ERASMUS UNIVERSITY ROTTERDAM

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How to influence parking behavior of shared e-mopeds on campus

Master Thesis Behavioural Economics

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Abstract

This paper examines the effect of different nudges on the parking behavior of shared e-moped users on the campus of the Erasmus University in Rotterdam. By investigating the parking behavior of this very specific but rapidly emerging market, it contributes to the existing literature that currently is mainly aimed at the parking behavior of shared bicycles or scooters. An experiment consisting of three different intervention periods was set up on one of the shared e-moped parking areas on campus, where students were confronted with either a social norm nudge, in the form of a poster, a visual prompt, in the form of marked parking spaces, or a combination of both. Using a Chi-squared test it is determined whether these treatments have a significant effect on the number of correctly parked mopeds, and with help of a Cramer's V and an odds ratio, the effect size is established. The results provided evidence that both the posters and the marked parking spaces seem to have a positive effect on the number of correctly parked e-mopeds. However, a combination of these interventions appears to have the largest positive effect on parking behavior.

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1 – Introduction

Traveling accounts for a large part of one's CO_2 emissions. The choice of transport can make a real difference to prevent climate change as much as possible. That is why more and more people are looking for sustainable transport methods. A transport method that is becoming increasingly popular is shared transport, and more specifically the shared e-moped. Worldwide the market of shared e-mopeds has largely grown over the past few years and is expected to continue doing so (Grand View Research, 2023). In 2017, Felyx was the first provider to enter the Dutch market, followed by Go Sharing, Check and Tier (RTL, 2022). With a view to car-free cities, more and more cities are offering this new alternative to move around the city as it is a convenient and sustainable addition to the traditional public transport (NOS, 2020). The number of e-mopeds in the Netherlands is increasing immensely and, in many cities, the shared scooters are an indispensable part of the streetscape (RTL, 2019; RTL, 2020).

However, with the creation of new possibilities, new problems arise. And a big-one in the shared e-moped world: the disorderly parking of e-mopeds. The introduction of shared e-mopeds was shortly followed by parking complaints (Vice, 2022). The mopeds must be parked within the assigned service areas, but besides the usual traffic rules, there are few for parking regulation considering the shared mopeds (ANWB, n.d.). As a result, mopeds can be parked haphazardly in front of houses or in the middle of a walking area, which leads to the frustration of other road users and local residents (NHniews, 2021). In some areas, the hindrance caused by incorrectly parked scooters caused municipalities to stop working with providers of the shared vehicles. For example, the providers of shared mopeds have already had to leave the municipality of Capelle aan den IJssel, a suburb of Rotterdam, due to the many complaints of parking nuisance experienced by residents (Radio Capelle, 2023).

To tackle this problem, both the providers of the e-mopeds as well as municipalities are trying to come up with ideas to reduce the experienced parking nuisance. Most e-moped providers already offer a hotline to report incorrectly parked mopeds and provider Check even created a Rewards Program that encourages correct parking through a point system (Check, 2021). The program reportedly reduced complaints about improperly parked scooter sharing to their address by 35%. Additionally, several municipalities aim to create parking spaces especially for shared e-mopeds in order to reduce disorderly parking (AD, 2021). An example of such an assigned parking space can be found on the campus of the Erasmus University Rotterdam, and although the e-mopeds do not roam around the campus, disorderly parking still seems to be a problem within the assigned area. This research will focus on how to influence the parking behavior of shared e-mopeds on the campus of the Erasmus University.

According to literature there are various factors that could help influencing parking behavior. Many papers state reasons causing disorderly behavior, which is often partially assigned to the lack of clear regulations (Owain et al. 2019; Su et al. 2020; Wang et al. 2021). Therefore, creating such regulations with use of visual prompts might help improve parking behavior. Other articles mention that the use of descriptive social norms can help increase better parking conduct (Su et al. 2020; Wang et al. 2021). Consequently, the purpose of this thesis is to examine the following research question:

Can social norms and visual prompts effectively influence students to park their shared e-moped in an orderly manner?

To test this research question, a field-experiment will be conducted at the assigned parking space for shared e-mopeds parking area at the campus of the Erasmus University in Rotterdam. Three different interventions, based on the previously mentioned literature, will take place to try to improve the parking behavior of students. The interventions will consist of the use of descriptive social norms through posters, creating clearly marked parking spaces, and a combination of the first two interventions. The effectiveness of these interventions on the parking behavior of e-moped users will be checked with help of a baseline measurement, the current parking situation without any intervention.

Due to the rapid development of dockless shared transportation, studies on parking behavior have increased in recent years, often focused on either shared bicycles or scooters. Several papers focus on user behavior in disorderly parking to investigate which factors play an important role (Zhao & Wang, 2019). Zhang et al. (2019) investigate the disorderly parking problem more from an operational point of view, aimed at suppliers. The research of Su et al. (2020) includes a hidden field experiment in which respondents perform tasks without knowing the purpose of their research in order to test the effect of nudges and financial incentives on stimulating correct parking behavior. Somewhat similar, this research contains a field experiment that applies nudges in practice in order to determine which factors might be important in improving parking behavior. However, in contrast to the previous mentioned studies, it is not focused on shared (electric) bicycles, scooters or cars, but on e-mopeds. By investigating the parking behavior of this very specific but rapidly emerging market, this will contribute to the existing literature that currently is mainly focused on the parking behavior of other shared vehicles. In addition, this research might be interesting for, among others, municipalities. With the obtained results they can optimize assigned parking spaces for shared e-mopeds in order to reduce disorderly parking, but without having to ban the shared e-mopeds.

2 – Literature Review

2.1 – Shared e-mopeds

According to European Union Directive (2007/46/EC), an electric moped (e-moped) is a two-wheeled vehicle equipped with an electric motor that has a top speed of 45 kilometers per hour. Along with the shared (electric) bicycles and scooters, electric mopeds are a large part of the increasingly popular form of transportation: shared mobility services (Shaheen et al., 2015; Fiorini et al., 2022). Shared transit systems have been widely adopted by municipal governments to promote sustainable on-demand modes of transportation to address the problems of atmospheric pollution and road congestion (Wei et al., 2022).

The concept for the shared vehicle services is generally the same, regardless the means of transport. Users can use the corresponding smartphone application to locate an available vehicle, to unlock it in order to ride, to park it in the designated area and to pay for the ride. (Su et al., 2020; Wei et al., 2022). Within these (electrical) sharing services, providers make sure that the vehicles are maintained and repaired if needed and that the batteries are replaced and charged when they are not being used (Schelte et al., 2021). The share service allows the vehicles to be available at short notice for any app-user. This flexible way of transportation can be part of a car-free mobility future in combination with bicycles, public transport, and walking by filling the gap between a rider's home or destination and public transport stops (James et al. 2019). Besides the benefit of convenience, shared electric vehicles are overall relatively inexpensive to use, environmentally friendly, and can help reduce traffic congestion (Ma et al., 2020). Where shared ways of transport often used to be picked up at the station or at fixed docking stations, sharing transport services have evolved to dockless vehicles due to technological development (Gu et al., 2019). In contrast to traditional shared vehicles, the creation of dockless system simplifies the rental process and thereby improves short distance travel.

In this thesis, the focus will be on shared e-mopeds in Rotterdam, more specifically on the campus of the Erasmus University. As mentioned before, there are currently four suppliers active in the Netherlands, being Felyx, Go Sharing, Check and Tier. However, Tier is currently only active in Almere, Amersfoort, Utrecht, and Eindhoven and will therefore be irrelevant for this research (TIER, 2023). Likewise, the e-mopeds of Go Sharing were unavailable in Rotterdam for a couple of months, but they were available during the experiment again (Go Sharing, n.d.). However, they were not once parked at the observed parking lot of the Erasmus University during the experiment. Therefore, Go Sharing will also not be considered in this research. Additionally, their service area is not limited to the shared e-moped parking, but they can be parked at more places around campus (Go Sharing, n.d.). The type of provider can be relevant because both Check and Felyx try to influence parking behavior of their e-moped users within their own app in different ways. For example, Check asks you to assess the parking behavior of your predecessor in exchange for points. In addition, you earn points if someone else thinks you parked your e-moped properly. Users also receive extra points if they use up e-mopeds that have not been used for a longer period of time. These points can be exchanged for free driving minutes. Felyx also uses this latter concept, but then by means of direct discounts (Felyx, n.d.).

2.2 – Parking behavior

Parking behavior is a multi-faceted topic that has been the subject of much research in recent years (Fukuda & Morichi, 2007). Parking behavior, regardless of the type of vehicle, involves human habitual behavior and positive social interactions, which can sometimes lead to undesirable outcomes often characterized by social dilemmas (Fukuda & Morichi, 2007; Waerden et al., 2015). There are many studies that investigate how different types of unwanted or illegal parking behavior can be positively influenced. Cope et al. (1991) tried to find a solution to discourage illegal use of reserved carparking spaces for people with physical disabilities. Spiliopoulou and Anoniou (2012) investigated the parking behavior of Greek car drivers and any changes caused by the evolution of controlled parking systems, changes in parking characteristics, and changes in the level of enforcement. Personal characteristics that might influence parking behavior include gender, as several studies find a difference in parking behavior between man and women (Fletcher, 1995; Van der Waerden et al., 2015). In addition to the parking behavior of cars, much research has also been done into the parking behavior of e-scooters and shared bicycles (James et al., 2019; Wang et al., 2021c; Wei et al., 2022).

2.2.1 – Disorderly parking

Important in this research is the definition of disorderly parking. Shared e-mopeds can technically be parked anywhere within the assigned service areas of the moped provider, but most companies give guidelines. For example, Check states that the e-mopeds must always be parked in a responsible manner in such a way that they do not get in the way of others in order to keep the public space passable for everyone (Check, n.d). Places where, according to Check, you are not allowed to park are on private property, in front of entrances or exits, on passages of footpaths or sidewalks, on guide strips for the blind, in parking bays for cars, in the grass, and outside bike racks. Felyx maintains the same definition, and emphasizes keeping the sidewalk clear for pedestrians, wheelchairs and strollers (Felyx, n.d). The ANWB, Dutch roadside assistance, shares the same idea, but adds that shared mopeds should also not lean against any street furniture and should preferably be parked in special parking spaces or near bicycle racks (ANWB, n.d.)

Definitions of disorderly parking of shared vehicles differs a little between studies. Many researchers divide parked shared e-vehicles into three groups, namely parked correctly, parked incorrectly and obstructing pedestrian access; or parked incorrectly but not obstructing pedestrian access (James et al. 2019). James et al. (2019) evaluated types of improper parking of e-scooters more detailed and divided certain conditions into different types of disorderly parking. They consider the e-scooter to be parked incorrectly when the scooter is, blocking pedestrian right-of-way; blocking vehicle right-of-way; parked on private property; damaging property (i.e. plants or trees); not standing up right; obstructing access to fire hydrants; obstructing access to street furniture; obstructing access to bus stops; or obstructing access to bikeshare station. Various researchers use these conditions and adapt them to the environment where necessary (Su et al., 2020). This will also be done in this research, since not all conditions are relevant on campus. Consequently, an e-moped will be considered disorderly parked when it is, blocking pedestrian right-of-way; blocking vehicle right-of-way; damaging property (i.e. plants or trees); not standing up right or obstructing access to street furniture. Moreover, some additional definitions of disorderly parking will be used based on the experiment and the situation on campus. Also, e-mopeds parked in front of each other, and with that obstructing access to other shared e-mopeds, is considered as disorderly parking. In addition, also considered as incorrect parking is parking outside the lines of the parking compartment in such a way that it causes a disturbance for other shared e-moped users who want to park their e-moped in the assigned spaces. If an e-moped is parked just a little outside the lines of the marked parking space, but does not cause a disturbance to other users, this behavior is not considered to be disorderly parking.

