exclusively physical, as environmental, economic, psychological, and societal burdens often accompany the devastating scenes of traffic accidents (WHO, 2023a). It is in this environment that road safety is rightfully becoming a topic of utmost importance both globally and at the national level in Hungary, with more safety campaigns and action programmes, stricter regulations and rule enforcement practices employed (European Commission, 2024; Ministry of Interior, 2023). However, the results of such conventional intervention methods are often not substantial enough, as for example, indicated by the fact that Hungary has still not managed to reach the EU average in road accident fatalities per million inhabitants (KSH, Care & Eurostat, 2023). In this critical situation, the question of “what else can be done?” has already emerged.

Nudging might just propose an alternative answer to the question by representing an approach that extends beyond simple motivation by effectively influencing human behaviour without imposing any restrictions or significantly altering economic incentives (Thaler & Sunstein, 2008). Previously, the concept has been successfully applied in a wide range of contexts, and more recently, researchers and policymakers in particular have become interested in its possible implications on driving behaviour as well. Various types of nudges have been shown to have positive impacts on inducing safe driving, such as speed reduction or improving sense of direction. Ill-constructed, poorly timed nudges, however, can be counterproductive and induce even more reckless driving.

Nudging, therefore, is a complex phenomenon with its effects depending on various factors, such as age, driving history and attitudes, or the overall practices and norms of the road in a specific country. Nudging may have a relevant positive effect on the intention to drive safely for individuals with a driving license and an already established driving style; therefore, the present study sets out to analyse the impacts of nudging on Hungarian Generation Z drivers, which has not yet been explored in literature up to this point.

The research question of this study is therefore the following: which nudge approaches could be utilised to enhance the road safety awareness and safe driving practices of Hungarian Generation Z drivers while also considering their demographic characteristics, driving history and attitudes in order to be able to personalise nudges for maximum effectiveness?

1. LITERATURE REVIEW

In this section, I am going to review and analyse the relevant literature published on the topic of nudging.

Section 1.1 introduces the roots of the concept from its popularisation, followed by a brief introduction to how nudging techniques can affect the human mind. Based on this, I am going to review how manipulation and nudging can occasionally intersect and what frameworks have been constructed to pave the way for the creation of both ethical and effective nudges. To conclude, I am going to outline some common areas of application.

Section 1.2 focuses on the current state of road safety, attempts at promoting safer driving behaviours, and how nudging could be utilised as such a promoting tool. Lastly, I am going to compare traditional intervention tactics with the nudge approach, highlighting some of the possible limitations as well.

1.1 NUDGING AT A GLANCE

Nudging is a relatively recent concept within the field of behavioural economics that was first popularised in the book *Nudge: Improving Decisions About Health, Wealth, and Happiness*, authored by American economist Richard H. Thaler and American legal scholar Cass R. Sunstein in 2008. Since its introduction, the concept has been the subject of extensive scholarly debate regarding what the most efficient implementation methods of nudging are, and what it can be used for. Furthermore, the ethical implications of nudging—particularly in contexts where it seeks to influence consumer behaviour—have also become a focal point of critical inquiry (Schmidt & Engelen, 2020).

1.1.1 How does nudging work? – Dual process theory

According to psychologist Daniel Kahneman, humans have two systems for processing information: System 1 (otherwise known as the Automatic System) and System 2 (otherwise known as the Reflective System). The main characteristics of the two systems are as can be seen in Table 1. In more straightforward terms, System 1 is the more intuitive, while System 2 is the more conscious part of our mind. System 1 runs quickly and automatically and requires little to no effort to operate. To demonstrate how and where System 1 thinking comes into action, Kahneman uses the example of “ $2+2=?$.” As soon as you see the equation, you cannot stop yourself from knowing that $2+2=4$ because the knowledge has been previously established and

stored in your memory, and System 1 can access it without conscious intention. However, for the multiplication problem 17×24 , your System 1 will most likely not have an immediate answer. At this point, your System 2 thinking comes into action to construct an answer in a systematic manner, with more effort and concentration involved (Kahneman, 2011).

When we encounter a nudge, these are the two systems that are stimulated. What nudges do is alter the environment in ways that trigger our System 1 and System 2 decision-making processes in various ways (Campbell-Arvai et al., 2014).

Table 1
Systems for processing information

Automatic System	Reflective System
Uncontrolled	Controlled
Effortless	Effortful
Associative	Deductive
Fast	Slow
Unconscious	Self-aware
Skilled	Rule-following

Source: Own editing based on Thaler & Sunstein (2008), page 20

The precise definition of a nudge takes careful consideration. According to Thaler and Sunstein (2008), a nudge can be defined as “any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives.” They also add, “to count as a mere nudge, the intervention must be easy and cheap to avoid.” Therefore, the definition suggests that nudges are subtle pushes that aim to steer a person’s decision-making process (their System 1 and System 2) in the direction desired by the architect of the nudge. The second part suggests, however, that the nudgee must be allowed to have choice: whether to accept or reject the attempted influence.

I would also add, however, that since the publication of *Nudge*, many have voiced their criticism of Thaler and Sunstein’s work and have consequently reinterpreted the definition of nudge (e.g., Hausman & Welch, 2010; Hansen, 2016). It is a topic in its relatively early stages and as such, continues to undergo ongoing review and scholarly debate (Congiu & Moscati, 2022).

1.1.2 Why do humans need nudging?

Humans face an overwhelming mass of choices each day, but they do not spend equal time dwelling on all of those choices because that would be simply unsustainable in the long term. To simplify the situation for themselves, individuals often select whichever option requires the least effort. These mental shortcuts are known as heuristics (Thaler & Sunstein, 2008). Some examples of heuristics described in *Nudge* by Thaler & Sunstein are herd mentality (following and copying what others do in certain situations; one of its manifestations being known as “peer pressure”), status quo bias (people’s tendency to maintain things in their current state rather than making changes), or anchoring (relying a decision mainly on easily accessible information or the initially found information).

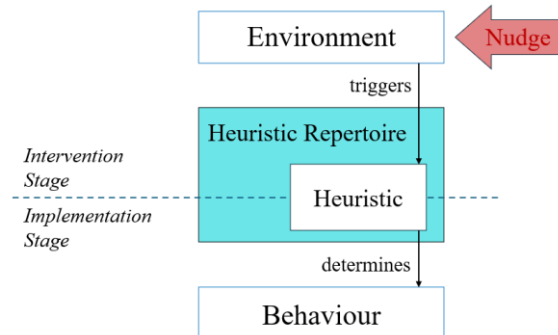
These heuristic forces suggest that when a default option—an option that is selected if the individual takes no action—exists for a particular choice, many people are likely to select that option, regardless of its suitability for their needs. It is merely the quickest and easiest option to choose, but not necessarily the most beneficial one (Thaler & Sunstein, 2008).

As an example, we can think of opening a website on the internet. Usually, the first thing that comes up is a pop-up window with the options whether to accept the default cookie settings or choose manually, one by one which ones to accept and which ones to decline. Furthermore, the “accept” button is usually the most visually attractive one (e.g., a button with coloured background, whereas the other buttons are smaller and colourless). Accepting the default is easy and takes about two seconds. However, this may raise a range of various privacy concerns, and we can be subjected to unwanted data collection (Bruns & Gaudeul, 2021). It is perhaps not ideal, but the vast majority of us will most likely still accept the consequences so that we can save the time and effort of choosing for ourselves.

The fact that we often rely on heuristics and default options in our decision-making processes points to the fact that humans have a tendency to disregard their own interests or may not even be aware of their own best interests in the first place. For that reason, choice architects can alter the environment in such ways that will help people make more advantageous decisions through triggering various heuristics that will then determine the consequent behaviour of the individual (Figure 1; Grüne-Yanoff et al., 2018).

Figure 1
Mechanisms of nudge interventions

Source: Own editing based on Grüne-Yanoff et al. (2018), page 250



1.1.3 Nudging or manipulation – ethical considerations

When discussing nudging, literature often arrives at the question of its ethical implications, as there is indeed a fine line between nudging and manipulation. Therefore, to have a better understanding of nudging, it would be beneficial to briefly overview the fundamental distinction between the two.

In order for nudging to avoid being considered manipulation, two important criteria must be met (Hansen & Jespersen, 2013):

1. Nudging must exert an effect on a person's behaviour instead of limiting their freedom of choice.
2. Nudging must be transparent, meaning that the targeted person must be aware they are being nudged.

Based on these two conditions, Hansen and Jespersen (2013) distinguish four types of nudges (see Table 2), which can be characterised by the following:

Transparent facilitation of consistent choice means that the nudge engages a person's reflective thinking in a way that the nudgee is aware of being under means of influence. They realise what decision they are being pushed towards, but they also know that they are free to choose other options. For instance, displaying pictures of health damages caused by smoking on cigarette packaging aims to deter people from tobacco use.

Transparent influence of behaviour engages a person's automatic system, while the reflective system is only engaged subsequently. An example is the colour red, which people automatically associate as a warning sign. However, upon further reflection—when they involve their reflective thinking—they can easily recognise the nudge.

When manipulation of choice occurs, the nudge engages the reflective system, but not in a way that makes the presence of the nudge easily recognisable. For example, seeing a long queue in front of a shop may lead people to believe that the product being sold must be of outstanding quality.

Finally, non-transparent manipulation of behaviour is the result of the nudge activating only the automatic system. In this case, the recipient has no knowledge of either the presence of a nudge or the decision they are being pushed towards. Reducing plate sizes to make people consume fewer calories can be categorised as this type of nudging.

Table 2
Suitable labels of intervention types

	Transparent	Non-transparent
System 2 thinking	Transparent facilitation of consistent choice	Manipulation of choice
System 1 thinking	Transparent influence (technical manipulation) of behaviour	Non-transparent manipulation of behaviour

Source: Own editing based on Hansen & Jespersen (2013), page 23

What literature appears to agree on is that choice architects must always thoroughly consider their societal and other responsibilities when implementing a nudge. Society needs discussions and communication to create transparent and ethical nudge policies (Schmidt & Engelen, 2020).

Numerous frameworks have been established with the purpose of summarising principles that can be easily and swiftly applied when designing a nudge that is both effective and ethical. The two most acclaimed frameworks, MINDSPACE and EAST, were both published by the United Kingdom’s Behavioural Insights Team (BIT) to facilitate the implementation of nudging methods in public policy (Pilat & Sekoul, 2021b).

The BIT defines MINDSPACE as “a checklist of influences on our behaviour.” It identifies nine of the most significant (but non-coercive) impacts on our behaviour (Dolan et al., 2010):

1. **Messenger.** We give more or less weight to information depending on who communicates it to us. For example, we are more likely to take the advice of a professional on a particular topic.
2. **Incentives.** We often respond to incentives in a predictable way because we use mental shortcuts to make decisions (e.g., avoiding losses as much as possible or preferring smaller but more immediate rewards over larger but more delayed ones).