2.3 Nudging

There are two different types of cognitive systems that coexist in the human brain and together aid decision making (Kahneman, 2011). System 1 is also called the fast-thinking mode and is associated with quickly thinking and automatic responses. It is therefore also more sensitive for changes in the decision-making environment. The first system guides individuals effortlessly to their needs and wants, where changes are unconsciously considered and can lead to new actions. Heuristics and mental shortcuts are used in the mental thinking process to connect pieces of information. Kahneman defines heuristics as cognitive shortcuts or rules of thumb that help simplify decisions (Kahneman, 2003). Heuristics are especially useful under conditions of uncertainty, but they can also lead to cognitive biases and irrational decisions (Kahneman, 2003; Kahneman et al., 1982). System 2, called slow thinking, is a more effortful, controlled, deliberate and reflective thinking process. In System 2, individuals are thinking more long-range plan actions based on long-term targeted outcomes (Sunstein, 2014b). Slow thinking is associated with making rational decisions, cautiously calculating costs, and benefits before acting. In cases where System 1 applies and thus when individuals often do not behave rationally, intervening with nudges may yield a more desirable outcome (Sunstein, 2015).

Therefore, a possible way to positively influence parking behavior could be with the use of behavioral interventions, such as nudges. Thaler & Sunstein (2009) define a nudge as a change in the decision-making environment without restricting people's freedom of choice. This way people's behavior can be altered towards a desired outcome without forbidding options or significantly changing economic incentives. The ultimate change in behavior can be achieved by changing the way individuals perceive an alternative decision or action (Shearer et al., 2017). This can be done by improving the messages they receive or the opportunities they have. Nudges mainly target the automatic system and can steer individuals to certain decisions without them necessary noticing that it is happening (Sunstein, 2016; Shearer et al., 2017). The approach of nudge intervention assumes that people will rely on past ways of thinking when they are encouraged to act or think differently by changes in the environment (Sunstein, 2016). The options for behavioral change focus on providing reminders and cues that place individuals in a modified choice environment at targeted times.

Nudging has multiple advantages of which Schmidt and Engelen (2020) highlight some important ones. For an intervention to be considered a nudge, it must be cheap and easy to avoid Thaler & Sunstein (2009). Therefore, one major advantage is that nudging avoids coercion and therefore preserves the freedom of choice (Sunstein, 2014; Schmidt & Engelen, 2020). A nudge intervention does not restrict any decision options and people can still resist, evade or opt out. In addition, they should never take the form of manipulation or deceit (Sunstein, 2014). Everyone should be able to assess and examine nudges. What is more, because nudges need to be inexpensive and are in some contexts more powerful than conventional interventions, they have comparative advantages over other public policies like taxes, incentives, and prohibitions (Schubert, 2017; Schmidt & Engelen, 2020). Moreover, with help of nudges, choice architects help individuals to make more desired decisions by eliminating biases as much as possible in the decision-making process (Thaler & Sunstein, 2009; Sunstein, 2014; Schmidt & Engelen, 2020). In conclusion, it could be argued that nudges are persistent with the freedom of choice, are fact-based, cost-effective and impartial, but also help individuals make more rational decisions (Sunstein, 2015; Schmidt & Engelen, 2020).

Contrary to the benefits of nudges, there is also much criticism of using these tools to change the behavior of individuals (Hansen & Jespersen, 2013; Schmidt & Engelen, 2020). There are several ethical objections and nudging is often seen as a manipulation technique. For example, opponents of nudging argue that nudging does not necessarily steer people to make better decisions, but rather pushes people into the behavioral choices that policymakers want people to make (Sunstein, 2014; Schmidt & Engelen; White, 2013). Both the ethical aspect of the techniques used to guide people's choices and the objectives of nudges are questioned. Opponents see nudging as a way of exercising control and thus eliminating freedom of choice rather than preserving it (Schmidt & Engelen, 2020).

Thaler and Sunstein (2003) counter these arguments by stating that nudges based on the view of libertarian paternalism are justified because individuals do not always make perfectly rational decisions. The paternalistic aspect refers to the goal of encouraging people to choose what they believe is best for them. (Thaler & Sunstein, 2009). The libertarian aspect focuses on carrying out the goals without restricting individuals' initial options. Unlike bans and mandates, nudges should be easy to avoid and thus provide significantly more freedom of choice for individuals (Sunstein, 2015). Moreover, individuals do not always make choices that are best for them (Thaler & Sunstein, 2003). This may be due to, among other things, incomplete information, a lack of willpower, or influences from the choice environment. In conclusion, according to libertarian paternalists, nudges are merely tools that try to steer people's choices in a beneficial direction without restricting freedom of choice (Sunstein & Thaler, 2003).

Nudges can operate in different ways including by changing the physical environment, information provision, changes to the default policy and the use of social norms and salience (Shearer et al., 2017). Nudges come in many variants, and it is therefore important to find the most suitable nudges to make them as effective as possible. Their effectiveness depends on several factors, including context, timing and habits, meaning that use under different circumstances leads to different results of effectiveness (Caraban et al., 2019). Orderly parking requires people to make a trade-off between their own convenience and benefits to society and is therefore considered to be a form of prosocial behavior (Wei et al., 2022). Many studies show that social norms can stimulate individuals to take more socially favorable decisions (Wang et al., 2021c). Therefore, a social norm nudge might be an effective intervention in influencing people's parking behavior. Additionally, when it comes to shared electric scooters, James et al. (2019) found that many e-scooter users lack knowledge about the laws concerning e-scooters, including parking rules. The confusion about e-scooter or other shared vehicle regulations might contribute to disorderly parking since parking characteristics are found to be affected by the way parking regulations are enforced by the responsible authorities (Spiliopoulou & Antoniou, 2012). Visual prompts are expected to create a better understanding of certain processes and concepts (Petrusal et al., 2016). Visual cues could therefore help in understanding the desired parking behavior of shared e-mopeds and positively influence individuals.

2.3.1 – Social norms nudge

Social norms are considered as collective representations of informal rules about what people should and should not do in different situations (Cialdini et al., 1990). They emphasize what most people do in certain situations and can have significant impact on human behavior (Sunstein, 2014a). Bicchieri & Mercier (2014) describe social norms as behavioral rules that are supported by a combination of empirical and normative expectations. They state that most people have a preference to obey social norms, provided they have accurate expectations. If these empirical expectations are absent, individuals may be tempted to disobey the social norms. This will be more likely when the desired behavior conflicts with self-interest. Moreover, when social norms are widely violated, the force of the norm is considerably weakened, and they may lose their influencing effect (Bicchieri & Mercier 2014).

According to various studies, social norms can effectively promote pro-social behavior, also compared to the use of monetary incentives or gifts (Riggs, 2016). The effectiveness of social norm nudges is mainly due to the fact that individuals are prone to model behavior on what others do or what they think others do (Bicchieri & Dimant, 2019). Individuals are often strongly influenced by what people around them do and tend to follow them in their actions and behavior (Dolan & Halpern, 2010). The power of social norms lies in the social consequences. Individuals who do not conform to the norm will face social punishment (e.g., a bad reputation) and individuals who do conform to the social norm will enjoy social benefits.

Cialdini divides social norms into two main categories: injunctive social norms and descriptive social norms (Cialdini, 2003; 2007). Injunctive social norms involve the perceptions of what most others approve or disapprove. In other words, it reflects one's beliefs about acceptable and unacceptable behavior in a particular situation (Reno et al., 1993). On the other hand, descriptive social norms reflect behaviors that are typically performed; it indicates one's ideas about how most people typically behave in a certain situation (Cialdini, 2003; Cialdini, 2007). In short, injunctive norms tell people what they are ought to do, while descriptive norms indicate what most people are actually doing (Cialdini et al., 1990; 1991).

As mentioned in the previous paragraph, descriptive social norms refer to how most people behave in certain situations. Especially these types of social norms are found to be successful in effectively changing individuals' behaviors as it does not require people to think too much about the given information (Cialdini, 2003; Kredentser et al., 2012). Descriptive social norms move people to act pro-social through social information about collective conduct in a certain setting. The message descriptive norms send can be described as "If a lot of people are doing this, it's probably a wise thing to do" (Cialdini, 2007). These types of messages encourage people to behave in a norm-congruent way.

Many studies also analyzed the effects of descriptive social norms in the field of transportation, including parking behavior. Kormos et al. (2015) found researched the influence of descriptive social norm information on reduction of private vehicle use. In their field experiment they found that messages emphasizing descriptive social norms increased the desired sustainable transportation behavior. Carter et al. (2014) conducted a study of distractive driving behavior among novice adolescents. Their results showed that descriptive social norms had more influence on predicting distractive driving behavior than injunctive social norms. Additionally, Wang et al. (2021a; 2021b;) found that descriptive social norms played a significant role in parking behavior of bike-sharing users. As mentioned before, orderly parking is a form of prosocial behavior (Wei et al., 2022). In general, studies show that descriptive social norms can stimulate individuals to take more socially favorable behavior (Wang et al., 2021c).

When using types of descriptive social norm nudges, it is not per se important what most people actually do, but the focus should be instead on what most people think people (should) do (Sunstein, 2014). The desired behavior in the nudge message is often set intentionally at a high level in order to encourage compliance, even if the stated level is higher than it actually is in real life (Goldstein et al., 2008; Su et al., 2020). For example, Goldstein et al. (2014) chose to use descriptive social norms to increase the number of hotel guests reusing their towels. In their study they used a message with the social descriptive norms presenting a much higher rate than the actual rate of hotel guests that reused their towel. Several studies use personalized messages comparing the behavior of individuals with the socially preferred behavior of others (Kroll et al., 2019). Even though personalization is not always possible, choice architects should relate the descriptive social norm to the target group as much as possible (Dolan & Halpern, 2010).

Also important is that the message is placed in a way that maximizes the chance that the motivational components of those messages stand out when it is crucial (Cialdini, 2003). Many papers use posters or cards with the descriptive social norm that are handed to or are clearly visible for the target group (Goldstein et al., 2008.; Su et al., 2020; Köbis et al., 2022). Many studies also explored important elements of design and placements of signs, and while not specifically targeting descriptive social norms, it can still be useful. For instance, Sussman and Gifford (2012) found that larger signs are more effective at attracting the attention of individuals and positively influencing behavior. Additionally, the use of symbols or images that are matching the textual information on the sign can result in higher salience of the sign and it may make the communication more effective (Jae et al., 2008; Sussman & Gifford, 2012). Also, the use of large fonts, bold letters, and bright colors can be effective in triggering people's attention (Sunstein, 2014a). Moreover, it is important that the text refers to specific behavior, the targeted behavior is relatively convenient to perform, and the sign should be placed in proximity of the target behavior (Geller et al., 1982). Poorly designed or situated signs can have a negative effect (Sussman & Gifford, 2012).