3. **Norms.** We conform to what those around us are doing and follow their lead. These norms can either be explicitly stated (such as ‘No Smoking’ signs) or they can be based on our own observations of others’ actions.
4. **Defaults.** As previously noted by Thaler and Sunstein (2008), we tend to choose pre-selected, default options rather than actively making decisions for ourselves.
5. **Salience.** To manage the flood of stimuli we encounter in our daily lives, we frequently unintentionally separate the information our attention is drawn to—therefore we think is relevant. According to the BIT, novel, accessible, and simple messages are more likely to capture interest.
6. **Priming.** Priming is the least understood, yet perhaps the most significant element of MINDSPACE. Priming demonstrates how exposure to specific sights, sounds, or sensations before another event or action can affect our subsequent behaviour.
7. **Affect.** Words, images, and situations can trigger certain emotional reactions that unconsciously guide our behaviour. For instance, individuals who are feeling upbeat tend to make overly positive assessments, whereas those who are depressed tend to make overly negative judgements.
8. **Commitments.** We frequently delay making decisions that could possibly benefit us in the long term. By making our commitments public, we risk not only failing ourselves but also losing face in front of others, motivating us to fulfil our promises.
9. **Ego.** Oftentimes, when our life goes well, we tend to take credit for it; when things go poorly, we either blame other people or the unfavourable circumstances. This is the ‘Ego’ element of MINDSPACE, which leverages our desire to maintain the perception of a favourable and steady self-image.

The MINDSPACE framework enabled the BIT to successfully implement behavioural influence tools in public policymaking, achieving promising results that could serve as a precedent for other governmental institutions around the world. However, several debates surround the framework, including questions about whether the effects of certain elements can be sustained in the long term and whether they can be implemented by government officials who themselves are affected by biases and heuristics (Pilat & Sekoul, 2021a).

Later, the BIT recognised that the MINDSPACE framework—although successfully applied in various policymaking contexts—was too complex for busy policymakers to keep in mind and implement. More importantly, it did not capture all the elements that facilitate effective behaviour change. As a result, the BIT established the EAST framework, a more practical and

easy-to-follow guide to creating nudges. The elements are as follows (The Behavioural Insights Team, 2017):

1. **Easy.** When confronted with numerous challenges, we tend to abandon our tasks. Therefore, making the desired action the seemingly simplest and easiest option can encourage us to commit to the behaviour. This can be achieved, for example, through default options or by simplifying otherwise complex messages.
2. **Attractive.** To be able to exert an influence, the nudge must be recognised first. Therefore, messages should employ eye-catching graphics, colours, and individualised features, such as gamification.
3. **Social.** What those around us say and do has a significant impact on us. Another understanding of the ‘Social’ element is that we feel considerably more obligated to follow through on our commitments after telling someone else that we will carry them out.
4. **Timely.** Context and individual life circumstances heavily impact our outlook; therefore, depending on when we receive a nudge, we react in different ways.

All things considered, the EAST framework has established itself as a global standard for applying behavioural insights, not only in policymaking but in all kinds of industries, such as marketing as well (Pilat & Sekoul, 2021b).

1.1.4 Categorisation of nudge types

Numerous structures exist that categorise the various types of nudging techniques, with one of the most prominent being that of Michie et al. (2013).

The framework, called Behavior Change Technique Taxonomy, version 1 (BCTTv1 or BCT), lists 93 behaviour change strategies clustered into 16 categories (see Table 3). The categories are as follows: (1) goals and planning, (2) feedback and monitoring, (3) social support, (4) shaping knowledge, (5) natural consequences, (6) comparison of behaviour, (7) associations, (8) repetition and substitution, (9) comparison of outcomes, (10) reward and threat, (11) regulations, (12) antecedents, (13) identity, (14) scheduled consequences, (15) self-belief, and (16) covert learning.

Table 3
16 categories of behavioural change techniques and their components

Cluster label and component BCTs	Cluster label and component BCTs
1. Goals and planning 1.1. Goal setting (behaviour) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behaviour goal(s) 1.6. Discrepancy between current behaviour and goal 1.7. Review outcome goal(s) 1.8. Behavioural contract 1.9. Commitment	9. Comparison of outcomes 9.1. Credible source 9.2. Pros and cons 9.3. Comparative imagining of future outcomes
2. Feedback and monitoring 2.1. Monitoring of behaviour by others without feedback 2.2. Feedback on behaviour 2.3. Self-monitoring of behaviour 2.4. Self-monitoring of outcome(s) of behaviour 2.5. Monitoring of outcome(s) of behaviour without feedback 2.6. Biofeedback 2.7. Feedback on outcome(s) of behaviour	10. Reward and threat 10.1. Material incentive (behaviour) 10.2. Material reward (behaviour) 10.3. Non-specific reward 10.4. Social reward 10.5. Social reward 10.6. Non-specific incentive 10.7. Self-incentive 10.8. Incentive (outcome) 10.9. Self-reward 10.10. Reward (outcome) 10.11. Future punishment
3. Social support 3.1. Social support (unspecified) 3.2. Social support (practical) 3.3. Social support (emotional)	11. Regulation 11.1. Pharmacological support 11.2. Reduce negative emotions 11.3. Conserving mental resources 11.4. Paradoxical instructions
4. Shaping knowledge 4.1. Instruction on how to perform the behaviour 4.2. Information about Antecedents 4.3. Re-attribution 4.4. Behavioural experiments	12. Antecedents 12.1. Restructuring the physical environment 12.2. Restructuring the social environment 12.3. Avoidance/reducing exposure to cues for the behaviour 12.4. Distraction 12.5. Adding objects to the environment 12.6. Body changes
5. Natural consequences 5.1. Information about health consequences 5.2. Salience of consequences 5.3. Information about social and environmental consequences 5.4. Monitoring of emotional consequences 5.5. Anticipated regret 5.6. Information about emotional consequences	13. Identity 13.1. Identification of self as role model 13.2. Framing/reframing 13.3. Incompatible beliefs 13.4. Valued self-identity 13.5. Identity associated with changed behaviour

Cluster label and component BCTs	Cluster label and component BCTs
6. Comparison of behaviour 6.1. Demonstration of the behaviour 6.2. Social comparison 6.3. Information about others' approval	14. Scheduled consequences 14.1. Behaviour cost 14.2. Punishment 14.3. Remove reward 14.4. Reward approximation 14.5. Rewarding completion 14.6. Situation-specific reward 14.7. Reward incompatible behaviour 14.8. Reward alternative behaviour 14.9. Reduce reward frequency 14.10. Remove punishment
7. Associations 7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues 7.4. Remove access to the reward 7.5. Remove aversive stimulus 7.6. Satiation 7.7. Exposure 7.8. Associative learning	15. Self-belief 15.1. Verbal persuasion about capability 15.2. Mental rehearsal of successful performance 15.3. Focus on past success 15.4. Self-talk
8. Repetition and substitution 8.1. Behavioural practice/rehearsal 8.2. Behaviour substitution 8.3. Habit formation 8.4. Habit reversal 8.5. Overcorrection 8.6. Generalisation of target behaviour 8.7. Graded tasks	16. Covert learning 16.1. Imaginary punishment 16.2. Imaginary reward 16.3. Vicarious consequences

Source: Own editing based on Michie et al. (2013), pages 92-93

The aim with the categorisation was to create a comprehensive hierarchical classification of behaviour change techniques with clearly defined labels and to create a taxonomy that is internationally and disciplinary agreed upon (Michie et al., 2013).

1.1.5 Common areas of application

Nudging has been welcomed as a favoured tool in a wide array of areas since its popularisation, some of those being public health and healthcare, sustainability, education, organ donation, public policymaking, or product marketing (Halpern & Sanders, 2016). To get a sense of the practical results, some examples are presented below.

One of the most common areas of application is promoting healthy food choices through the power of positional influence. A study conducted by Kahn & Wansink (2004) showed that participants of the experiment consumed more than twice as many jelly beans when they were organised according to colour compared to when they were disorganised.

Another example is a study conducted by Yi et al. (2022), where several initiatives related to product placement were put to the test. One of them involved placing a bright, striking poster calling attention to choosing a fresh fruit for only \$1.00. As a result, the number of fruits sold per day increased by 15% compared to the baseline.

Benartzi et al. (2017) compared traditional and unconventional types of interventions aimed at encouraging high school enrolment. In the nudge approach, some tax professionals provided low-income families with assistance by filling out financial aid forms and calculating potential aid amounts. As a result, 1.53 additional students enrolled in college the following year for every \$1,000 spent on the implementation of the intervention. Other conventional intervention strategies demonstrated significantly lower effectiveness, resulting in only 0.0351 additional students enrolling in college within the next year when supported by monthly stipends, and 0.0051 additional students when supported by state education subsidies.

There are even so-called “Nudge units” within governments, in particular in the United States, and the Behavioural Insights Team in the United Kingdom. The most notable tasks of these units are to encourage people to improve their lifestyles, pay their taxes and bills on time, recycle, and save up for retirement (Halpern & Sanders, 2016).

1.2 NUDGING TO ROAD SAFETY

As outlined previously, nudging can be an efficient tool in various fields, including road safety. So far, several studies have been published examining different methods by which nudging can be incorporated to improve driving safety. In this section, I am going to outline the currently available findings on the topic.

1.2.1 The current state of global road safety and initiatives aimed at improvement

Road traffic accidents are among the most common causes of death today. According to the World Health Organization’s Global Status Report on Road Safety (2023a), approximately 1.19 million people fall victim to road traffic crashes each year. Although there has been some progress in reducing road traffic fatalities and injuries in the ECE (United Nations Economic Commission for Europe) region, it did not meet the targeted Sustainable Development Goal (SDG), which set the objective to reduce the number of global fatalities and injuries from road traffic accidents by 50% from 2010 to 2020 (UNECE, 2023).

Additionally, injuries sustained from motor vehicle accidents are the worldwide leading causes of death for children and young adults aged 5–29 years (WHO, 2023a). However, the

consequences of dangerous driving behaviour and road accidents are not exclusively physical, especially for children. The fear of a car accident affecting either parents or the child themselves has been previously identified as a factor being associated with anxiety disorders such as separation anxiety or post-traumatic stress disorder (PTSD). Even individuals who were not directly involved in accidents (for example, witnessed a crash) can experience psychological problems (Kovess-Masfety et al., 2017).

WHO (2011, 2023a) and the European Commission (2024) list some of the most common causes of road traffic accidents:

1. **Speeding.** According to WHO, both the probability of a collision and the severity of its repercussions are directly correlated with an increase in average speed. For example, the risk of a fatal collision increases by 4% with each 1% increase in mean speed. Studies conducted by the European Commission reach similar conclusions. According to the EC's 2024 Road Safety Thematic Report, exceeding speed limits contributes to approximately 30% of fatal collisions. Yet, on urban roads, 27–79%, on non-motorway inter-urban roads, 7–71%, and on motorways, 11–60% of observed vehicles exceeded speed limits in 2023.
2. **Distractions.** Both WHO and the European Commission identify distractions as a common contributing factor to road accidents. It is estimated that drivers who use mobile phones while driving are four times more likely to be involved in an accident than those who do not. Estimates suggest that distractions (e.g., mobile phone use) are a factor in 5–25% of road crashes in Europe. Using a mobile phone while driving leads to longer reaction times, shorter following distances, and increased mental workload, among other impairing factors.
3. **Driving under the influence.** The consumption of alcohol and drugs greatly increases the likelihood and severity of an accident. Impaired driving leads to problems with visual perception, divided attention, and impairment in alertness. Research conducted in low- and middle-income countries indicates that 33–69% of drivers who died in crashes had alcohol in their system prior to the collision.
4. **Failure to use safety equipment.** Other risk factors associated with increasing the severity of accidents include failure to use seatbelts, child restraints, and motorcycle helmets.
5. **Non-driver related factors.** Other factors unrelated to drivers include dangerous road infrastructure, and inadequate care following a collision.

According to the European Commission's Road Safety Thematic Report (2024), human factors contribute to 95% of road crashes, infrastructure factors and vehicle factors account for approximately 30% and 10% of accidents, respectively. A study conducted by Penumaka et al. (2014) revealed that the most common human factors leading to accidents between powered two-wheelers and cars were perception failures (failing to sense an obstacle), comprehension failures (misjudgement of a perceived obstacle), and execution failures (incorrect or ineffective manoeuvre to avoid the perceived and understood obstacle). For this reason, initiatives aimed at the human factor could most prominently contribute to creating safer roads.

WHO (2023a) and the European Commission (2024) draft several recommendations regarding the prevention of road traffic accidents. WHO puts emphasis on the implementation of appropriate legislative measures. National laws should be in place applying strict regulations for the five key risk factors (speeding, drunk driving, motorcycle helmet use, seatbelt use, and child restraint system use). These regulations would limit road users' behaviour within firm boundaries and ensure responsible driving patterns.

The European Commission (2024) makes several recommendations regarding various interventions that emphasise promoting good driving practices instead of enforcing strict rules that may generate resistance. Measures to confine speeding include the implementation of dynamic speed limits, which consider traffic and weather conditions, and infrastructural modifications, such as narrowing roads to create the illusion of travelling at a higher speed. The use of Adaptive Cruise Control (ACC) contributes to maintaining safe speeds; thus, the technology should be further popularised. In-vehicle technologies that detect indicators of alcohol or drug impairment (such as Advanced Driver Assistance Systems, ADAS) may also help alleviate their effects on driving performance (e.g., collision warning and lane departure warning).

Both WHO and the EC bring attention to the role of education in promoting good practices; therefore, there are currently various campaign initiatives aimed at promoting global road safety. For example, the United Nations Global Road Safety Week is organised in May every other year with the intention of ensuring safe roads and vehicles, as well as promoting sustainable means of transportation and the importance of adequate emergency care (WHO, 2023b).

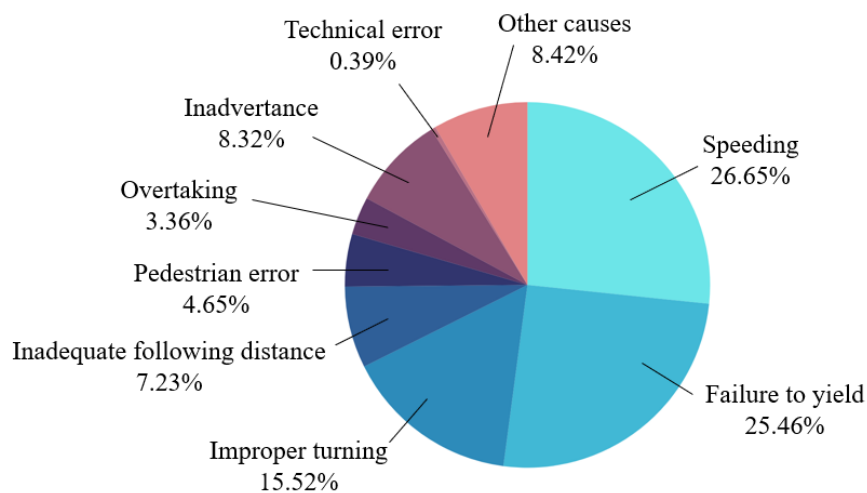
In line with its safety recommendations, the EU has already recognised the potential benefits of unconventional intervention methods and funded the MeBeSafe project, which aims to positively influence habitual traffic behaviour using the nudge approach. In the framework of the project, researchers developed and tested eight nudging measures. Among others, these include the use of the aforementioned ACC system, a phone application collecting driving data and

providing coaching feedback, and a driver alertness nudge that rewards sleepy drivers who take a break during the drive (European Union, 2024).

1.2.2 The current state of road safety in Hungary

Related to Hungary, according to the Hungarian Central Statistical Office (hereafter KSH; 2023a), there were more than 14,000 road traffic accidents involving personal injury in 2023, of which 438 accidents involved fatalities and more than 4,000 accidents involved serious injuries. According to the Monthly Statistical Statement published by the Hungarian National Police Headquarters (hereafter ORFK; 2023), among the most common causes of road traffic accidents involving injury in 2023 were speeding, failure to yield, improper turning, and failure to maintain adequate following distance (Figure 2). This indicates that human factors together led to more than 90% of road traffic accidents involving injury, while the percentages of technical error (0.39%) and other causes (8.42%) are minimal in comparison. This aligns with the global data regarding the human factor being the most significant contributor to traffic accidents.

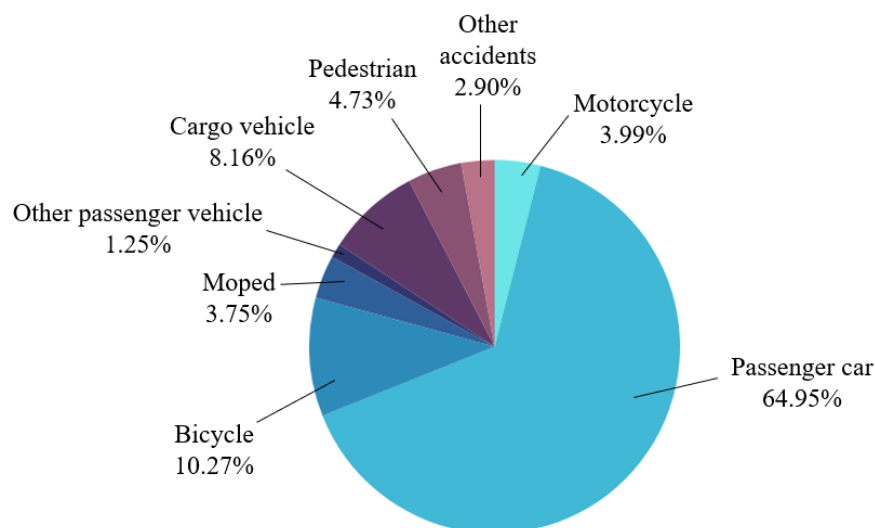
Figure 2
Causes of road traffic accidents involving injury in Hungary, 2023



Source: Own editing based on ORFK (2023)

According to KSH (2023b), approximately 65% of all crashes involving personal injury were caused by passenger cars in 2023 (Figure 3). In more than 13,000 cases of road traffic accidents involving personal injury, vehicle drivers were at fault, while in 33 cases passengers were the causers of the accident (KSH 2023c).

Figure 3
Distribution of road traffic accidents involving injury by causer in Hungary, 2023



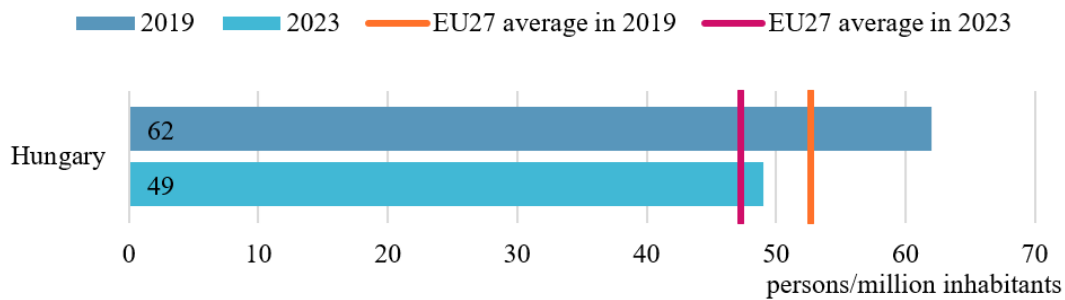
Source: Own editing based on KSH (2023b)

In 2022, the groups of 50 to 64-year-olds and those aged 65 or over together comprised the highest proportion of road traffic fatalities, with more than half (52.0%) of all reported road traffic deaths in Hungary. Individuals aged 25 to 49 accounted for 35.0%, individuals aged 24 or younger accounted for 12.1% of road traffic fatalities (Move, Care & Eurostat, 2022). This indicates a slight difference from global trends, with older age groups being more at risk of falling victim to traffic accidents than younger individuals. This could be attributed to the ageing of the population as well. Farooq & Juhasz (2018) analysed the behaviour of younger age groups of Hungarian drivers as part of their study and found that disregarding speed limits, driving too closely, and frequent changing of lanes were the most prominent dangerous driving practices of young individuals.

Road accident fatalities per million inhabitants decreased from 2019 to 2023, from 62 persons/million inhabitants to 49 persons/million inhabitants, which indicates a favourable trend. However, the rate is still above the average for Member States in the European Union, with an average of 52.7 persons/million inhabitants falling victim to road traffic accidents in 2019 and an average of 47.3 persons/million inhabitants in 2023 (Figure 4; KSH, Care & Eurostat, 2023).

Figure 4

Trend in the number of road accident fatalities per million inhabitants in Hungary, 2019–2023



Own editing based on KSH, Care & Eurostat (2023)

The Hungarian government considers improving road safety one of its main targets. The current Hungarian Road Safety Action Programme is in place from 2023 to 2025. It takes on initiatives such as “Vision Zero,” targeting the reduction of road fatalities and serious injuries to near zero by 2050 (Ministry of Interior, 2023). The Action Programme also identifies human factors as accounting for the majority of road traffic accidents, making addressing them the primary objective of safety initiatives. In accordance with the aforementioned European field of action, the objective is to raise road users’ level of compliance with the rules and regulations, to raise safety awareness through education, and to enhance vehicle safety (Török et al., 2014).

1.2.3 Previously explored nudging methods in road safety

Over the years, various studies set out to identify the causes and motivators of different driving behaviours (Rubaltelli et al., 2021) and how nudging could be used as a cost-effective and easily implemented tool to manage these behaviours.

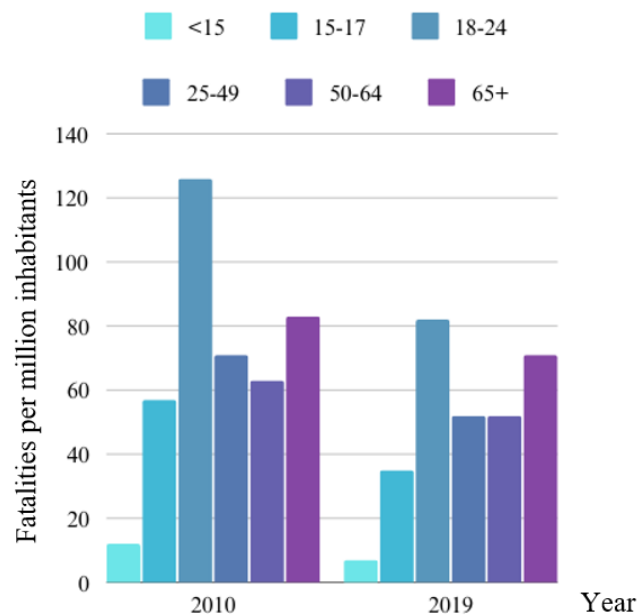
Emotions: Positive and negative emotions have been found to be among the most influential factors on drivers’ performance. The power of emotions has been examined through various types of music (e.g., happy, sad, calming, angry) in several studies, though the results are occasionally contradictory. Angry music has been shown to have a positive effect on reaction times but to result in drivers keeping a smaller distance from the leading car (Steinhauser et al., 2018). Happy, high-tempo music has been shown to attract drivers’ attention and result in a deterioration of control (Pêcher et al., 2009; Brodsky, 2001).