2.3.2 – Visual prompts

A prompt is a non-substantive informational intervention that can serve as a reminder or cue, or that can trigger individuals to act according to the desired behavior (Chui et al., 2015; Michalek & Schwarze, 2020). The likelihood of behavioral compliance is highest when the pursued behavior is not too difficult to perform and involves a repetitive action (Geller et al., 1982). Prompts can be presented in various ways such as a verbal, a textual or a visual prompt or a combination of these (Geller et al., 1985; Clayton & Myers, 2008; Chui et al., 2015). The intensity of prompts can differ from a simple notice that raises awareness to a more thorough statement that additionally provides context or reasoning (Shearer et al, 2017). Visual prompts are particularly effective in directing individuals' attention to certain important information and induce individuals to act instantly (Lin et al., 2016; Sunstein, 2014). Moreover, visual prompts are expected to create a better understanding of certain processes and concepts, which can be useful in this research as there may be ambiguity about the parking rules for shared mopeds causing disorderly parking (Spiliopoulou & Antoniou, 2012; Lin et al., 2016; Petrusal et al., 2016; James et al., 2019).

In addition to the previous distinction of type of prompts, prompts can also be divided into passive and active, or mediated, prompts. Passive prompting refers to the use of an inanimate object of some kind whereas active prompting refers to the use of persons or includes some kind of consequence upon compliance (Clayton & Myers, 2008). While both types of prompts are proven to be effective, active or mediated prompts normally require more time and effort to execute and are therefore not suitable for every situation.

Visual prompts can display factual or persuasive information or provide cues to help in behavioral decision making (Geller et al., 1982; Sussman & Gifford, 2012). Sussman and Gifford (2012) used a visual prompt in form of a sign and hung these up in washrooms to prompt people to switch off the lights when leaving the room. People in rooms with such a sign, turned off the lights significantly more than people in rooms without signs. Similarly, Miller et al. (2016) used visual prompts by means of symbols on signs to stimulate proper recycling among students on universities. The signboards indicated the type of items that were allowed to be thrown in the garbage cans and they found that the visual cues had an effective influence on the amount of waste recycled.

Visual prompts often take the form of posters, flyers or signs, but this is not a requirement, and the prompt can take other forms. For instance, Van Hoecke et al. (2018) used footprints leading to the stairs instead of the elevator to analyze the effect of visual prompts on stair climbing. The results showed that footprints tend to increase stairclimbing in a worksite setting. Clayton and Blaskeiwcz (2012) used different nudges, including a visual prompt, to try to improve cleanliness of public restrooms floors. They placed bullseyes inside urinals, which lead to a reduction of urine on restroom floors even after four months. The authors argue that a possible explanation for this long-term effectiveness of the prompts could be because the prompts contain rules that most users are already familiar with and act as reminders that effectively change the situation. The findings above align with the statement that visual prompts work best for behaviors that are simple, easy, effortless, and repetitive to perform and can be effective in a variety of settings (Schultz, 2014).

Also in the transportation domain, different types of prompts were used. Geller et al. (1985) effectively used a textual active prompt to increase the use of seatbelts. They presented a sign to drivers not wearing seatbelts that read "Please Buckle Up – I Care" and turned the sign around stating "Thank You" if the drivers subsequently buckled their seatbelts. Clayton et al. (2006) successfully used the same concept to decrease cell phone use behind the wheel. Clayton & Myers (2008) used both active as well as passive textual prompts in attempt to increase the use of turn signals. Although the prompts were both significantly effective, there was hardly any difference between the active and passive form. Visual prompts were used by Cope et al. (1991) to discourage the illegal use of reserved parking spaces for people with physical disabilities. Placing the international wheelchair sign vertically at the head of each of the reserved parking spaces decreased illegal parking from 51.3% to 37.3%. Huybers et al. (2004) used visual prompts to increase safety at crosswalks and uncontrolled intersections. The use of pedestrian priority signs and the use of road markings reduced the number of conflicts between pedestrians and motor vehicles and increased the distance between motorists and pedestrians.

Several studies show that visual prompts can also be effectively combined with other nudges in attempt to further improve the effect of the desired behavior (Yi et al., 2022; Lotti et al., 2023). Lotti et al. (2023) discovered that a combination of visual prompts and information nudges lead to a better desired result than when only visual prompts were used to influence behavior. In addition, visual prompts often reinforce other nudges as well (Manstead & Lee, 1979). Manstead and Lee tested two types of signs that should help encourage eyewitnesses to serious traffic accidents to report traffic violations. They found that the sign presenting a textual as well as a visual prompt was more effective than the sign with just the textual prompt. They largely attribute this to the fact that the addition of the visual prompt makes the board much more likely to be noticed.

Geller et al. (1982) state important characteristics that are necessary for a prompt to be effective in increasing the desired behavior. Although not all requirements are applicable to every type of prompt, some important requirements are that the target behavior should be convenient to engage in, and the visual prompt should be delivered, placed or visible in close proximity to the opportunity to engage in the target behavior. Additionally, the prompt should be noticeable, simple and clear (Sussman et al., 2013). Following these guidelines will lead to fulfilling the key aspects of effective nudges, such as low cost and high durability (Thaler & Sunstein, 2008; John, 2013).

2.4 Hypotheses

Based on the literature review, two main nudges might be effective in trying to improve parking behavior of e-mopeds. That is the use of descriptive social norms and the use of visual prompts. These two nudges will be tested by means of posters with descriptive norms and clearly marked parking spaces (visual prompts). Consequently, the following hypotheses were derived to answer the research question:

Hypothesis 1: The use of posters with descriptive social norms around shared e-moped parking area increases the number e-mopeds parked in an orderly manner.

Hypothesis 2: The use of clearly marked parking spaces at the shared e-moped parking areas increases the number e-mopeds parked in an orderly manner.

To see whether the before mentioned interventions could reinforce each other as mentioned as a possibility in the literature review, a third hypothesis was formed:

Hypothesis 3: The use of marked parking spaces in combination with posters with descriptive social norms around shared e-moped parking spaces is a more effective way of encouraging users to park in an orderly manner than using only one of these interventions.

3 – Methodology

The aim of this research is to see whether clearly marked parking spaces and/or descriptive social norm posters have a positive effect on the parking behavior of students at the Erasmus University Rotterdam who use shared e-mopeds. To answer the research question, a field experiment will be executed at one of the assigned parking spaces for (shared) e-mopeds on the campus of the Erasmus University Rotterdam.

Prior to the field experiment, the Real Estate & Facilities department of the Erasmus University Rotterdam granted approval to perform this experiment on the assigned shared e-moped parking space on campus.

3.1 Experimental design

As mentioned before, this research contains a field experiment on the campus of the Erasmus University. This section first describes the setting of the experiment, followed by the actual design of the experiment and the procedure of the data collection.

3.1.1 Setting

On the campus of the Erasmus University there are two assigned areas available for the parking of shared e-mopeds. In the apps of both Felyx and Check, these are also the only areas where it is allowed to park e-mopeds on campus. One of these shared parking spaces is located near one of the entrances of the campus next to the tennis court and is indicated by special shared e-moped parking signs (Figure 1 and 2). This is the parking area that was used to conduct the experiment. The reason for choosing this parking area is the fact that it is better observable, and that the other area is always very packed with parked mopeds with many mopeds not moving for days according to the app of Check.

Figure 1. *Shared e-moped parking space at the campus of the Erasmus University near one of the entrances next to the tennis court.*

Figure 2. *The parking-signs at the shared e-moped parking space.*

Other than these signs, this area does not contain any parking markings or other regulatory measures. In this designated area are also multiple benches, an Erasmus statue, a road and footpaths present. Despite the fact that there is a specially designated area for parking shared e-mopeds, disorderly parking still occurs. For example, the e-mopeds are placed in front of benches (Figure 3), they block the sidewalk for pedestrians (Figure 4), and they even block each other, which means that not every vehicle is accessible to users (Figure 5).

Figure 3. *Shared e-mopeds parked in front of a sit bench.*

Figure 4. *Shared e-mopeds parked on the footpath.*

Figure 5. *Shared e-mopeds parked blocking each other.*

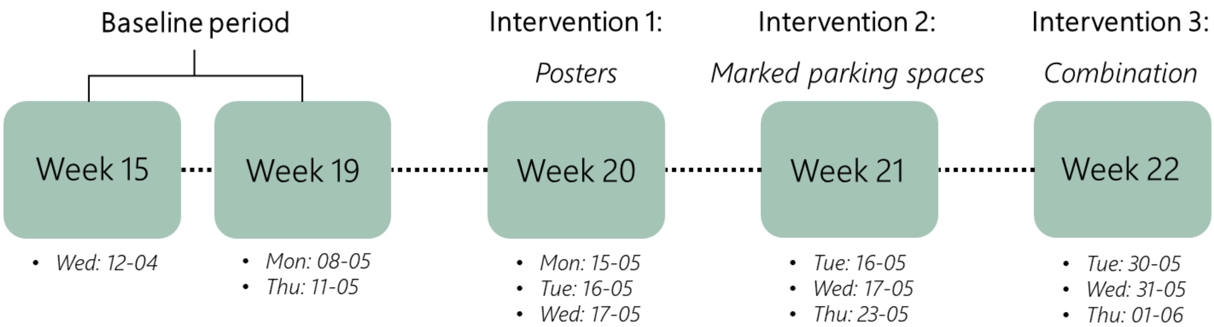
3.1.2 Design

As mentioned before, the research in this thesis contains a field experiment on the campus of the Erasmus University of Rotterdam. Before implementing the interventions of the experiment on the parking space, a baseline measurement was conducted to determine the current situation of the disorderly parking of e-mopeds without any interventions. The observations made during the intervention periods, the post-intervention period, can afterwards be compared to the observations made during the baseline measurement, the pre-intervention period. During the experiment there were three different interventions as mentioned in the literature review: *a poster with a descriptive social norm, clearly marked parking spaces* and *a combination of these two interventions.* After the baseline measurement, the first intervention was implemented. Posters with descriptive social norms were hung around the parking space in clear sight of the shared e-moped users when parking. During the second intervention, parking spaces were clearly marked with help of white duct tape. The duct tape being white, ensured that the places were clearly recognizable as parking compartments. During the last intervention period, the parking spaces were again marked with duct tape, but this time in combination with the use of the same posters as the ones of the first intervention period.

3.1.3 Data collection

Data was collected through observations that were not noticeable to the subjects. Observations were done during weekdays, on a day between Monday and Thursday, as those were likely to be the busiest on campus. Preferably the data of all three treatment groups would have been collected on the same days, for example Mondays, Tuesdays and Thursdays to keep external circumstances the same as much as possible so that the effect of the intervention can be measured more accurately. However, due to bad weather conditions and national holidays, such as Ascension Day and Pentecost, it was sometimes necessary to move the data collection to other days of the week. In addition, the data was not collected in weeks 17 and 18, since many students were having Spring break during that period and were therefore not present on campus. The data was eventually mostly collected between week 19 and week 22 as can be seen in the timeline underneath (Figure 6). Data collections started before most students arrived at campus (08:30 AM) until the time after the most last classes have generally started (15:30 PM). When a moped was parked, it was noted whether it was parked properly or incorrectly, and if it was parked incorrectly, it was also noted in which way it was parked improperly. In addition, the time, the type of moped, the gender of the driver, the number of mopeds present in the parking lot, and the number of mopeds present in the private moped parking space were written down.

Figure 6. *Timeline of the experiment*



3.2 Measurement & materials

The dependent variable in this research is a binary variable that indicates whether students correctly parked their e-mopeds on the campus parking space or not. The variable would take value 1 if the students parked their e-moped properly and 0 if they did not. The independent variable is also a binary indicator, this time stating the type of intervention. The independent variable of the first intervention, a poster with a descriptive social norm, will take the value of 1 for the students who parked during the first intervention and 0 for students who parked during the baseline period. For the second intervention, the indicator would take value 1 if students parked their shared e-moped during the second intervention period with the clearly marked parking spaces and 0 if it was during the baseline period. The same goes for the last intervention, where the indicator would take value 1 if students parked their e-moped during the third intervention period and 0 if it was during the first or second intervention.

3.2.1 Dependent variable

As previously mentioned, the dependent variable in this research is a binary variable that indicates whether students correctly parked their e-mopeds on the campus parking space or not. To determine when an e-moped is wrongly parked, definitions of disorderly parking from previous literature will be used and will be adopted to the situation (James et al. 2019). The definitions of disorderly parking can be seen in Table 1. If an observation falls within the description of the mentioned e-moped conditions mentioned in the table, the parking behavior will be considered as disorderly parking. The binary variable will take value 0 in those cases.

Table 1. *E-moped conditions that are considered disorderly parking.*

E-moped condition	Condition description
Blocking pedestrian right-of-way	The e-moped is impeding pedestrian access or crosswalks. This includes any e-moped that does not leave at least 50 centimeters of passable walkway
Blocking vehicle right-of-way	The e-moped is (even partially) in the street
Damaging properties (i.e., plants or trees)	The e-moped is on top of vegetation or grass
Not standing up right	The e-moped is laying on its side or leaning against another object
Obstructing access to street furniture	The e-moped is within 50 centimeters of a piece of furniture and thus obstructs a potential user of furniture (e.g., a bench)
Obstructing access to other shared e-mopeds	The e-moped is parked in front of another e-moped and with that obstructing a potential e-moped user to use the blocked e-moped.
Not parked within the marked parking compartments*	The e-moped is parked outside the lines of the parking spaces in such a way that it causes a disturbance for other e-moped users who want to park their e-moped in the marked parking spaces

**This condition is only relevant during the second and third intervention, when there are marked parking spaces.*

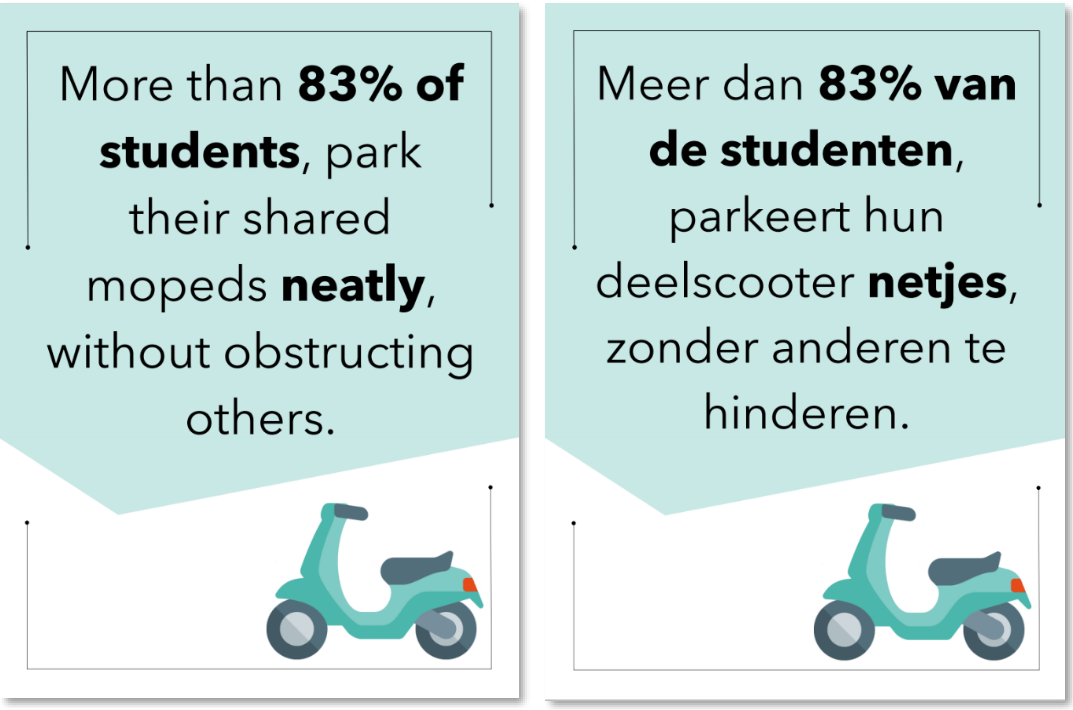
3.2.2 Materials – social nudge

During the first and third intervention, a poster with a descriptive social norm was used around the parking area of the shared e-mopeds. The posters contained the text written below, which conveys a descriptive social norm:

More than 83% of students, park their shared mopeds neatly, without obstructing others.

The 83% figure is a fabricated number and deliberately set at a high level in order to change the behavioral motivation of subjects (Su et al., 2020). The number is not based on any kind of data whatsoever. The design of the poster is intended to align with the features that should help create greater visibility and make the communication of the message more effective (Figure 7). Therefore, the sign includes an image of a moped, large fonts, bold letters, and bright colors (Jae et al., 2008; Sussman & Gifford, 2012). Additionally, since larger signs are found to be more useful in attracting the attention of individuals, the posters at least had a A3 size. The posters were created in both Dutch and English to appeal to Dutch students as well as international students.

***Figure** 7. The poster with a descriptive norm. English on the left and the Dutch translation on the right.*



It is also deemed important that the signs were clearly visible for the target group (Cialdini, 2003). The posters were therefore placed in several places around the parking lot. For instance, the A3 format posters were hung on the poles where the parking signs are also placed (Figure 8).

***Figure 8.** The A3 format posters in both languages underneath the parking signs.*

Additionally, a pavement sign with A1 format was placed in the middle of the parking area with (Figure 9). By using both type of posters, the likelihood that the posters are observed by the subject is enlarged. Both format types of posters were available in Dutch and English. In Figure 10 a more complete picture of the parking area can be seen with both types of signs during the second intervention.

Figure 9. *The A1 pavement sign with different languages on each side.*

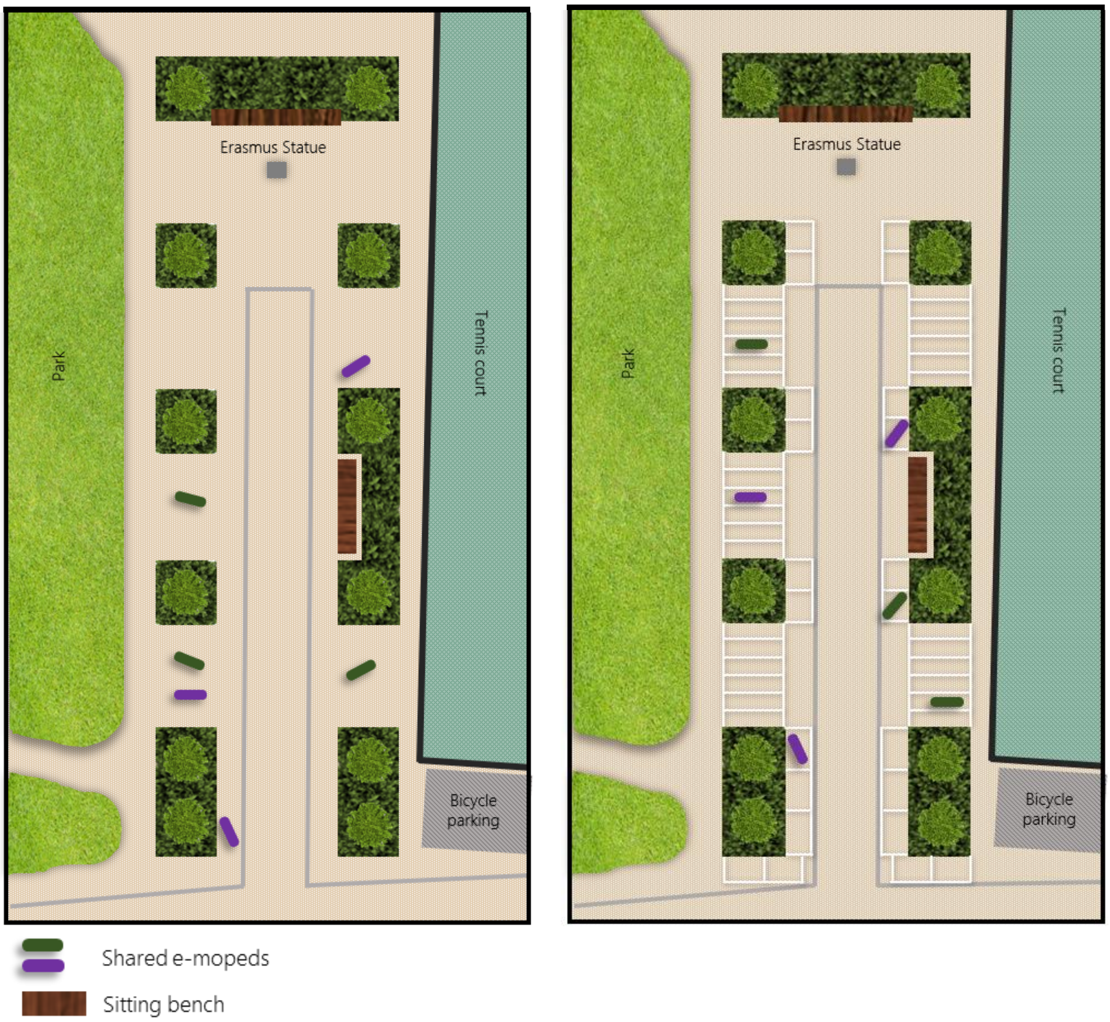
Figure 10. *The A3 format posters in both languages underneath the parking signs.*

3.2.3 Materials – visual prompt

The second and third intervention included a visual prompt in the form of marked parking spaces with help of white duct tape. In order to make the moped parking spaces as realistic as possible, general dimensions were be used for the size of the parking spaces. According to local laws and regulations, the net dimensions of a moped parking space in a built garage should be at least 75 centimeter wide and 180 centimeter long, as laid down in the 2019 Parking Standards Memorandum (Note Parkeernormen, 2019). Although these dimensions are intended for moped parking spaces in a garage, they are also often used to create moped parking spaces in other public places, such as at the station. Therefore, these dimensions were also adhered to as much as possible in this research. However, because the motorcycle parking area is interrupted several times with pieces of greenery, the parking spaces were be adjusted to sometimes smaller and sometimes larger dimensions to make them fit properly. Another important measurement is the ones the shared e-mopeds itself. Due to the compulsory helmet use for all mopeds that has been introduced on January 1st, 2023, Felyx and Check e-mopeds now all have top boxes on the back (Ministerie van Justitie en Veiligheid, 2022). With these boxes, the total length of the e-mopeds is now 200 centimeters.