Age: Age has also been identified as having significant effects on driving behaviour. In both 2010 and 2019, individuals aged 18–24 and those over the age of 65 were involved in the most road accidents resulting in fatalities (Figure 5; European Commission, 2021). Young people tend to engage more in risky driving behaviours, such as driving without a seatbelt, speeding,

driving under the influence, or street racing (Fergusson et al., 2003), while older drivers exhibit longer reaction times when trying to avoid dangerous situations on the road (Fildes et al., 2007).

Berry (2011) analysed whether older drivers can be nudged towards practicing more responsible self-regulation. The study makes several recommendations to improve the safety awareness of drivers in the older age groups. One such proposal is the revision of the licensing system to periodically require drivers to declare that they are fit to drive a vehicle. A second recommendation is to reconsider the role of education. Rather than being presented as a punishment, it should be framed as a positive opportunity—that is, as a chance to maintain driving autonomy.

Figure 5
Annual number of fatalities in road accidents per million
inhabitants by age group in the EU27, 2010–2019



Source: Own editing based on Care & Eurostat cited in European Commission (2021)

Social norms: Social norm nudges are specifically designed to communicate to people what others do or would do in certain situations, thus encouraging the recipient of the nudge to conform to the majority and alter their conduct. The concept is based on the idea of “social influence,” which holds that individuals frequently seek to follow the actions of those in their social group to establish what constitutes normal and acceptable behaviour in a given situation (Bicchieri & Dimant, 2023). Liu et al. (2022) analysed the effects of social norms on drivers’ yielding behaviour through eight different types of nudges (dynamic, static, injunctive norms, and positively and negatively worded messages). The study found that social norm nudges can significantly improve drivers’ willingness to give way. In particular, positively phrased dynamic

and injunctive nudges were the most effective. In another study, Nicolls et al. (2024) examined whether social norms could be used to deter young drivers from using their phones while driving and found that injunctive and descriptive norms combined were preferred by the majority of the participants, concluding that these nudges could be a promising tool to promote safer driving behaviour.

Reward mechanisms: Other types of nudges utilise reward systems and mechanisms. When humans encounter a reward, their brains naturally link a particular stimulus (places, activities, events, etc.) to a favourable or desired outcome. As a result, the individual's behaviour is subsequently modified, eventually prompting them to look for that specific favourable stimulus in other instances as well (Lewis et al., 2021). Building on the idea of reward mechanisms, game designer Kevin Richardson designed a camera known as the "Speed Camera Lottery" that pays out prizes to drivers who obey speed restrictions. For the reward, the money comes from the fines of those who do not obey the speed limit. The result was an instantaneous 20% average speed decrease at the checkpoint (Zichermann & Cunningham, 2011).

In-vehicle assistance: The issue with some of the traditional influencing techniques is that they only affect drivers' behaviour for a limited amount of time. For instance, traffic signs, speed enforcement cameras, and other speed indicators only alert drivers at specific locations, but the effect does not last for extended road sections (Berghaus et al., 2024). Being present through the entirety of the ride, in-vehicle nudges could possibly offer a more consistent solution. Nori et al. (2022) analysed whether GPS (digital) nudges could be used to reduce the number of road crashes. The results reveal that GPS positively influences drivers' sense of direction and contributes to having a better representation of the town. Being familiar with one's surroundings is one of the most significant internal components in the reduction or elimination of spatial differences that often cause road crashes (Nori & Piccardi, 2010). Zadka-Peer & Rosenbloom (2024) used irritating and repetitive beeping sounds as a negative reinforcement nudge when the driver exceeded the speed limit; the sound stopped when the driver slowed down below the speed limit. The results indicate that the negative reinforcement nudge elicited quicker reaction times, but the social norm nudge used in the study had more lasting effects. The fast reaction time could be attributed to the clear message of the negative reinforcement nudge regarding the required behaviour.

Perception of the magnitude: Rubaltelli et al. (2021) used a common marketing tactic known as the "left-digit effect," where price tags are displayed with low leftmost numbers and high rightmost numbers. In the study, the numbers on existing speed limit traffic signs were reduced and increased by one km/h (e.g., from 50 to 49 and from 50 to 51 km/h), and the effect

was examined with the help of a driving simulator. The findings indicated that while there was no significant difference in the presence of the 50 km/h and 51 km/h signs, the median speeds were significantly lower in the presence of the 49 km/h sign than the 50 km/h sign.

1.2.4 Nudging compared with conventional methods

It is important to analyse whether nudging methods are more reliable, efficient, and financially worthwhile than conventional traffic interventions.

Conventional methods of promoting safer driving behaviours include handing out fines to those who violate rules and regulations. The issue is that fines often come several weeks after the violation has occurred. From the point of the speeding to the arrival of the ticket, several other instances of exceeding speed limits could have occurred, and the delay also mitigates the impact of the warning (Camp et al., 2019). Handing out fines can also be understood as an intimidation tactic or punishment, which is likely to incite antagonism. Nudging, on the other hand, can directly and immediately influence behaviour, and the implementation of nudges involves a minimal alteration of the environment, which is improbable to provoke antagonism (Zadka-Peer & Rosenbloom, 2024).

Traditional road safety campaigns mainly utilise different media (e.g., newspapers, TV, radio, flyers, etc.). These campaigns usually convey information about road safety statistics, raise awareness of the consequences of reckless driving, and share useful tips about how to prevent dangerous situations and what to do when involved in such accidents. The objective of these efforts is to alter overall driving behaviour; however, they do not concentrate on specific road segments with elevated accident risk (Berghaus et al., 2024), nor do they take into account personal factors such as age, gender, mood, and personality traits of a driver. Though targeted campaigns focused on specific driving behaviours can be highly effective, they often involve substantial expenses (Zadka-Peer & Rosenbloom, 2024). Certain nudge types, however, can be implemented specifically at high-risk road segments (e.g., Liu et al., 2022; Berghaus et al., 2017; Camp et al., 2019), thus being able to exert a more direct influence on drivers' behaviour. To tackle the lack of personalisation, in-vehicle nudges could be a viable solution. For instance, Generosi et al. (2022) analysed whether adaptive HMIs (human machine interfaces) could be used as a tool to improve positive driving patterns. Adaptive HMIs should be able to identify feelings and emotions and choose suitable nudging techniques accordingly to create an optimal driving environment through adjusting music, temperature, lighting, vocal assistance, etc.

It is also noteworthy that ill-considered nudges can generate unintended consequences. Oftentimes, people do not enjoy being told what to do and may purposefully act against the

instructions. In the case of driving behaviour, they might speed excessively or drive even more recklessly (Duncan & Asad, 2021). Ineffective nudges can occur for various reasons.

If a nudge is designed based on incorrect comprehension of behaviour and stimuli to which people react, it might not result in the desired outcome. Furthermore, the effect might be diminished if the nudge is too complex and difficult for the human mind to process (Sunstein, 2017).

Another potential concern is whether nudges can exert a lasting impact on people's behaviour. Encountering a nudge for the first time is likely to attract more attention, but if we come across the nudge periodically, somewhat like a reminder, it might soon become less outstanding and less meaningful “background noise,” thus mitigating its influencing power. (Sunstein, 2017). Research conducted by Polman & Maglio (2024) supports the conclusion that nudges can often increase the likelihood of making a choice (such as choosing a healthy snack instead of an unhealthy one) but not the subsequent behaviour (actually eating the healthy snack). Similarly, traffic signs with informational messages (e.g., weather conditions or road risks) may offer drivers additional support in the vicinity of the sign, but they do not induce overall safer driving patterns in the long run (Duncan & Asad, 2021).

Nevertheless, the nudging methodology has demonstrated highly encouraging outcomes and can be exceedingly beneficial if the interventions are evaluated and reviewed in advance to confirm that they do not yield any adverse side effects (Thaler & Sunstein, 2008).

1.2.5 Why the use of the nudge approach is relevant in Hungarian road safety

The action programmes and measures taken so far demonstrate that road safety is receiving increasing attention not only globally but also at the national level in Hungary. The economic, physical, and psychological impacts of road traffic accidents cause considerable harm to society, communities, and individuals alike but could be significantly mitigated with the correct interventions (WHO, 2023a).

However, as the data indicates, the current state of road safety in Hungary is still inadequate in several respects, with substantial room for improvement to meet the determined targets and goals (e.g., Vision Zero, or reaching the EU average). Consequently, as traditional intervention techniques (e.g., speed enforcement cameras, handing out fines) have not been able to fully support the achievement of these targets thus far, it would be highly reasonable to introduce, test, and evaluate new methodologies, which could possibly facilitate a more considerable and rapid improvement in this crucial area. Thus, nudging—although previously explored in driving to some extent and in certain scenarios—could be more extensively utilised as such an innovative approach.

Furthermore, the high proportion of human contributing factors to road traffic accidents in Hungary (ORFK, 2023) indicates that any measure shaping driver behaviour in the right direction could significantly improve the state of road safety. This also justifies the implementation of the nudge approach, as nudges aim to exert positive influence on human behaviour.

As the European Union has already recognised the potential of nudging measures to promote driving safety (e.g., MeBeSafe project; European Union, 2024), it is of crucial importance to first assess the susceptibility and responsiveness of Hungarian drivers to the methodology and subsequently integrate the appropriate nudges into the Hungarian road safety practices as well. It is noteworthy that previous studies conducted regarding the possible applications of the nudge approach to driving are not exclusively focused on Hungary and therefore do not take into account the unique personality traits, driving habits, and attitudes of the Hungarian population—factors that can significantly influence the effectiveness of nudges. Particularly considering the characteristics of Generation Z, which constitutes the age group spending the most time travelling in a day (Kolnhofer-Derecskei, 2019) and using their cars the most frequently (forense.hu, 2017). Generation Z is also known for its receptiveness to nudges (e.g., Prits, 2023; Uehara & Sakurai, 2021), and therefore may respond positively to the subtle interventions proposed by nudges in driving contexts as well. Thus, the above elaborated arguments position the present study as a meaningful contribution to the existing literature on this topic.

2. PRIMARY RESEARCH

2.1 MATERIALS AND METHODOLOGY

2.1.1 Purpose of the study

The main objective of the present research is to investigate the most substantial influencing factors on driver behaviour of members of Generation Z in Hungary through the application of various types of nudge approaches while also considering drivers' demographic characteristics, driving history and attitudes. To achieve the primary focus of the study, exploratory factor analysis was utilised in the research.