Eventually 52 parking spaces were created, as can be seen on the ground plan in Figure 11. The left map shows the parking area before the second intervention and the right side shows the parking area with how the parking spaces were marked during the second and third intervention. The parking spaces between the pieces of greenery were eventually 90 centimeters wide and 350 centimeters long. The length was longer than required, but this was due the length of the greenery. Moreover, two parking in lengthwise would not have fit properly nor have been ideal.

Figure 11. *A ground plan of the parking area without marked parking spaces (left) and without marked parking spaces (right).*



On the right side of the parking area, creating two spots lengthwise would also ensure that people could not leave because of double parking. On the left side of the parking area, people could still leave by driving on the footpath, but because many people also parked their mopeds there, creating two parking spaces lengthwise would tempt people to drive over the grass, which is most likely not the intention (of the university). The parking space was therefore made longer, also to indicate that it only concerns one parking space. If the parking spaces were made shorter, there would have been enough space to put another scooter in front of it and there would still be double parking. The width of these parking spaces was also longer than necessary. Based on the required dimensions of the Parking Standards Memorandum required, there could have been realized seven parking spaces next to each other between the green areas. However, due to the presence of the poles with the parking signs in the middle of these areas, the parking space in the middle would be unusable. That is why six parking spaces were more convenient in this case. The parking spaces on the side of the greenery were 100 centimeters wide and had a length varying between 185 and 200 centimeters. The width of these parking spaces allowed for diagonally parking, which means that shared e-mopeds can still fit well in the parking spaces that are smaller lengthwise. Figure 12 shows pictures of the parking area with marked parking spaces during the second intervention period.

Figure 11. *Pictures of the parking area with the different marked parking spaces during the second intervention period.*

3.2.4 Materials – social nudge & visual prompt

During the third intervention period, both the posters of the social descriptive nudge intervention (first intervention period) and the marked parking spaces (second intervention period) were used. Figure 12 shows pictures of the parking area during the third intervention period.

Figure 12. *Pictures of the parking area with the during the third intervention period.*

3.3 Data analysis

Before the hypothesis was tested, a balance test was performed in order to assess the comparability of the baseline measurement and the three different interventions. This test examines possible differences between the groups that might have had an impact on the potential association of the independent variable, the type of intervention, and the dependent variable, the parking behavior (Mutz et al., 2019). Afterwards, in order to analyze the data and test the hypotheses, a non-parametric test was performed. The main reason for this choice is because the assumptions for using parametric tests, such as the existence of a normal distribution, are not met. As a result, parametric tests can cause a bias in the results, and it is therefore better to use a non-parametric test. The type of non-parametric test that was used in this research is a Chi-squared (χ^2-) test. A Chi-squared test determines whether two classifications of samples are independent (Zibran, 2007). In other words, a Chi-Squared test compares the distribution of a certain variable in a sample with the distribution of that variable in another sample to see if there is a significant difference between the distribution of the two samples. Some assumptions need to be met in order to use this test, being that the sample is sufficiently large and that that the samples are independent (McHugh, 2013). A sample is sufficiently large when the value within a cell frequency is more than 5, which is likely to be met if the sample size is equal to the number of cells multiplied by 5. Additionally, a Chi-squared test can only be applied to qualitative data (Zibran, 2007). Assuming all these assumptions are met, a Chi-squared test can be conducted to see if the distribution in the baseline measurement is the same as in one of the intervention periods to consequently determine whether there is a difference in the parking behavior of students during the different periods. The Chi-squared test essentially assessed multiple null hypotheses, including the following one:

H_0: There is no association between the use of posters with a descriptive social norm and the parking behavior of shared e-mopeds.

If the null hypothesis can be rejected, there is evidence that there is an association between the use of posters with a descriptive social norm and the parking behavior of shared e-mopeds. This means that the distribution of the sample in the first intervention period differs significantly from the sample in the baseline period. Assuming the difference is a positive one, this would indicate that a poster with a descriptive social norm effectively influences the parking behavior of shared e-mopeds. The same test was conducted in order to compare the baseline period with the second intervention period, the treatment with the marked parking spaces. Additionally, two different intervention groups were compared to see whether there is a difference in distribution in order to answer the third hypothesis. To see whether a combination of using a poster and using marked parking spaces is more effective than just using marked parking spaces, the Chi-squared test tested the following null hypothesis:

H_0: The distribution of parking behavior of shared e-mopeds is the same in the first intervention period as in the third intervention period.

In other words, the null hypothesis states there is no difference in the parking behavior when using the posters versus when using the posters in combination with the marked parking spaces. Again, if the null hypothesis can be rejected, there is a significant difference in distribution between the first and third intervention period. Assuming this is a positive difference, this would indicate a combination of the two interventions is more effective in influencing the parking behavior of students than just the marked parking spaces. The same test can be done to determine whether there is a difference between the second intervention period, with the marked parking spaces, and the third intervention, the combination of the two interventions.

To find out the magnitude of the potential associations between two observation periods, a Cramer's V is determined as well. A Cramer's V is a measure of effect size that provides information about the strength of the association between to variables (Field, 2013). A Cramer's V value of 0 means there is no coherence between the two variables at all, and a value of 1 indicates perfect cohesion. Moreover, Cramer's V is a standardized measure and therefore allows for comparison between different associations. In addition to the Cramer's V, another measure of effect size was used: the odds ratio. Unlike the Cramer's V, an odds ratio can also indicate the direction of an effect (Field, 2013). This way it can be examined whether the potential significant differences found between the observed groups are positive or negative differences.

3.3.1 Sample size

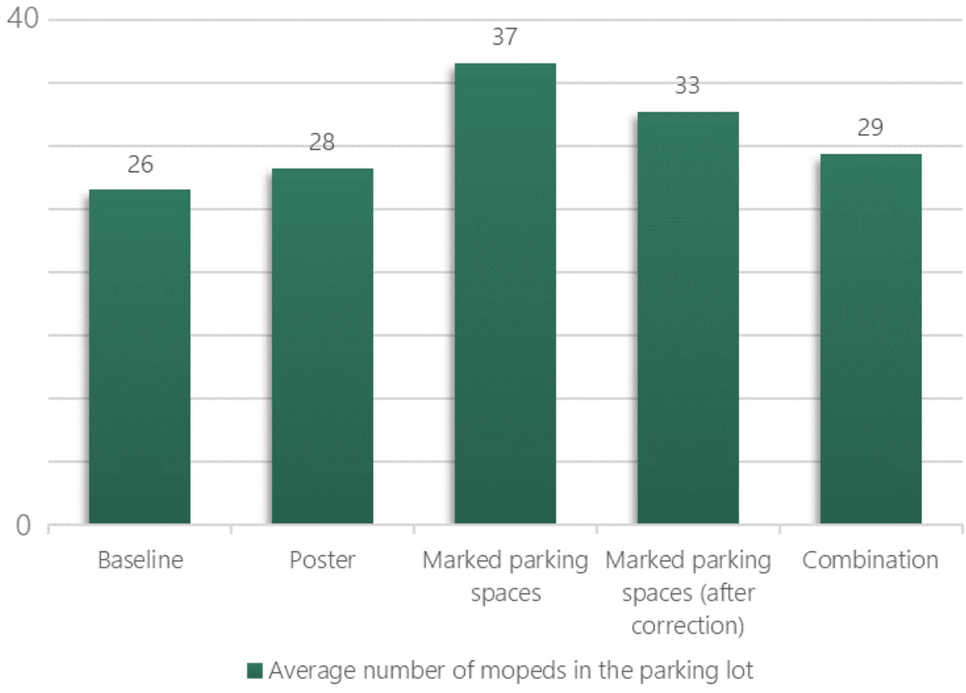
Preceding the data collection, a power calculation was performed to determine the required sample size to ensure statistical significance under the following standards. The paper of Mertens et al. (2022) includes a meta-analysis of effect sizes of different choice architecture interventions across various behavioral domains. The mentioned effect sizes of social reference and visibility interventions are respectively 0.32 and 0.36. However, since the behavioral domain can be considered prosocial and the research will include a field experiment, the effect size will be larger (Wang et al, 2021b). Therefore, the effect size of both interventions will be set to 0.41 based on presented effect sizes of Mertens et al. (2022). The significance level and the power will be set to standard values, based on Cohen (2016). This results in: $\alpha = 0.05$ and $1 - \beta = 0.80$. The degrees of freedom will be 1 as the contingency table of the corresponding data consists of 2 columns and two rows. Ultimately, based on a Chi-squared test in G*Power (Faul et al., 2009), the three different interventions require a sample size of 47 observations per group and the same holds for the baseline period. This leads to a total of 188 observations, consisting of 47 per period.

4 – Results

4.1 Summary statistics

During the total period of the experiment, 659 observations were made. 150 of these observations were made during the baseline period, 160 during the first treatment, 195 during the second treatment and 154 during the last treatment. The peak in observations during the second intervention period is due to the first day of observations, on the 16th of May, where the number of parked mopeds was higher than usual. At several points during the day, more than 60 mopeds were parked in the parking lot at the same time, with a maximum of 65. During the other intervention periods, there were never more than 52 e-mopeds present at once. The effect of this peak can also be seen in Figure 13, where the average number of mopeds in the parking lot per intervention period is indicated. While the average number of mopeds in both the baseline period and the other treatments did not exceed 30, the average number of mopeds in the parking lot during the second intervention period was 37.

***Figure 13.** The average number of mopeds in the parking lot.*



Additionally, as mentioned previously, due to the size of the parking lot, there were only 52 parking spaces created. Because the number of parked mopeds exceeded the number of parking spaces available, this led to incorrect parking of almost all (e-)moped users who arrived at the parking lot as 53rd or more. Therefore, to prevent the results from being skewed by this, a correction was made. The mopeds that were parked in the parking lot as the 53rd moped or more, were eliminated from the data. After the correction, the number of observations during the second intervention period was brought back to 168 and the total number of observations to 632.

Figure 14 shows the gender distribution of all observed moped riders during the experiment. Of all the moped drivers, 60% was male and 40% was female. In Figure 15 it is shown what percentage of both genders parked their vehicle orderly, and what percentage parked their moped disorderly. From the graph can be seen, relatively speaking, men parked their mopeds incorrectly more often: 23% of men parked their mopeds disorderly compared to 16% of women.