2.1.2 Survey design and participants

As reflected in Section 1.1.4 of the literature review, behaviour change techniques can be clustered into sixteen categories. The online questionnaire survey (see Appendices 1 and 2) constructed for the purpose of this study was based on Li et al. (2024), which selected seven out of the sixteen nudge approaches based on their effectiveness on drivers' intent to use driver tracking devices. The seven approaches included are as follows: (1) shaping knowledge, (2) natural consequences, (3) comparison of behaviour, (4) identity, (5) covert learning, (6) feedback and monitoring, and (7) driving safety evaluation. In the study, each specific nudge approach is represented by three to four statements. For the purpose of the present research, these statements were slightly altered and complemented with additional questions for two main reasons:

1. Getting a more detailed and precise understanding of the influencing factors on driver behaviour, such as whether the influence of friends and family members—people we often to maintain a closer, more direct relationship with—has a stronger influence on driving behaviour than that of vehicle drivers in general (as previously explored, for example, by Nicolls et al., 2024).
2. Adjusting the questions to the currently existing Hungarian driving practices, rules and regulations of the road, and requirements to drive a vehicle.

The statements incorporating the various nudge approaches included in the survey were as can be seen in Table 4. The questions were distributed in Hungarian in the form of an online survey and shared mainly through social media platforms (e.g., Facebook) and amongst university students at Széchenyi István University of Győr; the reason for this being that the study aimed at exploring the driving patterns of members of Generation Z, who can be most

efficiently reached through these platforms. The questionnaire consisted of closed-ended multiple-choice questions to assess the demographics, driving history and driving habits of the participants. To assess the level of agreement with the questions that incorporated the nudge approach, participants had to use a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Table 4
Statements incorporating the nudge approach included in the survey

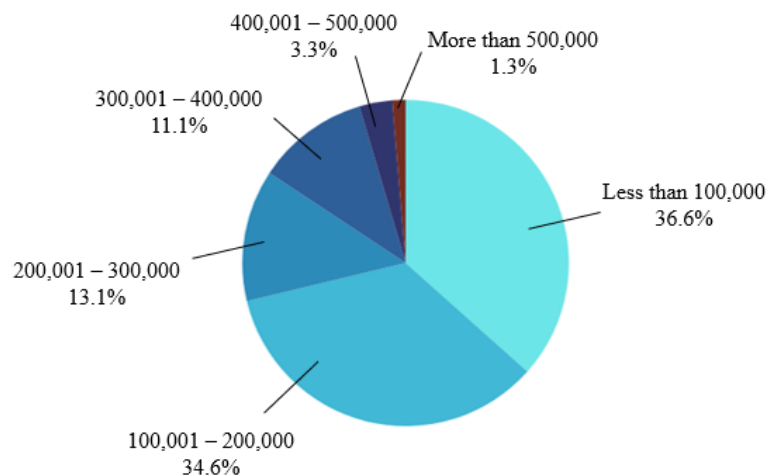
Nudge approach	Statements	Abbr.
Natural consequences	In the future, I would pay more attention to safe driving after being in a car accident or experiencing dangerous driving (e.g., sudden deceleration).	NC1
	I would try to avoid driving as much as possible after driving dangerously.	NC2
	Following learning of a traffic fatality in the news (e.g., TV, newspaper), I always try to drive more safely.	NC3
Covert learning	Real site photos and videos showing the misery of traffic accidents will remain in my memory for a long time.	CL1
	Written messages showing the consequences of a traffic accident (death, sadness of the victim's family, impact on society, etc.) will remain in my memory for a long time.	CL2
	Warning messages (e.g., billboards advertising safe driving) help me increase safe driving awareness.	CL3
	The fines handed out to me in case of violating the rules of the road help me increase safe driving awareness.	CL4
Comparison of behaviour	When my driving style/performance is compared to someone else's, I try to drive more safely.	CoB1
	If I am told that "80% of drivers slow down to less than 60 km/h" for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.	CoB2
	If I am told that "80% of my friends/family members slow down to less than 60 km/h" for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.	CoB3
	When I am praised by others, I try to drive more safely.	CoB4
Shaping knowledge	The introduction of mandatory education when renewing a driver's license would be useful for improving safe driving and safety awareness.	SK1
	Traffic safety campaigns help improve driving safety and safety awareness.	SK2
	Information shared with me on how to drive safely contributes to increasing my driving safety and safety awareness.	SK3
Driving safety evaluation	I like to drive.	DSE1
	I'm good at driving a car.	DSE2
	I feel safer when I am the one driving.	DSE3
	I want to use my car more.	DSE4
Feedback and monitoring	If I were able to record my driving history and performance (e.g., speed, fuel consumption) on my mobile, I would want to see the results after every drive.	FaM1
	In order to improve my driving safety, I have no psychological resistance to receiving safe driving advice and information by mobile phone (e.g., notification of GPS application of exceeding speed limit or foggy road section) or email address.	FaM2

Nudge approach	Statements	Abbr.
	In order to improve my driving safety, I have no psychological resistance to having my safety performance diagnosed and fed back to me by a government-certified public agency through tracking my driving history (e.g., speed, recording dangerous situations).	FaM3
Driver's identity	I am an anxious driver.	DI1
	I am a careless driver.	DI2
	I am an overconfident driver.	DI3

Source: Own editing based on questionnaire data

During the survey period (October 13, 2024 to October 27, 2024), a total of 220 people filled out the questionnaire. During the course of data screening responses with uniform answers, responses of people not obtaining a driver's license as well as responses of non-generation Z members were excluded. Following the screening, the survey ended up with 153 valid responses, of which males constituted 49.7%, and females 50.3%, respectively. In terms of residency, 36.6% of respondents lived in a village, 6.5% in the capital, 23.5% in a county seat, and 33.3% in a town. 83.0% of valid respondents owned a high school diploma, 7.8% have completed a higher-level vocational training (FOSZK), 7.8% owned a BA/BSc degree, 1.3% owned an MA/MSc degree. Figure 6 describes the distribution of respondents by average monthly net income.

Figure 6
Distribution of respondents by average monthly net income (HUF)



Source: Own editing based on questionnaire data

Table 5 depicts the distribution of respondents based on car ownership. As the survey focused exclusively on members of Generation Z, it was largely distributed amongst university

students. In line with this, the majority of respondents belong to the lower-level income groups, many of them likely supported by parents rather than earning their own living. Consequently, they possibly do not have the means to maintain their own car in the long run, as it involves high maintenance costs and extra expenses in case of mechanical failures. All male respondents in the relatively higher income groups (more than 300,000 HUF) owned a car without exception. For females, only participants with an income of 400,001–500,000 HUF owned a car without exception, although there were fewer responses from women in these higher income groups (and none of the female participants fell into the category of earning more than 500,000 HUF).

Table 5
Distribution of respondents based on car ownership

	Owns a car		Total
	Yes	No	
Male	40	36	76
Less than 100,000	7	19	26
100,001 – 200,000	13	15	28
200,001 – 300,000	8	2	10
300,001 – 400,000	9	-	9
400,001 – 500,000	1	-	1
More than 500,000	2	-	2
Female	33	44	77
Less than 100,000	9	21	30
100,001 – 200,000	8	17	25
200,001 – 300,000	8	2	10
300,001 – 400,000	4	4	8
400,001 – 500,000	4	-	4
More than 500,000	-	-	-
Total	73	80	153

Source: Own editing based on questionnaire data

Table 6 describes the distribution of respondents based on their preference for driving longer distances (min. 100 km). A substantial proportion of all respondents (71.2%) enjoy driving longer distances, while those who do not constitute 28.8% of all respondents. Altogether, both men and women enjoy driving for an extended stretch; however, regarding males, the proportion of these respondents is 81.6% of all males, while only 18.4% do not enjoy driving longer distances. For women, the percentages are much closer, with 61.0% of all females enjoying and

39.0% of all females not enjoying driving longer distances. These findings are consistent with research conducted by Matthies et al. (2002), who suggest that women even with access to a car tend to use public transport more frequently than men, likely due to stronger ecological norms, sustainability goals, and less established skills and habits of car usage. Matthies et al. (2002) also suggested that compared to men, women exhibit more inclination to reduce their car usage when public transport is available. Jiménez-Mejías et al. (2014) also found that the travelled distances as a car driver per year were higher among males.

Table 6
Distribution of respondents based on their preference for driving longer distances

Gender	Enjoys driving longer distances		Total
	Yes	No	
Male	62	14	76
Female	47	30	77
Total	109	44	153

Source: Own editing based on questionnaire data

2.1.2 Methodology

Exploratory factor analysis has been utilised as a preferred multivariate analysis tool by many researchers, as it provides a statistical approach that has been proven to be suitable for compressing a large number of variables into a smaller set of (latent) variables while simultaneously retaining as much of the information content of the database as possible as well as allowing the joint observance of multiple criteria. The methodology is also widely used for its suitability for revealing underlying dimensions of the observed phenomena (Jánosa, 2023; Williams et al., 2010).

The literature presents a range of perspectives on determining an adequate sample size for conducting the exploratory factor analysis. Hair et al. (2010) recommended that sample sizes should be 100 or above. According to Chua (2013) and MacCallum et al. (1999), sample sizes should be no less than five times the number of variables included in the study in question. Therefore, based on the latter recommendation, a minimum of 120 respondents should be adequate to conduct the exploratory factor analysis in the present research. Thus, the sample of 153 valid respondents should satisfy the requirements proposed by the cited literature.

In addition, to perform the exploratory factor analysis, the following acceptance criteria were defined that should ensure the validity of the research (Chan & Idris, 2017):

- Spearman's Rho: >0.3 (Kapoor, 2020; Watkins, 2018; Hair et al., 2010)
- Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO): >0.5
- Bartlett's Test sig.: <0.05
- Communalities: >0.25
- Goodness-of-Fit Test: >0.00
- Total Variance Explained: >33%
- Factor Weights: >0.25 (Barna & Székelyi, 2008).

Furthermore, the reliability of the research is corroborated by the Cronbach Alpha test conducted in the course of the study, where the criteria of >0.7 is defined in literature as widely accepted (Chan & Idris, 2017).

Several studies discuss the necessity of normal distribution to perform factor analysis (Ferguson & Cox, 1993). Muthén & Kaplan (1985) came to the conclusion that a certain level of univariate skew and kurtosis can be categorised as acceptable; however, values should fall between -2 and +2. Ryu (2011) also found that the skewness value of 2 can be identified as a critical level; however, the study was more permissive regarding kurtosis, considering kurtosis values falling below 7 acceptable. The findings of Ryu (2011) affirm research conducted by Curran et al. (1996), who came to the same—more permissive—conclusion.

2.2 RESULTS

2.2.1 Factor analysis

In the present research, three factors pertaining to the influence of the nudge approach on individuals' driving behaviour have been extracted using the maximum likelihood method:

1. Comparison of behaviour (COM_BEHA) – 3 items:

- CoB2: If I am told that “80% of drivers slow down to less than 60 km/h” for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.
- CoB3: If I am told that “80% of my friends/family members slow down to less than 60 km/h” for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.
- CoB4: When I am praised by others, I try to drive more safely.

2. Shaping knowledge (SHA_KNOW) – 3 items:

- SK1: The introduction of mandatory education when renewing a driver's license would be useful for improving safe driving and safety awareness.
- SK2: Traffic safety campaigns help improve driving safety and safety awareness.
- SK3: Information shared with me on how to drive safely contributes to increasing my driving safety and safety awareness.

3. Natural consequences (NAT_CONS) – 2 items:

- NC1: In the future, I would pay more attention to safe driving after being in a car accident or experiencing dangerous driving (e.g., sudden deceleration).
- NC3: Following learning of a traffic fatality in the news (e.g., TV, newspaper), I always try to drive more safely.

The comparison of behaviour factor can be defined as the effect of comparing one's driving behaviour with the actions of various social groups and individuals. The shaping knowledge factor encompasses the effect of information and instructions shared with drivers with educational purposes on why and how to adopt safe driving habits. Lastly, the natural consequences factor means the effect of information and experiences of real-life on-road scenarios that can either happen to the recipients of the nudge themselves or other individuals.

The reliability of the determined latent variables was assessed through the analysis of Cronbach Alpha values (Table 7). As indicated, the Cronbach Alpha values exceed the acceptance criterion of 0.7 for each latent variable. In the case of comparison of behaviour and shaping knowledge the values are sufficiently above the criteria, indicating reliable measures. In the case of natural consequences, the Cronbach Alpha value of 0.704 is minimally above the acceptance criteria, which may indicate minor inconsistencies, but is still marginally acceptable.

Table 7
Reliability of latent variables

Latent variable	N of items	Cronbach Alpha value
Comparison of behaviour (COM_BEHA)	3	0.844
Shaping knowledge (SHA_KNOW)	3	0.760
Natural consequences (NAT_CONS)	2	0.704

Source: Own editing based on questionnaire data

The model was tested for multicollinearity and suitability for factor analysis using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO

value is 0.780, which means that multicollinearity does not propose an issue for the data in the present study. The obtained approximate Chi-Square value in Bartlett's Test is 511.983, with a significance level of 0.000, thus the correlation matrix of the variables is not an identity matrix. As both values are below the applied acceptance criteria ($KMO > 0.5$ and Bartlett's test $sig. < 0.05$), factor analysis can be appropriately executed (Reddy & Kulshrestha, 2019). Furthermore, Goodness-of-Fit test was carried out to evaluate the fit of the statistical model. The result of the test was a significance level of 0.311, which satisfies the acceptance criteria.

Spearman's rank correlation (often referred to as Spearman's Rho) is a non-parametric test used to assess both the strength and direction of the relationship between two numerical variables. Its value ranges from -1 to +1; positive values indicate a positive relationship, while negative values indicate a negative relationship between variables. As it relies on ranks, the Spearman correlation does not require data to be at a continuous level, which makes it suitable for examining associations between variables measured on ordinal scales (Kapoor, 2020). In order to secure an appropriate factor analysis, a substantial number of correlations should be in line with the acceptance criterion of > 0.3 (Hair et al., 2010; Watkins, 2018). The Spearman's Rho values between the variables are indicated in Table 8. In general, the values range between -0.043 and 0.765; eight of the correlation coefficients do not reach the determined criterion. The higher significance value associated with the relationship between NC1 and SK2 and the relationship between CoB3 and SK2 indicates that the observed weak correlations are likely due to chance in these two cases.

Table 8
Spearman correlation coefficients

	NC1	NC3	CoB2	CoB3	CoB4	SK1	SK2	SK3
NC1	1.000	0.435*	0.294*	0.403*	0.360*	0.226*	-0.043***	0.272*
NC2		1.000	0.329*	0.395*	0.306*	0.426*	0.250*	0.466*
CoB2			1.000	0.765*	0.575*	0.321*	0.197**	0.334*
CoB3				1.000	0.573*	0.382*	0.148***	0.439*
CoB4					1.000	0.348*	0.201**	0.335*
SK1						1.000	0.385*	0.465*
SK2							1.000	0.549*
SK3								1.000

Source: Own editing based on questionnaire data

***. Significance level is above 0.05 (2-tailed).

**. Correlation is significant at the 0.05 level (2-tailed).

*. Correlation is significant at the 0.01 level (2-tailed).

Results of the testing of variables for skewness and kurtosis are demonstrated in Table 9. There is only one value (kurtosis in the case of NC1 is 3.034) that does not meet the criteria that considers values between -2 and +2 acceptable, but it falls below the threshold defined by Ryu (2011) and Curran et al. (1996)—that is, less than 7. All other values meet the stricter criteria as well.

Table 9
Skewness and kurtosis values of variables

Factor	Variable	Skewness	Kurtosis
COM_BEHA	CoB2	-0.248	-0.716
	CoB3	-0.620	-0.642
	CoB4	-0.747	-0.001
SHA_KNOW	SK1	-0.896	0.156
	SK2	-0.376	-0.339
	SK3	-0.933	0.570
NAT_CONS	NC1	-1.836	3.034
	NC3	-1.093	0.542

Source: Own editing based on questionnaire data

Communality values were calculated to analyse the significance of the variables that were included in the factor analysis. Generally, higher values are assessed as acceptable (Molnár, 2017); in the present study, values exceeding 0.25 can be accepted. The results of testing for communality are presented in Table 10. All values sufficiently exceed the acceptance criteria. CoB2 exhibits the highest communality value (0.824), which indicates that of all the variables, the actions of vehicle drivers in general have the most substantial influence on driving behaviour. The lowest value of communality (0.428) is exhibited by SK1, meaning that mandatory education programmes when renewing one's driver's license are the least influential on driving behaviour.

Table 10
Communalities of variables

Variable	Communalities
CoB2	0.824
CoB3	0.787
CoB4	0.431
SK1	0.428
SK2	0.740
SK3	0.620
NC1	0.631
NC3	0.559

Source: Own editing based on questionnaire data

Furthermore, the three factors together account for 62.743% of the total variance. Broken down to each factor separately, factor 1 (comparison of behaviour) explains 25.192% of the variance, factor 2 (shaping knowledge) 20.952%, and factor 3 (natural consequences) 16.599%, respectively (Table 11).

Table 11
Total variance explained

Factor	Name of factor	% of Variance	Cumulative %
1	Comparison of behaviour	25.192	25.192
2	Shaping knowledge	20.952	46.144
3	Natural consequences	16.599	62.743

Source: Own editing based on questionnaire data

Rotated factor matrix was created using the varimax method (Table 12). The highest value within factor one (comparison of behaviour) belongs to CoB2 (0.882), while the lowest to CoB4 (0.554). This indicates that in terms of comparing an individual's driving behaviour to someone else's, what vehicle drivers in general do has the most substantial effect, while praising someone for their good driving habits has the lowest. Related to the second factor (shaping knowledge), SK2 exhibits the highest (0.857), while SK1 the lowest (0.501) values, meaning that amongst educational methodologies, traffic safety campaigns are found to be most influential, while mandatory education programmes are the least influential. In terms of the third factor (natural consequences), the higher value (0.753) belongs to NC1, stating that the consequences of experiencing a car accident or dangerous driving have the stronger influence on

adapting safer driving behaviour, while learning of traffic fatalities in the news has a less substantial effect.

Table 12
Rotated factor matrix

Variable	Factor		
	1	2	3
NC1			0.753
NC3			0.622
CoB2	0.882		
CoB3	0.817		
CoB4	0.554		
SK1		0.501	
SK2		0.857	
SK3		0.717	

Source: Own editing based on questionnaire data

2.2.2 Nonparametric tests

Following the extraction of the three factors, nonparametric tests were performed to assess the relationship between groups of individuals with various demographics, driving history and practices, attitudes towards driving, and the three factors extracted during the factor analysis (comparison of behaviour, shaping knowledge, natural consequences). Nonparametric testing is due to the non-normally distributed nature of the data. In the case of variables with two groups, Mann-Whitney U test was run, while to handle the three groups in the case of ‘Car equipped with diagnostic devices,’ Kruskal-Wallis test was executed. In each case, the significance level is 0.05. The results are indicated in Table 13.

Table 13
Results of nonparametric tests

Variable	Factor			Type of testing
	1 (COM_BEHA)	2 (SHA_KNOW)	3 (NAT_CONS)	
Gender	0.723	0.156	0.000	Mann-Whitney U Test
Ownership of a car	0.002	0.223	0.183	Mann-Whitney U Test
Having caused an accident previously	0.118	0.185	0.786	Mann-Whitney U Test
Car equipped with diagnostic devices	0.423	0.522	0.015	Kruskal-Wallis Test
Enjoys driving long distances	0.238	0.389	0.095	Mann-Whitney U Test

Source: Own editing based on questionnaire data

The results of the nonparametric tests suggest that there is no significant difference between the relationship of genders and the effect of comparison of behaviour and shaping knowledge. However, there is a significant difference between males and females regarding the perception of the natural consequences factor. The testing showed that the mean value for men is -0.2778662 (N=76), while the mean value for women is 0.2742575 (N=77). This indicates that women have a stronger, positive perception of the natural consequences nudge approach, while the negative mean value for men indicates that not only is the effect of natural consequences less significant, but the direction of their perception also differs from women's.

Ownership of a car proposes no significant difference in terms of shaping knowledge and natural consequences but significantly differs in terms of comparison of behaviour. The mean values suggest that those who own a car (mean value=-0.2597721, N=73) have a weaker perception of this type of nudge, while those who do not own a car (mean value=0.2370421, N=80) react more positively.

There is no significant difference between either the comparison of behaviour nor the shaping knowledge factor and those who drive a car equipped with diagnostic tools, those whose car is not equipped with such devices, and those who do not know. There is, however, a difference in the case of natural consequences. The mean value of the group who drive a car equipped with diagnostic devices is 0.071155 (N=117), of those who drive a car not equipped with diagnostic devices is -0.6064819 (N=17), and of those who do not know is 0.1044738 (N=19). This indicates that the natural consequences nudge approach is most strongly perceived by those who do not know if their car has diagnostic tools, followed by those whose car is equipped with such devices.

The results also demonstrate that whether someone has caused a traffic accident previously exhibits no significant difference in the perception of any of the three factors. The same can be interpreted in the case of those who enjoy driving long distances and those who do not; this variable has no significant difference in any of the factors.

2.3 DISCUSSION

2.3.1 Factor analysis

The present study set out to identify which of seven nudge approaches exhibit the most substantial influence on the driving behaviour of members of Generation Z in Hungary. It was also important to consider individuals' various demographic characteristics, driving history and practices, and attitudes towards driving, which can significantly shape one's general driving habits as well.

As a result of the performed factor analysis, three nudge approaches—comparison of behaviour, shaping knowledge, and natural consequences—were identified as the most influential factors on driving behaviour. In this regard, the results are quite similar to the conclusions reached by Li et al. (2024), which was utilised as the foundational literature for the present study. Li et al. found that comparison of behaviour, shaping knowledge, and driver's identity have a positive and significant influence on drivers' willingness to use driver tracking in order to improve their driving safety performance, while natural consequences and covert learning may be utilised indirectly for the same purpose. Thus, the results of the present study show that in contrast to Japanese drivers—because the aforementioned study was distributed in Japan—Hungarian Generation Z drivers exhibit weaker responsiveness to nudges based on the assessment of their general driving style (identity) and exhibit stronger susceptibility to nudges that confront them with the consequences of unsafe driving. Therefore, it may be beneficial to implement the natural consequences approach not only indirectly but also directly and in a more straightforward manner to achieve the desired positive change in overall driving behaviour.