Figure 14. *Gender distribution of all observations .*

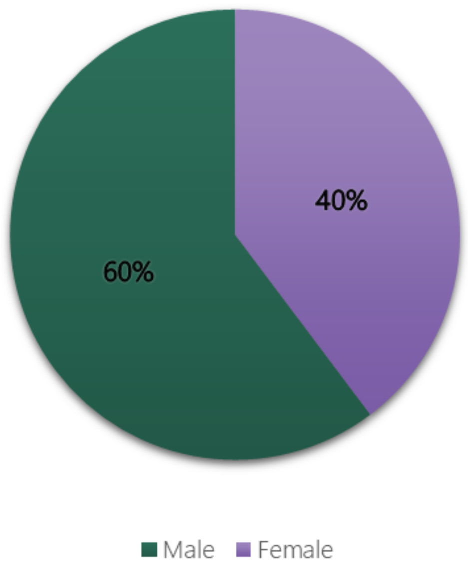
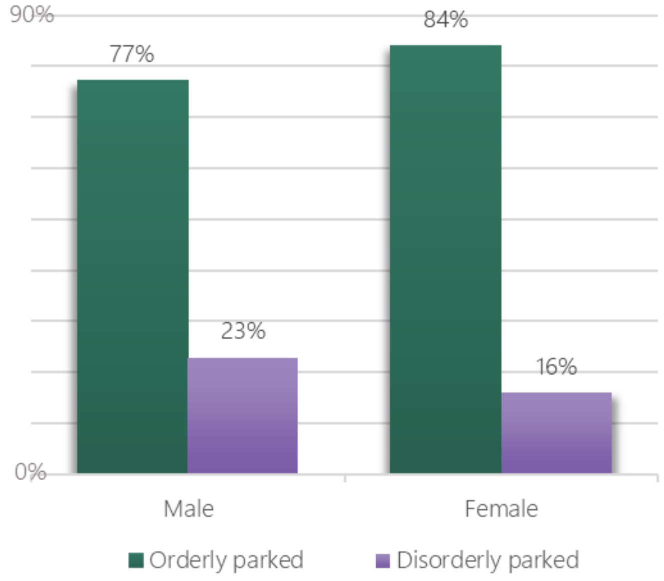


Figure 15. *Parking behavior of men and women during the entire experiment.*



In Figure 16 the distribution of the different types of mopeds can be seen. While the chosen parking area in this experiment is only intended for shared e-mopeds, many privately owned mopeds were also parked there during the experiment. Because these mopeds influence the crowds in the parking lot, they were included during the observations. Although the posters during the first and third intervention periods are specifically aimed at shared e-moped users, the parking spaces of the second intervention can also influence the parking behavior of private moped users. Eventually 48% of the observations included Check mopeds and 21% were Felyx mopeds. The remaining 31% were private mopeds, which is even a larger number than the number of observed Felyx vehicles. A summary of the parking behavior of the different types of mopeds is presented in Figure 17. The data visualized in this figure shows that the privately owned mopeds are parked correctly more often than the shared e-mopeds from Check and Felyx. The Felyx mopeds are parked incorrectly most often, almost twice as many as the shared mopeds from Check. In this experiment, 37% of Felyx drivers parked their mopeds disorderly, compared to 19% of Check drivers.

Figure 16. *Distribution of types of mopeds all observations*

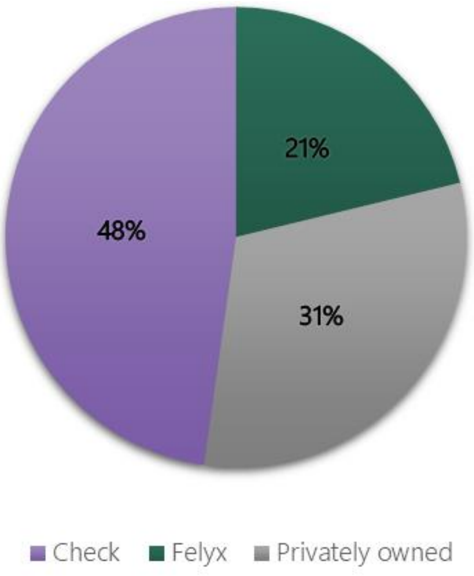
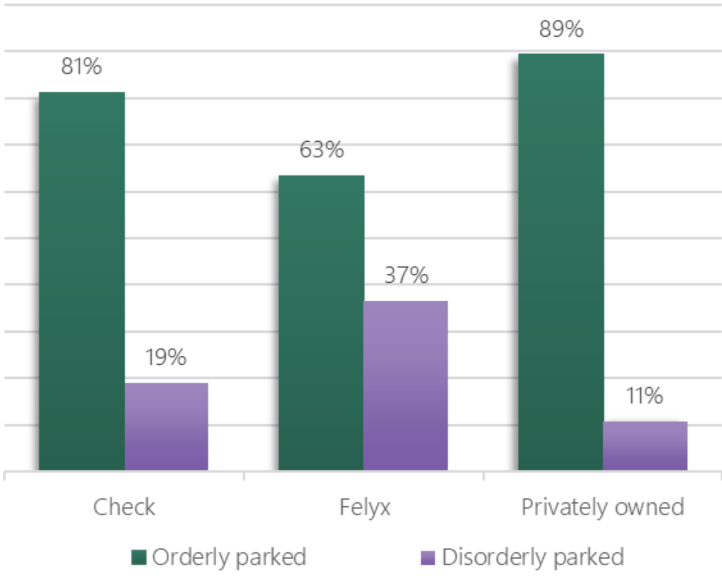
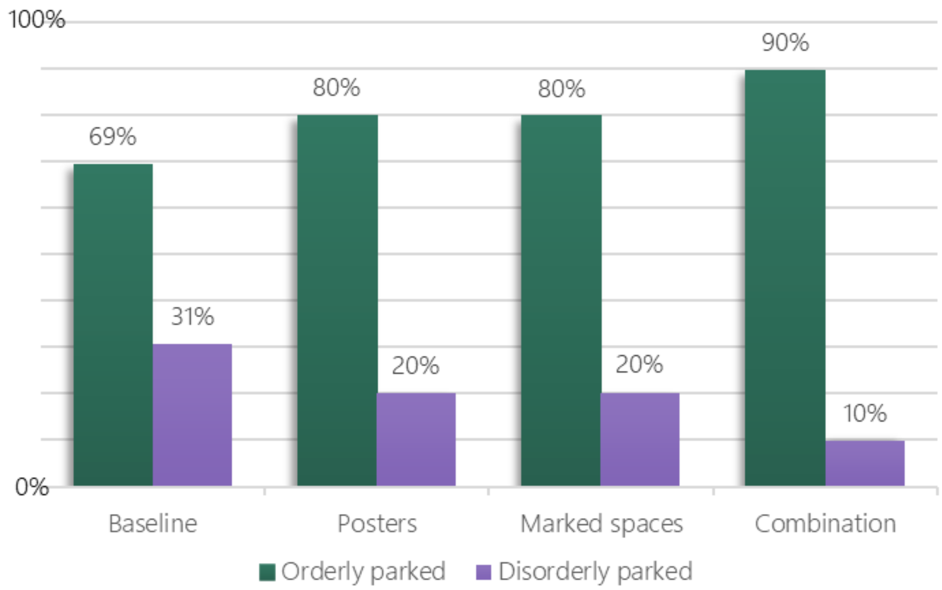


Figure 17. *Parking behavior of the users of the different during types of mopeds during the entire experiment.*



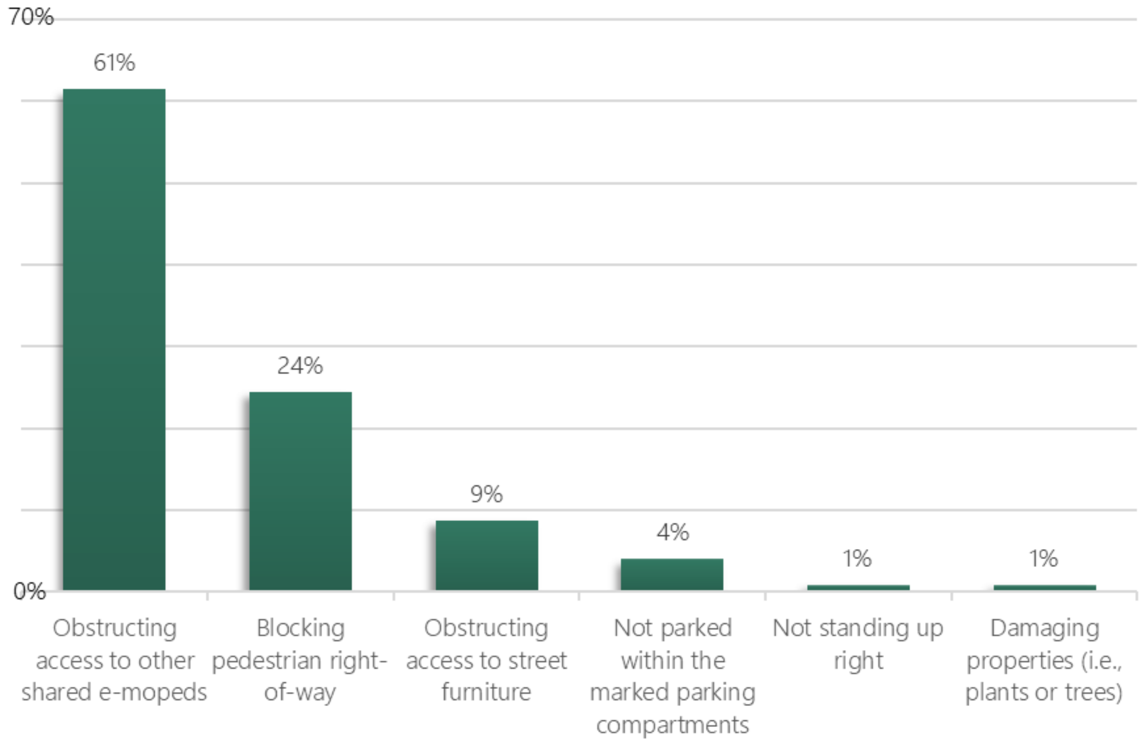
As mentioned before, this study aims to test the effect of three different interventions on the parking behavior of (shared e-) mopeds users in the assigned parking lot at the Erasmus University campus. The preliminary results of these interventions are shown in Figure 18. These initial results show that, during the absence of treatment, around one-third of the mopeds was parked incorrectly. Throughout the intervention period with descriptive social norm-posters, this number decreased with 11 percentage points. Also, during the second intervention period, when the parking spaces were marked, only one-fifth of the mopeds was parked disorderly. A combination of both treatments seems to yield the strongest results, with an incorrect parking rate of 10% during the third intervention period.

Figure 18. *The parking behavior of moped users during the different intervention periods*



In the methodology section, different situations were described in which a moped is considered to be parked incorrectly or disorderly. Figure 19 shows the different conditions that were observed during the different observation periods. In addition, this figure indicates which incorrect parking conditions occurred most often. For example, 61% of the incorrectly parked mopeds blocked access to other mopeds and 24% of the mopeds were parked blocking footpaths. Moreover, 9% of the disorderly parked mopeds blocked access to street furniture, which in this experiment generally meant that the mopeds were parked in front of sitting benches. In addition, during the last two intervention periods, several mopeds, a total of 4%, were not parked within the marked parking spaces, in a way that also made it impossible for other mopeds to do so. Lastly, during the entire experiment, one moped was leaning against a lamppost and one moped was placed on the grass.

Figure 19. *Overview of observed disorderly parking conditions.*



During the observations for this study, more data was collected, and although interesting, not all turned out to be as relevant for this research. An overview of additional and more detailed data can be found in the table of Appendix 1.