The results indicate that of all the variables included in the analysis, the actions of vehicle drivers in general have the most substantial influence on driving behaviour in the analysed generation. This is categorised as a social norm nudge, which has been shown to exhibit strong effects on behaviour (Cialdini et al., 2006). The findings of this research are in line with, for example, research conducted by Zadka-Peer & Rosenbloom (2024), who found that even though social norm messages about what the majority of other participants of the test do in a

specific situation required the longest reaction time, in the long run they were significantly more effective. The longer response times are due to more cognitive effort required for the interpretation of the nudge; therefore, these nudges may be most effective when incorporated into, for instance, educational materials or safety campaigns that allow time for processing. However, these nudges must be designed with precautions, as ill-worded messages may be ineffective or even counterproductive (Liu et al., 2022; Cialdini et al., 2006).

It would be interesting to analyse the difference in the impact of “vehicle drivers” in comparison to “your friends/family members.” Several studies conclude that as the reference group becomes more distant (e.g., friends, classmates, students, people), the significance of the reference group diminishes correspondingly (e.g., Berkowitz, 2003; Borsari & Carey, 2003; Koruska & Thombs, 2003). This phenomenon is attributed to trust, as it has been shown that people identify more strongly and easily with smaller groups as well as with those whom they have increased social interactions with, and therefore it is easier to build familiarity and cultivate trust (Ma et al., 2019). However, the same effect on driving behaviour might not be observable in certain scenarios. Research conducted by Nicolls et al. (2024) aimed at investigating what kind of safety campaign messages would be most effective in deterring young people from hand-held mobile phone use while driving and whether “your friends” or “drivers your age” should be stated in the messages for elevated influence. Several participants found messages about friends less credible and believable since researchers would not know what their friends think. Therefore, using broader terms (such as “vehicle drivers” in the present study) may be more influential in the context of driving.

Mandatory education when renewing one’s driver’s license was identified as having the least substantial influence on driving behaviour. This may be attributed to the fact that in Hungary, apart from medical fitness examinations, there is no other requirement to renew one’s license, and there are also currently no initiatives in either Hungary or the European Union aimed at the introduction of mandatory education and/or driving assessment. Therefore, this item was rather a hypothetical question to assess the respondents’ attitudes and thoughts on the usefulness of mandatory education, and as the results suggest, they find it less motivating and influential compared to other methods of behaviour change.

The comparison of behaviour factor explained most of the total variance, followed by shaping knowledge and natural consequences. This means that comparing individuals’ driving behaviour to someone else’s or even praising them for their safe driving could be a key element in forming safe driving habits. The effect of social norms has been elaborated above, but the effect of praising is also corroborated by literature. For example, Zichermann & Cunningham

(2011) built a reward system, essentially praising drivers when they drove below the speed limit and achieved a significant average speed decrease. Praise can also be successful in reducing drivers' anger state and consequently improving driving performance. (Li et al., 2020). This is because praise elicits positive emotions, including happiness, fulfilment, joy, and pride (Delin & Baumeister, 1994), providing motivation, resulting in elevated self-esteem and work performance (e.g., Brophy, 1981).

2.3.2 Nonparametric tests

The results of the nonparametric tests suggested that there is a significant difference between males and females regarding the perception of the natural consequences factor. The mean values indicated that women have a stronger, positive perception of the natural consequences nudge approach than men. This means that women feel more inclined to drive safely after learning about traffic fatalities in the news and experiencing dangerous driving situations.

The latter may be explained by the fact that men tend to hold their driving skills in high regard and be more optimistic about them and therefore assess dangerous traffic situations more optimistically as well (DeJoy, 1992). In DeJoy's study, clear gender differences were identified in the ratings of accident seriousness, with males rating dangerous situations much less serious than females. Furthermore, they feel as if these dangers do not apply to them personally. That may be the reason why men feel less inclined to change their behaviour after experiencing dangerous driving. DeJoy (1992) also found slight evidence of males' higher optimism resulting in taking more risks while driving, which could explain the difference of direction in males' and females' responses to the natural consequences nudge in the present study: they feel that no matter the level of danger, they can handle it either way. Other studies came to similar conclusions, stating that men are more accepting of dangerous driving practices such as traffic violations, speeding, or driving under the influence (e.g., Cordellieri et al., 2016; Pan et al., 2023; Özkan & Lajunen, 2006).

Women's stronger perception of traffic fatality news may be attributed to women generally exhibiting higher levels of empathy than men, thus they identify with others' perspective more easily (e.g., Pang et al., 2023). In this case, they take on the perspective of the victim and their family, prompting them to do everything they can to avoid experiencing such devastating situations themselves, which they can achieve by adopting safer driving behaviours.

The results of nonparametric tests also demonstrate a difference in the perception of the comparison of behaviour factor among those who own a car and those who do not. The mean values suggest that those who own a car have a weaker perception of praising good driving

behaviour and comparison to other social groups, while those who do not own a car react more positively.

Several studies have revealed that car ownership is often linked to more reckless overall driving habits among young drivers (e.g., Scott-Parker et al., 2011; Gershon et al., 2018). One explanation might be that owning a vehicle as a younger driver proposes more independence from their parents, thus allowing the driver to form more dangerous driving habits. It is also important to note that these drivers are likely to take other young people as passengers who encourage reckless driving (Gershon et al., 2018) instead of praising them for following traffic rules and respecting speed limits. In this case, “praising,” in a way, even refers to reckless driving, which only induces even more recklessness. For this reason, they might also find social norm messages less believable—they see and know what kind of driving patterns the people they drive with exhibit, which is the opposite of what the nudge suggests.

Young drivers who do not own a car—instead drive the family car, for example—are more likely to drive with their parents, which has been linked to lower accident risk (Gershon et al., 2017). Doncel et al. (2023) found that young drivers whose parents provided positive feedback, encouragement, and open communication were characterised by more careful driving. In the case of drivers who do not own a vehicle, the social norms might prove to be more credible and believable as well, encouraging the driver to conform to the described behaviour.

An interesting result is the indicated significant differences in the relationship between natural consequences and driving a car with or without diagnostic devices. The mean values show that the natural consequences nudge approach is most strongly and positively perceived by those who do not know if their car has diagnostic tools, followed by those whose car is equipped with such devices, and lastly, those whose car lacks diagnostic devices.

On-Board Diagnostics (OBD) is a computer system that monitors and controls a car’s operation and performance (e.g., engine performance or fuel consumption) through gathering data from the sensors of the vehicle. These diagnostic tools also notify the operator of the vehicle of the detected problems, which can be immensely useful for drivers to better understand their car (noregon.com). Vehicle familiarity—in this case awareness and knowledge of the presence of diagnostic tools in the driven car—has been shown to greatly influence driving behaviour and accident risk, though the results are occasionally contradicting. Intini et al. (2018) identified increased familiarity itself as a risk factor, as it tends to make drivers overconfident in their abilities as well as the abilities of the vehicle. Tefft et al. (2019), on the other hand, found that it is the lack of familiarity with one’s vehicle that resulted in increased risk of a fatal accident as these drivers have a limited understanding of the vehicle’s features, which also results in

more insecure interactions with the car, causing more stress and anxiety while driving. High levels of stress have been identified as having significant impacts on performance, resulting in more errors (Magaña et al., 2020).

Unfamiliarity with diagnostic tools forces drivers to rely on their own perceptions of the car's operations. Essentially, they rely exclusively on themselves for keeping safe, which—paired with more stress and anxiety and consequently more errors—might make drivers more perceptive of news coverage about fatalities and experiencing dangerous driving. They feel as if they only have themselves and their own abilities—and not their car—to rely on to avoid these devastating situations, which is undoubtedly a heavy burden imploring safe and careful driving.

CONCLUSIONS

The primary focus of the present study was to answer the research question proposed in the introduction of the paper: which nudge approaches could be utilised to enhance the road safety awareness and safe driving practices of Hungarian Generation Z drivers while also considering their demographic characteristics, driving history and attitudes in order to be able to personalise nudges for maximum effectiveness?

To fulfil this objective and gather the necessary data, a questionnaire survey was constructed, which included statements incorporating various nudge approaches to assess respondents' perception and level of agreement with them.

Following the questionnaire survey, exploratory factor analysis was utilised, as a result of which three latent variables pertaining to the influence of the nudge approach on individuals' driving behaviour have been extracted as the most influential factors—comparison of behaviour, shaping knowledge, and natural consequences. Furthermore, as it was crucial to analyse the links between the effectiveness of the above-mentioned three nudge approaches and the characteristics of drivers, nonparametric tests were performed. As a result, it was identified that women respond more positively to the natural consequences approach than men, those who do not own a car respond more positively to comparison of behaviour than those who do not, and those who do not know whether their car is equipped with diagnostic devices have a more positive perception of natural consequences than those whose car is either equipped or not.

Of all the nudge approaches included in the questionnaire survey, comparison of behaviour exhibited the most substantial influence in the analysed generation; thus, these types of carefully constructed and implemented nudges could possibly greatly contribute to creating a safer driving environment in Hungary. This may include praising good driving performance or social norm nudges, such as comparing individuals' performance to other drivers. As the interpretation of these nudges requires more cognitive effort and therefore longer response times, they may be most effectively implemented to enhance the quality of educational materials and safety campaigns. These methods allow time for processing information, unlike on-road scenarios.

Nudges may also be personalised for maximum impact, as indicated by the findings of this research as well. For example, as young drivers who do not own a vehicle respond positively to comparison of behaviour, the nudging effect of praising could be utilised in this context. It may exhibit great advantages to educate driving instructors and parents about the importance of the manner of communication and delivering positive messages to encourage novice drivers to adopt safe driving habits instead of inciting antagonism.

An important role may be allocated to policymakers in the implementation of nudges as well. A crucial step would be the reformation of the driving education system with the help of shaping knowledge nudges to put more emphasis on the importance of safe driving, precautionary measures that can be taken to avoid dangerous situations, and the importance of emergency care, which rather often gets overlooked. Another possible implication would be the revision of road signs to incorporate the nudging methodology, such as dynamic weather feedback, so that drivers are informed about the conditions of the road ahead. Consequently, this could also form a basis for the introduction of dynamic speed limits that take into account the current weather and visibility conditions on a given road section. To incorporate the natural consequences methodology, these dynamic signs may also display crash statistics based on the current traffic conditions.

However, it is also important to note that the present study is subject to some degree of limitation. Given the cross-sectional nature of the questionnaire survey conducted in the framework of the research, the results only refer to a specific place and moment in time. Furthermore, the survey was based on a non-representative and self-reported sample. However, the results have revealed interesting findings on what factors have the most substantial influence on driving behaviour among the analysed respondents, which were largely corroborated by existing literature as well. Therefore, it would be intriguing to conduct representative surveys in the future to further analyse the impacts of nudging on shaping safe driving habits on a larger sample, where other generations could be involved as well. Of course, the research may also be extended to operators of other vehicles and pedestrians as well. A current growing and prolonged issue is the lack of regulations on scooter usage, which governments are actively trying to overcome by forming appropriate rules. Nudging might just propose a new, innovative solution to this crucial problem as well.