4.2 Balance test

To assess the comparability of the baseline period and the three different interventions, a balance test was conducted. The results of this balance test can be found in Table 2.

Table 2. *Balance test*

	Baseline	Treatment 1		Treatment 2		Treatment 3	
	n = 150	*n = 160*	*p-value*	*n = 168*	*p-value*	*n = 154*	*p-value*
Mopeds on the parking	26.44	28.21	*(0.314)*	32.65	*(0.000)*	29.28	*(0.072)*
Gender			*(0.804)*		*(0.129)*		*(0.516)*
Male	62.00	60.63		53.57		65.58	
Female	38.00	39.37		46.43		34.42	
Type of Moped			*(0.276)*		*(0.163)*		*(0.100)*
Check	42.00	50.00		45.83		53.25	
Felyx	27.33	20.63		18.45		18.83	
Private moped	30.67	29.37		35.72		27.92	

Note: Mopeds on the parking shows the average number, Gender and Type of moped are percentages. The table shows the diffences compared to the baseline period. The p-value of the differences are based on a Mann-Whitney U test for the number of mopeds on the parking and based on a Chi-squared test for Gender and Brand type.

Table 2 shows that most differences between the treatment groups and the baseline group are insignificant. This means that there is no reason to assume that any potential differences in the outcome of this research can be attributed to the differences between the groups. However, there is one significant difference at a 1% significance level, indicating that the number of mopeds in the parking lot during the second intervention period is significantly different from the number of mopeds in the parking lot during the baseline period. Even though this number has previously been corrected, as mentioned before, there were still significantly more mopeds present during the intervention when the parking spaces were marked. This difference needs to be taken into account when interpreting the final results.

Another difference, that is only significant at a 10% significance level, can be seen in the third treatment group. Again, the number of mopeds on the parking lot differs from the number of mopeds during the baseline period. However, this difference is only significant at a 10% significance level. The fact that the other differences between the groups are insignificant, does not mean that there are no differences between the groups. Therefore, results still need to be interpreted with caution. However, it does rule out a few alternative explanations for any potential finding or effects and therefore strengthen the validity of the research.

4.3 Chi-squared (χ^2-) test

In order to answer the research question, three hypotheses were formed in the theoretical framework. As described in the methodology, those hypotheses will be tested with help of a Chi-squared test in this section.

4.3.1 Hypothesis 1

The first hypothesis mentioned in the theoretical framework aimed to find out whether the use of posters with descriptive social norms increases the number of correctly parked e-mopeds. A Chi-squared test was performed to test the following null hypothesis:

H_0: There is no association between the use of posters with a descriptive social norm and the parking behavior of shared e-mopeds.

The test showed a significant result between the independent and the dependent variable, with $\chi^2(1) = 4.6779$ and $p = 0.031$ (Table 3). The null hypothesis can thus be rejected at a 5% significance level. This indicates that there is an association between the use of posters with descriptive social norms and the number of correctly parked e-mopeds.

Table 3. *Contingency table of Chi-squared test for Baseline and Treatment 1.*

Parking status	**Observation period**		
	Baseline	Treatment 1	Total
Parked incorrectly	46	32	**78**
Parked correctly	104	128	**232**
Total	**150**	**160**	**310**

The corresponding Cramer's V has a value of 0.1228, indicating that there is a weak to moderate statistical coherence between the found association. Based on the odds ratio it seems that the odds that moped users parked their moped correctly were 1.77 times higher when the posters with descriptive social norms were placed around the shared e-moped parking area. In other words, there was a 77% increase in the odds that mopeds were parked correctly during the first intervention period compared to the baseline period.

4.3.2 Hypothesis 2

The second hypothesis aimed to find out whether the use of clearly marked parking spaces increases the number e-mopeds parked in an orderly manner. With help of a Chi-squared test, the following null hypothesis was tested:

H_0: There is no association between the use of clearly marked parking spaces and the parking behavior of shared e-mopeds.

The test revealed $\chi^2(1) = 4.5773$ and $p = 0.032$ (Table 4), which indicates that there exists an association between the independent and the dependent variable. Again, the null hypothesis can be rejected at a 5% significance level. This result suggests that there is also an association between the use of clearly marked parking spaces and the number of correctly parked e-mopeds.

Table 4. *Contingency table of Chi-squared test for Baseline and Treatment 2.*

Parking status	**Observation period**		
	Baseline	Treatment 2	Total
Parked incorrectly	46	34	**80**
Parked correctly	104	134	**238**
Total	**150**	**168**	**318**

The corresponding Cramer's V of this result is 0.1200, indicating that the statistical coherence between the found association is slightly weaker than the previously found association. According to the odds ratio, the odds that moped users parked their moped correctly were 1.74 times higher when the parking area had marked parking spaces. This corresponds to, a 74% increase in the odds that mopeds were parked correctly during second treatment period compared to the baseline period.

4.3.3 Hypothesis 3

The third and last hypothesis of this research aims to find out whether the use of clearly marked parking spaces in combination with posters with descriptive social norms is more effective in increasing the number of correctly parked e-mopeds than using only one of these interventions. To test this hypothesis, two Chi-squared tests were performed. The first Chi-squared test assessed the following null hypothesis:

H_0: The distribution of parking behavior of shared e-mopeds is the same in the first intervention period as in the third intervention period.

The null hypothesis states there is no difference in the parking behavior when using the posters versus when using the posters in combination with the marked parking spaces. The test showed a significant result between the independent and the dependent variable, with $\chi^2(1) = 6.4898$ and $p = 0.011$ (Table 5). Therefore, the null hypothesis can be rejected at a 5% significance level. This result suggests that the distribution of parking behavior of shared e-mopeds is not the same in the first and the third intervention period. This implies that there is an association between correct parking of mopeds and a combination intervention rather than just an intervention with posters.

Table 5. Contingency table of Chi-squared test for Treatment 1 and Treatment 3.

Parking status	**Observation period**		
	Treatment 1	Treatment 3	Total
Parked incorrectly	32	15	**47**
Parked correctly	128	139	**267**
Total	**160**	**154**	**314**

The value of Cramer's V is 0.1438, showing that there is a moderate to strong coherence between the association. According to the odds ratio of 2.32, there is a 132% increase in the odds of people parking their moped correctly when there are marked parking spaces and posters descriptive statistics, then when there are only posters around the parking area.

A second Chi-squared test was conducted to test the following null hypothesis:

H_0: The distribution of parking behavior of shared e-mopeds is the same in the second intervention period as in the third intervention period.

This Chi-squared test also showed a significant result, with $\chi^2(1) = 6.8632$ and $p = 0.009$ (Table 6). Again, the null hypothesis can be rejected at a 5% significance level. According to the result the distribution of parking behavior of shared e-mopeds is not the same in the second and the third intervention period, indicating there is an association between the correct parking of mopeds and a combination intervention rather than just using clearly marked parking spaces.

Table 6. Contingency table of Chi-squared test for Treatment 2 and Treatment 3.

Parking status	**Observation period**		
	Treatment 1	Treatment 3	Total
Parked incorrectly	34	15	**49**
Parked correctly	134	139	**273**
Total	**168**	**154**	**322**

The corresponding Cramer's V of this result is 0.1460, showing that there is also a moderate to strong statistical coherence between the found association that is of somewhat the same size as the previous association. Based on the odds ratio it seems that the odds that moped users parked their moped correctly were 2.35 times higher when there were posters and marked parking spaces present at the parking area then when there were only marked parking spaces. This means there was an increase of 135% in the odds that mopeds were parked correctly during the third intervention period compared to the second period. The combined intervention seems to have a stronger effect on the parking behavior than only using posters with descriptive social norms or than using clearly marked parking spaces.

5 – Conclusion and discussion

5.1 Conclusion

This Master thesis is dedicated to answer the question whether social norms in the form of posters and visual prompts in the form of marked parking spaces can effectively influence students to park their shared e-moped in an orderly manner. In order to answer this question, three hypotheses were formed.

The first hypothesis stated that the use of posters with descriptive social norms around shared e-moped parking areas would increase the number e-mopeds parked in an orderly manner. Based on the results of a Chi-squared test it was found that there is a significant difference between the parking behavior of the observation group without treatment and the observation group where multiple posters were placed around the shared e-moped parking area. The corresponding Cramer's V of this result showed that there is a weak to moderate coherence between the use of posters with descriptive social norms and the parking behavior of moped users. Additionally, according to the odds ratio, this is a positive association, meaning that the use of the posters positively influences the parking behavior of the moped users. There was a 77% increase in the odds that mopeds were parked correctly during the first intervention period compared to the baseline period. All in all, it can be concluded that the use of posters with descriptive social norms indeed seems to effectively influence the number of shared e-mopeds that were parked correctly.

The second hypothesis concerns that the use of clearly marked parking spaces present at shared e-moped parking area, increases the number of e-mopeds parked correctly. The results of a Chi-squared test showed a significant difference between the parking behavior during the baseline period and the parking behavior during the period when there were clearly marked parking spaces present. The Cramer's V indicates that there is a weak to moderate coherence between the use of marked parking spaces and the number of correctly parked e-mopeds. The association between the use marked parking spaces and the correctly parked mopeds is a positive one according to the odds ratio. Based on the odds ratio there a 74% increase in the odds that mopeds were parked correctly during second treatment period compared to the baseline period. Similar to the previous hypothesis, there can be concluded that the use of marked parking spaces at the parking area seem to effectively influence the number of correctly parked e-mopeds. However, the balance test that was performed prior to the analysis showed that the number of mopeds present at the parking area was significantly different between the baseline measurement and the second intervention. This may distort the observed association and therefore, these results need to be interpreted with caution.

The last hypothesis aimed to see whether the formerly mentioned interventions could reinforce each other and stated that the use of marked parking spaces in combination with posters with descriptive social norms is a more effective way of encouraging users to park in an orderly manner than using either one of these interventions. In order to answer this hypothesis two Chi-squared tests were conducted. The results of the first Chi-squared test showed that there was a significant difference in distribution of the correctly parked mopeds during the first intervention period and the second intervention period. This result indicates that there is a positive association between the combination of the use of posters and the use of clearly marked parking spaces, and the number of correctly parked e-mopeds, compared to the solely use of posters. The corresponding Cramer's V shows that there is a moderate to strong coherence between this association. The odds ratio shows there is a positive association; there is a 132% increase in the odds of people parking their moped correctly when there are marked parking spaces and posters descriptive statistics, compared to when there are only posters present at the parking area.

The results of the second Chi-squared test show a similar result. The results indicate that there is an association between the correct parking of mopeds and a combination intervention, rather than just using clearly marked parking spaces. The Cramer's V of this test shows that there is also a moderate to strong coherence between this found association. According to the odds ratio, the odds that moped users parked their moped correctly were 2.35 times higher when there were posters and marker parking spaces at the parking area, then when there were only marked parking spaces. Based on these results it can be concluded that it is likely that a combination of the first two interventions is indeed more effective in encouraging shared e-moped users to park in an orderly manner. However, because the balance test showed that the number of mopeds present at the parking area was significantly different during the second intervention and the third intervention period, this can distort the observed associations and therefore the results need to be interpreted with caution.