SUMMARY

Motivation and influence both represent fascinating psychological issues applicable to a wide range of topics. The considerable number of road traffic accidents worldwide, as well as at the national level in Hungary have become a focal point of attention, which provides a valuable opportunity for investigating and applying safe driving practices.

Nudging represents an intriguing approach that extends beyond simple motivation by effectively influencing human behaviour without imposing any restrictions or significantly altering economic incentives. Nudging has been previously shown to have positive impacts on safe driving, but its effect on Hungarian Generation Z drivers has not yet been analysed in literature. Therefore, the following research question was proposed in the present study: which nudge approaches could be utilised to enhance the road safety awareness and safe driving practices of Hungarian Generation Z drivers while also considering their demographic characteristics, driving history and attitudes in order to be able to personalise nudges for maximum effectiveness?

The impact of the nudging concept is challenging to quantify, and therefore in the present study it was evaluated through a questionnaire survey based on a purposive sample. To identify the most substantially influencing nudge approaches, exploratory factor analysis was utilised, as a result of which comparison of behaviour, natural consequences, and shaping knowledge were identified as having the most significant impacts on driving behaviour. Furthermore, to analyse the links between the effects of nudge approaches and drivers' characteristics, nonparametric tests were performed. It was identified that women respond more positively to the natural consequences approach than men, those who do not own a car respond more positively to comparison of behaviour than those who do not, and those who do not know whether their car is equipped with diagnostic devices have a more positive perception of natural consequences than those whose car is either equipped or not.

Based on the results, several recommendations were proposed to incorporate nudges into promoting driving safety, such as safety campaigns, the revision of the driving education system, or the implementation of new road signs. Ultimately, the results of this study may contribute to forming a better understanding of driver behaviour as well as the identification of the most appropriate nudging strategies to enhance driving habits among the analysed population. The present study may also serve as a basis for future research on the topic.

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APPENDIX

QUESTIONNAIRE SURVEY (IN ENGLISH)

Do you have a driver's license for passenger car?

- Yes
- No

The year you obtained your driver's license:

- Dropdown list from 1950 to 2024

Do you own a passenger car?

- Yes
- No

Year of manufacture of the car you drive most frequently:

- Dropdown list from 1980 to 2024

Type of car you drive most frequently:

- Petrol
- Diesel
- Hybrid
- Electric

Have you ever caused an accident while driving a car?

- Yes
- No

Is the car you drive most frequently equipped with diagnostic devices (e.g., fuel consumption meter)?

- Yes
- No
- I do not know

I enjoy driving long distances (minimum 100 km):

- Yes
- No

Please, indicate how much you agree with the following statements using the scale below:

- 1 – Strongly disagree
- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Strongly agree

Natural consequences:

- In the future, I would pay more attention to safe driving after being in a car accident or experiencing dangerous driving (e.g., sudden deceleration).
- I would try to avoid driving as much as possible after driving dangerously.

- Following learning of a traffic fatality in the news (e.g., TV, newspaper), I always try to drive more safely.

Covert learning:

- Real site photos and videos showing the misery of traffic accidents will remain in my memory for a long time.
- Written messages showing the consequences of a traffic accident (death, sadness of the victim's family, impact on society, etc.) will remain in my memory for a long time.
- Warning messages (e.g., billboards advertising safe driving) help me increase safe driving awareness.
- The fines handed out to me in case of violating the rules of the road help me increase safe driving awareness.

Comparison of behaviour:

- When my driving style/performance is compared to someone else's, I try to drive more safely.
- If I am told that "80% of drivers slow down to less than 60 km/h" for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.
- If I am told that "80% of my friends/family members slow down to less than 60 km/h" for a given road space, but the road space is flat and there are no signs, I will slow down to 60 km/h or less.
- When I am praised by others, I try to drive more safely.

Shaping knowledge:

- The introduction of mandatory education when renewing a driver's license would be useful for improving safe driving and safety awareness.
- Traffic safety campaigns help improve driving safety and safety awareness.
- Information shared with me on how to drive safely contributes to increasing my driving safety and safety awareness.

Driving safety evaluation:

- I like to drive.
- I'm good at driving a car.
- I feel safer when I am the one driving.
- I want to use my car more.

Feedback and monitoring:

- If I were able to record my driving history and performance (e.g., speed, fuel consumption) on my mobile, I would want to see the results after every drive.
- In order to improve my driving safety, I have no psychological resistance to receiving safe driving advice and information by mobile phone (e.g., notification of GPS application of exceeding speed limit or foggy road section) or email address.
- In order to improve my driving safety, I have no psychological resistance to having my safety performance diagnosed and fed back to me by a government-certified public agency through tracking my driving history (e.g., speed, recording dangerous situations).

Driver's identity:

- I am an anxious driver.
- I am a careless driver.
- I am an overconfident driver.

Your gender:

- Female
- Male

Please, mark your date of birth:

- 1946–1964
- 1965–1979
- 1980–1994
- 1995–2009
- 2010–

Your place of residence:

- Capital city
- County seat
- Town
- Village
- Homestead

Your level of education:

- Less than 8th grade of primary school
- 8th grade of primary school
- Secondary education
- Higher education vocational training (FOSZK)
- Bachelor's degree (BA/BSc)
- Master's degree (MA/MSc)
- PhD

What is your average monthly net income?

- Less than 100,000 HUF
- 100,000 – 200,000 HUF
- 200,001 – 300,000 HUF
- 300,001 - 400,000 HUF
- 400,001 - 500,000 HUF
- More than 500,000 HUF

QUESTIONNAIRE SURVEY (IN HUNGARIAN)

Rendelkezem jogosítvánnyal személygépkocsira.

- Igen
- Nem

Jogosítványom megszerzésének éve:

- Legördülő lista 1950-től 2024-ig

Rendelkezem saját személygépkocsival.

- Igen
- Nem

Az általam leggyakrabban vezetett személygépkocsi gyártási éve:

- Legördülő lista 1980-tól 2024-ig

Az általam leggyakrabban vezetett személygépkocsi típusa:

- Benzin
- Dízel
- Hibrid
- Elektromos

Szívesen vezetek hosszabb távon (min. 100 km).

- Igen
- Nem

A személygépkocsi, amit vezetni szoktam rendelkezik vezetésdiagnosztikai (pl. fogyasztás-mérő) funkciókkal.

- Igen
- Nem
- Nem tudom

Szívesen vezetek hosszabb távon (min. 100 km):

- Igen
- Nem

Kérem, jelölje meg, hogy mennyire ért egyet az alábbi állításokkal a következő skála figyelembevételével:

- 1 – Határozottan nem értek egyet
- 2 – Nem értek egyet
- 3 – Egyet is értek és nem is
- 4 – Egyetértek
- 5 – Határozottan egyetértek

Natural consequences:

- A jövőben jobban odafigyelnék a biztonságos vezetésre, ha autóbalesetet szenvednék, vagy ha vezetés közben veszélyhelyzetbe (pl. hirtelen fékezési kényszer) kerülnék.

- Amennyiben veszélyhelyzetet okoznék azáltal, ahogyan vezetek, a jövőben próbálnám elkerülni az autóvezetést.
- A halálos autóbalesetről szóló hírek (pl. TV, újság) arra ösztönöznek, hogy próbáljak mindig biztonságosabban vezetni.

Covert learning:

- A közlekedési balesetek szenvedéssel járó következményeit bemutató helyszíni fotók és videók sokáig az emlékezetemben maradnak.
- A közlekedési balesetek következményeit (haláleset, az áldozat családjára és a társadalomra gyakorolt hatás stb.) bemutató írásos üzenetek sokáig az emlékezetemben maradnak.
- A figyelmeztető üzenetek (pl. biztonságos vezetést ösztönző óriásplakátok) segítenek növelni a tudatos és biztonságos vezetést.
- A Közúti Rendelkezések Egységes Szabályozásának (KRESZ) megszegése esetén részemre kiszabott büntetések segítenék növelni a tudatos és biztonságos vezetést.

Comparison of behaviour:

- Biztonságosabb vezetésre ösztönöz, ha másokhoz hasonlítják a vezetési stílusom/teljesítményem.
- Amennyiben azt mondják nekem, hogy "a járművezetők 80%-a 60 km/h-nál kisebb sebességre lassít egy adott útszakaszon", de az útszakasz sík és nincsenek táblák, akkor 60 km/h-ra vagy annál kisebb sebességre lassítok.
- Amennyiben azt mondják nekem, hogy "a barátaim/családtagjaim 80%-a 60 km/h-nál kisebb sebességre lassít egy adott útszakaszon", de az útszakasz sík és nincsenek táblák, akkor 60 km/h-ra vagy annál kisebb sebességre lassítok.
- Biztonságosabb vezetésre ösztönöz, ha mások dicsérnek.

Shaping knowledge:

- A jogosítvány megújításakor alkalmazott kötelező oktatások hozzájárulnának a tudatosabb és biztonságosabb vezetési szokások elsajátításához.
- A közlekedésbiztonsági kampányok hozzájárulnak a tudatosabb és biztonságosabb vezetési szokások elsajátításához.
- A velem megosztott biztonságos közúti közlekedésről szóló információk hozzájárulnak ahhoz, hogy tudatosabb és biztonságosabb vezetési szokásaim alakuljanak ki.

Driving safety evaluation:

- Szeretek autót vezetni.
- Jól tudok autót vezetni.
- Biztonságosabbnak érzem azt, ha saját magam vezetek.
- Szeretném többet használni az autót.

Feedback and monitoring:

- Amennyiben a mobiltelefonomon képes lennék rögzíteni a vezetési adataim (pl. fogyasztás, sebesség), minden vezetés után megnézném azokat.
- A mobiltelefonon (pl. GPS alkalmazás jelzése gyorsajtásról, ködös útszakasz jelzése) vagy e-mailen érkező vezetésbiztonság javítására irányuló közvetlen ajánlások nem fészélyeznek.
- A biztonságos vezetés érdekében állami hatóság által működtetett vezetésdiagnosztikai és visszajelzési rendszer (pl. sebesség, veszélyhelyzetek rögzítése) működése nem fészélyezne.

Driver's identity:

- Nyugtalan sofőrnek tartom magam.
- Figyelmetlen sofőrnek tartom magam.
- Túlságosan magabiztos sofőrnek tartom magam.

Az Ön neve:

- Nő
- Férfi

Kérem, jelölje meg a születési évét:

- 1946–1964
- 1965–1979
- 1980–1994
- 1995–2009
- 2010–

Az Ön lakóhelye:

- Főváros
- Megyeszékhely
- Város
- Falu/község
- Tanya

Az Ön legmagasabb iskolai végzettsége:

- 8 általános iskolánál kevesebb
- Általános iskola 8. osztálya
- Középfokú végzettség
- Felsőoktatási szakképzés (FOSZK)
- Alapképzés (BA/BSc)
- Mesterképzés (MA/MSc)
- PhD

Mekkora az Ön havi nettó átlagjövedelme?

- Kevesebb, mint 100.000 Ft
- 100.000 – 200.000 Ft
- 200.001 – 300.000 Ft
- 300.001 – 400.000 Ft
- 400.001 – 500.000 Ft
- Több, mint 500.000 Ft