It is important to note is that all the conclusions above should be interpreted with extra caution since the hypotheses are referring to the parking behavior of shared e-mopeds, but the obtained data also involved the parking behavior of privately owned mopeds.

Based on the conclusions of the three hypothesis that were answered in this research, an answer can be given to the main research question:

Can social norms and visual prompts effectively influence students to park their shared e-moped in an orderly manner?

Both the posters (with social norms) as the marked parking spaces (visual prompts) seemed to have a significantly positive effect on the parking behavior of the (shared e-) moped users who parked their moped at one of the parking areas on the campus of the Erasmus University. Therefore, an affirmative answer can be given to this question. Moreover, a combination of these two nudges seems to enhance the positive effect on the parking behavior.

5.2 Discussion

The findings presented in this study are in line with the expected results based on the literature. The posters with descriptive social norms used during the first intervention period appear to have a positive relationship with correct parking behavior of e-moped riders. Overall, studies show that descriptive social norms can stimulate individuals to behave in a more socially beneficial way and increase desirable behavior (Kormos et al., 2015; Wang et al., 2021c). This corresponds with the results found in the studies more related to by Wang et al. (2021a; 2021b), who which is more specifically related to parking behavior, also found similar results: descriptive social norms played a significant, positive role in influencing the parking behavior of bike-share users.

The second intervention yield similar results, which are also in accordance with expectations based on existing literature. Several studies show that visual prompts can also effectively improve the desired behavior, such as an increase the use of seatbelts and decrease cell phone use behind the wheel (Geller et al., 1985; Cope et al., 1991; Huybers et al., 2004; Clayton et al., 2006). The desired behavior in this thesis was orderly parking and there was found a positive association between the use of visual prompts, marked parking spaces, and correct parking.

Lastly, several studies show that visual prompts can also be effectively combined with other nudges in attempt to further improve the effect of influencing behavior to the desired behavior (Manstead & Lee, 1979; Yi et al., 2022; Lotti et al., 2023). In this research a visual prompt was used in combination with a descriptive social nudge which indeed seems to have a more positive effect on the parking behavior of students than when only using one of the two interventions.

5.2.1 Implications

The results from this research show how different interventions may have an effect on the parking behavior of shared e-moped users. Since the experiment took place at the campus of Erasmus University, the conclusions from this research can be useful for the University as support in deciding on how to structure their shared e-moped parking areas in the (near) future.

This study also contributed to the existing literature because it looked at the parking behavior of a very specific but rapidly emerging market, where most current comparable studies mainly look at the parking behavior of shared bicycles or shared scooters. There is not much literature available yet on the parking behavior of shared e-moped users, thus this research can serve as a steppingstone for future researchers investigating a similar topic. Additionally, since the parking of these shared e-mopeds cause a lot of problems in different cities, this research might also be useful for municipalities, like Rotterdam, that want to tackle these issues (AD, 2021).

Lastly this research might also be insightful for the suppliers of shared e-mopeds like Check and Felyx. Figure 17 showed that a larger percentage of Felyx users tend to park their e-moped incorrectly, compared to the users of Check. This might be because of how the suppliers themselves deal with the parking behavior of their users in their apps (Felyx, n.d.; Check, n.d.). If the same results are found in future experiments, it might be a reason for Felyx to change their vision and approach to combat the disorderly parking behavior of their users.

5.2.2 Limitations

A major limitation of this research is the possibility that the independence assumption that is required for performing a Chi-squared, and many other statistical tests, is violated. According to the independence assumption, observations need to be independent of each other (McHugh, 2013). This means that the parking behavior of an individual during one of the observation periods cannot be influenced by the behavior of another individual (whether in another period or not). For this research it was assumed that the assumptions were met, however, there is a high possibility that the same individuals parked their e-mopeds multiple times during the experiment. This would mean that the independence assumption has been violated. This would also create another problem, namely the possibility of a learning effect. If subjects parked their moped multiple times during the experiment, it is possible that they learned that it was beneficial to park their moped neatly. This could for instance have affected the behavior of the moped users during the intervention period, as the marked parking spaces were not removed in between the second and third intervention period.

As mentioned before, many privately owned mopeds were parked as well on the parking area that is initially meant for shared e-mopeds during the experiment. This might also have influenced the results, since the research is mainly focused on shared e-mopeds. For example, in Figure 17 it can be seen that only 11% of the privately owned mopeds were parked incorrectly. This number differs from the number of incorrectly parked shared e-mopeds, which is higher for both e-moped brands, being 19% for Check and 37% for Felyx respectively. The reason for this lower number of incorrectly parked private mopeds might be dependent on the fact that those mopeds are not shared, but someone's property. When drawing conclusions from this research, this is something that needs to be considered.

Another possible limitation of this research is the design of the parking area during the second and third intervention period. The marked parking spaces were adjusted to the available area, but due to the greenery and other present street furniture, the dimensions of the marked parking spaces might not have been optimal. Especially the parking spaces between the pieces of greenery were quite long, which still caused a lot of double parking, even though the mopeds stayed within the marked lines.

From the balance test it became clear that the number of mopeds on the parking lot was significantly different between two treatment groups. The fact that the balance test was significant, causes problems when interpretating the results, since the found associations can now not be fully attributed to the intervention, but might also be caused by the difference between groups. During the second intervention period, the number of e-mopeds exceeded the number of available marked parking spaces at a certain point, which led to incorrect parking of all the mopeds parking from that point on. Because this number of mopeds in the parking area was never reached during the other intervention periods, it is hard to say what the parking situation would have been if that situation would have occurred. If the parking situation would have been worse than the observed situation during the second treatment period, the effect of marked parking spaces might be underestimated.

Lastly, it is possible that other, unobserved circumstances or events have had an effect on the found association. Despite the fact that circumstances have been kept the same as much as possible, differences in circumstances can never be completely avoided. For example, it is difficult to predict which days in the school year are busy for many students, which means that the bustle on campus can unexpectedly increase compared to other days. In addition, although observations have never been made during days when it rained, effects such as temperature also may have played a role. There may be many potentials, unobserved circumstances that effect the parking behavior of e-mopeds. This can be a cause for omitted variable bias and must be considered when interpreting these results.

5.2.3 Future Research

The limitations of this research also provide opportunities for future research. Future experiments can be carried out on different designated shared e-moped parking areas to be able to compare them. This way other possible effects on parking behavior can be identified and investigated. This can also include looking at parking areas in different cities or in different regions to get a more complete picture of parking behavior among all shared e-moped users, not just students. During these experiments it might be useful to keep the number of mopeds on the parking between a certain range. Additionally, it is important to make sure that individuals do not appear multiple times in the same samples or appear in different samples of the experiment, to be able to meet all required assumptions for statistical tests.

Additionally, future research can focus on the long-term effects of the interventions used in this experiment, to see whether posters with descriptive social norms or marked parking spaces still have a positive effect on the parking behavior of e-moped users in the long run.

Future research can also concentrate on designing parking areas especially for shared e-mopeds. It can be examined which designs work optimally to influence parking behavior. In addition, there could be cooperation with suppliers of e-scooter companies to see how the service areas can be optimized. For example, more small parking areas could be created instead of large service areas where parking is possible everywhere, in order to limit the parking nuisance for local residents of these scooters. In addition, it could be examined whether it is possible to work with maximum limits for shared e-moped parking areas. These limits can make it impossible to park your moped somewhere if the maximum number of mopeds allowed in the parking lot has been reached.

Lastly, future research can also focus on the difference in parking behavior of the different brands of e-mopeds. Parking behavior can then be approached from a different angle, and in this way, it can be seen what works best to make users more aware of their parking behavior.

5.2.4 Recommendations

In conclusion, it is advisable for the university to provide the parking space for shared e-mopeds with marked parking spaces. In addition, posters with descriptive social norms also seem to have a positive influence on parking behavior among students. However, it might be better to use another layout for the parking area to allocate the parking spaces or to use other dimensions for the parking spaces itself, in order to optimize the positive parking behavior.

Additionally, it might also be helpful to optimally make use of the parking space that is intended for privately owned mopeds, located 20 meters to the right of the shared e-moped parking lot. In this parking area it is not possible for shared e-mopeds to park, as it falls outside their service area. Since the number of mopeds in the shared e-moped parking lot seems to have an effect on the parking behavior of mopeds, it might be beneficial to tempt users of their private moped to park there. Currently this parking lot is not used as much by private moped owners as the shared parking lot, as can be seen in the table of Appendix A. By alluring private moped users to park at the assigned private moped parking area, crowds in the shared e-moped parking lot can be reduced, which may result in less disorderly parking behavior.

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Appendix

Appendix A – Additional table of summary statistics

	Baseline	Treatment 1	Treatment 2	Treatment 2 *(after correction)*	Treatment 3
	N = 150	*N = 160*	*N = 195*	*N = 168*	*N = 154*
Totel period					
Average number of mopeds	26	28	37	33	29
Minimum number of mopeds	2	6	4	4	7
Maximum number of mopeds	45	52	65	52	52
First day of observations	*n = 53*	*n = 50*	*n = 78*	*n = 51*	*n = 50*
Average number of mopeds	31	23	40	28	29
Minimum number of mopeds	9	8	4	4	8
Maximum number of mopeds	45	38	65	52	46
Second day of observations	*n = 43*	*n = 55*	*n = 64*	*n = 64*	*n = 43*
Average number of mopeds	23	30	36	36	25
Minimum number of mopeds	4	8	10	10	7
Maximum number of mopeds	42	43	52	52	38
Third day of observations	*n = 54*	*n = 55*	*n = 54*	*n = 53*	*n = 61*
Average number of mopeds	24	31	32	32	33
Minimum number of mopeds	2	6	10	10	7
Maximum number of mopeds	42	52	46	46	52
Disorderly parking conditions					
Obstructing access to other shared e-mopeds	30	19	27	19	10
Blocking pedestrian right-of-way	9	7	12	12	3
Obstructing access to street furniture	6	5	4	0	0
Not parked within the marked parking compartments	0	0	5	3	2
Not standing up right	1	0	0	0	0
Damaging properties	0	1	0	0	0
Total	**46**	**32**	**48**	**34**	**15**
Gender					
Male	93	97	107	90	101
%	*0,62*	*0,61*	*0,55*	*0,54*	*0,66*
Female	57	63	88	78	53
%	*0,38*	*0,39*	*0,45*	*0,46*	*0,34*
Brand					
Check	63	80	87	77	82
%	*0,42*	*0,50*	*0,45*	*0,46*	*0,53*
Felyx	41	33	37	31	29
%	*0,27*	*0,21*	*0,19*	*0,18*	*0,19*
Private moped	46	47	71	60	43
%	*0,31*	*0,29*	*0,36*	*0,36*	*0,28*
Time					
First quarter	29	38	46	35	34
Second quarter	29	33	41	35	28
Thrid quarter	32	36	43	41	36
Fourth quarter	60	53	65	57	56
Private moped parking					
Average number of mopeds	4	6	2	2	4
Minimum number of mopeds	0	0	0	0	0
Maximum number of mopeds	9	11	8	8	10

Note: Treatment 2 *(after correction)* refers to the correction made to the data as described in the results section. Time is in quarters of an hour e.g. quarter 1 is the first 15 minutes of an hour